AGENDA

FLORIDA GREENBOOK ADVISORY COMMITTEE MEETING

Wednesday, April 13, 2016, 8:00 AM – 4:30 PM

Thursday, April 14, 2016, 8:30 AM – 11:30 PM

FDOT's Deland Operations Center, Sailfish Meeting Room
1650 N. Kepler Road
Deland, Florida 32724

Below is the Go-To-Meeting information if you are not able to attend in person.
https://global.gotomeeting.com/join/679916525
Dial +1 (408) 650-3123
Access Code: 679-916-525
Audio PIN: Shown after joining the meeting

Wednesday, April 13, 2016

8:00 – 8:30 Introductions and General Information

- Welcome and Introductions (Michael Shepard)
- Handouts and Green Ring Binders
- Committee and Associate Member Changes (Mary Anne Koos)
- January 2016 Meeting Minutes & Approval (Mary Anne Koos)
- Contact Information, Subcommittee Assignments, Chapter Chair Opportunities (Mary Anne Koos)
- Rulemaking Status of 2016 Greenbook (Mary Anne Koos)

8:30 – 9:45 Presentation of Proposed Revisions for 2018 Greenbook

- Chapter 1 – Planning (Rick Hall)
- Chapter 2 – Land Development (Margaret Smith)
- Introduction and Chapter 3 – Geometric Design (Howard Webb)

9:45 – 10:00 ***Morning Break***

10:00 – 11:00 Subcommittee Meetings for Final Drafting of Proposed 2018 Revisions

- Chapter 1 and 2 – Planning (Rick Hall, Blue Marlin) and Land Development (Margaret Smith, Blue Marlin)
- Introduction and Chapter 3 – Geometric Design (Howard Webb, Sailfish)

11:00 - 12:00 Chapter Report and Vote on 2018 Chapter Revisions

- Introduction and Chapter 3 – Geometric Design (Howard Webb)

12:00 – 1:30 ***Lunch***

1:30 – 3:30 Chapter Report and Vote on 2018 Chapter Revisions

- Chapter 1 – Planning (Rick Hall)
- Chapter 2 – Land Development (Margaret Smith)

3:00 – 3:15 *Afternoon Break*

3:15 – 4:30 Presentation of Proposed Revisions and Vote for 2018 Greenbook

- Chapter 14 – Design Exceptions (Ramon Gavarrete)

4:30 *Adjourn*

Thursday, April 14, 2016

8:30 – 9:00 Future Greenbook Revisions

- Parking Lot Topics Discussion (Michael Shepard)
- Future Revisions Needed for Clear Zone and Lateral Offset
- Goals and Selection of Chapters for Future Work (Michael Shepard)

9:00 – 9:30 Presentation on Reduced Speed Zone Criteria

- Revisions to Speed Zoning Manual (Alan El-Urfali)

9:30 – 9:45 Break

9:45 - 10:30 Breakout Sessions for Future Greenbook Revisions

- Chapter ______________ (Sailfish, Mary Anne)
- Chapter ______________ (Sailfish, Mary Jane)
- Chapter ______________ (Blue Marlin, Jeremy)
- Chapter ______________ (Sailfish, Paul)
- Chapter ______________ (Dolphin, Alan)
- Chapter ______________ (Sailfish, Michael)

10:30 – 11:15 Chapter Chair Reports for Future Greenbook Revisions and Discussion

11:15 – 11:30 Closing Remarks (Michael Shepard)

11:30 *Adjourn*

Note – There is no registration fee to attend and no meals are provided.

Minutes (Approved)

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Wednesday, April 13, 2016

Attendance

The following members, associate members, Department staff, technical advisors and public were in attendance, either in-person or remotely via Go-To-Meeting.

- **Members**

  Milton Martinez, John Veilleux, Kathy Thomas, Howard Webb, Robert Behar, Charles Ramdatt, Gail Woods, Annette Brennan, George Webb, Ramon Gavarrete, Chris Tavella, Andy Tilton, Jared Perdue, Andy Garganta, Gaspar Miranda, Juvenal Santana, Richard Moss, Bernie Masing, Richard Baier, Steve Neff, Margaret Smith, Rick Hall; Gene Howerton, Richard Diaz

- **Associate Members**

  Fred Schneider, Mark Massaro, David F. Kuhlman

- **FDOT Staff, Technical Advisors and Public**

  Tim Lattner, Michael Shepard, Mary Anne Koos, Mary Jane Hayden, Paul Hiers, Alan El-Urfali, Gail Holley, Frank Yokiel, Susan Ussach, Jeremy Crowe, Christine Lofye, Kevin Miller, Jeremy Fletcher, Gabe Matthews, Regina Colson, Maria Cahill

General Information

- **Welcome and Introductions (Michael Shepard & Mary Anne Koos)**

  Florida Greenbook Committee and Associate Member Changes - Changes in membership for the Greenbook Committee were discussed and a new member, John Veilleux, City of Gainesville (urban local government for District 2) was introduced. Mr. Veilleux replaces Dave Cerlanek, who is now working for FDOT. Ramon Gavarrete will be leaving Highlands County in May to join Alachua County's Public Works Department, and will transition from a voting Committee member to an Associate member. He was thanked for his leadership as chair of Chapter 14 – Design Exceptions and for his years of service.

Regina Colson joined as the Technical Advisor for Chapter 1 – Planning. Maria Cahill, the Technical Advisor for Chapter 2 – Land Development, is now the Director, Florida Transportation Technology Transfer Center at the University of Florida Transportation Institute. Ms. Cahill will continue supporting the work of the Florida Greenbook Committee.

- **Review Contact Information (Mary Anne Koos)**

The Committee Membership list was circulated for everyone to update their contact information.

- **Update Subcommittee Assignments (Mary Anne Koos)**

The list of current chairs for the chapter subcommittees was reviewed, and chair assignments updated. Richard Moss indicated an interest in serving as the chair of Chapter 14 when it becomes vacant. Members also updated their subcommittee membership preferences.

- **Review January 2016 Meeting Minutes (Mary Anne Koos)**

The draft minutes were sent electronically on March 31, 2016 to all members for comment. No revisions were requested and the minutes are considered approved.

- **Rulemaking**

The 2016 Florida Greenbook (Draft) has been submitted for rulemaking to FDOT's General Counsel Office. The version in the green 3-ring binder that committee members received in January has been updated slightly. The revised version was e-mailed in conjunction with the draft minutes. In addition, a modification is proposed for the 2016 draft regarding Design Speed and will be discussed later in the morning.

- **Sunshine Law**

Ms. Koos reminded the committee that we are required to follow Florida's Sunshine law requirements. All discussion between voting members must be conducted in a public meeting.

Presentation of Proposed Revisions for Chapter 3, 2016 and 2018 Florida Greenbook

All revisions shown today, except for the table on design speed in Chapter 3, are for revisions to the 2018 Greenbook Edition. The meeting package includes the revisions that will be discussed today and can be added to the ring binders as an update to the chapters. Ms. Koos reviewed the color-coding of the text for the group. Green-highlighted text has already been approved by the Committee in previous meetings. Yellow are notes that will be deleted in the final format or are areas that need follow up discussion.

- **Chapter 1 – Planning (Rick Hall)**

  Mary Anne Koos presented the proposed changes to the chapter, as shown in the draft dated April 6, 2016.

  - Section B.2.a Basic Classification was edited to be based on land use, and a reference to FHWA’s Highway Functional Classification Concepts, Criteria and Procedures, 2013 Edition was added. The terminology was updated to match the Introduction definitions and there was agreement to reorganize as Arterial, Collector and Local subsections to follow the same order used in tables elsewhere.

  - Section B.2.b Classification Modifications was updated to reflect land use and context and a reference to the 21st Century Land Development Code, which links land use to transportation corridors, was added. Table 1-1 Functional Classification Modifications was added as an example of how functional classification and land use can be linked. A narrative was added to define rural versus urban in terms of land use, not presence of curb and gutter. References to other Greenbook chapters that support context-based design were added.

  - References section was updated.

- **Chapter 2 – Land Development (Margaret Smith)**

  Mary Anne Koos presented the proposed changes to the chapter, as shown in the draft dated April 6, 2016.

  - Section A Introduction was edited to update language and be more positive. Context-based street design was introduced: streets are sized and scaled to accurately serve all road users. The first sentence of page 2-2 was revised to read “creation of high quality networks.”

  - Section B Objectives was updated to be more grammatically correct and current. George Webb questioned what the bullet on “economic design” means. This bullet will be edited in the breakout session.

- Section C 1 Development Types and Area Types was added to describe the following development patterns – Conventional Suburban, Traditional Neighborhood Design (TND), Transit-Oriented Design (TOD). References to APA's 21st Century Land Development Code and the Department's Traditional Neighborhood Development Handbook were added. The term "rethinks" was revised to "examines".

- Section C.2 Network Design will be reviewed in the breakout section to review the 6th bullet, which addresses posted speed. A suggestion was made for the bullet on roundabouts to add the full reference for NCHRP 672 and include a reference to Chapter 15 – Traffic Calming. The bullet on one-way streets was revised to remove "local" and add "highways". The bullet on vehicle speeds was revised to remove "local" and to replace "limit" with "promote safe".

- Section D Coordination was edited to remove "Conflict" from the title. A paragraph was added to provide information on the Florida Metropolitan Planning Organization Advisory Council since they can be a valuable resource in managing land development.

- Section E.2 was revised from "Police Power" to "Regulatory Authority".

- Section F References was added to the Chapter.

- Mark Massaro asked whether language regarding Road Diets was needed. Committee will consider discussing tomorrow when they talk about future revisions.

- **Introduction – (Howard Webb)**

Howard Webb and Mary Anne Koos presented the proposed changes to the Introduction, as shown in the draft dated April 7, 2016.

- Section 336.045(2), F.S. was added to the narrative to clarify how membership is established.

- Information on the how the Greenbook criteria apply to the National Highway System was added, along with a link to maps showing the system.

- Paragraph describing how the standards in the Greenbook are applied to different types of projects, new construction, reconstruction, and resurfacing was revised. Guidance on Chapter 10 – Maintenance and Resurfacing and Chapter 14 – Design Exceptions apply was added. The Committee requested that a definition for "reconstruction" be developed for the Definition of Terms section.

- Clear Zone – the definition was revised to be consistent with AASHTO.

- The term Horizontal Clearance was revised to Lateral Offset, and the definition revised to be consistent with AASHTO.

- **Chapter 3 – Geometric Design (Howard Webb)**

Mary Anne Koos requested the Committee review two proposed changes for the **2016 Greenbook,** as shown in the draft dated April 7, 2016**.** The changes affect Table 3 – 1 Recommended Design Speed and Table 3 – 5 Horizontal Curvature.

- Table 3 – 1 Recommended Design Speed - Ms. Koos explained that the revisions made during the January 2016 meeting by the Committee fall outside the limits suggested by AASHTO. A revised Table 3 – 1 was presented that includes terrain as a factor to be considered when selecting design speed and is consistent with the limits in the AASHTO Greenbook. The Committee voted unanimously to accept the revised table.

- Table 3 – 5 Horizontal Curvature - Ms. Hayden explained the values have been added for 20 and 25 mph for HSO, which had been requested at the January meeting. These values are based on 2004 AASHTO friction values (to match the rest of the table). This table, and the associated figures, will need to be updated for 2018 since the friction factors changed in 2011 AASHTO. The Committee agreed with this revision.

Howard Webb and Mary Anne Koos then presented the proposed revisions for the **2018 Greenbook**, as shown in the draft dated April 7, 2016.

- Section C.7.d Sidewalks was revised to include references to additional design criteria found in Section C.10.a.3 – Sidewalks and Curb Ramps of this chapter, Chapter 8 - Pedestrian Facilities, AASHTO's Guide for the Planning, Design and Operation of Pedestrian Facilities (2004), and Section 4.17.1 Sidewalks of AASHTO's Policy on Geometric Design of Highways and Streets (2011).

- Section C.7.f Islands was added. It includes criteria for three types of islands – Channelizing, Divisional, and Refuge. Information on the purpose, location, and dimensions is included. References to the AASHTO Greenbook, AASHTO Roadside Design Guide, MUTCD, and Design Standards were included.

- Figure 3-9 General Types and Shapes of Islands and Medians has an arrow pointing in the wrong direction and will need to be revised.

- Figure 3-13 Pedestrian Refuge Island shows the pedestrian crossing warning sign on the far side of the crosswalk and should be replaced.

- Section C.7.g. Roadside Clear Zone and Lateral Offset was revised to include two sub sections, Clear Zone and Lateral Offset.

- Section C.7.g.1 Clear Zone was rewritten to clarify the purpose, location, and width of clear zones. The type of slopes were classified, and references to when additional clear zone width or protection should be included in the design.

- Table 3 – 15 Minimum Width of Clear Zone was added, with values consistent with AASHTO criteria. The footnotes in the Table apply to very low volume roads and may be developed as their own section or table for discussion at the 2017 meeting of the Greenbook Committee.

- Figure 3 – 14 Clear Zone Plan View, Figure 3 – 15 Basic Clear Zone Concept and Figure 3 – 16 Adjusted Clear Zone Concept were added.

- Figure 3 – 17 Roadside Ditches – Bottom Width 0 to 4 feet and Figure 3 – 18 Roadside Ditches Bottom Width ≥ 4 Feet were added.

- Section C.7.g.2 Lateral Offset was added. This is a new section that provides lateral offset requirements for roadside features and fixed objects.

- Table 3 – 16 Lateral Offset was added, and provides offset values for above ground fixed objects and drop off hazards, consistent with AASHTO criteria. For water bodies and canal hazards, the table references Chapter 4 – Roadside Design of the Florida Greenbook for criteria.

- Section C.7.g.3 Roadside Slopes was revised to encourage flatter slopes (1:6) but continues to allow for a 1:4 slope. Conditions were included for slopes as steep as 1:3, and references made to Figures 3 – 17 and 3 – 18.

Subcommittee Meetings for Final Drafting of 2018 Revisions

Rather than breaking out into subcommittees to address comments from the morning's chapter presentations on Chapters 1 and 2, the full committee decided to work together on finalizing the Introduction and Chapter 3 – Geometric Design.

- **Introduction (Howard Webb)**

  - Reconstruction – The definition was revised, based upon FHWA's definition. It now reads "Reconstruction is defined as streets and highways that are rebuilt primarily along existing alignment. Reconstruction normally involves full-depth pavement replacement. Other work that would fall into the category of reconstruction would be adding lanes adjacent to an existing alignment, changing the fundamental character of the roadway (e.g., converting a two-lane highway to a multi-lane divided arterial) or reconfiguring intersections and interchanges.'

  - Border Area – The committee requested a definition for border area be added that would identify all the elements that are part of the "border".

- **Chapter 3 – Geometric Design (Howard Webb)**

  - Section C.7.f Islands was revised regarding the placement of mast arms in islands and medians. The third sentence in the second paragraph was revised to read "While mast arms are discouraged in channelizing islands, when they are used the minimum lateral offset as shown in Table 3 – 16 Lateral Offset shall be provided." The last sentence "Mast arms shall not be placed in medians." was moved to C.7.e Medians. The final placement will be worked out for 2018.

  - Section C.7.f.1 was revised to move a portion of the fourth paragraph regarding lateral offset to Section C.7.f. The remainder was deleted. The last sentence of second paragraph was updated to use correct terminology (flush shoulder, not rural, and streets and highways, not area).

  - Figure 3 – 13 should be revised to use either photos or drawings which correctly illustrate the pavement markings and signage to be included at pedestrian crossings in conjunction with a refuge island. Examples of both yield and stop conditions should be included. The revised Figure should be brought back to the Committee for approval in 2017.

  - Table 3 – 5 Horizontal Curves is based on emax = 0.10, which doesn't seem to make sense and also doesn't appear to match Figure 3 – 4 Stopping Sight Distance on Curves. Committee decided to review all of the tables, figures, and calculations for 2018 to ensure consistency with the 2011 AASHTO Greenbook.

  - Section C.7.g.1 should include information on what is considered to be an "obstruction" for lateral clearance and clear zone. Provide guidance on acceptable curb heights.

  - The illustrations accompanying Table 3 – 22 Minimum Acceleration Lengths for Entrance Terminals, as an example, should be reviewed to remove specific lane width callouts. This would be proactive in supporting Complete Streets and allow flexibility. All the figures and tables should be reviewed for lane width and other unintended dimensions.

Chapter Report and Vote on 2018 Chapter Revisions

The Committee reconvened for a final review and adoption of the proposed revisions to the Introduction and Chapter 3 – Geometric Design.

- **Introduction**

  - Mr. Webb gave a summary of the proposed changes, including the revised definitions for Clear Zone, Lateral Offset, and Reconstruction.

- A motion was made by Howard Webb to approve the changes, seconded by Richard Baier. The changes were approved unanimously.

- **Chapter 3 – Geometric Design**
  - Mr. Webb gave a summary of the proposed changes, including the expanded references to sidewalk design criteria, new sections for islands, roadside clear zone and lateral offset, and revised section for roadside slopes. The entire Greenbook should be reviewed for consistency with 2011 AASHTO Greenbook values. Existing figures and illustrations will be reviewed to remove unnecessary geometric design requirements such as lane width to ensure flexibility.
  - Moved by Howard Webb to approve the changes, seconded by Richard Baier. The changes were approved unanimously.

The Committee reconvened after lunch for a final review and adoption of the proposed revisions to Chapter 1 – Planning and Chapter 2 – Land Development.

- **Chapter 1 – Planning**
  - Rick Hall and Ms. Koos gave a summary of the proposed changes, including update of Classification Modifications to reflect land use and context, and new references to FHWA's Highway Functional Classification Concepts, Criteria and Procedures, 2013 Edition and APA's 21st Century Land Development Code.
  - Moved by Andy Tilton to approve the changes, seconded by Gail Woods. The changes were approved unanimously.

- **Chapter 2 – Land Development**
  - Margaret Smith and Ms. Koos gave a summary of the proposed changes, including an introduction of Context-based street design. A section describing a variety of development patterns was added, and included Conventional Suburban, Traditional Neighborhood Design (TND), and Transit-Oriented Design (TOD). Information on the Florida Metropolitan Planning Organization Advisory Council (MPOAC) was added, along with a new reference section.
  - Moved by Rick Hall to approve the changes, seconded by Andy Garganta. The changes were approved unanimously.

Presentation of Proposed Revisions for 2018 Florida Greenbook and Vote on Chapter Revisions (continued)

Ramon Gavarrete and Mary Anne Koos presented the proposed changes to Chapter 14 – Design Exceptions, as shown in the draft dated April 7, 2016.

- **Chapter 14 – Design Exceptions (Ramon Gavarrete)**
    - Section A General and Section B Design Exceptions (old numbering) were merged to highlight the 13 AASHTO controlling elements and streamline the information. A fourth paragraph was added regarding the documentation needed when proposed design elements, other than the 13 controlling elements do not meet the criteria contained in the Florida Greenbook.
    - Section B Recommendations for Approval of Design Exceptions was revised to clarify that processing of exceptions that involve a state or federal facility must be processed through the Department's district office and follow the process given in Chapter 23 of the PPM, Volume 1.
    - Section C Coordination of Design Exceptions was expanded to clarify that the Department will only be involved if the proposed project on a local road is part of a Department project.
    - Section D Justification and Documentation of Design Exceptions added a reference to FHWA's Mitigation Strategies for Design Exceptions and Chapter 23 of the PPM, Volume 1 for information on benefit/cost analysis.
    - The committee discussed whether further guidance is needed for documentation of deviations from criteria other than the 13 controlling elements identified by AASHTO. Do engineering ethics and professional standards guide engineers sufficiently? Some members felt that it was beneficial to clarify expectations of documentation. The committee agreed the chapter will need further work once FHWA revises its guidance on the 13 controlling elements.
    - The committee agreed that a consistent term (maintaining agency or authority) should be used to describe who is the responsible party for developing, approving and retaining the Design Exception. The term should be included in the Introduction.

  The following revisions were then made to the draft chapter:

    - Revise the title to Design Exceptions and Variations.
    - Section A General was revised to move the fourth paragraph regarding documentation for design elements other than the 13 controlling elements to a new section called F Design Variations.

- Section F Design Variations was added and reads "When proposed design elements other than the 13 controlling Design Elements do not meet the criteria contained in this Manual, sufficient detail and justification of such deviations documented by the Responsible Professional Engineer shall be provided to the responsible agency.

- Moved by Andy Garganta to approve the changes, seconded by Ramon Gavarrete. The changes were approved unanimously.

FDOT Complete Streets Update (Michael Shepard)

Michael Shepard provided an overview of FDOT's Complete Streets progress. The Department has a web page at http://www.flcompletestreets.com. George Webb asked if FDOT has considered midblock crossing criteria with the Complete Streets initiative. Annette Brennan, Michael Shepard, Jared Perdue, and Mary Anne Koos responded that the FDOT Traffic Engineering Manual (TEM) provides guidance on midblock crossings. Christine Lofye explained that the TEM provides some reduced requirements for installation of midblock crossings (require fewer pedestrian crossings/hour than MUTCD).

Andy Garganta asked if the PPM had been updated with the vertical curve criteria for a 2.5-ft object height (per AASHTO). Michael Shepard answered that the PPM will keep the 6"-in object height for new construction criteria, but changed the RRR criteria to be less conservative and use the 2.5-ft object height.

Future Greenbook Revisions (Mary Anne Koos)

Mary Anne Koos presented options for the Committee's future work. The entire Greenbook needs to be reviewed to be consistent with the 2011 AASHTO Greenbook.

- Chapter 3 – Geometric Design needs to be updated for consistent use of the term "lateral offset" and review of the horizontal curve tables/figures.
- Chapter 4 – Roadside Design also needs to be revised for the changes to clear zone & lateral offset.
- Chapter 14 – Design Exceptions will need to be revised to reflect changes FHWA may make regarding the 13 controlling elements.
- Chapter 17 – Bridges and Other Structures should be updated to reflect changes in Florida Statues and the Structures Design Guidelines. Andre Pavlov has already drafted some revisions.
- Chapter 18 – Signing and Marking will need to be revised to include the reference to the Speed Zoning Manual for reduced speeds in school zones.
- Chapter 19 – Traditional Neighborhood Development could be updated to reflect Complete Streets. Rick Hall suggested this chapter also include sight distance criteria, rather than continue to refer to Chapter 3.

The Greenbook Committee adjourned for the day at 4:30 PM.

Thursday, April 14, 2016

Continuing Education Credits for PE and AICP Certification (Mark Massaro)

Mark Massaro contacted Nancy Wilkins, Florida Board of Professional Engineers yesterday and asked whether participation in Florida Greenbook Committee activities would qualify for professional development hours (PDHs). Her response was positive since the Committee works to establish engineering criteria. Ms. Koos asked the group if they would like FDOT to follow up with the Board on obtaining credits, which they agreed with. Charles Ramdatt also asked if credits for AICP certification could be provided. Ms. Koos circulated the sign in sheets where members added their PE and AICP numbers.

Future Greenbook Revisions (Mary Anne Koos)

Ms. Koos provided a refresher of which chapters were identified for revisions during the next year (2017): Chapter 3 – Geometric Design, Chapter 4 – Roadside Design, Chapter 14 – Design Exceptions, Chapter 17 – Bridges and Other Structures, Chapter 18 – Signing and Marking, and Chapter 19 – Traditional Neighborhood Development. The group was still in agreement with these chapters, except for Chapter 17. The Chapter Chair, Keith Bryant was not able to join the meeting. Ms. Koos will follow up with him later. It was noted that Chapters 3 and 18 will probably not be large efforts.

Presentation on Reduced Speed Zone Criteria (Alan El-Urfali and Gail Holley)

Alan El-Urfali and Gail Holley, FDOT Traffic Operations Office, presented on the need to include further guidance for posting of reduced speeds in school zones via GoToMeeting. They felt the best fit for this topic is in the Manual on Speed Zoning for Highways, Roads and Streets in Florida, which is adopted by rule (Rule 14-15.012 F.A.C). This Manual provides guidelines and recommended procedures for establishing uniform speed zones on State, Municipal and County roadways throughout the state of Florida.

The Manual on Speed Zoning already has language for school zones in Section 15.1 Time Period Speed (Regulatory). FDOT Traffic Operations Office proposes to create a stand-alone section for school zones and add to it. These proposed revisions will need to be adopted through rulemaking, planned for later in 2016. Once adopted, Chapter 18 of the Greenbook could be revised in 2017 to reference the Manual and be included in the 2018 Greenbook.

Breakout Sessions for Future Greenbook Revisions

The Committee broke out into smaller groups by Chapter to develop a work plan for future Chapter revisions.

Chapter Chair Reports for Future Greenbook Revisions and Discussion

- **Chapter 3 – Geometric Design (Mary Anne Koos)**
    - Housekeeping for clear zone & lateral offset, in this Chapter and the entire Florida Greenbook.
    - Develop definition for "maintaining agency" for the Introduction and use in Chapter 14 – Design Exceptions. Subcommittee will review entire FGB for consistent use of this term.
    - Review for and update outdated criteria within figures and tables.
    - Review for consistency with 2011 AASHTO Greenbook.
- **Chapter 4 – Roadside Design (Charles Ramdatt)**
    - Review revisions made to the Plans Preparation Manual (PPM), Chapter 4 – Roadside Design and determine what should be included in criteria for local roads.
    - Consider reformatting the Greenbook chapter to be organized similar to the PPM's chapter.
    - Consider moving Chapter 3, C.7.g Roadside Clear Zone and Lateral Offset to Chapter 4. Everything "shoulders-in" would be in Chapter 3, and everything "shoulders-out" would be in Chapter 4. Include Chapter 3 subcommittee when discussing merging sections of Chapter 3 with Chapter 4.
    - Charles Ramdatt asked that David Kuhlman be included on subcommittee to ensure utilities can participate in the discussion. (Mr. Kuhlman is already a member of this subcommittee).
    - The subcommittee would also like to have additional technical advisors (possibly Tom Bane, Derwood Sheppard, or Jeremy Fletcher).
    - Follow legislation called "Chloe's Law", HB 7061, 2016 and how it may ultimately impact local roads. Chloe's law addresses the protection of water bodies near roadways.
    - Review Utility Accommodation Manual (UAM) for consistency/best practices.
    - Would like to start subcommittee meetings in May/June. FDOT to provide subcommittee with PPM Chapter 4, and Greenbook Chapters 3 and 4.
- **Chapter 18 – Signing and Marking (Gail Woods)**
    - No proposed changes to Chapter other than reference to the Speed Zoning Manual. The materials presented earlier today were a draft, with more changes to come.
    - The subcommittee would like to reconvene in May to review the updated Speed Zoning Manual draft to be provided by Gail Holley.

- **Chapter 19 – Traditional Neighborhood Development (Rick Hall)**
    - This chapter is directly impacted by the Complete Streets revisions proposed for FDOT's other manuals.
    - Section C Planning Criteria should be updated to include the new Context Zones that are currently being finalized for Complete Streets.

Future Meetings (Mary Anne Koos)

Ms. Koos presented the tentative date for the next full Greenbook Committee meeting, scheduled for Wednesday and Thursday, February 22 – 23, 2017 at the Florida Turnpike offices. This date did not work for everyone. The committee preferred to meet a full day Thursday, half day Friday, in February. Ms. Koos agreed to search for an alternative date at the Turnpike. The committee agreed that if needed, the Deland Operations Center is an agreeable alternative. *(Note: The next Florida Greenbook meeting will be February 16 – 17, 2017 at the Florida Turnpike Headquarters. The meeting will be a full day Thursday, 1/2 day Friday).*

The Greenbook Committee adjourned at 11:30 AM.

FLORIDA GREENBOOK ADVISORY COMMITTEE MEMBERS 2016

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2.	Land Development	Margaret Smith
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4.	Roadside Design	Charles Ramdatt
5.	Pavement Design and Construction	Richard Moss
6.	Lighting	Bernie Masing
7.	Rail-Highway Crossings	Chris Tavella
8.	Pedestrian Facilities	Annette Brennan
9.	Bicycle Facilities	Annette Brennan
10.	Maintenance and Resurfacing	Richard Moss
11.	Work Zone Safety	Chris Tavella
12.	Construction	Ramon Gavarrete
13.	Public Transit	Charles Ramdatt
14.	Design Exceptions	Ramon Gavarrete
15.	Traffic Calming	Steve Neff
16.	Residential Street Design	Richard Baier
17.	Bridges and Other Structures	Keith Bryant
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Minutes (Draft)

FLORIDA GREENBOOK ADVISORY COMMITTEE MEETING

Thursday, January 21, 2016, 8:30 AM – 5:00 PM

FDOT Turnpike Headquarters
Turkey Lake Service Plaza Florida's Turnpike Headquarters
Turnpike Mile Post 263
Auditorium A
Ocoee, Florida 34761

Thursday, January 21, 2016

Members in Attendance

Andy Garganta, Robert Behar, Gaspar Miranda, Kathy Thomas, Chris Tavella, Howard Webb, George Webb, Christopher Mora, Milton Martinez, Gail Woods, Margaret Smith, Gene Howerton, Richard Moss, Steve Neff, Richard Baier, Bernie Masing, Annette Brennan, Keith Bryant, John Fowler (for Jared Perdue), Charles Ramdatt

Associate Members in Attendance

Fred Schneider, David F. Kuhlman

FDOT Staff, Technical Advisors and Public in Attendance

Tim Lattner, Michael Shepard, Mary Anne Koos, Mary Jane Hayden, Paul Hiers, Alan El-Urfali, Frank Yokiel, Susan Ussach, Jeremy Crowe

General Information

- **Welcome and Introductions (Michael Shepard & Mary Anne Koos)**

  Florida Greenbook Committee and Associate Member Changes - Changes in membership for the Greenbook Committee were discussed and a new member, Milton Martinez, City of Tampa (urban local government for District 7)) was introduced. Mr. Martinez replaces Pete Brett. David Cerlanek (former urban local government for District 2) is now working for FDOT and a new member will need to be appointed.

- **Review Contact Information (Mary Anne Koos)**

  The Committee Membership list was circulated for everyone to update their contact information.

- **Update Subcommittee Assignments (Mary Anne Koos)**

The list of current chairs for the chapter subcommittees was reviewed, and chair assignments updated. Members also updated their subcommittee membership preferences.

- **School Zone Signing and Marking (Alan El-Urfali)**

Alan El-Urfali advised the committee that FDOT has been asked to develop criteria for reduced speeds in school zones that would apply to all public roads. He asked whether FDOT should create a new manual to address school zone signing and marking on local roads. This would cover the establishment of the school zone and corresponding signing and marking. Charles Ramdatt suggested the Greenbook Committee review Chapter 7 of the MUTCD and see what changes can be made to the Greenbook before creating a new manual. Mary Anne Koos suggested the Chapter 18 - Signing and Marking subcommittee look into this issue. Gail Woods (subcommittee chair) and Alan El-Urfali (technical advisor to this subcommittee) agreed.

Review March 2015 Meeting Minutes & Vote to Approve (Mary Anne Koos)

- Steve Neff moved to approve the minutes as presented, seconded by Gail Woods, approved by the Committee with no objections.

Rulemaking and Sunshine Law

- **Sunshine Law (Jason Watts, General Counsel's Office)**

To comply with Florida's Sunshine law, Mr. Watts explained that members cannot discuss with each other the action they intend to take at a later meeting of the Greenbook Committee. An intermediary cannot be used either. Meetings of the Florida Greenbook and Subcommittees are posted on FDOT's public meetings web page. Mr. Watts stated that he is available to assist, if needed. If you email a committee member, that is considered a violation. Correspondence from a non-committee member to the committee (as a one-way communication to set up meetings) is acceptable.

- **Rulemaking Process (Susan Schwartz, General Counsel's Office)**

The Rule for the Florida Greenbook is 14-15.002, Florida Administrative Code (F.A.C.). Ms. Schwartz reviewed the "Rulemaking – 2015" presentation included in the meeting materials along with an overview of Florida's Government in the Sunshine Law.

"Rulemaking" is defined as the adoption, amendment or repeal of a rule and is the process used to adopt the Greenbook. In its simplest form, rulemaking consists of drafting the rule text, providing notice to the public, accepting public comment and filing the rule for adoption. Revisions to the Florida Greenbook begin with drafting proposed changes and review by the Committee. The proposed changes are then reviewed by FDOT's General Counsel Office and approved by FDOT's Secretary.

The Greenbook is published first in Rule Development, then in Rule Making. If there are no comments, or if all comments are addressed, it then goes to the Department of State (DOS) for Rule Adoption. Twenty days after it is posted by DOS, the manual becomes effective.

Presentation of Proposed Revisions for the 2015 Greenbook

- **Introduction (Howard Webb)**

Ms. Koos reviewed the color-coding of the text for the group. Green-highlighted text has already been approved by the Committee in previous meetings. Yellow are notes that will be deleted in the final format or are areas that need follow up discussion. Richard Baier questioned whether "design vehicle" and "complete streets" should be included as a new definition in this section. Ms. Koos stated that some definitions are included in specific chapters, rather than the introduction, because they were lengthy and better suited to the chapters.

George Webb questioned why Section 334.048, F.S. is included in the introduction, and suggested it be deleted. Mary Anne Koos will defer this question to FDOT General Counsel. (General Counsel's Office agreed we could remove the reference to this statute.)

The following comments were made on the definitions in the Introduction:

- Auxiliary Lane – George Webb suggested striking the last sentence. The group agreed.
- Boarding and Alighting – Charles Ramdatt suggested "…movement on or off a transit vehicle ~~bus~~"; Richard Baier questioned whether ADA should be mentioned in this definition. Ms. Koos explained that this definition is the US Access Board's definition, and that ADA requirements are covered within the chapters.
- Design Hour Volume – George Webb suggested "It includes total traffic…"
- High Speed – Bernie Masing suggested revising this to read "speeds greater than 45 mph" instead of "speeds of 50 mph or greater." (Was later revised to remain as written to be consistent with Chapter 3.)
- High Speed Rail – Charles Ramdatt wanted to make sure rail speeds between 70 mph and 110 mph are covered in the tables in the rail chapter.
- Horizontal Clearance – John Fowler suggested removing "motor vehicle" from the definition since horizontal clearance is also measured for shared use paths. The group agreed to discuss this during the breakout session later today. Decision was to revise definition when horizontal clearance is addressed in Chapter 3.
- Recovery Area – the group questioned the use of "clear zone" in this definition because a clear zone could be larger than a recovery area. This is the terminology that is directly from AASHTO. Michael Shepard agreed to take this question to AASHTO.
- Right of Way – George Webb asked to add "special district" to the list in this definition.

- Traffic Lane – Gail Woods suggested removing “Traffic lanes” from definition since it is redundant.
- Vertical Clearance - Milton Martinez questioned if we should define “Vertical Clearance” since Horizontal Clearance is defined. The subcommittee will review this in the breakout session.
- Wide Outside Lane – Christopher Mora questioned if we could make this 13’ instead of 14’. Howard Webb clarified that 14’ provides the minimum width for a vehicle and a bike to be in the same lane. The definition remained as was written in the draft.

- **Chapter 3 – Geometric Design (Howard Webb)**

Mr. Webb presented the proposed changes for the chapter, as shown in the draft dated January 14, 2016.

- Section C.1 Design Speed was rewritten and the corresponding Table 3-1 Recommended Design Speed modified to provide a range of speed, differentiate between rural and urban streets and highways, and include values for lower volume roads. The group decided to have the subcommittee look at the updated language related to selecting design speed (2nd paragraph) in the breakout session.
- Table 3-2 Design Vehicles, Table 3-3 Stopping Sight Distances, Table 3-4 Passing Sight Distances, Table 3-9 Rounded K-Values, and Table 3-10 Minimum Lane Widths were updated with 2011 AASHTO values. The object height for stopping sight distance was revised from 6 inches to 2 feet.
- Keith Bryant requested Table 3-10 be changed from 12’ travel lanes for local rural roads with an ADT> 1500 to 11’.

- **Chapter 7 – Rail-Highway Grade Crossings (Chris Tavella)**

Mr. Tavella presented the proposed changes for the chapter, as shown in the draft dated January 12, 2016.

The Objective was updated to be more in-line with the intent of this chapter.

- Table 7-1 Sight Distance at Rail- Highway Grade Crossings was revised to use a WB-67 design vehicle, since it is the largest anticipated vehicle (73.5 feet).
- Section C.3.c Medians was revised to state that a raised median is the ideal way to deter vehicles from crossing through the closed gates.
- Section C.3.d Sidewalks and Shared Use Paths is a new section.
- Figures 7-2 Pedestrian Crossings and 7-3 Flangeways and Flangeway Gaps were added to clarify where detectable warnings should be placed and to illustrate the location of the flangeway in the rail crossing.

- Sections C.5 Vertical Clearance and C.6 Horizontal Clearance language was added.
- Figure 7-4 Track Section was added to show where the dimensions are taken from in measuring horizontal and vertical clearance.
- Section C.9 Traffic Control Devices includes minor clarifications and added Figure 7-5 Median Signal Gates for Multilane Curbed Section to illustrate different gate mounting options and gap dimensions.
- The Figures in Section C.12 Crossing Configuration were updated to be consistent with the current MUTCD. Figures 7-6 and 7-7 for Passive and Active Rail-Highway Grade Crossing Configuration replaced the old Figure 7-2. Chris Tavella polled the committee to determine whether we should include the values for dimension "A" in the Greenbook or simply reference the MUTCD. Consensus was that referring to the MUTCD is the preferred approach. This way, if the MUTCD is updated, we do not have to change the Greenbook.
- Section E. Quiet Zones was added, including a new Figure 7-8 Gate Configurations for Quiet Zones.
- Section D High Speed Rail was added.

**** Lunch Break 11:45 AM – 12:45 PM ****

Subcommittee Breakout Meetings for Final Drafting of Proposed 2015 Revisions

The Committee broke out into chapter subcommittee groups to discuss in more detail the revisions proposed in the meeting package and to follow up on the comments from the morning's presentations. The following subcommittees met:

- Introduction and Chapter 3 – Geometric Design
- Chapter 7 – Rail-Highway Crossings

Chapter Reports and Approval of Updates for 2016 Greenbook

- **Introduction (Howard Webb)**
- Mr. Webb presented an overview of the proposed revisions to the draft following the Introduction and Geometric Design subcommittee breakout meeting. The draft was approved, with the following revisions:
- Design Vehicle - added the definition "A vehicle, with representative weight, dimensions, and operating characteristics, used to establish highway design controls for accommodating vehicles of designated classes" consistent with AASHTO.
- High Speed – retain "Speeds of 50 mph or greater." to be consistent with Chapter 3.
- High Speed Rail – leave definition as-is.

- Vertical Clearance – added the definition “Minimum unobstructed vertical passage space”.

Moved by Howard Webb to approve the changes, seconded by Richard Moss. The changes were approved unanimously.

- **Chapter 3 – Geometric Design (Howard Webb)**

Mr. Webb presented an overview of the proposed revisions to the draft following the Geometric Design subcommittee breakout meeting. The draft was approved, with the following revisions:

- Section C.1 Design Speed – the second paragraph was revised to read “For this reason, the selected design speed should be consistent with the speeds that drivers are likely to expect on a given street or highway facility. The design speed shall not be less than the expected posted or legal speed limit.
- Table 3-1 Recommended Design Speed – the committee discussed lower design speeds for the following types of facilities: rural arterial, 45 mph; rural collectors, all volumes, 35 mph; rural local, all volumes, 25 mph. Delete the provisions of 50 mph minimum for rural collectors and 30 mph for rolling terrain for local facilities and the fourth footnote. Revise footnote 1 to expand the areas in which urban design speeds can be appropriate to short, local rural roads. The committee directed that the proposed revisions be verified for consistency with AASHTO. (Following review of the AASHTO criteria, the values proposed during the Greenbook meeting for rural arterials, rural collectors, and rural local roads are below the AASHTO recommended values. Revisions are on hold until a revised table reflecting the AASHTO recommended values can be presented to the full Greenbook Committee for approval.)
- Section C.2 Design Vehicles – revised the definition for design vehicle to be consistent with the AASHTO Glossary (2009).
- Table 3-2 Design Vehicle – retained the WB-67 values since this was the design vehicle used in Chapter 7 to determine dimensions for sight distance triangles at grade crossings.
- Table 3-10 Minimum Lane Widths – revised the table values for arterial urban facilities with design speeds 45 mph or less to 11 feet. Footnote 3 was extended to apply to all urban arterials with speeds 45 mph or less, rural collectors with ADT of 400 to 1500 vpd, all urban collectors, all rural local roads with an ADT of 400 to 1500 vpd, and rural local roads with ADT less than 400 vpd with design speeds greater than 45 mph. The committee added an additional footnote 8 to allow 11 foot lanes for design speeds less than 50 mph. Footnote 8 applies to all rural arterials, and rural collectors and local roads with ADT greater than 1500 vpd.
- Section C.7.c Shoulders - revised to read “Paved outside shoulders are required for rural high speed multilane highways and freeways. They provide added safety…”

- Table 3-14 Median Width for Rural Highways and Urban Streets - remains unchanged, but will be discussed in future meetings. The committee will discuss a provision for traffic separators which can support pedestrian crossings.
- C.8.b.4 Auxiliary Lanes – delete the third paragraph about acceleration lanes, as it was not found to be necessary.

Moved by Howard Webb to approve the changes, seconded by Steve Neff. The changes were approved unanimously.

- **Chapter 7 – Rail-Highway Crossings (Chris Tavella)**

Mr. Tavella presented an overview of the subsequent revisions to the draft following the Rail-Highway Crossings subcommittee breakout meeting. These include:

- Section C.3.c Medians – revised the second paragraph for clarity and added a photo of flush median channelization to create Figure 7-2 Flush Median Channelization Devices.
- Section C.12 Crossing Configuration – added descriptions of active and passive rail-highway grade crossings and revised the names of Figures 7-6 and 7-7 to Passive and Active Rail-Highway Grade Crossing Configuration.
- Sections and Figures should be renumbered to adjust for the addition of the new Figure on median channelization and edit to have Section B.3 Rail-Highway Grade Crossing Near or Within Project Limits become its own Section C.

Moved by Chris Tavella to approve the changes, seconded by Charles Ramdatt. The changes were approved unanimously.

Review of the Purpose of Today's Meeting, and Next Steps (Mary Anne Koos)

- Today's meeting was to approve revisions for the Introduction, Chapter 3 and Chapter 7 of the Florida Greenbook. These revisions will now be moved forward with earlier approved revisions that have not been included in rulemaking. The new edition will be the 2016 Florida Greenbook.
- April's meeting will be to begin revisions for the 2018 (?) edition of the Greenbook Chapters to be updated for the next edition will be 1, 2, 3, 14, & 18.

Update of AASHTO's 13 Controlling Elements (Michael Shepard)

Mr. Shepard provided a brief update of AASHTO's proposed revisions to the 13 controlling elements.

- High Speed: 13 elements changing to 10 (bridge width, vert. align, & horizontal clearance are going away)
- Low Speed: 13 elements changing to 2 (design speed & structural capacity (newly-named design loading structural capacity) will remain).

Breakout Sessions and Chapter Chair Reports for Future Greenbook Revisions and Discussion

Subcommittees met in separate groups to strategize future revisions to the following chapters:

- Chapter 1 and 2– Planning (Rick Hall) and Land Development (Margaret Smith)

The subcommittees agreed to meet jointly to develop their revisions. Chapter 2 will take the lead.

- Chapter 3 – Geometric Design (Howard Webb)

The subcommittee agreed to review the criteria pertaining to horizontal clearance and lateral offset. In response to Mr. Ramdatt's request, they agreed to review median widths in general and to add criteria for traffic separators and pedestrian median refuges. Review refuge islands in Chapter 8 - Pedestrians and Chapter 15 – Traffic Calming for options to support pedestrian crossings.

- Chapter 14 - Design Exceptions (Ramon Gavarrete)

The subcommittee agreed to meet at a later date by teleconference.

- Chapter 18 – Signing and Marking (Gail Woods)

The subcommittee agreed to work with FDOT's Traffic Operations Office to determine if we need to add criteria to the Florida Greenbook to satisfy ***F.S. 316.1895 Establishment of school speed zones, enforcement; designation***. Alan El-Urfali (FDOT, Traffic Operations) will look into placing guidance in Traffic Engineering Manual (TEM), and the Greenbook will refer to TEM. (A subsequent discussion with Susan Schwartz, of FDOT's General Counsel Office, clarified the guidance will need to be in the Greenbook if it will be a requirement for local governments, since the TEM does not go through rulemaking.)

Other Topics

- Andy Garganta recommended that the FGB Committee always meet at the Turnpike HQ. There was no opposition to this suggestion.
- It may be too late to relocate the April 2016 FGB meeting, but we will attempt to do so. Future meetings can be located at the Florida Turnpike Headquarters.
- George Webb asked how Complete Streets has impacted FDOT's business. Michael provided a general overview and stated that they are already (and have been) implementing the Complete Streets philosophy.

The Meeting adjourned at 4:15 PM.

INTRODUCTION

The purpose of this Manual is to provide uniform minimum standards and criteria for the design, construction, and maintenance of all public streets, roads, highways, bridges, sidewalks, curbs and curb ramps, crosswalks~~ (where feasible)~~, bicycle facilities, underpasses, and overpasses used by the public for vehicular and pedestrian traffic as directed by Sections 20.23(4)(a), 334.044(10)(a), and 336.045, F.S.

In the following statutory excerpts, the term "Department" refers to the Florida Department of Transportation.

Section 20.23, F.S. Department of Transportation. There is created a Department of Transportation which shall be a decentralized agency.

(3)(a) The central office shall establish departmental policies, rules, procedures, and standards and shall monitor the implementation of such policies, rules, procedures, and standards in order to ensure uniform compliance and quality performance by the districts and central office units that implement transportation programs. Major transportation policy initiatives or revisions shall be submitted to the commission for review.

Section 334.044, F.S. Department; powers and duties. The department shall have the following general powers and duties:

(10)(a) To develop and adopt uniform minimum standards and criteria for the design, construction, maintenance, and operation of public roads pursuant to the provisions of Section, 336.045, **F.S**.

Section 336.045, F.S. Uniform minimum standards for design, construction, and maintenance; advisory committees.

(1) The department shall develop and adopt uniform minimum standards and criteria for the design, construction, and maintenance of all public streets, roads, highways, bridges, sidewalks, curbs and curb ramps, crosswalks, where feasible, bicycle ways, underpasses and overpasses used by the public for vehicular and pedestrian traffic. In developing such standards and criteria, the department shall consider design approaches which provide for the compatibility of such facilities with the surrounding natural or manmade environment; the safety and security of public spaces; and the appropriate aesthetics based upon scale, color, architectural style, materials used to construct the facilities, and the landscape design and landscape materials around the facilities.

(2) An advisory committee of professional engineers employed by any city or any county in each transportation district to aid in the development of such standards shall be appointed by the head of the department. Such committee shall be composed of: one member representing an urban center within each district; one member representing a rural area within each district; one member within each district who is a professional engineer and who is not employed by any governmental agency; and one member employed by the department for each district[KM1].

(4) All design and construction plans for projects that are to become part of the county road system and are required to conform with the design and construction standards established pursuant to subsection (1) must be certified to be in substantial conformance with the standards established pursuant to subsection (1) that are then in effect by a professional engineer who is registered in this state.

These standards are intended to provide basic guidance for developing and maintaining a highway system with reasonable operating characteristics and a minimum number of hazards[KM2].

Standards established by this Manual are intended for use on all streets and highways off the State Highway System (SHS). Certain projects off the SHS but on the National Highway System (NHS) utilizing federal funds may be required to follow additional design criteria. Please see ***Chapter 19*** of the ***Local Agency Program Manual*** for further information. Information on roadways included in the NHS is found at the Department's Transportation Statistics Office website: ***National Highway System Maps***.

Standards are provided for the design of new ~~and resurfacing~~[KM3] construction and reconstruction projects as well as maintenance and resurfacing projects. ~~off the state highway and federal aid systems. Unless specified otherwise herein,~~ It is understood that existing streets and highways may not conform to all minimum standards applicable to the design of new and ~~standards herein cannot be applied completely to all~~ reconstruction ~~and maintenance type~~ projects. For existing roads not being replaced or reconstructed, it is intended the requirements provided in ***Chapter 10 – Maintenance and Resurfacing*** are applied. For all type projects there may be practical reasons a certain standard is not met. A process is provided in ***Chapter 14 – Design Exceptions*** to address those situations.~~However, the standards shall be applied to reconstruction and maintenance projects to the extent state or federal statute requires and that economic and environmental considerations and existing development will allow.~~

When this Manual refers to guidelines and design standards given by current American Association of State Highway and Transportation Officials (AASHTO) publications, these guidelines and standards shall generally be considered as minimum criteria. The Department may have standards and criteria that differ from the minimum presented in this Manual or by AASHTO for streets and highways under its jurisdiction. A county or municipality may substitute standards and criteria adopted by the Department for some or all portions of design, construction, and maintenance of their facilities. Department standards, criteria, and manuals must be used when preparing projects on the state highway system or the national highway system.

Criteria and standards set forth in other manuals, which have been incorporated by reference, shall be considered as requirements within the authority of this Manual.

This Manual is intended for use by qualified engineering practitioners for the communication of standards and criteria (including various numerical design values and use conditions). The design, construction, and maintenance references for the infrastructure features contained in this Manual recognize many variable and often complex process considerations. The engineering design process, and associated use of this Manual, incorporates aspects of engineering judgment, design principles, science, and recognized standards towards matters involving roadway infrastructure.

Users of this Manual are cautioned that the strict application of exact numerical values, conditions or use information taken from portions of the text may not be appropriate for all circumstances. Individual references to design values or concepts should not be used out of context or without supporting engineering judgment.

The contents of this Manual are reviewed annually by the Florida "Greenbook" Advisory Committee. Membership of this committee is established by the above referenced Section 336.045(2), F.S. Comments, suggestions, or questions may be directed to any committee member.

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POLICY

Specific policies governing the activities of planning, design, construction, reconstruction, maintenance, or operation of streets and highways are listed throughout this Manual. All agencies and individuals involved in these activities shall be governed by the following general policies:

- Each public street and highway, and all activities thereon, shall be assigned to the jurisdiction of some highway agency. Each highway agency should establish and maintain a program to promote safety in all activities on streets and highways under its jurisdiction.
- Highway safety shall be considered and given a high priority in order to promote the achievement of the maximum safety benefits for given expenditures and efforts.
- The provision for safe, high-quality streets and highways, and maximum transit opportunities should take priority over the provision for the maximum highway mileage obtainable for the available funds.

OBJECTIVES

The planning, design, construction, reconstruction, maintenance, and operation of streets and highways should be predicated upon meeting the following objectives:

- Develop and maintain a highway system that provides the safest practicable environment for motorists, cyclists, pedestrians, and workers.
- Establish and maintain procedures for construction, maintenance, utility, and emergency operations that provide for safe highway and transit operating conditions during these activities.
- Provide streets and highways with operating characteristics that allow for reasonable limitations upon the capabilities of vehicles, drivers, cyclists, pedestrians, and workers.
- Provide uniformity and consistency in the design and operation of streets and highways.

- Provide for satisfactory resolution of conflicts between the surface transportation system and social and environmental considerations to aid neighborhood integrity.
- Reconstruct or modify existing facilities to reduce the hazard to the highway users.
- Reduce the deaths, injuries, and damage due to highway crashes.

Additional general and specific objectives related to various topics and activities are listed throughout this Manual. Where specific standards or recommendations are not available or applicable, the related objectives shall be utilized as general guidelines.

DEFINITIONS OF TERMS

The following terms shall, for the purpose of this Manual, have the meanings respectively ascribed to them, except instances where the context clearly indicates a different meaning. The ***Manual of Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May 2012, MUTCD)*** includes additional information on terms used in conjunction with the application of the ***MUTCD***.

ALLEY — A narrow right of way to provide access to the side or rear of individual land parcels.

ANNUAL AVERAGE DAILY TRAFFIC (AADT) — The total volume of traffic on a highway segment for one year, divided by the number of days in the year. This volume is usually estimated by adjusting a short-term traffic count with weekly and monthly factors

AVERAGE DAILY TRAFFIC (ADT) — The total traffic volume during a given time period (more than a day, less than a year) divided by the number of days in that time period.

AUXILIARY LANE — A designated width of roadway pavement marked to separate speed change, turning, passing, and climbing maneuvers from through traffic. .

AVERAGE RUNNING SPEED — For all traffic, or component thereof, the summation of distances divided by the summation of running times.

BICYCLE LANE (BIKE LANE) — A portion of a roadway that has been designated for preferential use by bicyclists by pavement markings, and if used, signs. They are one-way facilities that typically carry traffic in the same direction as adjacent motor vehicle traffic.

BOARDING AND ALIGHTING (B&A) AREA

A firm, stable, slip resistant surface that accommodates passenger movement on or off a transit vehicle.

CLEAR ZONE

The unobstructed, traversable area beyond the edge of the traveled way for the recovery of errant vehicles. The clear zone includes shoulders and bicycle lanes. ~~The roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, recoverable slope, non-recoverable slope, clear runout area, or combination thereof. The desired width is dependent upon the traffic volumes and speeds, and on the roadside geometry. Note: The aforementioned "border area" is not the same as "border width". Also, see Horizontal Clearance.~~

CORRIDOR

A strip of land between two termini within which traffic, topography, environment, population, access management, and other characteristics are evaluated for transportation purposes.

CROSSWALK

Portion of the roadway at an intersection included within the connections of lateral lines of the sidewalks on opposite sides of the highway, measured from the curbs or in the absence of curbs from the traversable roadway. Crosswalks may also occur at an intersection or elsewhere distinctly indicated for pedestrian crossing.

DESIGN HOUR VOLUME (DHV)

Traffic volume expected to use a highway segment during the design hour of the design year. The DHV is related to the AADT by the “K” factor. It includes total traffic in both directions of travel.

DIRECTIONAL DESIGN HOUR VOLUME (DDHV)	Traffic volume expected to use a highway segment during the design hour of the design year in the peak direction.
DESIGN SPEED	A selected speed used to determine the various geometric design features of the roadway. The selected design speed should be a logical one with respect to the topography, anticipated operating speed, adjacent land use, and functional classification of the highway.
DESIGN VEHICLE	A vehicle, with representative weight, dimensions, and operating characteristics, used to establish highway design controls for accommodating vehicles of designated classes.
DRIVEWAY	An access from a public way to adjacent property.
EXPRESSWAY	A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at major intersections.
FEDERAL AID HIGHWAY	A highway eligible for assistance under the United States Code Title 23 other than a highway classified as a local road or rural minor collector.
FREEWAY/LIMITED ACCESS HIGHWAY	An expressway with full control of access.
FRONTAGE ROAD/STREET	A street or highway constructed adjacent to a higher classification street or other roadway network for the purpose of serving adjacent property or control access.
GRADE SEPARATION	A crossing of two roadways or a roadway and a railroad or pedestrian pathway at different levels.

HIGH SPEED Speeds of 50 mph or greater.

HIGH-SPEED RAIL Intercity passenger rail service that is reasonably expected to reach speeds of at least 110 miles per hour.

HIGHWAY, STREET, OR ROAD General terms, denoting a public way for purposes of traffic, both vehicular and pedestrian, including the entire area within the right of way. The term street is generally used for urban or suburban areas.

LATERAL OFFSET~~HORIZONTAL CLEARANCE~~ The l~~L~~ateral distance from the edge of the travel way ~~motor vehicle travel lane~~or when applicable, face of curb, to a roadside object or feature.

INTERSECTION The general area where two or more streets or highways join or cross.

MAY A permissive condition. Where "may" is used, it is considered to denote permissive usage.

MAINTENANCE A strategy of treatments to an existing roadway system that preserves it, retards future deterioration, and maintains or improves the functional condition.

NEW CONSTRUCTION The construction of any public way (paved or unpaved) where none previously existed, or the act of paving any previously unpaved road, except as provided in Chapter 3, Section A of these standards.

OPERATING SPEED The rate of travel at which vehicles are observed traveling during free-flow conditions.

PARATRANSIT	Comparable transportation service required by the ADA for individuals with disabilities who are unable to use fixed route transportation systems.
PEDESTRIAN ACCESS ROUTE	A continuous and unobstructed path of travel provided for pedestrians with disabilities within or coinciding with a pedestrian circulation path.
PEDESTRIAN CIRCULATION PATH	A prepared exterior or interior surface provided for pedestrian travel in the public right-of-way.
PREFERENTIAL LANE	A street or highway lane reserved for the exclusive use of one or more specific types of vehicles or vehicles with at least a specific number of occupants.
PUBLIC WAY	All public streets, roads, highways, bridges, sidewalks, curbs and curb ramps, crosswalks (where feasible), bicycle facilities, underpasses, and overpasses used by the public for vehicular and pedestrian traffic.
RAMP	1) Includes all types, arrangements, and sizes of turning roadways that connect two or more legs at an interchange. 2) A combined ramp and landing to accomplish a change in level at a curb (curb ramp).
RECONSTRUCTION	Any road construction other than new construction.
RECOVERY AREA	A clear zone that includes the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles.

RESIDENTIAL STREETS

Streets primarily serving residential access to the commercial, social, and recreational needs of the community. These are generally lower volume and lower speed facilities than the primary arterial and collector routes of the local system "or as adopted by local government ordinance".

RESURFACING

Work to place additional layers of surfacing on highway pavement, shoulders, bridge decks, and necessary incidental work to extend the structural integrity of these features for a substantial time period.

RIGHT OF WAY

A general term denoting land, property or interest therein, usually in a strip, acquired or donated for transportation purposes. More specifically, land in which the State, the Department, a county, a transit authority, municipality, or special districts owns the fee or has an easement devoted to or required for use as a public road.

ROADWAY

The portion of a street or highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

RURAL AREAS

Those areas outside of urban boundaries. Urban area boundary maps based upon the 2010 Census are located on the Department's Urban Area 1-Mile Buffer Maps.

SHALL/MUST

A mandatory condition. (When certain requirements are described with the "shall" or "must" stipulation, it is mandatory these requirements be met.)

SHARED STREET	Specially designed residential or commercial street where space is shared by all users and alignment supports slower vehicle speeds and the perception of shared space.
SHARED ROADWAY	A roadway that is open to both bicycle and motor vehicle travel. This may be an existing roadway, street with wide curb lanes, or road with paved shoulders.
SHARED USE PATH	Paved facilities physically separated from motorized vehicular traffic by an open space or barrier. May be within the highway right of way or an independent right of way, with minimal cross flow by motor vehicles. Users are non-motorized and may include: pedestrians, bicyclists, skaters, people with disabilities, and others.
SHOULD	An advisory condition. Where the word "should" is used, it is considered to denote advisable usage, recommended but not mandatory.
SLOPE	The relative steepness of the terrain, expressed as a ratio or percentage. Slopes may be categorized as positive (backslopes) or negative (foreslopes) and as parallel or cross slopes in relation to the direction of traffic. In this manual slope is expressed as a ratio of vertical to horizontal (V:H).
SURFACE TRANSPORTATION SYSTEM	Network of highways, streets, and/or roads. Term can be applied to local system or expanded to desired limits of influence.

TRADITIONAL NEIGHBORHOOD DEVELOPMENT (TND)
TND refers to the development or redevelopment of a neighborhood or town using traditional town planning principles. Projects should include a range of housing types and commercial establishments, a network of well-connected streets and blocks, civic buildings and public spaces, and include other uses such as stores, schools, and places of worship within walking distances of residences.

TRAFFIC
Pedestrians, bicyclists, motor vehicles, streetcars and other conveyances either singularly or together while using for purposes of travel any highway or private road open to public travel.

TRAFFIC LANE
Includes travel lanes, auxiliary lanes, turn lanes, weaving, passing, and climbing lanes.

TRAVEL LANE
A designated width of roadway pavement marked to carry through traffic and to separate it from opposing traffic or traffic occupying other traffic lanes. Generally, travel lanes equate to the basic number of lanes for a facility.

TRAVELED WAY
The portion of the roadway for the movement of vehicles, exclusive of shoulders, berms, sidewalks and parking lanes.

TURNING ROADWAY
A connecting roadway for traffic turning between two intersection legs.

URBAN AREA	A geographic region comprising as a minimum the area inside the United States Bureau of the Census boundary of an urban place with a population of 5,000 or more persons, expanded to include adjacent developed areas as provided for by Federal Highway Administration (FHWA) regulations. Urban area boundary maps based upon the 2010 Census are located on the Department's Urban Area 1-Mile Buffer Maps.
URBANIZED AREA	A geographic region comprising as a minimum the area inside an urban place of 50,000 or more persons, as designated by the United States Bureau of the Census, expanded to include adjacent developed areas as provided for by Federal Highway Administration (FHWA) regulations. Urban areas with a population of fewer than 50,000 persons which are located within the expanded boundary of an urbanized area are not separately recognized.
VEHICLE	Every device upon, or by which any person or property is or may be transported or drawn upon a traveled way, excepting devices used exclusively upon stationary rails or tracks. Bicycles are defined as vehicles per Section 316.003, Florida Statutes.
VERTICAL CLEARANCE	Minimum unobstructed vertical passage space.
VERY LOW-VOLUME ROAD	A road that is functionally classified as a local road and has a design average daily traffic volume of 400 vehicles per day or less.
WIDE OUTSIDE LANE	Through lanes that provide a minimum of 14' in width. This lane should always be the through lane closest to the curb or shoulder of the road when a curb is not provided.

CHAPTER 1

PLANNING

TABLES

CHAPTER 1

PLANNING

A INTRODUCTION[KM1]

Developing and maintaining an efficient multi-modal system requires careful planning by each unit in a transportation agency. This includes both planning for the design and construction of streets and highways and planning for operating the facilities. Overall planning would include a consideration for all aspects of design, construction, and operations (including maintenance) affecting the resulting characteristics of streets and highways. These characteristics will be significantly affected by the degree to which the various demands and requirements on the highway system are satisfied in the initial planning and design.

Successful highway design requires that the role of each new facility in the overall highway system be clearly delineated. The determination and clear definition of the function and classification of each street and highway is also required. Safety and efficiency of new facilities is predicated, to a large extent, on corridor selection and provisions for adequate right of way, alignment, and access control. Initial planning and design should also consider provisions for future modifications and upgrading required by changes in speed, volume, or standards.

Plans for actually operating a new street or highway should be considered in the initial planning and should be closely coordinated with the design of the facility. Development of plans and procedures for successfully operating an existing highway system must include a consideration of all activities affecting the operating characteristics of each street and highway.

Planning, designing, operating, and maintaining a street system has become more complex in recent years. These disciplines must address the relationship to land use and the desire for access to public transit, pedestrian and bicycle traffic, the growing number of elder road users, and the mobility needs of persons with disabilities. This begins in planning and continues throughout the design and operational process.

B FUNCTIONAL CLASSIFICATION

A determination of the function and operational requirements, and a clear definition of the classification of each new facility are required prior to the actual design.

B.1 Function

Design of each new street or highway is based upon its function in the highway system. Operational requirements that must be satisfied to fulfill this function are dependent upon the following factors:

B.1.a Volume

Volume of traffic that must be carried by the facility is a primary factor governing the design. Variations in volume with respect to direction and time should also be evaluated to determine the expected requirements for peak capacities.

B.1.b Speed

Operating speed (to be maintained) should meet reasonable expectations of the users.

B.1.c Traveler Characteristics

Unless prohibited by law, a variety of travelers should be expected on all public roads. These could include pedestrians, bicyclists, and motor vehicle operators and passengers. Types and relative volumes of people expected to use the street or highway influence trip characteristics and design features.

B.1.d Trip Characteristics

Functions of a new facility are, to a large extent, determined by the length and purpose of vehicle trips. Trip characteristics are influenced by land use characteristics and the highway network layout.

B.1.e Safety

Functional classification plays an important role in setting expectations and measuring outcomes for safety. Since agencies consider the type of roadway in evaluating the significance of crash rates, functional classification can be used as part of evaluating the relative safety of roadways and the implementation of safety improvements and programs.

B.1.f Measures of Level of Service

Level of service (LOS) is essentially a measure of the quality of the operating characteristics of a street or highway. Factors involved in determining the level of service include speed and safety, as well as travel time; traffic conflicts and interruptions; freedom to maneuver; convenience and comfort; and operating costs. Level of service is also dependent upon actual traffic volume and composition of traffic (motor vehicles, trucks, transit, bicyclists, and pedestrians).

The ***Highway Capacity Manual 2010*** provides further information on assessing the traffic and environmental effects of highway projects.

B.1.g Access Requirements

Degree and type of access permitted on a given facility is dependent upon its intended function and should conform to the guidelines in ***Chapter 3 – Geometric Design***. Reasonable access control must be exercised to allow a street or highway to fulfill its function.

B.1.h Public Transit Use

Both current and planned use by public transit influence design features. Transit vehicles increase capacity on a roadway.

B.2 Classification

Road classifications are defined in Section 334.03 F.S. Functional classification is the assignment of roads into systems according to the character of service they provide in relation to the total road network.

B.2.a Basic Classification

An effective transportation network includes a variety of streets and highways. ~~Basic functional categories include arterial, collector, and local roads which may be subdivided into principal, major, or minor levels.~~ Arterials provide a high level of mobility, locals provide a high level of accessibility, and ~~those that~~collectors provide a balanced blend of mobility and access~~ are collectors~~. These levels may be additionally divided into rural and urban categories. This basic classification system is utilized throughout this Manual. Additional information on the functional classification of roadways can be found in ***Highway Functional Classification Concepts, Criteria and Procedures, 2013 Edition (FHWA)***.

B.2.a.1 Local~~ Road~~

A street or highway~~route~~ providing service which is of relatively low average traffic volume, short average trip length or minimal through-traffic movements, and high land access for abutting property.

B.2.a.2 Collector~~ Road~~

A street or highway~~route~~ providing service which is of relatively moderate average traffic volume, moderately average trip length, and moderately average operating speed. These routes also collect and distribute traffic between local roads or arterial roads and serve as a linkage between land access and mobility needs.

B.2.a.3 Arterial

A street or highway providing service which is relatively continuous and of relatively high traffic volume, long average trip length, generally higher operating speed, and high mobility importance. In addition, every United States numbered highway is an arterial.~~ road.~~

B.2.b Classification Modifications

Design and classification of streets and highways should ~~also~~ be based upon a consideration of existing and proposed land uses and development patterns~~highway user expectations. The function of any facility, as perceived by the user, essentially determines the driver's willingness to accept restrictions upon speed, capacity, access, or level of service~~.

To better reflect the local context and function of the street or highway, the b~~B~~asic classification systems may ~~also~~ be further refined. An example is ~~modified by the following variables~~shown in Table 1 - 1 Functional Classification Modifications, ~~and~~which includes a variety of highways, streets and roads, and development types. The street types shown in the example are from the ***21st Century Land Development Code***, available from the America Planning Association.

Table 1 – 1 Functional Classification Modifications

Functional Classification		Street Type	Development Type				
			Residential	Employ-ment/ Commercial	Mixed Use/TND /Greenfield	TOD	Rural
Freeway	Rural	Freeway	-	-	-	-	x
	Urban		-	x	x	-	x
Arterial	Rural	Road	-	x	x	-	x
	Urban	Boulevard Main Street	-	x	x	x	-
Collector	Rural	Road	x	x	x	-	x
	Urban	Avenue Main Street	x	x	x	x	-
Local	Rural	Road	x	-	x	-	x
	Urban	Alley Lane	x	-	x	x	-

~~,~~Urban and rural are based on population density gathered from the ~~2010~~most recent census and mapped as urban area boundaries. Urban areas are considered to have *dense* development patterns, while rural areas are considered to have *sparse* development patterns. The Department's ***Urban Area 1-Mile Buffer Maps*** identify urban and rural areas based on the census data and regional travel patterns.

~~B.2.b.1 Urban~~

~~Urban area highway users will generally accept lower speeds and levels of service. Economic constraints in urban areas are also generally more severe. Minor~~ To meet local needs and travel demands, deviations ~~modifications~~ in design criteria may be~~are, therefore,~~ appropriate for urban streets. ***Chapter 3 – Geometric Design, Chapter 8 – Pedestrian***

Facilities, Chapter 9 – Bicycle Facilities, Chapter 13 – Transit, Chapter 15 – Traffic Calming, Chapter 16 – Residential Street Design, and ***Chapter 19 – Traditional Neighborhood Development*** provide~~s~~ additional information for the design of urban streets.

~~**B.2.b.2 Major/Minor**~~

~~**Streets and highways may be classified as major or minor depending upon traffic volume, trip length, and mobility.**~~

~~**Additional information on the functional classification of roadways may be found in** *Highway Functional Classification Concepts, Criteria and Procedures, 2013 Edition (FHWA)*.~~

C CONSIDERATIONS ~~for~~ FOR ROADSIDE DESIGN

The following criteria should be considered and resolved in the initial planning and design of streets and highways. The criteria are not listed in order of priority, and the weighting of each criterion should be based on the context of a project, the available resources, and the users.

C.1 Safety

Development of safe streets and highways for all modes of surface transportation (autos, trucks, bicycles, pedestrians, transit vehicles, etc.) should be given a high priority in the design process. Good roadway design is key to safe and efficient operation and should be sensitive to the surrounding environment. The safety performance of roadway elements should be considered in planning, design, construction, maintenance, and operation phases to be truly comprehensive.

C.2 Economic Constraints

In determining the benefit/cost ratio for any proposed facility, the economic evaluation should go beyond the actual expenditure of highway funds and the capacity and efficiency of the facility. Overall costs and benefits of various alternatives should include an evaluation of all known environmental, community, and social impact and their effect upon highway quality and cost.

Allocation of sufficient funds for obtaining the proper corridor and adequate right of way and alignment should receive the initial priority. Future acquisition of additional right of way and major changes in alignment are often economically prohibitive. This can result in substandard streets and highways with permanent hazards. Reconstruction or modification under traffic is expensive, inconvenient, and hazardous to the highway user. This increase in costs, hazards, and inconvenience can be limited by initial development of quality facilities.

C.3 Access

Although the public must have reasonable access to the highway network, it is necessary to have certain controls and restrictions. Allowing indiscriminate access can seriously compromise the safety capacity and level of service of a street or highway, consequently reducing its utility and general economic value. The level and type of access should be tied to the functional class of the roadway.

The proper layout of the highway network and the utilization of effective land use controls (***Chapter 2 - Land Development***) can provide the basis for regulating access. The actual access controls should conform to the guidelines given in ***Chapter 3 - Geometric Design***.

C.4 Maintenance Capabilities

Planning and design of streets and highways should include provisions for the performance of required maintenance. The planning of the expected maintenance program should be coordinated with the initial highway design to ensure maintenance activities may be conducted without excessive traffic conflicts or hazards.

C.5 Utility and Transit Operations

Utility accommodation within rights of way is generally considered to be in the public's best interest, since rights of way frequently offer the most practical engineering, construction, and maintenance solutions for utility service to businesses and residences. Utility and transit facility locations should be carefully chosen to optimize operations and safety of the transportation facility. Additional information on the design of transit facilities can be found in ***Chapter 13 - Transit***.

C.6 Emergency Response

Development of an effective emergency response program is dependent upon the nature of the highway network and the effectiveness of the operation of the system. Provisions for emergency access and communication should be considered in the initial planning and design of all streets and highways. Local emergency response personnel should be included in primary activities.

C.7 Environmental Impact

Construction and operation of streets and highways frequently produces an adverse effect upon the environment. Early consideration and resolution of environmental issues can avoid costly delays and modifications that may compromise the quality and efficiency of operation. Specific topics often encountered include the following:

- Air Quality

- Coastal Zone Resources
- Farmland
- Floodplains
- Hazardous Waste and Brownfields
- Noise
- Roadside vegetation
- Safe Drinking Water Act
- Water Quality
- Watersheds Management
- Wetlands
- Wild and Scenic Rivers and Wilderness Areas
- Wildlife and Threatened and Endangered Species
- Wildlife, Habitat and Ecosystems

C.8 Community and Social Impact

Quality and value of a community is directly influenced by the layout and design of streets and highways. Quality of the network determines the freedom and efficiency of movement. Inadequate design of the network and poor land use practices can lead to undesirable community separation and deterioration. Specific design of streets and highways has a large effect upon the overall aesthetic value which is important to the motorist and resident. When using federal funds for transportation projects, the following considerations should be addressed:

- Corridor Preservation
- Historical and Archaeological Preservation
- Scenic Byways
- Section 4(f) and 5(f) if federally funded
- Visual Impacts

C.9 Modes of Transportation

Planning processes should analyze/evaluate other modes of transportation, including walking and cycling and their relationship to the highway system. Recommendations for incorporation into the design process should be made. This will involve coordination with local, city, county, special interest groups, etc., in developing such recommendations.

D OPERATION

The concept of operating the existing highway network as a system is essential to promote safety, efficiency, mobility, and economy. This requires comprehensive planning and coordination of all activities on each street and highway. These activities would include maintenance, construction, utility operations, public transit operations, traffic control, and emergency response operations. The behavior of traffic should be considered as an integral part of the operation of streets and highways. Coordination of the planning and supervision of each activity on each facility is necessary to achieve safety and efficient operation of the total highway system.

D.1 Policy

Each highway agency with general responsibility for existing streets and highways should establish and maintain an operations department. Each existing street or highway should be assigned to the jurisdiction of the operations department. The operations department shall be responsible for planning, supervising, and coordinating all activities affecting the operating characteristics of the highway system under its jurisdiction.

D.2 Objectives

The primary objective of an operations department shall be to maintain or improve the operating characteristics of the highway system under its jurisdiction. These characteristics include safety, capacity, and level of service. The preservation of the function of each facility, which would include access control, is necessary to maintain these characteristics and the overall general value of a street or highway.

D.3 Activities

The achievement of these objectives requires the performance of a variety of coordinated activities by the operations department. The following activities should be considered as minimal for promoting the safe and efficient operation of a highway system.

D.3.a Maintenance and Reconstruction

Maintaining or upgrading the quality of existing facilities is an essential factor in preserving desirable operating characteristics. The planning and execution of maintenance and reconstruction activity on existing facilities must be closely coordinated with all other operational activities and, therefore, should be under the general supervision of the operations department.

All maintenance work should be conducted in accordance with the requirements of ***Chapter 10 - Maintenance***. The priorities and procedures utilized should be directed toward improvement of the existing system. The standards set forth in this Manual should be used as guidelines for establishing maintenance and reconstruction objectives. All maintenance and reconstruction projects should be planned to minimize traffic control conflicts and hazards.

D.3.b Work Zone Safety

An important responsibility of the operations department is the promotion of work zone safety on the existing highway system. The planning and execution of maintenance, construction, and other activities shall include provisions for the safety of motorists, bicyclists, pedestrians, and workers. All work shall be conducted in accordance with the requirements presented in ***Chapter 11 - Work Zone Safety***.

D.3.c Traffic Control

Traffic engineering is a vital component of highway operations. The planning and design of traffic control devices should be carried out in conjunction with the overall design of the street or highway and highway user. The devices and procedures utilized for traffic control should be predicated upon developing uniformity throughout the system and compatibility with adjacent jurisdictions.

A primary objective to be followed in establishing traffic control procedures is the promotion of safe, orderly traffic flow. The cooperation of police agencies and coordination with local transit providers is essential for the achievement of this objective. Traffic control during maintenance, construction, utility, or emergency response operations should receive special consideration.

D.3.d Emergency Response

The emergency response activities (i.e., emergency maintenance and traffic control) of the operations department should be closely coordinated with the work of police, fire, ambulance, medical, and other emergency response agencies. The provisions for emergency access and communications should be included in the initial planning for these activities.

D.3.e Coordination and Supervision

Coordination and supervision of activities on the highway system should include the following:

- Supervision and/or coordination of all activities of the operations department and other agencies to promote safe and efficient operation
- Coordination of all activities to provide consistency within a given jurisdiction
- Coordination with adjacent jurisdictions to develop compatible highway systems
- Coordination with other transportation modes to promote overall transportation efficiency

D.3.f Inspection and Evaluation

The actual operation of streets and highways provides valuable experience and information regarding the effectiveness of various activities. Each operations department should maintain a complete inventory of its highway system and continuously inspect and evaluate the priorities, procedures, and techniques utilized in all activities on the existing system under its jurisdiction. Activities by other agencies, as well as any highway agency, should be subjected to this supervision.

Promotion of highway safety should be aided by including a safety office (or officer) as an integral part of the operations department. Functions of this office would include the identification and inventory of hazardous locations and procedures for improving the safety characteristics of highway operations.

Results of this inspection and evaluation program should be utilized to make the modification necessary to promote safe and efficient operation. Feedback for modifying design criteria should be generated by this program. Experience and data obtained from operating the system should be utilized as a basis for recommending regulatory changes. Cooperation of legislative, law enforcement, and regulatory agencies is essential to develop the regulation of vehicles, driver behavior, utility, emergency response activities, and the access land use practices necessary for the safe and efficient operation of the highway system.

E REFERENCES

Design criteria are established for transportation projects to ensure that they provide safe, economical, and fully-functional multimodal transportation facilities. Various FDOT publications contain information on procedures, criteria, and standards for guiding and controlling design and construction activities. There are many local, state, and federal laws and rules that may impact the design of a project. These laws and rules are referenced in the publications when the Department is aware of them.

For situations where specific design standards or criteria cannot be found in the FDOT publications, current approved technical publications such as AASHTO's *Policy on Geometric Design of Highways and Streets* should be used as design guidelines. Local agencies must ensure that project designs meet or exceed the referenced design criteria and that the standards developed from acceptable guidelines are appropriate for the proposed facility.

The following publications provide further information and guidance for Roadway and Bridge/Structure designs:

- Plans Preparation Manual, Volume I (Topic No. 625-000-007) and Volume II (Topic No. 625-000-008)
  http://www.dot.state.fl.us/rddesign/PPMManual/PPM.shtm

- Design Standards (Standard Indexes) (Topic No. 625-010-003)
  http://www.dot.state.fl.us/rddesign/DesignStandards/Standards.shtm

- Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways (Florida Greenbook) (Topic No. 625-000-015)
  http://www.dot.state.fl.us/rddesign/FloridaGreenbook/FGB.shtm

- A Policy on Geometric Design of Highways and Streets, 6th Edition (AASHTO Green Book) (AASHTO Bookstore GDHS-6)
  https://bookstore.transportation.org/collection_detail.aspx?ID=110

- FDOT Standard Specifications for Road and Bridge Construction
  http://www.dot.state.fl.us/specificationsoffice/Implemented/SpecBooks/default.shtm

- AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 6th Edition (AASHTO Bookstore LRFDUS-6-M)
  https://bookstore.transportation.org/item_details.aspx?id=1924

- FDOT Structures Manual (Topic No. 625-020-018)
  http://www.dot.state.fl.us/structures/StructuresManual/CurrentRelease/StructuresManual.shtm

- FDOT Facilities Design Manual (Topic No. 625-020-016)
  http://www.dot.state.fl.us/projectmanagementoffice/Publications/default.shtm

- Florida Intersection Design Guide
  http://www.dot.state.fl.us/rddesign/FIDG-Manual/FIDG.shtm

- NCHRP Report 672 – Roundabouts: An Informational Guide, 2nd Edition
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf

- AASHTO Highway Safety Manual, 1st Edition (AASHTO Bookstore HSM-1)
  ~~https://bookstore.transportation.org/collection_detail.aspx?ID=33~~
  ttps://bookstore.transportation.org/

- Local Agency Program Manual (Topic No. 525-010-300)
  ~~http://www.dot.state.fl.us/projectmanagementoffice/lap/LAP_TOC.shtm~~

- http://www.dot.state.fl.us/programmanagement/LAP/Default.shtm

- Project Development and Environmental Manual Part 1 and Part 2 (Topic No. 650-000-001)
  http://www.dot.state.fl.us/emo/pubs/pdeman/pdeman1.shtm

- Rigid Pavement Design Manual (Topic No. 625-010-006)
  http://www.dot.state.fl.us/rddesign/PM/Publications.shtm

- Flexible Pavement Design Manual (Topic No. 625-010-002)
  http://www.dot.state.fl.us/rddesign/PM/publicationS.shtm

- FDOT Drainage Manual (Topic No. 625-040-002)
  ~~http://www.dot.state.fl.us/rddesign/Hydraulics/ManualsandHandbooks.shtm~~http://www.dot.state.fl.us/rddesign/Drainage/default.shtm

- Soils and Foundations Handbook
  http://www.dot.state.fl.us/structures/DocsandPubs.shtm

- Standard Highway Signs (FHWA)
  http://mutcd.fhwa.dot.gov/ser-shs_millennium.htm

- Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 Edition
  http://mutcd.fhwa.dot.gov/kno_2009r1r2.htm

- Roadway Lighting Design Guide (AASHTO Bookstore GL-6)

  ~~https://bookstore.transportation.org/item_details.aspx?id=320~~https://bookstore.transportation.org/

- AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition with Interims (AASHTO Bookstore LTS-6) https://bookstore.transportation.org/collection_detail.aspx?ID=126

- Highway Functional Classification: Concepts, Criteria and Procedures, 2013 Edition (FHWA)
  http://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section00.cfm

- Highway Capacity Manual 2010 (Transportation Research Board) (TRB Bookstore HCM10)

  ~~http://books.trbbookstore.org/hcm10.aspx~~http://www.trb.org/Main/Blurbs/164718.aspx

- Quality/Level of Service Handbook
  http://www.dot.state.fl.us/planning/systems/programs/sm/los/default.shtm

- Manual on Uniform Traffic Studies (Topic No. 750-020-007)
  http://www.dot.state.fl.us/trafficoperations/Operations/Studies/MUTS/muts.shtm

- Surveying Procedure (Topic No. 550-030-101)
  http://www.dot.state.fl.us/surveyingandmapping/doc_pubs.shtm

- Right of Way Mapping Procedure (Topic No. 550-030-015)
  http://www.dot.state.fl.us/surveyingandmapping/doc_pubs.shtm

- Guide for the Development of Bicycle Facilities, 4th Edition (AASHTO Bookstore GBF-4) https://bookstore.transportation.org/collection_detail.aspx?ID=116
- Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition (AASHTO Bookstore GPF-1) https://bookstore.transportation.org/
- Accessing Transit Design Handbook for Florida Bus Passenger Facilities http://www.dot.state.fl.us/transit/Pages/NewTransitFacilitiesDesign.shtm

CHAPTER 2

LAND DEVELOPMENT

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CHAPTER 2

LAND DEVELOPMENT[HMJ1][HMJ2]

A INTRODUCTION

A major portion of street and highway construction and reconstruction is ~~generated by, and is accomplished as~~ a result of~~,~~ land development for residential, commercial, industrial, and public uses. The general land use layout influences, and is controlled by, connections to adjacent road networks with different transportation modes. Techniques, principles, and general layout used for any development also dictate the resulting internal road network. The arrangement and space allocations for this network may determine whether safe, efficient, and economical streets and highways are constructed or reconstructed.

Land development practices should ~~include design to~~ promote high quality street networks that provide interconnectivity and access control. The street network shall be designed for the safety of all road users ~~-~~– ~~; vehicles,~~ pedestrians, ~~and~~ bicyclists, transit, and motor vehicle operators and passengers.

~~Design t~~The design of the street network and features should be consistent with ~~based on~~ the desired~~appropriate~~ context and ~~features should~~ meet the criteria in this manual. Context based street design ~~should~~ incorporates the following elements:

- Streets are sized and detailed to equitably serve the needs of the intended road users~~automobile and the pedestrian~~,
- Building size and character ~~are regulated to~~ spatially define streets and squares,
- Compact form reduces requirements for energy, infrastructure, and automobile use,
- ~~Facilitates~~ P~~p~~ublic transit is supported through a high level of connectivity and attractive facilities (stops, shelters, hubs).

Some ~~land~~ development patterns, such as conventional suburban ~~development~~, ~~practices~~ do not promote the creation of a high quality, ~~interconnected~~ accessible ~~road~~street network. To promote the creation of context-sensitive high quality interconnected streets~~networks~~:

- Design for desired/target speeds,~~Poor development layouts often result in streets and highways with~~
- Design desirable geometry to achieve sufficient sight distance and appropriate cross section (not too wide or too narrow for the context)~~bad alignment,~~,
- Provide ~~insufficient sight distance, and inadequate cross section. In~~sufficient right of way and space allocations for stormwater, utilities, pedestrian features, and lighting, etc., ~~result in cramped, hazardous intersections, narrow roadside clear zones, and inadequate room for future modifications and expansions.~~
- ~~Failure to p~~Provide reasonable control of access ~~causes hazardous operating conditions and a dramatic reduction in the capacity and economic value of streets and highways~~.

Two of the more recent alternatives to the conventional suburban development patterns include Traditional Neighborhood Development (TND) and Transit Oriented Development (TOD). For more information, refer to ***21st Century Land Development Code***.

~~Although there are many conflicting demands in land development, the provision of an adequate road network is essential in preserving the social and economic value of any area.~~ Development controls are needed to aid in the establishment of safe streets and highways that will retain their efficiency and economic worth. Provisions for adequate alignment, right of way, setbacks, expansion, and access control are essential.

~~It is recognized there are~~There may be ~~many~~ legal, social, and economic ~~problems~~ challenges~~involved~~ in land use controls. Proper coordination among the public, various governmental bodies, and public transit and highway agencies ~~should,~~can ~~however, allow for the~~provide solutions ~~of~~ to many of these ~~problems~~challenges. Implementation of responsible land use and development regulations along with intergovernmental respect for the goals and objectives of each, will promote a ~~superior,~~high-quality long term transportation network.

B OBJECTIVES

Provisions for vehicular and pedestrian safety are important objectives to be considered in land development. Other land development objectives, related to surface transportation, should include the promotion of smooth traffic flow, efficiency, economy, aesthetics, and environmental compatibility of the transportation network.

General objectives for land development that should be followed to promote good highway design include the following:

- ~~Preserve~~ Ensure the function of each street and highway meets its intended purpose and context ~~(i.e., use of arterial and collector streets for local circulation seriously compromises safety and capacity)~~
- Provide for ~~smooth,~~ logical~~,~~ and energy efficient ~~traffic types~~interconnected street network and flow patterns
- Reduce trip lengths
- Encourage~~Provide for~~ the appropriate vehicular speed
- Reduce traffic conflicts to a minimum and eliminate confusion
- ~~Allow for the application of~~Apply safe geometric design principles
- ~~Provide for~~Promote bicycle and pedestrian ~~safety~~use through connectivity and access
- Provide for future modifications and expansion
- Provide for aesthetic and environmental compatibility
- Develop economic design, construction, and maintenance strategies
- Provide for ~~appropriate~~ public transit facilities
- Provide accessibility for ~~disabled individuals~~persons with disabilities

C PRINCIPLES AND GUIDELINES[HMJ3]

There are many variables involved in land development; therefore, specific standards and requirements for land use and road network layouts cannot always be applied. Use of sound principles and guidelines can, however, aid in meeting the objectives of a better road network. Proper planning and design of the development layout are necessary to provide a satisfactory road network and to allow for the construction of safe roadways. The following principles and guidelines should be utilized in the design of the road network, in the control of access, and in the land use controls and space allocation that would affect vehicular and pedestrian use.

C.1 Development Types and Area Types

C.1.a Conventional Suburban Design

This development type was common practice through the 20th century. It is characterized by automobile-dominant design, segregated land uses, and roadways that are often designed primarily for the use of the automobile. The street patterns channel local traffic onto collector streets and roads to reach most destinations. Although destinations are oftentimes adjacent to one another, this conventional suburban design does not typically connect to them directly. This makes walking an inefficient form of transportation in this development type.[HMJ4][KM5]

C.1.b Traditional Neighborhood Design (TND)

This development type is a development alternative that promotes a strong integration of land use and transportation. For further information on TND, refer to Chapter 19 of this Manual.

C.1.c Transit–Oriented Design (TOD)

This development type is defined as a compact, mixed use area within one half mile of a transit stop or station that is designed to maximize walking trips and access to transit. They also are characterized by streetscapes and an urban form oriented to pedestrians to promote walking trips to stations and varied other uses within station areas. Further information on TOD can be found on the Department's website: http://www.fltod.com/.

Transit-supportive planning and development rethinks land-use and development patterns so that communities may be effectively served by a balanced transportation system. Transit-supportive development enables citizens to use a variety of transportation modes for at least one or more of their daily trips between home, work, shopping, school, or services. These concepts are often called new urbanism to distinguish that form of urban design practice.

For more information on Conventional Suburban, TND and TOD, refer to the ***21st Century Land Development Code*** and ***Traditional Neighborhood Development Handbook.***

C.~~1~~2 Network Design

The general layout of the road network establishes the traffic flow patterns and conflicts, thereby determining the basic safety and efficiency criteria. The design of the road network should be based on the following principles:

- The layout of street and highway systems should be logical and easily understood by the user.
- The design and layout of all streets and highways should clearly indicate their function ~~(arterial, collector, etc.)~~[HMJ6].
- Local circulation patterns should be compatible with adjacent areas. ~~Arterials and collectors should not be interrupted or substantially altered at development or jurisdictional boundary lines.~~[HMJ7]
- Flow patterns should be designed to interconnect neighborhoods while discouraging through motorized traffic on local street networks.
- Elements in the local circulation should be adequate to avoid the need for extensive traffic controls.
- Typically, some streets are designed to accommodate a higher speed than the posted speed, which may cause ~~Often there are streets where abuse of posted speed limits becomes an~~ enforcement problems and can have a negative safety impact on the circulation within an urban or residential network. In other situations, ~~there are community concerns with~~ controlling speed levels is important ~~such as~~ in areas of concentrated pedestrian activities, ~~those~~ areas with narrow right of way, areas with numerous access

points, and ~~on~~ on-street parking~~, and other similar concerns~~. Local authorities may elect to use traffic calming design features which are presented in ***Chapter 15 - Traffic Calming***.

- The internal circulation should be sufficient to provide reasonable travel distance for local trips.

- The road network should be compatible with other transportation modes such as mass transit and pedestrian and bicycle facilities. Conflicts between different modes (particularly with pedestrian and bicycle traffic) should be kept to a minimum.

- The road network layout should be designed to reduce internal traffic and pedestrian conflicts and ~~eliminate confusion~~to design effective transition elements ~~. Particular emphasis should be directed toward~~ to eliminate~~ing~~ substantial speed differentials and hazardous turning and crossing maneuvers. The following principles should be utilized for conflict reduction:

- Generally the number of intersections should ~~be kept to a minimum but should~~ meet user needs, support development patterns, ~~land use needs~~ and traffic flow and connectivity requirements.

- Roundabouts should be evaluated for installation at new intersections. Consideration should be given to redesigning existing intersections as roundabouts. For further information on roundabouts, refer to the ***National Cooperative Highway Research Project (NCHRP) 672*** and ***674***.

- ~~Local~~ O~~o~~ne-way streets are an option to consider where feasible.

- ~~Local~~ S~~s~~treets should be designed to limit vehicle speeds (length, width, alignment, and intersections).

- The network should be designed to reduce the number of crossings and left turn maneuvers that are required.

C.~~2~~3 Access Control[HMJ8]

The standards and requirements presented in ***Chapter 3 - Geometric Design***, are absolutely necessary to maintain safe and efficient streets and highways. Failure to provide adequate control of access has seriously damaged many existing roadways. Unrestricted access to major collectors and arterials has dramatically reduced their capacity and general economic value. The safety characteristics of these facilities have similarly been diminished by significantly increasing the number of vehicular, pedestrian, and bicycle traffic conflicts.

The utilization of proper control over access is one of the most effective and economical means for maintaining the safety and utility of streets and highways. The procedures and controls used for land development significantly affect access control. The following principles should be utilized in the formation of land use controls for limiting access:

- The standards presented in ***CHAPTER 3 - GEOMETRIC DESIGN, C.8 Access Control***, should provide the basis for establishing land development criteria for control of access.
- The use of an arterial or major collector as an integral part of the internal circulation pattern on private property should be prohibited.
- The intersection of private roads and driveways with arterials or major collectors should be strictly controlled.
- Access to sites which generate major traffic (vehicular, pedestrian, and bicycle), should be located to provide the minimum conflict with other traffic. These generators include schools, shopping centers, business establishments, industrial areas, entertainment facilities, etc.
- Commercial strip development, with the associated proliferation of driveways, should be eliminated. Vehicular and pedestrian interconnections should be encouraged.
- The function of all streets and highways should be preserved by the application of the appropriate access controls.
- The spacing and location of access points should be predicated upon reducing the total traffic and pedestrian conflict.
- Hazardous maneuvers should be restricted by access controls. For example, crossing and left turn maneuvers may be controlled by continuous median separation. Pedestrian access should be allowed at appropriate intervals. Medians with waiting space for pedestrians crossing the street are often necessary.

C.~~3~~4 Land Use Controls and Space Allocation[HMJ9][HMJ10]

The provisions for adequate space and proper location of various activities is essential to promote safety and efficiency. The following guidelines should be utilized in land use:

- Adequate corridors and space should be considered for utilities. Utility locations should be carefully chosen to minimize interference with the operation of the streets, highways, and sidewalks.

- Adequate space for drainage facilities should be provided. Open drainage facilities should be located well clear of the traveled way.

- Design for pedestrian and bicycle facilities should comply with ***Chapter 8 – Pedestrian Facilities*** and ***Chapter 9 – Bicycle Facilities***.

- Adequate space should be provided for off-street and side-street parking. This is essential in commercial and industrial areas.

- Right of way and setback requirements should be adequate to provide ample sight distance at all intersections.

- Sufficient space should be allocated for the development of adequate intersections, including accessibility for disabled individuals.

- Space allocation for street lighting (existing or planned) should be incorporated into the initial plan. Supports for this lighting should be located outside of the required clear zone unless they are clearly of breakaway type, or are guarded by adequate protective devices. Lighting plans should provide for well-lit, safe waiting and walking areas and shall conform with the provisions of ***Chapter 6 – Lighting***.

- Sufficient right of way should be provided for future widening, modification, or expansion of the highway network.

- Adequate corridors for future freeways, High Occupancy Vehicle (HOV) lanes, arterials, or major collectors should be provided.

- Adequate space for desired or required greenways should be provided.

- Adequate space for appropriate public transit facilities should be provided.

D ~~CONFLICT AND~~ COORDINATION[HMJ11][HMJ12]

There are many demands that ~~tend to~~can conflict with the development of safe and efficient streets and highways. Meeting the demand for access can ~~frequently destroy~~negatively impact the capacity of a roadway. Pressure to limit the amount of land dedicated for streets and highways inhibits the construction of an adequate road system. Coordination between highway agencies and other governmental bodies can~~, however,~~ assist in improving the procedures used in land development. Proper coordination should be solicited from legislative bodies, courts, planning and zoning departments, and transit and other governmental agencies to aid in ~~guaranteeing~~ developing a ~~well~~ well-designed ~~and adequate~~ highway network. Coordination with transit planners, developers, engineers, architects, contractors, and other private individuals~~, which is also beneficial,~~ should be a continuous process.

The ***Florida Metropolitan Planning Organization Advisory Council (MPOAC)*** is a statewide transportation planning and policy organization created by the Florida Legislature pursuant to ***Section 339.175(11), Florida Statutes***, to augment the role of individual MPOs in the cooperative transportation planning process. The MPOAC assists MPOs in carrying out the urbanized area transportation planning process by serving as the principal forum for collective policy discussion. Further information on the MPOAC, including links to MPOs, can be found at http://www.mpoac.org/.

E CONTROL TECHNIQUES[HMJ13]

The implementation of a sound highway transportation plan requires certain controls. A logical network design, adequate access controls, and proper land use controls are dependent upon and foster proper land development practices. Techniques that may be utilized to establish these necessary controls include the following:

E.1 Right of Way Acquisition

The acquisition of sufficient right of way is essential to allow for the construction of adequate streets and highways as specified in CHAPTER 3 - GEOMETRIC DESIGN and CHAPTER 4 - ROADSIDE DESIGN. The provision of adequate space for clear roadside, sight distance, drainage facilities, buffer zones, intersections, transit, sidewalks, frontage roads, and future expansion is also necessary to develop and maintain safe streets and highways.

E.2 ~~Police Power~~Regulatory Authority

The regulatory authority of state and local highway agencies (and other related agencies) should be sufficient to implement the necessary land use controls. The following general regulatory requirements and specific areas of control should be considered as minimum:

E.2.a General Regulatory Requirements

The necessary elements for achieving the following transportation goals should be incorporated into all land use and zoning ordinances:

- General highway transportation plans should be created and implemented.
- Determination and acquisition of transportation corridors for future expansions is essential.
- Development plans clearly showing all street and highway layouts, transit facilities, pedestrian and bicycle facilities, and utility corridors should be required. The execution of these plans should be enforceable.

- Development plans, building permits, and zoning should be reviewed by the appropriate agency.
- A safety check of proposed streets and highways should be a required step in the review and acceptance of all development plans.

E.2.b Specific Control

Specific areas of control necessary to develop adequate and efficient roadways include the following:

- Land use control and development regulations
- Control of access
- Driveway design
- Street and highway layouts
- Location of vehicular and pedestrian generators
- Location of transit, pedestrian, and bicycle facilities
- Right of way and setback requirements for sight distances and clear zone
- Provisions for drainage

E.3 Contracts and Agreements

Where land purchase or regulatory authority is not available or appropriate, the use of contractual arrangements or agreements with individuals can be beneficial. Negotiations with developers, builders, and private individuals should be used, where appropriate, to aid in the implementation of the necessary controls.

E.4 Education

Education of the public, developers, and governmental bodies can be beneficial in promoting proper land development controls. The need for future planning, access control, and design standards should be clearly and continuously emphasized. Successful solidification of the cooperation of the public and other governmental bodies depends upon clear presentation of the necessity for reasonable land development controls.

F REFERENCES

- ~~-~~21st Century Land Development Code
  https://www.planning.org/publications/book/9026709/
- Florida Transportation Plan
  http://floridatransportationplan.com/
- Florida Growth Management and Comprehensive P~~p~~lanning L~~l~~aws (DOE)
  http://www.floridajobs.org/community-planning-and-development
- 1000 Friends of~~OF~~ Florida~~ and land development~~
  http://www.1000fof.org/
- Florida Metropolitan Planning Organization Advisory Council (MPOAC)
  http://www.mpoac.org/
- Understanding Sprawl, A Citizen's Guide
  http://www.davidsuzuki.org/publications/resources/2003/understanding-sprawl-a-citizens-guide/
- Traditional Neighborhood Development Handbook
  http://www.dot.state.fl.us/rddesign/FloridaGreenbook/TND-Handbook.pdf

CHAPTER 3

GEOMETRIC DESIGN

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CHAPTER 3

GEOMETRIC DESIGN

A INTRODUCTION

Geometric design is defined as the design or proportioning of the visible elements of the street or highway. The geometry of the street or highway is of central importance since it provides the framework for the design of other highway elements. In addition, the geometric design establishes the basic nature and quality of the vehicle path, which has a primary effect upon the overall safety characteristics of the street or highway.

The design of roadway geometry must be conducted in close coordination with other design elements of the street or highway. These other elements include: pavement design, roadway lighting, traffic control devices, transit, drainage, and structural design. The design should consider safe roadside clear zones, pedestrian safety, emergency response, and maintenance capabilities.

The safety characteristics of the design should be given primary consideration. The initial establishment of sufficient right of way and adequate horizontal and vertical alignment is not only essential from a safety standpoint, but also necessary to allow future upgrading and expansion without exorbitant expenditure of highway funds.

The design elements selected should be reasonably uniform but should not be inflexible.

The minimum standards presented in this chapter should not automatically become the standards for geometric design. The designer should consider use of a higher level, when practical, and consider cost-benefits as well as consistency with adjacent facilities. Reconstruction and maintenance of facilities should, where practical, include upgrading to these minimum standards.

In restricted or unusual conditions, it may not be possible to meet the minimum standards. In such cases, the designer shall obtain an exception in accordance with ***Chapter 14 – Design Exceptions*** from the reviewing or permitting organization. However, every effort should be made to obtain the best possible alignment, grade, sight distance, and proper drainage consistent with the terrain, the development, safety, and fund availability. The concept of road users has expanded in recent years creating additional considerations for the designer.

In making decisions on the standards to be applied to a particular project, the designer must also address the needs of pedestrians, bicyclists, elder road and transit users, people with disabilities, freight movement and other users and uses. This is true for both urban and rural facilities.

The design features of urban local streets are governed by practical limitations to a greater extent than those of similar roads in rural areas. The two dominant design controls are: (1) the type and extent of urban development and its limitations on rights of way and (2) zoning or regulatory restrictions. Some streets primarily are land service streets in residential areas. In such cases, the overriding consideration is to foster a safe and pleasing environment. Other streets are land service only in part, and features of traffic and public transit service may be predominant.

The selection of the type and exact design details of a particular street or highway requires considerable study and thought. When reference is made to guidelines and design details given by current American Association of State Highway and Transportation Officials (AASHTO) publications, these guidelines and standards should generally be considered as minimum criteria. For the design of recreational roads, local service roads, and alleys, see ***AASHTO Policy on Geometric Design of Streets and Highways (2011) (Greenbook)*** and other publications.

Right of way and pavement width requirements for new construction may be reduced for the paving of certain existing unpaved streets and very low volume rural roads provided all of the conditions listed below are satisfied:

- The road is functionally classified as a local road.
- The 20-year projected ADT is less than or equal to 400 vehicles per day and the design year projected peak hourly volume is 100 vehicles per hour or less. Note: The design year may be any time within a range of the present to 20 years in the future, depending on the nature of the improvement.
- The road has no foreseeable probability of changing to a higher functional classification through changes in land use, extensions to serve new developing land areas, or any other use which would generate daily or hourly traffic volumes greater than those listed above.
- There is no reasonable possibility of acquiring additional right of way without:
    - Incurring expenditures of public funds in an amount which would be excessive compared to the public benefits achieved

- Causing substantial damage or disruption to abutting property improvements to a degree that is unacceptable considering the local environment

B OBJECTIVES

The major objective in geometric design is to establish a vehicle path and environment providing a reasonable margin of safety for the motorist, transit, bicyclist, and pedestrian under the expected operating conditions and speed. It is recognized that Florida's design driver is aging and tourism is our major industry. This gives even more emphasis on simplicity and easily understood geometry. The design of street or highway features should consider the following:

- Provide the most simple geometry attainable, consistent with the physical constraints
- Provide a design that has a reasonable and consistent margin of safety at the expected operating speed
- Provide a design that is safe at night and under adverse weather conditions
- Provide a facility that is adequate for the expected traffic conditions and transit needs
- Allow for reasonable deficiencies in the driver, such as:
    - Periodic inattention
    - Reduced skill and judgment
    - Slow reaction and response
- Provide an environment that minimizes hazards, is as hazard free as practical, and is "forgiving" to a vehicle that has deviated from the travel path or is out of control.

C DESIGN ELEMENTS

C.1 Design Speed

Design speed is a selected speed used to determine the various geometric design features of the street or highway. Selection of an appropriate design speed must consider the anticipated operating speed, topography, existing and future adjacent land use, and functional classification. Consideration must also be given to pedestrian and bicycle usage.

Many critical design features such as sight distance and curvature are directly related to, and vary appreciably with, design speed. For this reason, the selected design speed should be consistent with the speeds that drivers are likely to expect on a given street or highway facility. The design speed shall not be less than the expected posted or legal speed limit. Once the design speed is selected, all pertinent highway features should be related to it to obtain a balanced design.

Above minimum design criteria for specific design elements such as flatter curves and longer sight distances should be used where practical, particularly on high speed facilities. On lower speed facilities, use of above minimum values may encourage travel at speeds higher than the design speed.

The design speed utilized should be consistent over a given section of street or highway. Required changes in design speed should be effected in a gradual fashion. When isolated reductions in design speed cannot reasonably be avoided, appropriate speed signs should be posted.

The AASHTO Policy on Geometric Design of Streets and Highways (2011) may be referenced for a more thorough discussion of design speed.

Recommended values for design speed are provided in Table 3-1 Recommended Design Speed. These values should be considered as general guidelines only.

High speed facilities are defined as those facilities with design speeds 50 mph and greater. Low speed facilities are defined as those facilities with design speeds 45 mph and less.

Table 3 – 1 Recommended ~~MINIMUM~~ Design Speed (mph[KM1])

Facility[1]		AADT (vpd)	Terrain	Design Speed[KM2] (mph)
Freeways	Rural	All	Level and Rolling	70
	Urban	All	Level and Rolling	50 – 70[2]
Arterials	Rural	All	Level	60 – 70
			Rolling	50 – 70
	Urban	All	All	30 – 60[3]
Collectors	Rural	≥ 400	Level	60 – 65 (50 mph min for AADT 400 to 2000)
			Rolling	50 – 65 (40 mph min for AADT 400 to 2000)
		< 400	Level	40 – 60
			Rolling	30 – 60
	Urban	All	All	30 – 50[3]
Local	Rural	≥ 400	Level	50 – 60
			Rolling	40 – 60
		< 400	Level	40 – 60 (30 mph min for AADT < 250)
			Rolling	30 – 60 (20 mph min for AADT < 50)
	Urban	All	All	20 – 30[4]

Footnotes:

1. Urban design speeds are applicable to streets and highways located within designated urban boundaries as well as those streets and highways outside designated urban boundaries yet within small communities or urban like developed areas~~in designated rural areas~~. Rural design speeds are applicable to all other rural areas.
2. A design speed of 70 mph should be used for urban freeways when practical. Lower design speeds should only be used in highly developed areas with closely spaced interchanges. For these areas a minimum design speed of 60 mph is recommended unless it can be shown lower speeds will be consistent with driver expectancy.
3. Lower speeds apply to central business districts and in more developed areas while higher speeds are more applicable to outlying and developing areas.
4. Since the function of urban local streets is to provide access to adjacent property, all design elements should be consistent with the character of activity on and adjacent to the street, and should encourage speeds generally not exceeding 30 mph.

~~TYPE OF ROADWAY~~	~~URBAN~~		~~RURAL~~	
	~~*SPEED RESTRICTIONS~~		~~*SPEED RESTRICTIONS~~	
	~~WITH~~	~~WITHOUT~~	~~WITH~~	~~WITHOUT~~
~~Freeway or Expressway~~	~~50 - 60~~		~~70~~	
~~Arterial (Major)~~	~~040 - 4555~~		~~55 70~~	
~~Arterial (Minor)~~	~~3550~~		~~5570~~	
~~Collector (Major)~~	~~203545~~		~~50065~~	
~~Collector (Minor)~~	~~3040~~		~~4060~~	
~~Local **~~	~~152030~~		~~3050~~	

~~Source: 2004 AASHTO Greenbook, Design Controls and Criteria, Design Speed, Pages 67 – 72, 420~~

~~* Speed restrictions are features of the design which would effectively limit the operating speed, such as:~~

~~a. Short length of roadway (i.e., dead-end street)~~
~~b. Closely spaced stop signs, traffic signals or other control devices~~
~~c. Locations that would by nature of the surrounding development or land use, indicate to the driver that lower speeds were necessary~~

~~** Design speeds lower that 30 mph may be used for local, subdivision type roads and streets. Streets with a design speed less than 30 mph shall be posted with appropriate legal speed limit signs.~~

C.2 Design Vehicles

A "design vehicle" is a vehicle with representative weight, dimensions, and operating characteristics, used to establish street and highway design controls for accommodating vehicles of designated classes. For the purpose of geometric design, the design vehicle should be one with dimensions and minimum turning radii larger than those of almost all vehicles in its class. Design vehicles are listed in Table 3 -2 Design Vehicles. One or more of these vehicles should be used as a control in the selection of geometric design elements. In certain industrial (or other) areas, special service vehicles may have to be considered in the design.

Fire equipment and emergency vehicles should have reasonable access to all areas.

If a significant number or percentage (5 percent of all the total traffic) of vehicles of those classes larger than passenger vehicles are likely to use a particular street or highway, that class should be used as a design control. The design of arterial streets and highways should normally be adequate to accommodate all design vehicles. The decision as to which of the design vehicles (or other special vehicles) should be used as a control is complex and requires careful study. Each situation must be evaluated individually to arrive at a reasonable estimate of the type and volume of expected traffic.

- Design criteria significantly affected by the type of vehicle include:
- Horizontal and vertical clearances
- Alignment
- Lane widening on curves
- Shoulder width requirements
- Turning roadway and intersection radii
- Intersection sight distance
- Acceleration criteria

Particular care should be taken in establishing the radii at intersections, so vehicles may enter the street or highway without encroaching on adjacent travel lanes or leaving the pavement. It is acceptable for occasional trucks or buses to make use of both receiving lanes, especially on side streets.

Table 3 – 2 Design Vehicles[JM3][KM4][KM5][KM6][MAK7]

DESIGN VEHICLE		DIMENSIONS IN FEET					
Type	Symbol	Wheelbase	Overhang		Overall Length	Overall Width	Height
			Front	Rear			
Passenger Car	P	11	3	5	19	7	4.3
Single Unit Truck	SU-30	20	4	6	30	8	11-13.5
Single Unit Truck – 3 Axle	SU-40	25	4	10.5	39.5	8	11-13.5
City Transit Bus	CITY-BUS	25	7	8	40	8.5	10.5
Conventional School Bus (65 passenger)	S-BUS 36	21.3	2.5	12.0	35.8	8.0	10.5
Articulated Bus	A-BUS	22+19.4=41.4	8.6	10	60	8.5	11
Motor Home	MH	20	4	6	30	8	12
Car & Camper Trailer	P/T	11+5+17.7=33.7**	3	12	48.7	8	10
Car & Boat Trailer	P/B	11+5+15=31**	3	8	42	8	---
Intermediate Semitrailer	WB-40	12.5+25.5=38	3	4.5	45.5	8	13.5
Interstate Semitrailer	WB-62	19.5+41=60.5	4	4.5	69	8.5	13.5
Florida Interstate Semitrailer	WB-62FL	19.5+41=60.5	4	9	73.5	8.5	13.5
Interstate Semitrailer	WB-67	21.6+45.4=67	4	2.5	73.5	8.5	13.5
"Double-Bottom"-Semitrailer/Trailer Combination	WB-67D[JM8]	11+23+10*+22.5=66.5	2.3	3.0	72.3	8.5	13.5

Source: 2011 AASHTO Greenbook, Design Controls and Criteria, Table 2-1b.

* Distance between rear wheels of front trailer and front wheels of rear trailer

** Distance between rear wheels of trailer and front wheels of car

C.3 Sight Distance

The provision for adequate horizontal and vertical sight distance is an essential factor in the development of a safe street or highway. An unobstructed view of the upcoming roadway is necessary to allow time and space for the safe execution of passing, stopping, intersection movements, and other normal and emergency maneuvers. It is also important to provide as great a sight distance as possible to allow the driver time to plan for future actions. The driver is continuously required to execute normal slowing, turning, and acceleration maneuvers. If he can plan in advance for these actions, traffic flow will be smoother and less hazardous. Unexpected emergency maneuvers will also be less hazardous if they are not combined with uncertainty regarding the required normal maneuvers. The appropriate use of lighting (***Chapter 6 - Lighting***) may be required to provide adequate sight distances for night driving.

Future obstruction to sight distance that may develop (e.g., vegetation) or be constructed should be taken into consideration in the initial design. Areas outside of the road right of way that are not under the highway agency's jurisdiction should be considered as points of obstruction. Planned future construction of median barriers, guardrails, grade separations, or other structures should also be considered as possible sight obstructions.

C.3.a Stopping Sight Distance

Safe stopping sight distances shall be provided continuously on all streets and highways. The factors, which determine the minimum distance required to stop, include:

- Vehicle speed
- Driver's total reaction time
- Characteristics and conditions of the vehicle
- Friction capabilities between the tires and the roadway surface
- Vertical and horizontal alignment of the roadway

It is desirable that the driver be given sufficient sight distance to avoid an object or slow moving vehicle with a natural, smooth maneuver rather than an extreme or panic reaction.

The determination of available stopping sight distance shall be based on a height of the driver's eye equal to 3.50 feet and a height of obstruction to be avoided equal to two feet (2.0 feet). It would, of course, be desirable to use a height of obstruction equal to zero (coincident with the roadway surface) to provide the driver with a more positive sight condition. Where horizontal sight distance may be obstructed on curves, the driver's eye and the obstruction shall be assumed to be located at the centerline of the traffic lane on the inside of the curve.

The stopping sight distance shall be no less than the values given in Table 3-3 Stopping Sight Distances.

Table 3 – 3 Stopping Sight Distances

MINIMUM STOPPING SIGHT DISTANCES (feet) (For application of stopping sight distance, use an eye height of 3.50 feet and an object height of 2 feet above the road surface)												
Design Speed (mph)		20	25	30	35	40	45	50	55	60	65	70
Stopping Sight Distance (feet)		115	155	200	250	305	360	425	495	570	645	730

Source: 2011 AASHTO Greenbook, Table 3-1.

C.3.b Passing Sight Distance

The passing maneuver, which requires occupation of the opposing travel lane, is inherently dangerous. The driver is required to make simultaneous estimates of time, distance, relative speeds, and vehicle capabilities. Errors in these estimates result in frequent and serious crashes.

Streets or highways with two or more travel lanes in a given direction are not subject to requirements for safe passing sight distance. Two-lane, two-way highways should be provided with safe passing sight distance for as much of the highway as feasible. The driver demand for passing opportunity is high and serious limitations on the opportunity for passing reduces the capacity and safe characteristics of the highway.

The distance traveled after the driver's final decision to pass (while encroaching into the opposite travel path) is that which is required to pass and return to the original travel lane in front of the overtaken vehicle. In addition to this distance, the safe passing sight distance must include the distance traveled by an opposing vehicle during this time period, as well as a reasonable margin of safety. Due to the many variables in vehicle characteristics and driver behavior, the passing sight distance should be as long as is practicable.

The determination of passing sight distance shall be based on a height of eye equal to 3.50 feet and a height of object passing equal to 3.50 feet. Where passing is permitted, the passing sight distance shall be no less than the values given in Table 3-4 Passing Sight Distances.

Table 3 – 4 Passing Sight Distances

MINIMUM PASSING SIGHT DISTANCES (feet) (For application of passing sight distance, use an eye height of 3.50 feet and an object height of 3.50 feet above the road surface)											
Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
Minimum Passing Sight Distance (feet)	400	450	500	550	600	700	800	900	1000	1100	1200

Source: 2011 AASHTO Greenbook, Table 3-4.

C.3.c Sight Distance at Decision Points

It is desirable to provide sight distances exceeding the minimum at changes in geometry, approaches to intersections, entrances and exits, and other potential decision points or hazards. The sight distance should be adequate to allow the driver sufficient time to observe the upcoming situation, make the proper decision, and take the appropriate action in a normal manner.

Minimum stopping distance does not provide sufficient space or time for the driver to make decisions regarding complex situations requiring more than simple perception-reaction process. In many cases, rapid stopping or lane changing may be extremely undesirable and cause hazardous maneuvers (i.e., in heavy traffic conditions); therefore, it would be preferable to provide sufficient sight distance to allow for a more gradual reaction.

The sight distance on a freeway preceding the approach nose of an exit ramp should exceed the minimum by 25 percent or more. A minimum sight distance of 1000 feet, measured from the driver's eye to the road surface is a desirable goal. There should be a clear view of the exit terminal including the exit nose.

C.3.d Intersection Sight Distance

Sight distances for intersection movements are given in the general intersection requirements (C.9 Intersection Design, this chapter).

C.4 Horizontal Alignment

C.4.a General Criteria

The standard of alignment selected for a particular section of street or highway should extend throughout the section with no sudden changes from easy to sharp curvature. Where sharper curvature is unavoidable, a sequence of curves of increasing degree should be utilized.

Winding alignment consisting of sharp curves is hazardous, reduces capacity, and should be avoided. The use of as flat a curve as possible is recommended. Flatter curves are not only less hazardous, but also frequently less costly due to the shortened roadway.

Maximum curvature should not be used in the following locations:

- High fills or elevated structures. The lack of surrounding objects reduces the driver's perception of the roadway alignment.
- At or near a crest in grade
- At or near a low point in a sag or grade
- At the end of long tangents
- At or near intersections, transit stops, or points of ingress or egress
- At or near other decision points

The "broken back" arrangement of curves (short tangent between two curves in the same direction) should be avoided. This is acceptable only at design speeds of 30 mph or less. This arrangement produces an unexpected and hazardous situation.

When reversals in alignment are used and superelevation is required, a sufficient length of tangent between the reverse curves is required for adequate superelevation transition.

Compound curves should be avoided, especially when curves are sharp. They tend to produce erratic and dangerous vehicle operations. When compound curves are necessary, the radius of the flatter curve should not be more than 50 percent greater than the sharper curve.

The transition between tangents and curves should normally be accomplished by the use of appropriate straight-line transitions or spirals. This is essential to assist the driver in maintaining his vehicle in the proper travel path.

For small deflection angles, curves should be suitably lengthened to avoid the distracting appearance of a kink. Curves should be at least 900 feet long for a central angle of 1 degree or 500 feet long for a central angle of 5 degrees. Gently flowing alignment is generally more pleasing in appearance, as well as, superior from a safety standpoint.

C.4.b Superelevation

In the design of street and highway curves, it is necessary to establish a proper relationship between curvature of the roadway and design speed. The use of superelevation (rotation of the roadway about its axis) is employed to counteract centrifugal force and allow drivers to comfortably and safely travel through curves at the design speed.

The superelevation rates for rural highways, urban freeways, and high speed urban highways are shown in Figure 3 - 1 Rural Highways, Urban Freeways and High Speed Urban Highways. These rates are based on a maximum rate of 0.10 foot per foot of roadway width. Additional superelevation details, given in the Department's Design Standards, may be considered.

The superelevation rates recommended for urban highways and high speed urban streets are shown in Figure 3 -2 Superelevation Rates (e) For Urban Highways and High Speed Urban Streets. These rates are based on a maximum superelevation rate of 0.05 foot per foot and are recommended for arterials and collectors in built up areas. Additional information regarding superelevation, given in the Department's Design Standards, and ***AASHTO – "A Policy on Geometric Design of Highways and Streets" -2011***, may be considered.

Although superelevation is advantageous for traffic operations, various factors combine to make its use impractical in many built-up areas. Such factors include:

- Wide pavement areas
- Need to meet grade of adjacent property
- Surface drainage considerations
- Frequency of cross streets, alleys, and driveways

Therefore, horizontal curves on lower speed streets in residential and urban areas are usually designed without superelevation, only side friction being used to counteract the centrifugal force. Figure 3 3 Maximum Safe Speed for Horizontal Curves Urban-Lower Speed Streets may be used for determination of the maximum safe speed for horizontal curves on lower speed urban streets.

Figure 3 – 1 Rural Highways, Urban Freeways and High Speed Urban Highways

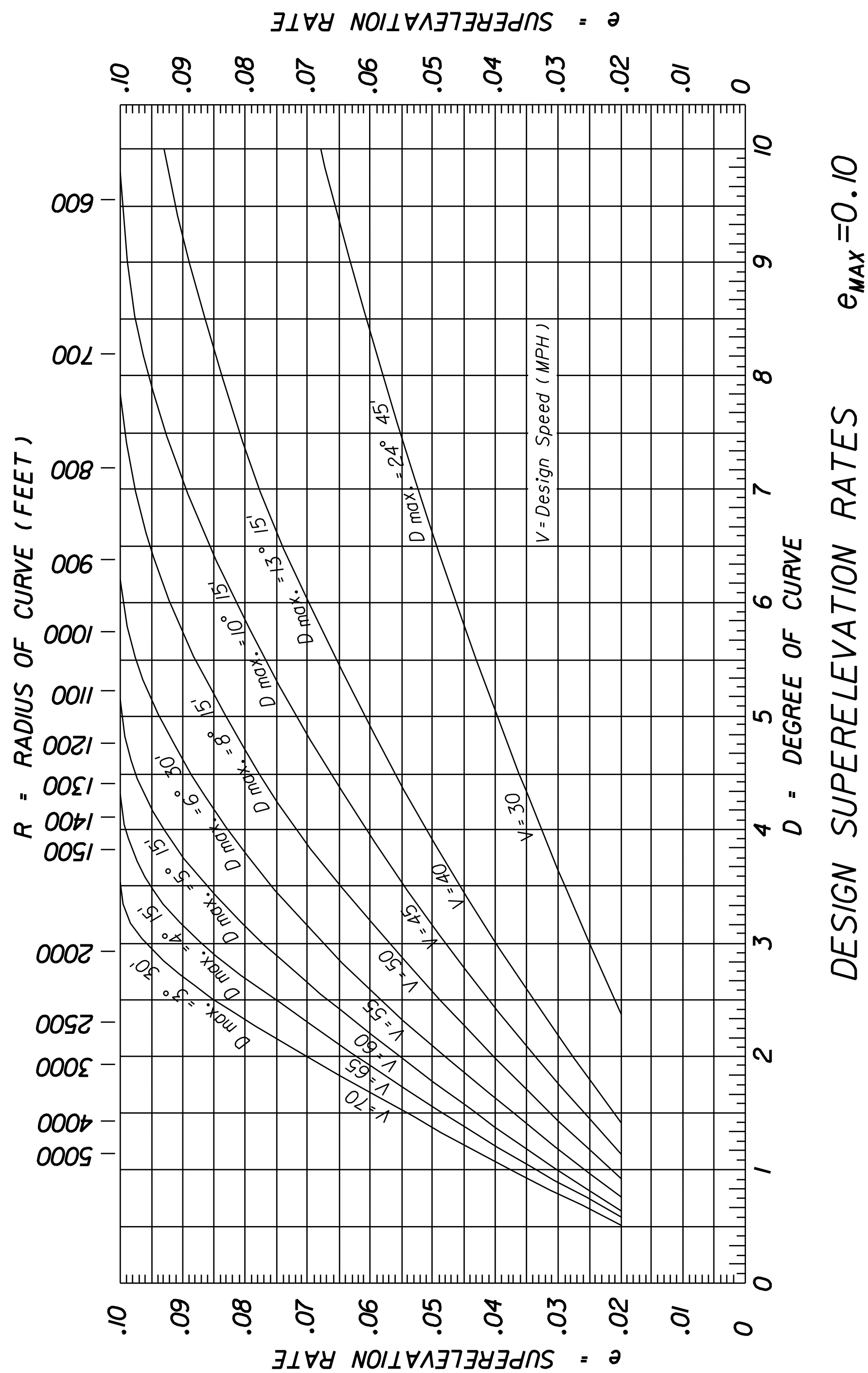
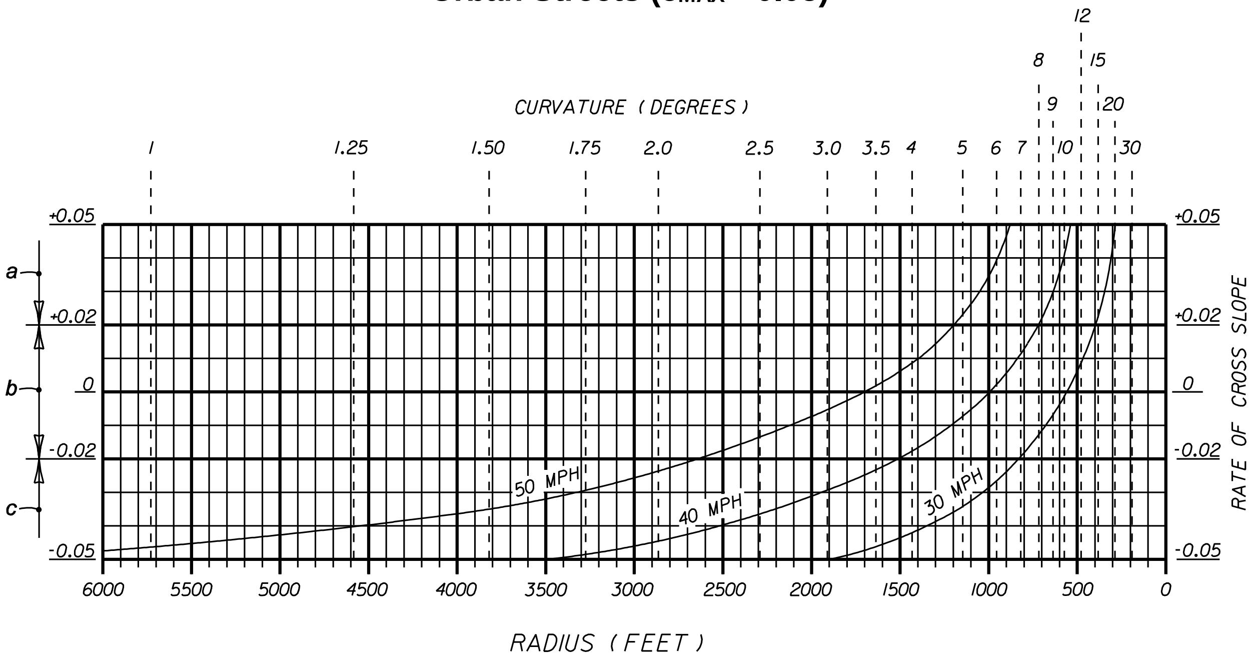


Figure 3 – 2 Superelevation Rates (e) For Urban Highways and High Speed Urban Streets (e_{MAX} =0.05)



a. When the speed curves and the degree of curve lines intersect above this line, the pavement is to be superelevated (positive slope) at the rates indicated at the lines intersecting points.

b. When the speed curves and the degree of curve lines intersect between these limits, the pavement is to be superelevated at the rate of 0.02 (positive slope).

c. When the speed curves and the degree of curve lines intersect below this line, the pavement is to have normal crown (typically 0.02 and 0.03 downward slopes).

Figure 3 – 3 Maximum Safe Speed For Horizontal Curves Urban-Lower Speed Streets[MAK9]

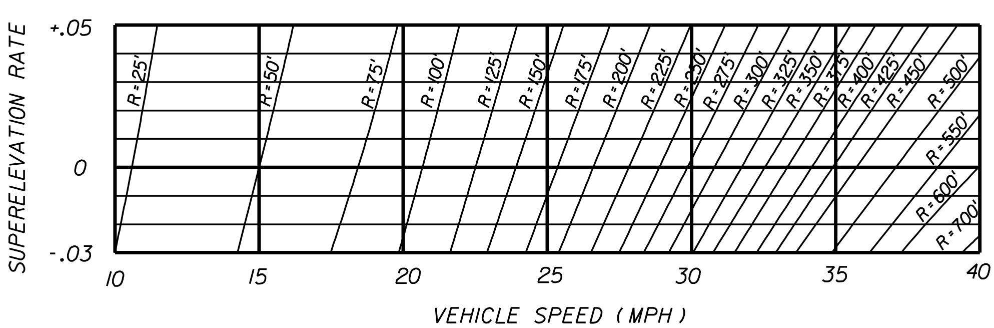
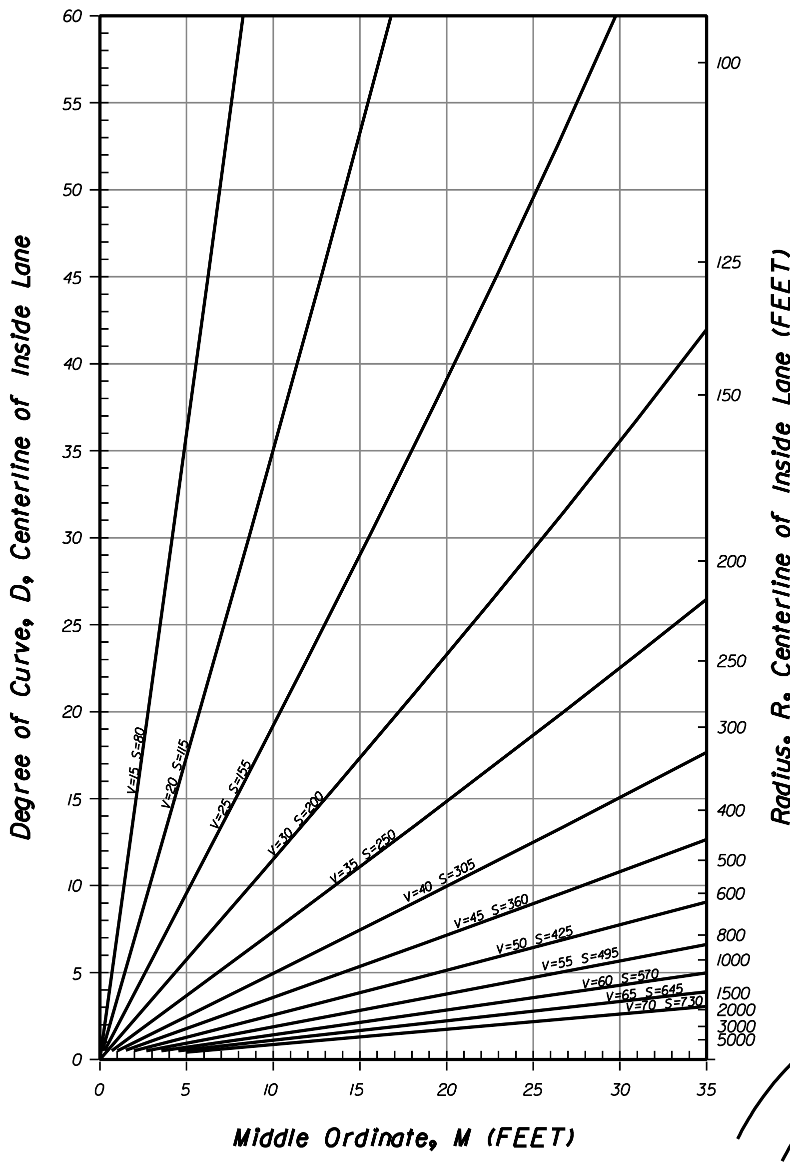


Figure 3 – 4 Sight Distance on Curves



$$M = \frac{5730}{D}\left(1 - \cos\frac{SD}{200}\right)$$

$$R = \frac{5730}{D} \quad \text{and} \quad \theta = \frac{SD}{200}$$

$$M = R\,(1 - \cos\theta)$$

$$M = R\left(1 - \cos\frac{28.65\,S}{R}\right)$$

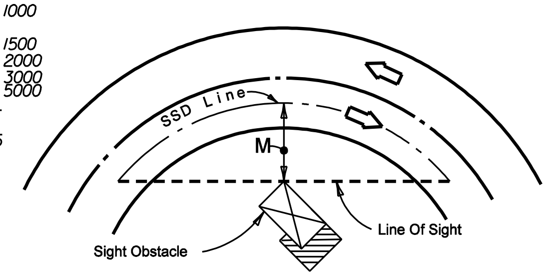
Where

S = Stopping Sight Distance (FEET)

D = Degree of Curve

M = Middle Ordinate (FEET)

R = Radius (FEET)



RELATION BETWEEN DEGREE OF CURVE AND VALUE OF MIDDLE ORDINATE NECESSARY TO PROVIDE STOPPING SIGHT DISTANCE ON HORIZONTAL CURVES UNDER OPEN ROAD CONDITIONS.

C.4.c Curvature

Where a directional change in alignment is required, every effort should be made to utilize the smallest degree (largest radius) curvature possible. The use of the maximum degree of curvature should be avoided when possible. Design speed maximum degree of curvature relationships are given in Table 3 - 5 Horizontal Curvature. The use of sharper curvature for the design speeds shown in Table 3 - 5 would call for superelevation beyond the limit considered practical or for operation with tire friction beyond safe or comfortable limits or both. The maximum degree of curvature is a significant value in alignment design.

Table 3 – 5 Horizontal Curvature[HMJ10]

RURAL Based on e_{MAX} = 0.10			URBAN High-Speed Highways and Streets Based on e_{MAX} = 0.05		
Design Speed (mph)	Max. Degree of Curvature	Min. Radius (feet)	Design Speed (mph)	Max. Degree of Curvature	Min. Radius (feet)
20	~~79~~57° ~~30'~~45'	~~75~~100	---	---	---
25	~~45~~36° 15'	~~130~~160	---	---	---
30	~~28~~24° ~~30'~~45'	~~200~~230	30	~~23~~20° ~~45'~~00'	~~245~~285
35	~~19~~17° ~~30'~~45'	~~295~~320	35	~~16~~14° ~~00'~~15'	~~360~~400
40	13° ~~45'~~15'	~~415~~430	40	~~11~~10° ~~15'~~45'	~~510~~535
45	10° ~~30'~~15'	~~540~~555	45	8° 15'	~~680~~695
50	8° 15'	695	50	6° 30'	880
55	6° 30'	880	55	5° 00'	1125
60	5° 15'	1095	---	---	---
65	4° 15'	1345	---	---	---
70	3° 30'	1640	---	---	---

LOW-SPEED URBAN STREETS				
Design Speed (mph)	With e_{MAX} = 0.05		Without Superelevation (e_{MAX} = -0.02)	
	Max. Degree of Curvature	Min. Radius (feet)	Max. Degree of Curvature	Min. Radius (feet)
20	~~68~~75° ~~45'~~00'	~~85~~75	~~53~~60° ~~30'~~00'	~~110~~95
25	~~38~~41° 30'	~~150~~140	~~28~~31° 45'	~~200~~180
30	~~23~~25° 45'	~~240~~225	~~17~~19° ~~00'~~15'	~~335~~300

(TABLE CONTINUES ON NEXT PAGE)

Table 3 – 5 Horizontal Curvature
(Continued)

LATERAL CLEARANCE FROM EDGE OF TRAVELED WAY~~PAVEMENT~~ TO OBSTRUCTION FOR MAXIMUM CURVATURE (DEGREES), BASED ON LINE OF SIGHT ON INSIDE LANE (Lateral Clearance = $M_{\text{Inside Lane}} - 6'$) Based on $e_{MAX} = 0.10$		
Design Speed (mph)	Maximum Curvature	Clearance (feet)
20	57° 45'	11[KM11][KM12][HMJ13]
25	36° 15'	13
30	24° 45'	16
35	17° 45'	19
40	13° 15'	21
45	10° 15'	23
50	8° 15'	27
55	6° 30'	29
60	5° 15'	31
65	4° 15'	33
70	3° 30'	35

C.4.d Superelevation Transition (superelevation runoffs plus tangent runoff)

Superelevation runoff is the general term denoting the length of street or highway needed to accomplish the change in cross slope from a section with the adverse crown removed (level) fully superelevated section, or vice versa. Tangent runoff is the general term denoting the length of street or highway needed to accomplish the change in cross slope from a normal cross section to a section with the adverse crown removed, or vice versa. Spiral curves can be used to transition from the tangent to the curve. Where the spiral curve is employed, its length is used to make the entire superelevation transition.

The Department's Design Standards show in detail superelevation transitions for various sections and methods for determining length of transition.

C.4.e Lane Widening on Curves

The traveled way should be widened on sharp curves due to the increased difficulty for the driver to follow the proper path. Trucks and transit vehicles experience additional difficulty due to the fact that the rear wheels may track considerably inside the front wheels thus requiring additional width. Adjustments to traveled way widths for mainline and turning roadways are given in Tables 3 - 6A Calculated and Design Values for Traveled Way Widening on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way and 3 - 6B Adjustments or Traveled Way Widening Values on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way. A transition length shall be introduced in changing to an increased/decreased lane width. This transition length shall be proportional to the increase/decrease in traveled way width in a ratio of not less than 50 feet of transition length for each foot of change in lane width.

Table 3 – 6A
Calculated and Design Values for Traveled Way Widening on Open Highway Curves
(Two-Lane Highways, One-Way or Two-Way)

Radius of Curve (FEET)	Roadway width = 24 feet. Design Speed (mph)							Roadway width = 22 feet. Design Speed (mph)							Roadway width = 20 feet. Design Speed (mph)						
	30	35	40	45	50	55	60	30	35	40	45	50	55	60	30	35	40	45	50	55	60
7000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.6	1.6	1.7	1.7	1.8	1.9	1.9
6500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.7	0.8	0.8	0.9	1.0	1.6	1.7	1.7	1.8	1.8	1.9	2.0
6000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.6	1.7	1.8	1.8	1.9	2.0	2.0
5500	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.7	1.7	1.8	1.9	1.9	2.0	2.1
5000	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.7	0.8	0.9	0.9	1.0	1.1	1.1	1.7	1.8	1.9	1.9	2.0	2.1	2.1
4500	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.8	0.8	0.9	1.0	1.1	1.1	1.2	1.8	1.8	1.9	2.0	2.1	2.1	2.2
4000	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.8	1.9	2.0	2.1	2.2	2.2	2.3
3500	0.0	0.0	0.1	0.2	0.3	0.3	0.4	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.9	2.0	2.1	2.2	2.3	2.3	2.4
3000	0.0	0.1	0.2	0.3	0.4	0.5	0.6	1.0	1.1	1.2	1.3	1.4	1.5	1.6	2.0	2.1	2.2	2.3	2.4	2.5	2.6
2500	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.2	2.3	2.4	2.5	2.6	2.7	2.8
2000	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.4	2.5	2.6	2.7	2.8	3.0	3.1
1800	0.5	0.6	0.8	0.9	1.0	1.1	1.2	1.5	1.6	1.8	1.9	2.0	2.1	2.2	2.5	2.6	2.8	2.9	3.0	3.1	3.2
1600	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.7	2.8	2.9	3.0	3.2	3.3	3.4
1400	0.8	1.0	1.1	1.2	1.4	1.5	1.6	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.8	3.0	3.1	3.2	3.4	3.5	3.6
1200	1.1	1.2	1.4	1.5	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.4	3.5	3.7	3.8	3.9
1000	1.4	1.6	1.7	1.9	2.0	2.2	2.4	2.4	2.6	2.7	2.9	3.0	3.2	3.4	3.4	3.6	3.7	3.9	4.0	4.2	4.4
900	1.6	1.8	2.0	2.1	2.3	2.5		2.6	2.8	3.0	3.1	3.3	3.5		3.6	3.8	4.0	4.1	4.3	4.5	
800	1.9	2.1	2.2	2.4	2.6	2.8		2.9	3.1	3.2	3.4	3.6	3.8		3.9	4.1	4.2	4.4	4.6	4.8	
700	2.2	2.4	2.6	2.8	3.0			3.2	3.4	3.6	3.8	4.0			4.2	4.4	4.6	4.8	5.0		
600	2.7	2.9	3.1	3.3	3.5			3.7	3.9	4.1	4.3	4.5			4.7	4.9	5.1	5.3	5.5		
500	3.3	3.5	3.7	3.9				4.3	4.5	4.7	4.9				5.3	5.5	5.7	5.9			
450	3.7	3.9	4.1					4.7	4.9	5.1					5.7	5.9	6.1				
400	4.2	4.4	4.7					5.2	5.4	5.7					6.2	6.4	6.7				
350	4.8	5.1	5.3					5.8	6.1	6.3					6.8	7.1	7.3				
300	5.6	5.9						6.6	6.9						7.6	7.9					
250	6.8							7.8							8.8						
200	8.5							9.5							10.5						

Notes: Values shown are for WB-50[JM15] design vehicle and represent widening in feet. For other design vehicles, use adjustments in Table 3-6B.

Values less than 2.0 feet may be disregarded.
For 3-lane roadways, multiply above values by 1.5.
For 4-lane roadways, multiply above values by 2.

Table 3 – 6B
Adjustments for Traveled Way Widening Values on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way)

Radius of Curve (FEET)	Design Vehicle						
	SU	WB-40	WB-62	WB-65	WB-67D	WB-100T	WB-109D
7000	-1.1	-1.1	0.1	0.1	0.0	0.0	0.3
6500	-1.1	-1.1	0.1	0.1	0.0	0.1	0.3
6000	-1.2	-1.1	0.1	0.2	0.0	0.1	0.3
5500	-1.2	-1.1	0.1	0.2	0.0	0.1	0.4
5000	-1.2	-1.1	0.1	0.2	0.0	0.1	0.4
4500	-1.2	-1.1	0.1	0.2	0.0	0.1	0.5
4000	-1.2	-1.2	0.2	0.2	-0.1	0.1	0.5
3500	-1.3	-1.2	0.2	0.3	-0.1	0.1	0.6
3000	-1.3	-1.2	0.2	0.3	-0.1	0.1	0.7
2500	-1.4	-1.2	0.3	0.4	-0.1	0.1	0.8
2000	-1.5	-1.3	0.3	0.5	-0.1	0.2	1.0
1800	-1.5	-1.3	0.4	0.5	-0.1	0.2	1.1
1600	-1.6	-1.4	0.4	0.6	-0.1	0.2	1.3
1400	-1.7	-1.4	0.5	0.6	-0.2	0.2	1.5
1200	-1.8	-1.5	0.5	0.8	-0.2	0.3	1.7
1000	-2.0	-1.6	0.6	0.9	-0.2	0.3	2.0
900	-2.1	-1.7	0.7	1.0	-0.2	0.4	2.3
800	-2.2	-1.8	0.8	1.1	-0.3	0.4	2.6
700	-2.4	-1.9	0.9	1.3	-0.3	0.5	2.9
600	-2.6	-2.0	1.1	1.5	-0.4	0.6	3.4
500	-2.9	-2.2	1.3	1.8	-0.4	0.7	4.1
450	-3.2	-2.4	1.4	2.0	-0.5	0.7	4.6
400	-3.4	-2.5	1.6	2.3	-0.5	0.8	5.1
350	-3.8	-2.8	1.9	2.6	-0.6	1.0	5.9
300	-4.3	-3.0	2.2	3.0	-0.7	1.1	6.9
250	-4.9	-3.5	2.6	3.7	-0.9	1.4	8.3
200	-5.9	-4.1	3.3	4.6	-1.1	1.7	10.5

Notes: Adjustments are applied by adding to or subtracting from the values in Table 3-6A
Adjustments depend only on radius and design vehicle; they are independent of traveled way width and design speed.
For 3-lane roadways, multiply above values by 1.5.
For 4-lane roadways, multiply above values by 2.0.

C.5 Vertical Alignment

C.5.a General Criteria

The selection of vertical alignment should be predicated to a large extent upon the following criteria:

- Obtaining maximum sight distances
- Limiting speed differences (particularly for trucks and buses) by reducing magnitude and length of grades
- A "hidden dip" which would not be apparent to the driver must be avoided.
- Steep grades and sharp crest vertical curves should be avoided at or near intersections.
- Flat grades and long gentle vertical curves should be used whenever possible.

C.5.b Grades

The grades selected for vertical alignment should be as flat as practical, and should not be greater than the value given in Table 3 - 7 Recommended Maximum Grades in Percent.

For streets and highways requiring long upgrades, the maximum grade should be reduced so the speed reduction of slow-moving vehicles (e.g., trucks and buses) is not greater than 10 mph. The critical lengths of grade for these speed reductions are shown in Figure 3 – 5 Critical Length Versus Upgrade. Where reduction of grade is not practical, climbing lanes should be provided to meet these speed reduction limitations.

The criteria for a climbing lane and the adjacent shoulder are the same as for any travel lane except that the climbing lane should be clearly designated by the appropriate pavement markings. Entrance to and exit from the climbing lane shall follow the same criteria as other merging traffic lanes; however, the climbing lane should not be terminated until well beyond the crest of the vertical curve. Differences in superelevation should not be sufficient to produce a change in pavement cross slope between the climbing lane and through lane in excess of 0.04 feet per foot.

Recommended minimum gutter grades:

Rolling terrain - 0.5%   Flat terrain - 0.3%

Table 3 – 7   Recommended Maximum Grades in Percent

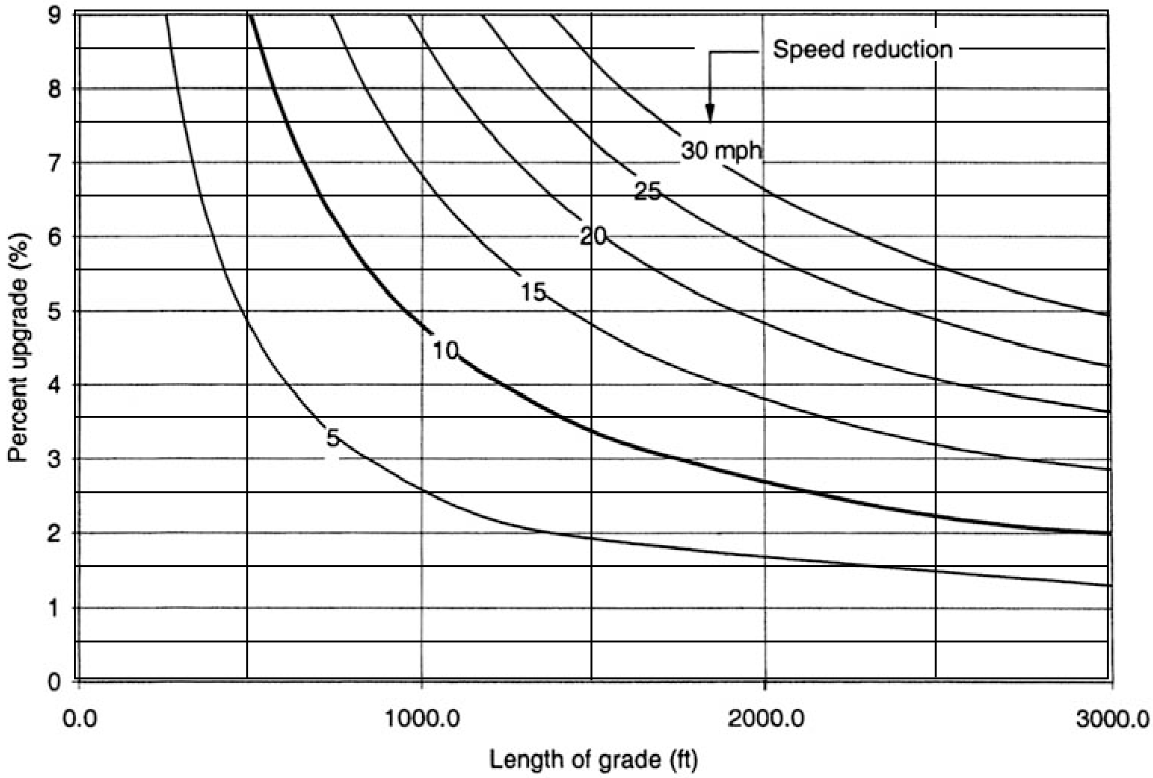
TYPE OF ROADWAY	FLAT TERRAIN											ROLLING TERRAIN										
	DESIGN SPEED (mph)											DESIGN SPEED (mph)										
	20	25	30	35	40	45	50	55	60	65	70	20	25	30	35	40	45	50	55	60	65	70
Freeway	---	---	---	---	---	---	4	4	3	3	3	---	---	---	---	---	---	5	5	4	4	4
Arterial* Rural	---	---	---	---	5	5	4	4	3	3	3	---	---	---	---	6	6	5	5	4	4	4
Arterial* Urban	---	---	8	7	7	6	6	5	5	---	---	---	---	9	8	8	7	7	6	6	---	---
Collector* Rural	7	7	7	7	7	7	6	6	5	---	---	10	10	9	9	8	8	7	7	6	---	---
Collector* Urban	9	9	9	9	9	8	7	7	6	---	---	12	12	11	10	10	9	8	8	7	---	---
Local*	8	7	7	7	7	7	6	6	5	---	---	11	11	10	10	10	9	8	7	6	---	---
Industrial**	---	---	4	4	4	4	3	3	3	---	---	---	---	5	5	5	5	4	4	4	---	---

* May be increased by 2 percent for urban streets under extreme conditions.

** Local and collector streets with significant (15% or more) truck traffic.

For short sections less than 500' and for one-way downgrades, the maximum gradient may be 1% steeper.

Figure 3 – 5 Critical Length Versus Upgrade



Critical Lengths of Grade for Design[JM16][KM17], Assumed Typical Heavy Truck of 200 lb/hp, Entering Speed = 70 mph

Source: 2011 AASHTO A Policy on Geometric Design of Highways and Streets, Figure 3-28,

C.5.c Vertical Curves

Changes in grade should be connected by a parabolic curve (the vertical offset being proportional to the square of the horizontal distance). Vertical curves are required when the algebraic difference of intersecting grades exceeds the values given in Table 3 - 8 Maximum Change In Grade Without Using Vertical Curve. Table 3 – 9 Rounded K Values for Minimum Lengths Vertical Curves provides additional information. The length of vertical curve on a crest, as governed by stopping sight distance, is obtained from Figure 3 - 6 Length of Crest Vertical Curve (Stopping Sight Distance). The minimum length of a crest vertical curve to obtain minimum passing sight distance is given in Figure 3 - 7 Length of Crest Vertical Curve (Passing Sight Distance). The minimum length of a sag vertical curve, as governed by vehicle headlight capabilities, is obtained from Figure 3 - 8 Length of Sag Vertical Curve (Headlight Sight Distance)***.***

Wherever feasible, curves longer than the minimum should be considered to improve both aesthetic and safety characteristics.

Table 3 – 8 Maximum Change in Grade without Using Vertical Curve

Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
Maximum Change in Grade in Percent	1.20	1.10	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20

Table 3 – 9 Rounded K Values for Minimum Lengths Vertical Curves

Rounded K Values For Minimum Lengths Vertical Curves

(Based upon an eye height of 3.50 feet and an object height of 2 feet above the road surface)

L = KA

L = LENGTH OF VERTICAL CURVE A = ALGEBRAIC DIFFERENCE OF GRADES IN PERCENT

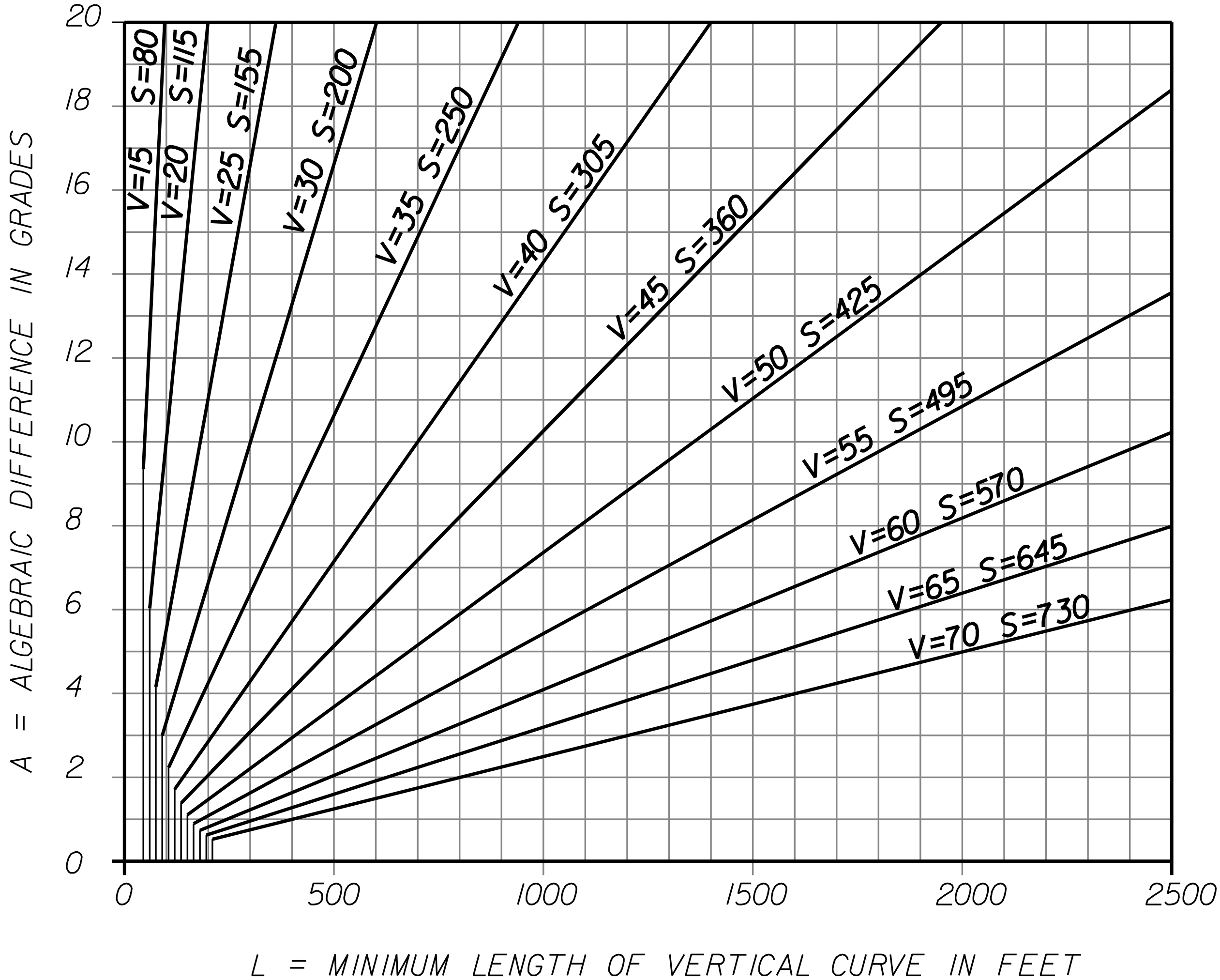
Design Speed (mph)		20	25	30	35	40	45	50	55	60	65	70
K Values for Crest Vertical Curves		7	12	19	29	44	61	84	114	151	193	247
K Values for Sag Vertical Curves		17	26	37	49	64	79	96	115	136	157	181

- The length of vertical curve must never be less than three times the design speed of the highway
- Curve lengths computed from the formula L = KA should be rounded upward when feasible
- The minimum lengths of vertical curves to be used on collectors, arterials and freeways are shown in the table below:

Minimum Lengths for Vertical Curves
on Collectors, Arterials, and Freeways (feet)

Design Speed (mph)	50	60	70
Crest Vertical Curves (feet)	300	400	500
Sag Vertical Curves (feet)	200	300	400

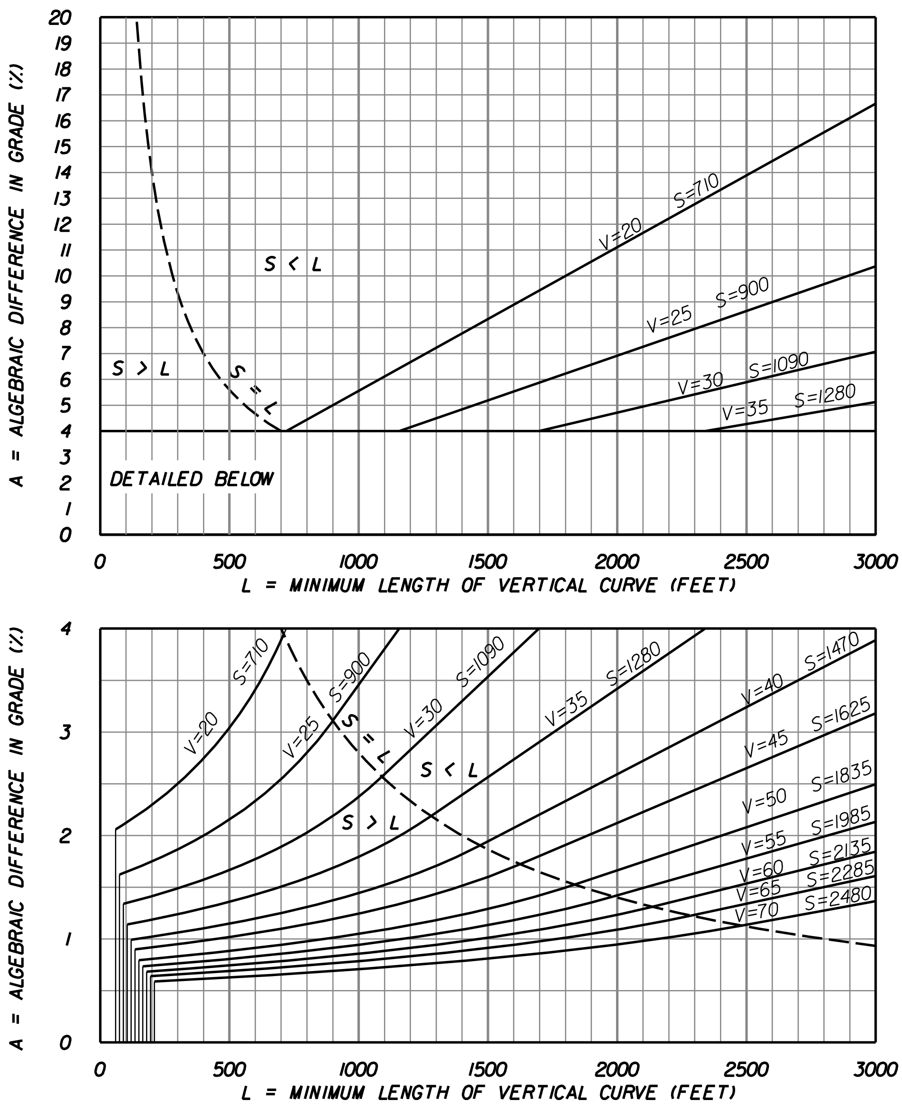
Figure 3 – 6 Length of Crest Vertical Curve
(Stopping Sight Distance)



Lengths of vertical curves are computed from the formula: $L = \frac{AS^2}{1329}$

A = Algebraic Difference In Grades In Percent
S = Sight Distance
L = Minimum Length of Vertical Curve In Feet

Figure 3 – 7 Length of Crest Vertical Curve (Passing Sight Distance)



The sight distance is computed from the following formulas:

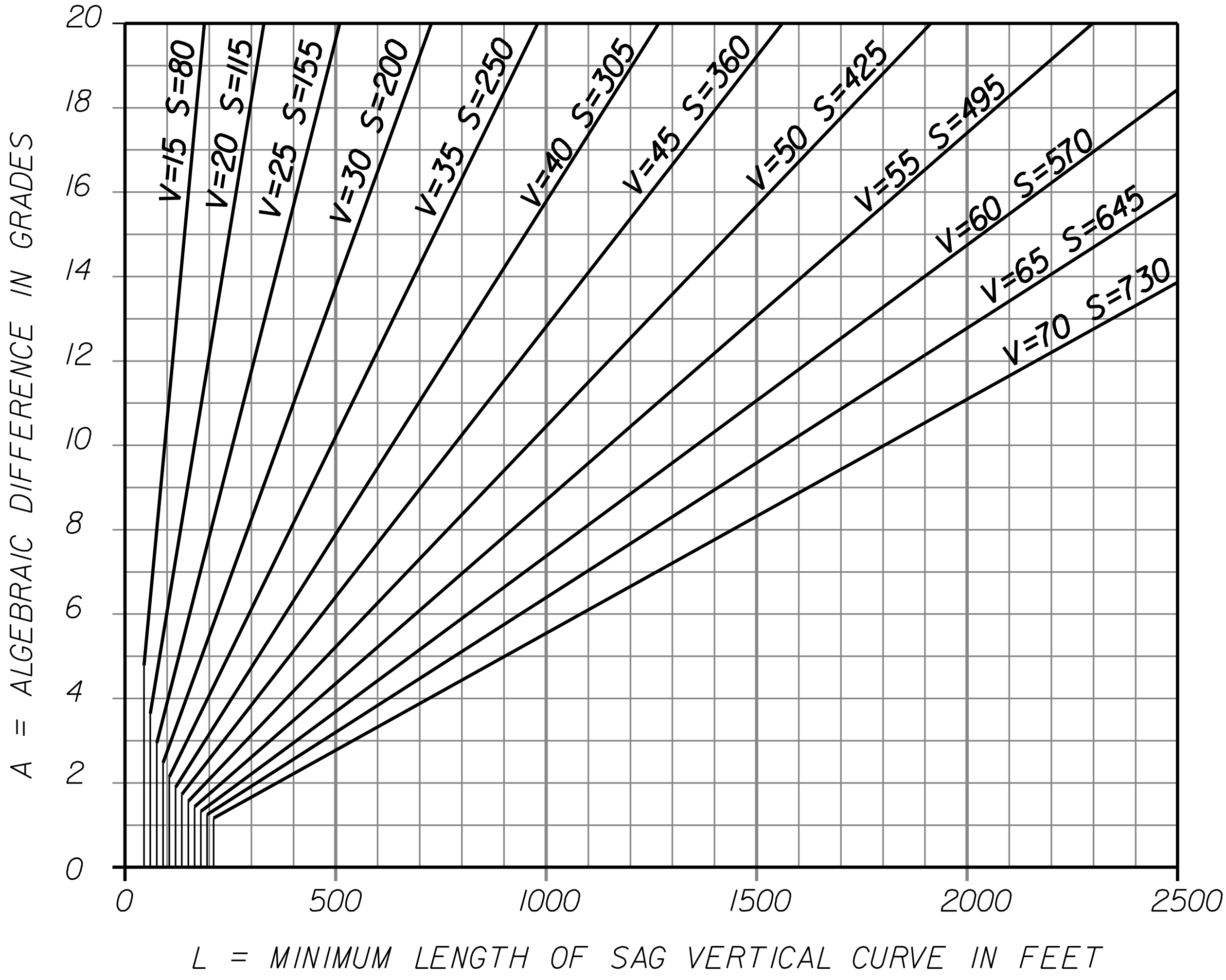
$S < L,\quad L = \dfrac{AS^2}{2800}$ $\qquad S > L,\quad L = 2S - \dfrac{2800}{A}$

A = Algebraic Difference in Grades, Percent
S = Sight Distance
L = Length of Vertical Curve

Figure 3 – 8 Length of Sag Vertical Curve (Headlight Sight Distance)

Lengths of vertical curves are computed from the formula:

$$L = \frac{AS^2}{400 + 3.5(S)}$$



C.6 Alignment Coordination

Horizontal and vertical alignment should not be designed independently. Poor combinations can spoil the good points of a design. Properly coordinated horizontal and vertical alignment can improve appearance, enhance community values, increase safety, and encourage uniform speed. Coordination of horizontal and vertical alignment should begin with preliminary design, during which stage adjustments can be readily made.

Proper combinations of horizontal alignment and profile can be obtained by engineering study and consideration of the following general controls:

- Curvature and grades should be in proper balance. Tangent alignment or flat curvature with steep grades and excessive curvature with flat grades are both poor design. A logical design is a compromise between the two conditions. Wherever feasible the roadway should "roll with" rather than "buck" the terrain.
- Vertical curvature superimposed on horizontal curvature, or vice versa, generally results in a more pleasing facility, but it should be analyzed for effect on driver's view and operation. Changes in profile not in combination with horizontal alignment may result in a series of disconnected humps to the driver for some distance.
- Sharp horizontal curvature should not be introduced at or near the top of a pronounced crest vertical curve. Drivers cannot perceive the horizontal change in alignment, especially at night. This condition can be avoided by setting the horizontal curve so it leads the vertical curve or by making the horizontal curve longer. Suitable design can be made by using design values well above the minimums.
- Sharp horizontal curvature should not be introduced at or near the low point of a pronounced sag vertical curve to prevent an undesirable distorted appearance. Vehicle speeds are often high at the bottom of grades and erratic operation may result, especially at night.
- On divided highways, variation of the median width and the use of independent vertical and horizontal alignment should be considered. Where right of way is available, a superior design without significant additional costs can result from the use of independent alignment.
- Horizontal alignment and profile should be made as flat as possible at interchanges and intersections where sight distance along both highways is

important. Sight distances above the minimum are desirable at these locations.

- Alignment should be designed to enhance scenic views for the motorists.
- In residential areas, the alignment should be designed to minimize nuisance to the neighborhood.

C.7 Cross Section Elements

The design of the street or highway cross section should be predicated upon the design speed, terrain, adjacent land use, classification, and the type and volume of traffic expected. The cross section selected should be uniform throughout a given length of street or highway without frequent or abrupt changes.

C.7.a Number of Lanes

The number of travel lanes is determined by several interrelated factors such as capacity, level of service, and service volume. ((AASHTO "A Policy on Geometric Design of Highways and Streets" - latest edition, and the current Highway Capacity Manual)

C.7.b Pavement

The paved surface of roadways shall be designed and constructed in accordance with the requirements set forth in ***Chapter 5 - Pavement Design and Construction***.

C.7.b.1 Pavement Width

Minimum lane widths for travel lanes, speed change lanes, turn lanes and passing lanes are provided in Table 3 - 10 Minimum Lane Widths. On multilane urban curb and gutter streets where there is insufficient space for a separate bicycle lane, consideration should be given to using unequal-width lanes. In such cases, the wider lane is located on the outside (right). This provides more space for large vehicles that usually occupy that lane, provides more space for bicycles, and allows drivers to keep their vehicles at a greater distance from the right edge. See ***Chapter 9 – Bicycle Facilities.***

Table 3 – 10 Minimum Lane Widths

Facility		ADT (vpd)	Design Speed (mph)	Divided/ Undivided	Lane Width - FT			
					Travel Lanes[1]	Speed Change Lanes	Turn Lanes[5] (LT/RT/MD)	Passing Lanes
Freeway	Rural	All	All	All	12	12	--	--
	Urban	All	All	All	12	12	--	--
Arterial	Rural	All	All	All	12[8]	12[8]	12[8]	12[8]
	Urban	All	> 45	All	12	12	12	12
		All	≤ 45	Undivided	11[3]	11[3]	11[3, 6]	11[3]
				Divided	11[3]	11[3]	11[3, 6]	11[3]
Collector	Rural	> 1500	All	All	12[8]	12[8]	12[8]	12[8]
		400 to 1500	All	All	11[3]	11[3]	11[3]	--
		< 400	> 45	All	11	11	11[6]	--
			≤ 45	All	10	10	10	--
	Urban	All	All	All	11[2, 3]	11[2, 3]	11[2, 6]	--
Local	Rural	> 1500	All	All	12[8]	12[8]	12[8]	12[8]
		400 to 1500	All	All	11[3]	--	11[3]	--
		< 400	> 50	All	11[3]	--	11[3]	--
			45 to 50	All	10	--	10	--
			< 45	All	9	--	9	--
	Urban	All	All	All	10[2,4]	--	10[7]	--

Footnotes

1. A minimum traveled way width equal to the width of two adjacent travel lanes (one way or two way) shall be provided on all rural facilities.
2. In industrial areas and where truck volumes are significant, 12' lanes should be provided, but may be reduced to 11' where right of way severely limited.
3. In constrained areas where truck and bus volumes are low and speeds are less than 35 mph, 10; lanes may be used.
4. In residential areas where right of way is severely limited, 9' may be used.
5. Median turn lane widths shall not exceed 15'.
6. Turn Lane width should be same as Travel Lane width. May be reduced to 10' where right of way is constrained.
7. Turn Lane width should be same as Travel Lane width. May be reduced to 9' where truck volumes are low.
8. For design speeds below 50 mph, lane widths of 11 feet are acceptable.

C.7.b.2 Traveled Way Cross Slope (not in superelevation)

The selection of traveled way cross slope should be a compromise between meeting the drainage requirements and providing for smooth vehicle operation. The recommended traveled way cross slope is 0.02 feet per foot. When three lanes in each direction are necessary, the outside lane should have a cross slope of 0.03 feet per foot. The cross slope shall not be less than 0.015 feet per foot or greater than 0.04 feet per foot. The change in cross slope between adjacent through travel lanes should not exceed 0.04 feet per foot.

C.7.c Shoulders

The primary functions of a shoulder are to provide emergency parking for disabled vehicles and an alternate path for vehicles during avoidance or other emergency maneuvers. In order to fulfill these functions satisfactorily, the shoulder should have adequate stability and surface characteristics. The design and construction of shoulders shall be in accordance with the requirements given in ***Chapter 5 - Pavement Design and Construction.***

Shoulders should be provided on all streets and highways incorporating open drainage. The absence of a contiguous emergency travel or storage lane is not only undesirable from a safety standpoint, but also is disadvantageous from an operations viewpoint. Disabled vehicles that must stop in a through lane impose a severe safety hazard and produce a dramatic reduction in traffic flow. Shoulders should be free of abrupt changes in slope, discontinuities, soft ground, or other hazards that would prevent the driver from retaining or regaining vehicle control.

Paved outside shoulders are required for rural high speed multilane highways and freeways. They provide added safety to the motorist, public transit and pedestrians, for accommodation of bicyclists, reduced shoulder maintenance costs, and improved drainage

C.7.c.1 Shoulder Width

Since the function of the shoulders is to provide an emergency storage or travel path, the desirable width of all shoulders should be at least 10 feet. Where economic or practical constraints are severe, it is permissible, but not desirable, to reduce the shoulder width. Outside shoulders shall be provided on all streets and highways with open drainage and should be at least 6 feet wide. Facilities with a heavy traffic volume or a significant volume of truck traffic SHOULD have outside shoulders at least 8 feet wide. The width of outside shoulders for two-lane, two-way shoulders shall not be less than the values given in Table 3 - 11 Shoulder Widths for Rural Highways

Median shoulders are desirable on all multi-lane, non-curb and gutter divided streets and highways. For shoulder widths on multi-lane divided highways see Table 3 - 11.

Table 3 – 11 Shoulder Widths for Rural Highways[KM18]

Two Lane

Design Speed (mph)	Average Daily Traffic (2 – Way)		
	0 - 400	400 - 750	750 - 1600
All	2 feet	6 feet	8 feet

Multilane Divided

Numbr of Lanes Each Direction	Shoulder Width (feet)			
	Outside		Median	
	Roadway	Bridge	Roadway	Bridge
2	10 (min.)	10	6 (min.)	6
3 or more	10 (min.)	10	10 (min.)	10

C.7.c.2 Shoulder Cross Slope

The shoulder serves as a continuation of the drainage system, therefore, the shoulder cross slope should be somewhat greater than the adjacent traffic lane. The cross slope of shoulders should be within the range given in Table 3 – 12 Shoulder Cross Slope.

Table 3 – 12 Shoulder Cross Slope

	Shoulder Type		
	Paved	Gravel or Crushed Rock	Turf
Shoulder Cross Slope (Percent)	2 to 6%	4 to 6%	6 to 8%

Notes: 1. Existing shoulder cross-slope (paved and unpaved) ≤ 12% may remain.

Source – 2011 AASHTO Greenbook, Section 4.4.3 Shoulder Cross Sections.

Whenever possible, shoulders should be sloped away from the traveled way to aid in their drainage. The combination of shoulder cross slope and texture should be sufficient to promote rapid drainage and to avoid retention of surface water. The maximum algebraic difference between the traveled way and adjacent shoulder should not be greater than 0.07 feet per foot. Shoulders on the outside of superelevated curves should be rounded (vertical curve) to avoid an excessive break in cross slope and to divert a portion of the drainage away from the adjacent traveled way.

C.7.d Sidewalks

The design of sidewalks is affected by many factors, including, but not limited to, pedestrian volume, roadway type, characteristics of vehicular traffic, and other design elements. ***Chapter 8 - Pedestrian Facilities*** of this Manual and the ***AASHTO – "A Policy on Geometric Design of Highways and Streets***," present the various factors that influence the design of sidewalks and other pedestrian facilities.

Sidewalks should be constructed in conjunction with new construction and major reconstruction in or within one mile of an urban area. As a general rule, sidewalks should be constructed on both sides of the roadway. Exceptions may be made where physical barriers (e.g., a canal paralleling one side of the roadway) would substantially reduce the expectation of pedestrian use of one side of the roadway. Also, if only one side is possible, sidewalks should be available on the same side of the road as transit stops or other pedestrian generators.

The decision to construct a sidewalk in a rural area should be based on engineering judgment, after observation of existing pedestrian traffic and expectation of additional demand, should a sidewalk be made available.

Sidewalks should be constructed as defined in this Manual - ***Chapter 8 - Pedestrian Facilities***. ***Section C.10.a.3 – Sidewalks and Curb Ramps*** of this chapter, and ***Chapter 8 - Pedestrian Facilities****[KM19]*[KM20] provide additional detailed information. ***AASHTO's Guide for the Planning, Design and Operation of Pedestrian Facilities (2004)***, and ***Section 4.17.1 Sidewalks*** of ***AASHTO's Policy on Geometric Design of Highways and Streets (2011)*** provide additional information.

In areas of high use, refer to the ***Highway Capacity Manual, Volume 3, Chapter 23, Off-Street Pedestrian and Bicycle Facilities (2010)*** for calculation of appropriate additional width.

Curb ramps shall be provided at all intersections with curb (***Section 336.045 (3), Florida Statutes)***. In addition to the design criteria provided in this chapter, the ***2006 Americans with Disabilities Act Standards for Transportation Facilities*** as required by 49 C.F.R 37.41 or 37.43 and the ***2012 Florida Accessibility Code for Building Construction*** as required by 61G20-4.002 impose additional requirements for the design and construction of pedestrian facilities.

C.7.e Medians

Median separation of opposing traffic lanes provides a beneficial safety feature and should be used wherever feasible. Separation of the opposing traffic also reduces the problem of headlight glare, thus improving safety and comfort for night driving. When sufficient width of medians is available, some landscaping is also possible.

The use of medians often aids in the provision of drainage for the roadway surface, particularly for highways with six or more traffic lanes. The median also provides a vehicle refuge area, improves the safety of pedestrian crossings, provides a logical location for left turn auxiliary lanes, and provides the means for future addition of traffic lanes and mass transit. In many situations, the median strip aids in roadway delineation and the overall highway aesthetics.

Median separation is required on the following streets and highways:

- Freeways
- All streets and highways, rural and urban, with 4 or more travel lanes and with a design speed of 40 mph or greater

Median separation is desirable on all other multi-lane roadways to enhance pedestrian crossings.

The nature and degree of median separation required is dependent upon the design speed, traffic volume, adjacent land use, and the frequency of access. There are basically two approaches to median separation. The first is the use of horizontal separation of opposing lanes to reduce the probability of vehicles crossing the median into incoming traffic. The second method is to attempt to limit crossovers by introducing a positive median barrier structure.

In rural areas, the use of wide medians is not only aesthetically pleasing, but is often more economical than barriers. In urban areas where space and/or economic constraints are severe, the use of barriers is permitted to fulfill the requirements for median separation.

Uncurbed medians should be free of abrupt changes in slope, discontinuities, soft ground, or other hazards that would prevent the driver from retaining or regaining control of the vehicle. Consideration should be given to increasing the width and decreasing the slope of medians on horizontal curves. The requirements for a hazard free median environment are given in ***Chapter 4 - Roadside Design***, and shall be followed in the design and construction of medians.

C.7.e.1 Type of Median

A wide, gently depressed median is the preferred design. This type allows a reasonable vehicle recovery area and aids in the drainage of the adjacent shoulders and travel lanes. Where space and drainage limitations are severe, narrower medians, flush with the roadway, or raised medians, are permitted. Raised medians should be used to support pedestrian crossings of multi-laned streets and highways.

C.7.e.2 Median Width

The median width is defined as the horizontal distance between the inside (median) edge of travel lanes of the opposing roadways. The selection of the median width for a given type of street or highway is primarily dependent on design speed and traffic volume. Since the probability of crossover crashes is decreased by increasing the separation, medians should be as wide as practicable. Median widths in excess of 30 feet to 35 feet reduce the problem of disabling headlight glare from opposing traffic.

The minimum permitted widths of freeway medians are given in Table 3 - 13 Median Width for Freeways (Urban and Rural). Where the expected traffic volume is heavy, the widths should be increased over these minimum values. Median barriers shall be used on freeways when these minimum values are not attainable.

The minimum permitted median widths for multi-lane rural highways are given in Table 3 - 14 Median Width for Rural Highways (Multilane Facilities). On urban streets, the median widths shall not be less than the values given in Table 3 - 14. Where median openings or access points are frequent, the median width should be increased.

The minimum median widths given in these Tables may have to be increased to meet the requirements for cross slopes, drainage, and turning movements (C.9 Intersection Design, this chapter). The median area should also include adequate additional width to allow for expected additions of through lanes and left turn auxiliary lanes. Where the median width is sufficient to produce essentially two separate, independent roadways, the left side of each roadway shall meet the requirements for roadside clear zone. Changes in the median width should be accomplished by gently flowing horizontal alignment of one or both of the separate roadways.

Table 3 – 13[JM21] Median Width for Freeways (Urban and Rural)

DESIGN SPEED (mph)	MINIMUM PERMITTED MEDIAN WIDTH (feet)
60 and Over	60 **
Under 60	40 *

* Applicable for urban areas ONLY.

** Applicable for new construction ONLY.
(40 feet minimum allowed when lanes added to median)

Table 3 – 14[JM22] Median Width for Rural Highways (Multilane Facilities)

DESIGN SPEED (mph)	MINIMUM WIDTH (feet)
55 and Over[JM23]	40
Under 55	22

Median Width for Urban Streets[JM24][KM25]

DESIGN SPEED (mph)	MINIMUM WIDTH (feet)
50[JM26]	19.5
45 [JM27]and LESS	15.5

Paved medians with a minimum width of 10 feet may be used for two-way turn lanes and painted or raised medians when design speeds are 40 mph or less.

C.7.e.3 Median Slopes

A vehicle should be able to transverse a median without turning over and with sufficient smoothness to allow the driver a reasonable chance to control the vehicle. The transition between the median slope and the shoulder (or pavement) slope should be smooth, gently rounded, and free from discontinuities.

The median cross slope should not be steeper than1:6 (preferably not steeper than 1:10). The depth of depressed medians may be controlled by drainage requirements. Increasing the width of the median, rather than increasing the cross slope, is the proper method for developing the required median depth.

Longitudinal slopes (median profile parallel to the roadway) should be shallow and gently rounded at intersections of grade. The longitudinal slope, relative to the roadway slope, shall not exceed a ratio of 1:10 and preferably 1:20. The change in longitudinal slope shall not exceed 1:8 (change in grade of 12.5 %).

C.7.e.4 Median Barriers

The primary objective for placing a barrier structure in the median is to prevent vehicles from entering the opposing traffic stream, either accidentally or intentionally. Median barriers may also be used to reduce the glare produced by oncoming vehicle headlights. When selecting the type of barrier, care should be exercised to avoid headlight flicker through barriers.

The use of median barriers to reduce horizontal separation is permitted on facilities with substantially full control of access. Frequent openings in the barrier for intersections or crossovers expose the barrier end, which constitute severe hazard at locations with an inherently high crash potential and should be shielded. Median barriers may be considered for urban freeways and high speed arterials with controlled access.

Median barriers shall be used on controlled access facilities if the median width is less than the minimum permitted values given in Table 3 - 13. The median barrier should not be placed closer than 10 feet[JM28][KM29] from the inside edge of traveled way[JM30]. Further requirements for median barriers are given in ***Chapter 4 - Roadside Design***.

C.7.f Islands

An island is a defined area between traffic lanes used for control of vehicle movements. Most islands combine two or more of these primary functions:

1. Channelization — To control and direct traffic movement, usually turning;

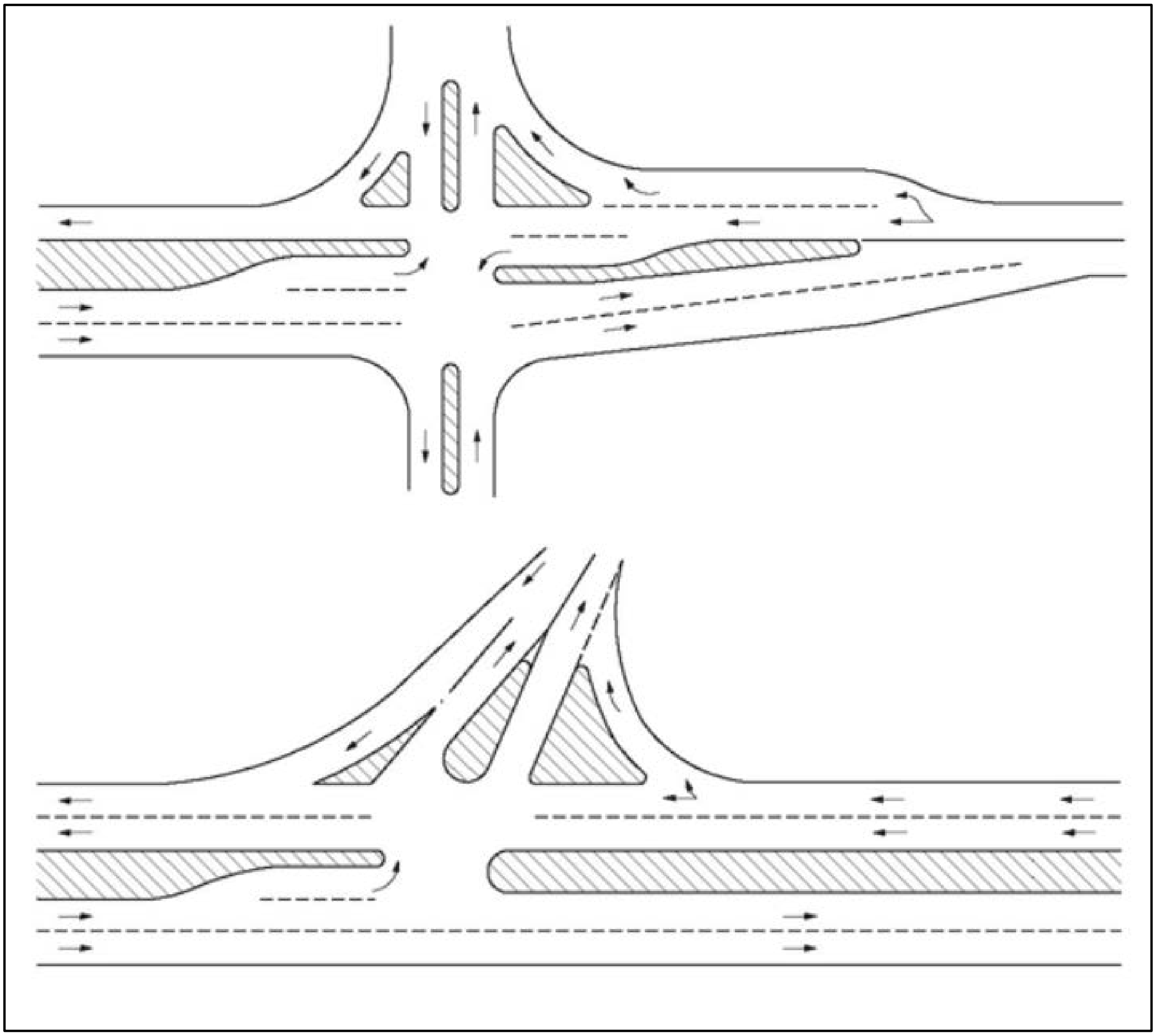
2. Division — To divide opposing or same direction traffic streams, usually through movements; and

3. Refuge — To provide refuge for pedestrians.

Islands generally are either elongated or triangular in shape and situated in areas unused for vehicle paths. Islands should be located and designed to offer little obstruction to vehicles and be commanding enough that motorists will not drive over them. The placement of mast arms in channelizing islands is discouraged. Mast arms are not permitted in median islands[KM31].

The dimensions and details depend on the particular intersection design as illustrated in Figure 3 - 9 General Types and Shapes of Islands and Medians. They should conform to the general principles that follow[KM32].

Figure 3 – 9 General Types and Shapes of Islands and Medians



Curbed islands are sometimes difficult to see at night. Where curbed islands are used, the intersection should have fixed–source lighting or appropriate delineation. Under certain conditions, painted, flush medians and islands or traversable type medians may be preferable to the raised curb type islands. These conditions include the following:

- Lightly developed areas that will not be considered for access management;

- Intersections where approach speeds are relatively high;
- Areas where there is little pedestrian traffic;
- Areas where fixed-source lighting is not provided;
- Median or corner islands where signals, signs, or luminaire supports are not needed; and
- Aareas where extensive development exists and may demand left-turn lanes into many entrances.

Painted islands may be used at the traveled way edge. At some intersections, both curbed and painted islands may be desirable. All pavement markings should be reflectorized. The use of thermoplastic striping, raised dots, spaced and raised retroreflective markers, and other forms of long-life markings also may be desirable. See ***Section 9.6.3*** of the ***2011 AASHTO Greenbook*** and the ***MUTCD, Part 3*** for additional information on the design and marking of islands.

The central area of large channelizing islands in most cases has a turf or other vegetative cover. As space and the overall character of the highway determine, low plant material may be included, but it should not obstruct sight distance. Ground cover or plant growth, such as turf, vines, and shrubs, can be used for channelizing islands and provides excellent contrast with the paved areas, assuming that the ground cover is cost-effective and can be properly maintained. ***Index 546*** of the Department's Design Standards provide additional information on designing landscaping in medians or at intersections[KM33].

Small curbed islands may be mounded, but where pavement cross slopes are outward, large islands should be depressed to avoid draining water across the pavement. For small curbed islands and in areas where growing conditions are not favorable, some type of paved surface is used on the island.

Careful consideration should be given to the location and type of plantings. Plantings, particularly in narrow islands, may create problems for maintenance activities. Plantings and other landscaping features in channelization areas may constitute roadside obstacles and should be consistent with the ***AASHTO Roadside Design Guide.***

C.7.f.1 Channelizing Islands

Channelizing islands may be of many shapes and sizes, depending on the conditions and dimensions of the intersection. A common form is the corner triangular shape that separates right-turning traffic from through traffic. Central islands may serve as a guide around which turning vehicles operate.

Channelizing islands should be placed so that the proper course of travel is immediately obvious, easy to follow, and of unquestionable continuity. Where islands separate turning traffic from through traffic, the radii of curved portions should equal or exceed the minimum for the turning speeds expected. Curbed islands generally should not be used in rural areas and at isolated locations unless the intersection is lighted and curbs are delineated.

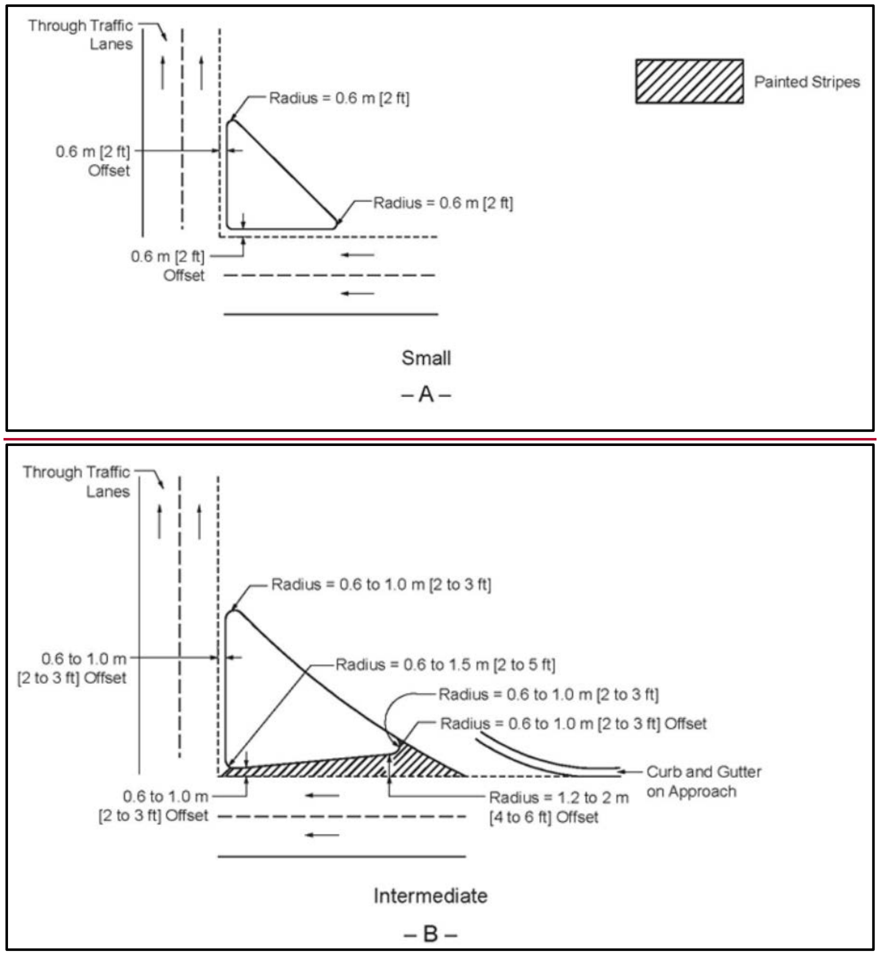
Islands should be sufficiently large to command attention, with 100 ft^2 preferred. The smallest curbed corner island should have an area of at least 50 ft^2 for urban and 75 ft^2 for rural intersections. A corner triangular island should be at least 15 feet on a side (12 ft. minimum) after the rounding of corners.

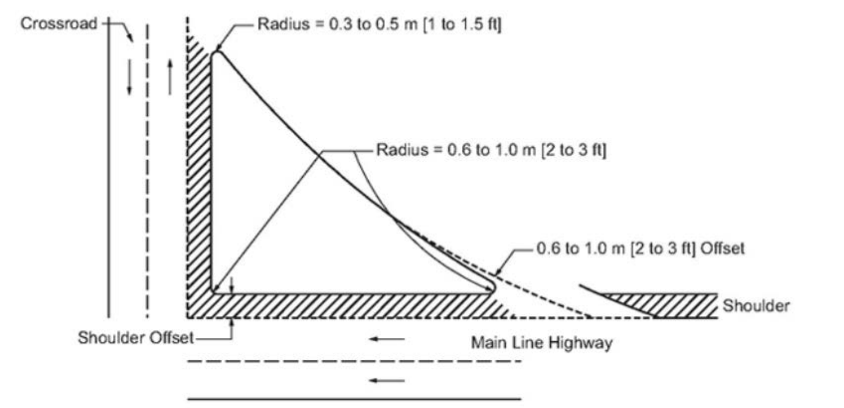
While mast arms are discouraged in channelizing islands, when they are used the minimum lateral offset as shown in Table 3 – 16 Lateral Offset shall be provided. Mast arm bases and foundation shafts vary in width, ranging from 3.5 feet to 4.5 feet in diameter[KM34]. The minimum lateral offset for 45 mph and less should be based on minimum offset to a hazard from curb face – 4 feet standard, 1.5 feet absolute minimum[KM35].

Details of curbed corner island designs used in conjunction with turning roadways are shown in Figures 3-10 and 3-11 Details of Corner Island for Turning Roadways (Curb and Gutter) and (Flush Shoulder). The approach corner of each curbed island is designed with an approach nose treatment.

Further information on the pavement markings that can be used with islands can be found in ***Index 17346*** of the Department's ***Design Standards***.

Figure 3 – 10 Details of Corner Island for Turning Roadways (Curb and Gutter)

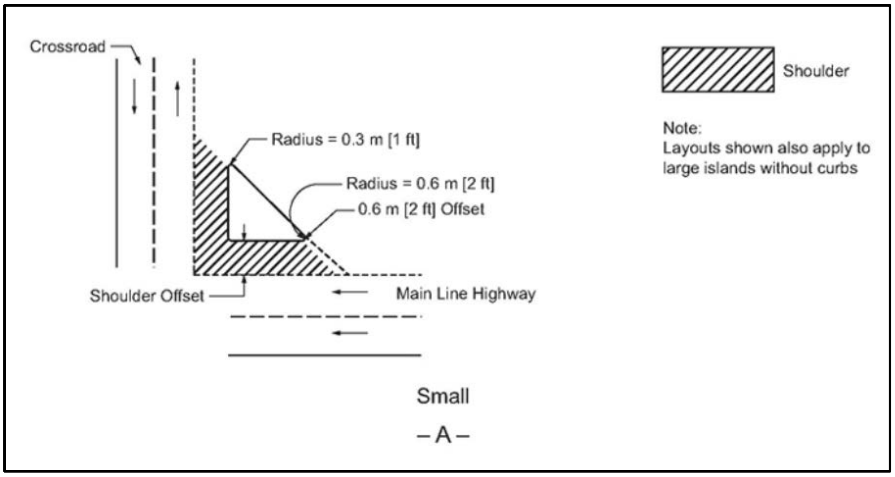


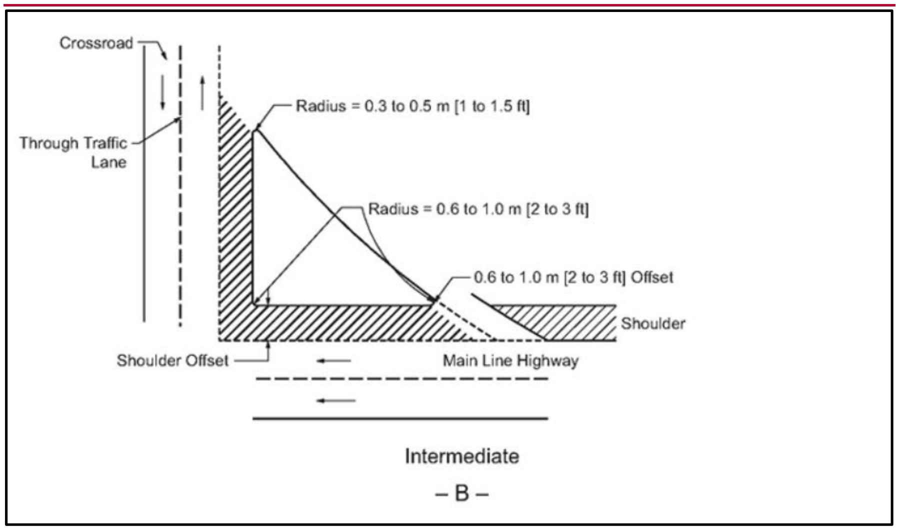

Crossroad
Radius = 0.3 to 0.5 m [1 to 1.5 ft]
Radius = 0.6 to 1.0 m [2 to 3 ft]
0.6 to 1.0 m [2 to 3 ft] Offset
Shoulder
Shoulder Offset
Main Line Highway

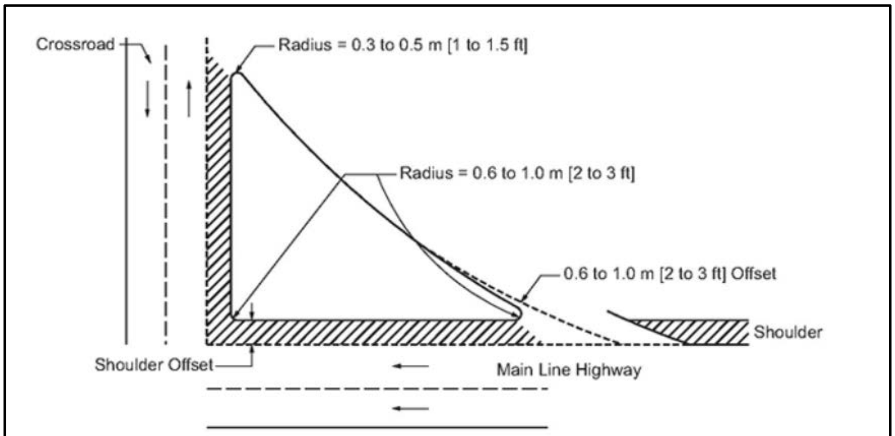
Large

– C –

Figure 3 – 11 Details of Corner Island for Turning Roadways (Flush Shoulder)






Crossroad
Radius = 0.3 to 0.5 m [1 to 1.5 ft]
Radius = 0.6 to 1.0 m [2 to 3 ft]
0.6 to 1.0 m [2 to 3 ft] Offset
Shoulder
Shoulder Offset
Main Line Highway

Large

– C –

C.7.f.2 Divisional Islands

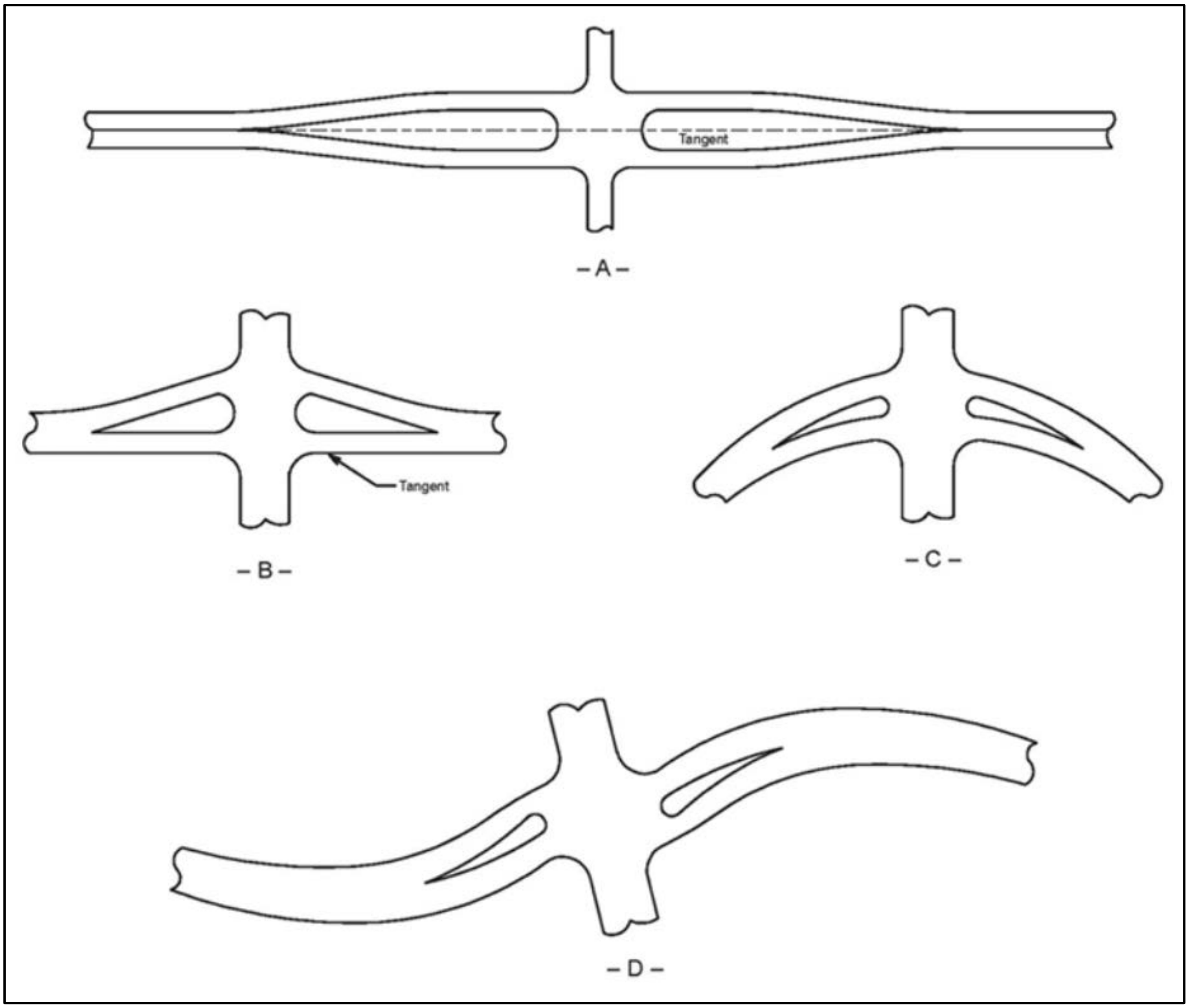
Divisional islands often are introduced on undivided highways at intersections. They alert drivers to the crossroad ahead and regulate traffic through the intersection. These islands are particularly advantageous in controlling left turns at skewed intersections and at locations where separate roadways are provided for right-turning traffic.

Widening a roadway to include a divisional island should be done in such a manner that the proper paths to follow are unmistakably evident to drivers. The alignment should require no appreciable conscious effort in vehicle steering.

Elongated or divisional islands should be not less than 4 feet wide and 20 to 25 feet long. In general, introducing curbed divisional islands at isolated intersections on high-speed highways is undesirable unless special attention is directed to providing high visibility for the islands. Curbed divisional islands introduced at isolated intersections on high-speed highways should be 100 feet or more in length. When situated in the vicinity of a high point in the roadway profile or at or near the beginning of a horizontal curve, the approach end of the curbed island should be extended to be clearly visible to approaching drivers.

Where an island is introduced at an intersection to separate opposing traffic on a four-lane road or on a major two-lane highway carrying high volumes, two full lanes should be provided on each side of the dividing island (particularly where future conversion to a wider highway is likely). In other instances, narrower roadways may be used. For moderate volumes, roadway widths shown under Case II (one-lane, one-way operation with provision for passing a stalled vehicle) in Table 3 - 27 Derived Pavement Widths for Turning Roadways for Different Design Vehicles are appropriate. For light volumes and where small islands are needed, widths on each side of the island corresponding to Case I in Table 3 – 27 may be used

Figure 3 – 12 Alignment for Divisional Islands at Intersections



C.7.f.3 Refuge Islands

A refuge island for pedestrians at or near a crosswalk or shared use path crossing aids ~~and protects~~ pedestrians[KM36] and bicyclists who cross the roadway. Raised-curb corner islands and center channelizing or divisional islands can be used as refuge areas. Refuge islands for pedestrians and bicyclists crossing a wide street, for loading or unloading transit riders, or for wheelchair ramps are used primarily in urban areas. Figure 3 – 13 Pedestrian Refuge

Island shows a divisional island that supports a midblock crosswalk between transit stops.

The location and width of crosswalks, the location and size of transit loading zones, and the provision of curb ramps influence the size and location of refuge islands. Refuge islands should be a minimum of 6 feet wide. Pedestrians and bicyclists should have a clear path through the island and should not be obstructed by poles, sign posts, utility boxes, etc. Sidewalk and shared use path curb ramps in islands shall meet the requirements found in ***Section C.10.a.4*** of this chapter and ***Chapter 8 – Pedestrian Facilities.*** Curb ramps that are part of a shared use path shall also meet the requirements of ***Chapter 9 – Bicycle Facilities.***

Figure 3 – 13 Pedestrian Refuge Island

North Main Street, Gainesville, FL

C.7.g~~f~~ Roadside Clear Zone and Lateral Offset

~~The roadside clear zone is that area outside the traveled way available for use by errant vehicles. Vehicles frequently leave the traveled way during avoidance maneuvers, due to loss of control by the driver (e.g., falling asleep) or due to collisions with other vehicles. The primary function of the clear zone is to allow space and time for the driver to retain control of his vehicle and avoid or reduce the consequences of collision with roadside objects. This area also serves as an emergency refuge location for disabled vehicles.~~

~~The design of the roadway must also provide for adequate drainage of the roadway. Drainage swales within the clear zone should be gently rounded and free of discontinuities. Where large volumes of water must be carried, the approach should be to provide wide, rather than deep drainage channels. Side slopes and drainage swales that lie within the clear zone should be free of protruding drainage structures (***Chapter 4 - Roadside Design, D.6.c. Culverts***).~~

~~In the design of the roadside, the designer should consider the consequences of a vehicle leaving the traveled way at any location. It should always be the policy that protection of vehicles and occupants shall take priority over the protection of roadside objects. Further criteria and requirements for safe roadside design are given in ***Chapter 4 - Roadside Design***.~~

C.7.g~~f~~.1 ~~Roadside~~ Clear Zone ~~Width~~

Clear zone is the unobstructed, traversable area beyond the edge of the traveled way for the recovery of errant vehicles. The clear zone includes shoulders and bicycle lanes. The clear zone must be free of aboveground fixed objects, water bodies and non-traversable or critical slopes. Clear zone width requirements are dependent on AADT, design speed, and roadside slope conditions. With regard to the ability of an errant vehicle to traverse a roadside slope, slopes are classified as follows:

1. Recoverable Slope – Traversable Slope 1:4 or flatter. Motorists who encroach on recoverable foreslopes generally can stop their vehicles or slow them enough to return to the roadway safely.
2. Non-Recoverable Slope – Traversable Slope steeper than 1:4 and flatter than 1:3. Non-recoverable foreslopes are traversable but most vehicles will not be able to stop or return to the roadway easily. Vehicles on such slopes typically can be expected to reach the bottom.
3. Critical Slope – Non-Traversable Slope steeper than 1:3. A critical foreslope is one on which an errant vehicle has a higher propensity to overturn.

Clear zone widths for recoverable foreslopes 1V:4H and flatter are provided in Table 3-15 Minimum Width of Clear Zone. Clear zone is applied as shown in Figures 3 - 14 Clear Zone Plan View and 3 – 15 Basic Clear Zone Concept.

On non-recoverable slopes steeper than 1:4 and flatter than 1:3, a high percentage of encroaching vehicles will reach the toe of these slopes. Therefore, the clear-zone distance cannot logically end at the toe of a non-recoverable slope. When such non-recoverable slopes are present within the clear zone width provided in Table 3-15, additional clear zone width is required. The minimum amount of additional width provided must equal the width of the non-recoverable slope with no less than 10 feet of recoverable slope provided at the toe of the non-recoverable slope. See Figure 3 – 16 Adjusted Clear Zone Concept.

When clear zone requirements cannot be met, see Chapter 4 – Roadside Design for requirements for roadside barriers and other treatments for safe roadside design. In addition, the FDOT Plans Preparation Manual, AASHTO Roadside Design Guide (2011), and AASHTO Guidelines for Geometric Design of Very Low Volume Local Roads (ADT ≤ 400) (2001) may be referenced for a more thorough discussion of roadside design.

Table 3 - 15 Minimum Width of Clear Zone

Clear Zone Widths – Feet						
	AADT ≥ 1500			AADT < 1500[1]		
Design Speed mph	Travel Lanes & Multilane Ramps		Aux Lanes and Single Lane Ramps	Travel Lanes & Multilane Ramps		Aux Lanes and Single Lane Ramps
	1V:6H or flatter	1V:5H to 1V:4H	1V:4H or flatter	1V:6H or flatter	1V:5H to 1V:4H	1V:4H or flatter
≤ 40	14	16	10	10[2]	12[2]	10[2]
45 – 50	20	24	14	14	16	14
55	22	26	18	16	20	14
60	30	30	24	20	26	18
65 – 70	30	30	24	24	28	18

1. Clear Zone for roads functionally classified as Local Roads with a design AADT ≤ 400 vehicles per day[KM37]:
   a. A clear zone of 6 feet or more in width must be provided if it can be done so with minimum social/environmental impacts.
   b. Where constraints of cost, terrain, right of way, or potential social/environmental impacts make the provision of a 6 feet clear zone impractical, clear zones less than 6 feet in width may be used, including designs with 0 feet clear zone.
   c. In all cases, clear zone must be tailored to site-specific conditions, considering cost-effectiveness and safety tradeoffs. The use of adjustable clear zone widths, such as wider clear zone dimensions at sharp horizontal curves where there is a history of run-off-road crashes, or where there is evidence of vehicle encroachments such as scarring of trees or utility poles, may be appropriate. Lesser values of clear zone width may be appropriate on tangent sections of the same roadway.
   d. Other factors for consideration in analyzing the need for providing clear zones include the crash history, the expectation for future traffic volume growth on the facility, and the presence of vehicles wider than 8.5 feet and vehicles with wide loads, such as farm equipment.
2. May be reduced to 7 feet for a design AADT < 750 vehicles per day.

Figure 3 – 14 Clear Zone Plan View

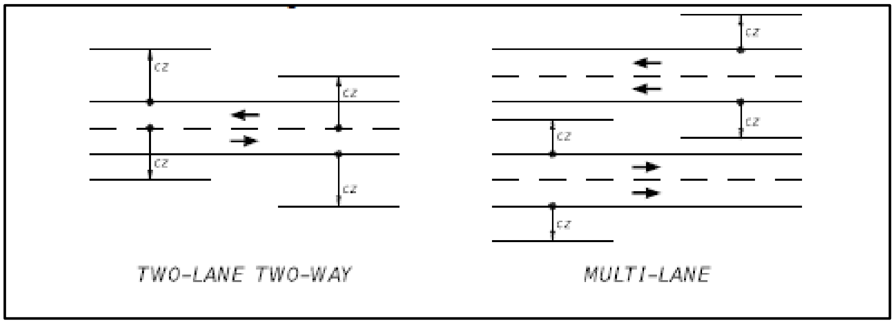


Figure 3 – 15 Basic Clear Zone Concept

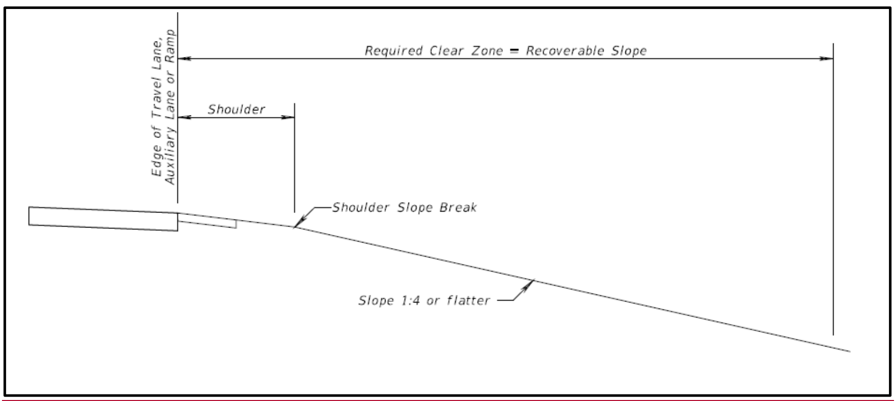
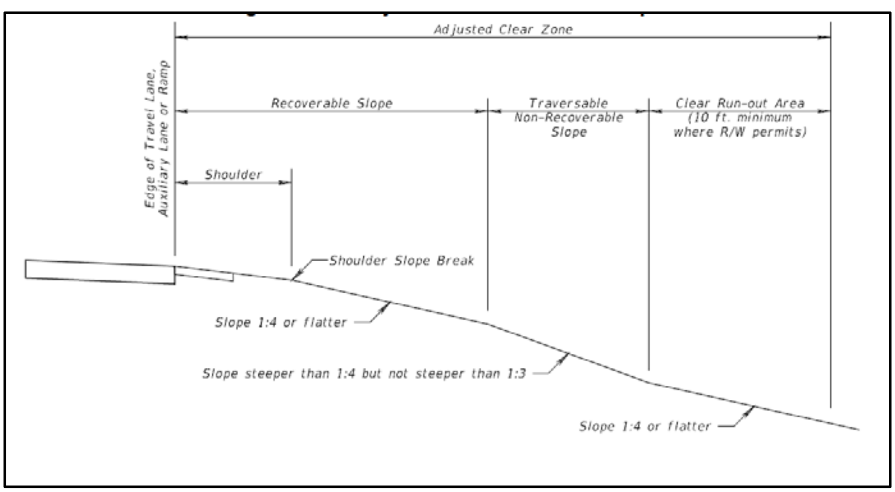


Figure 3 – 16 Adjusted Clear Zone Concept



Roadside ditches may be included within the clear zone if properly designed to be traversable. Acceptable cross section slope criteria for roadside ditches within the clear zone is provided in Figure 3 - 17 Roadside Ditches – Bottom Width 0 to 4 Feet and Figure 3 - 18. These roadside ditch configurations are considered traversable.

Figure 3 – 17 Roadside Ditches – Bottom Width 0 to 4 Feet

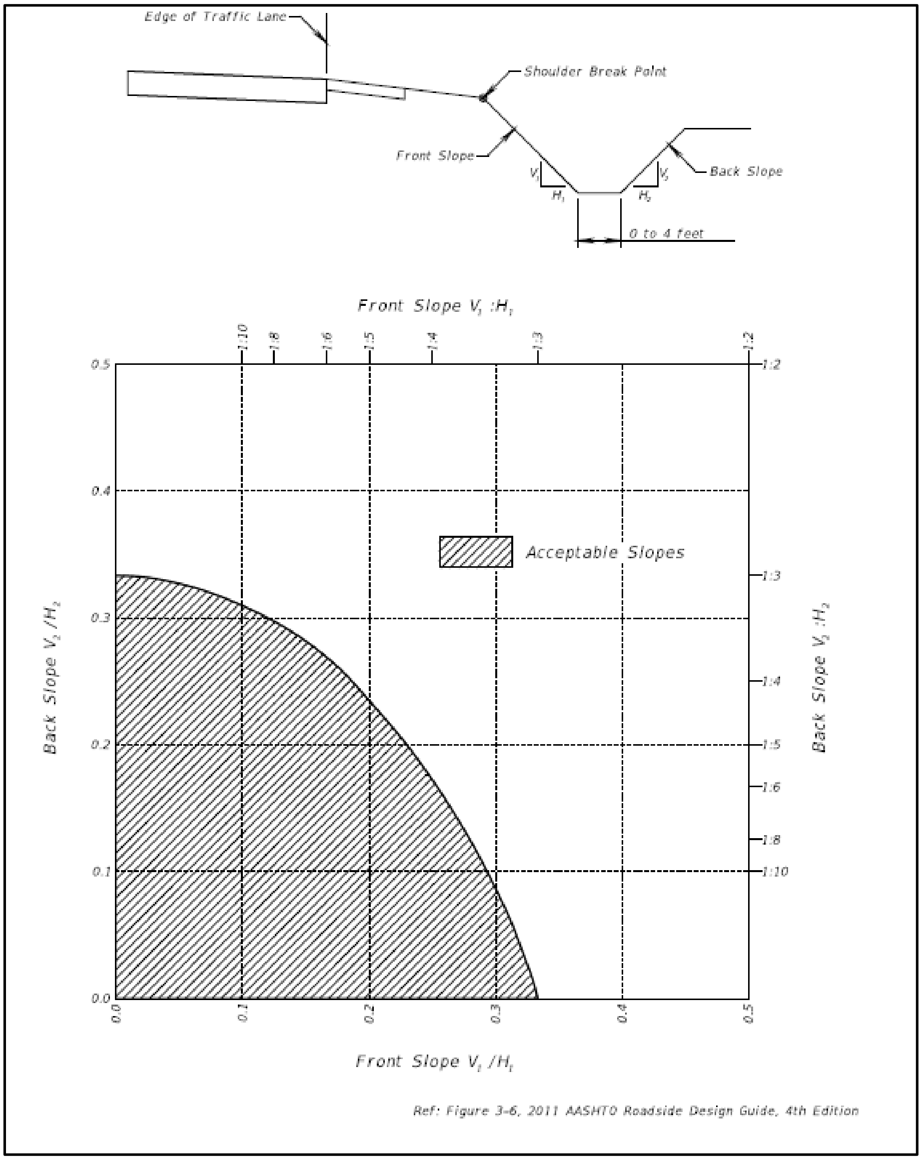
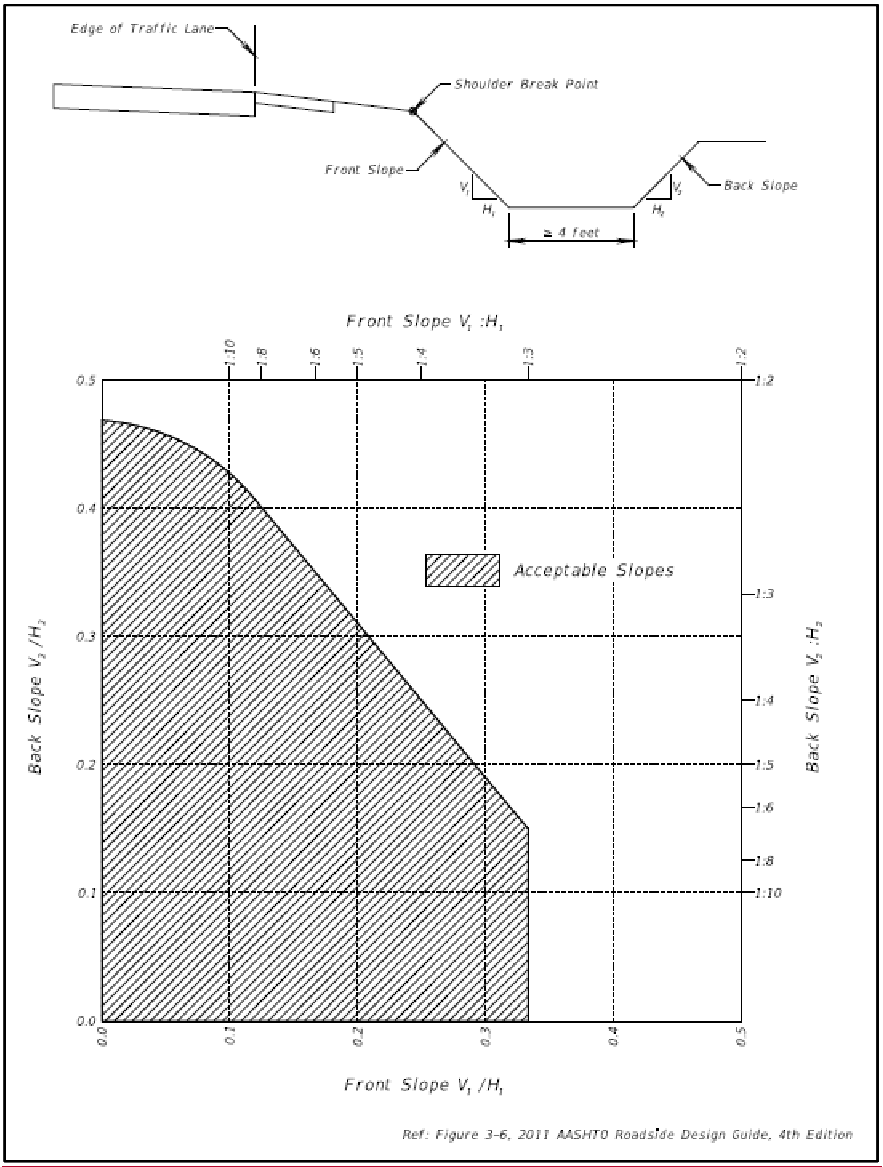


Figure 3 – 18 Roadside Ditches – Bottom Width ≥ 4 Feet



C.7.g.2 Lateral Offset

Lateral offset is the lateral distance from a specified point on the roadway such as the edge of traveled way or face of curb, to a roadside feature or above ground object that is more than 4 inches above grade. Lateral offset requirements apply to all roadways. The requirements for various objects or features are based on:

- Design speed,
- Location; i.e. rural areas or within urban boundary,
- Flush shoulder or with curb,
- Traffic volumes, and
- Lane type; e.g. travel lanes, auxiliary lanes, and ramps.

Lateral Offset requirements are provided in Table 3-16.

Flush shoulder roadways typically have sufficient right of way to provide the required clear zone widths. Therefore, lateral offset requirements for these type roadway are based on providing the clear zone widths provided in Table 3-15.

On urban curbed roadways with design speeds ≤ 45 mph, lateral offsets based on Table 3-15 clear zone requirements should be provided where practical. However, these urban low speed roads are typically located in areas where right of way is restricted (characterized by more dense abutting development, presence of parking, closer spaced intersections and accesses to property, and more bicyclists and pedestrians). The available right of way is typically insufficient to provide the required clear zone widths. Therefore, lateral offset requirements for above ground objects on these roadways are based on offsets needed for normal operation and not on maintaining a clear roadside for errant vehicles.

Table 3 - 16 Lateral Offset

Lateral Offset (feet)		
Roadside Feature	Urban Curbed Roadways Design Speed ≤ 45 mph	All Other
Above Ground Objects[1]	4 ft from Face of Curb[2]	Clear Zone Width
Drop Off Hazards[3]	Clear Zone Width	Clear Zone Width
Water Bodies and Canal Hazards	See Chapter 4	See Chapter 4

1. Aboveground objects are anything greater than 4 inches in height and are firm and unyielding or do not meet crashworthy or breakaway criteria. For urban curbed areas ≤ 45 mph this also includes crashworthy or breakaway objects except those necessary for the safe operation of the roadway.
2. May be reduced to 1.5 ft. from Face of Curb on roads functionally classified as Local Streets and on all roads where the 4 ft. minimum offset cannot be reasonably obtained and other alternatives are deemed impractical.
3. Drop off hazards are:
   a. Any vertical faced structure with a drop off (e.g. retaining wall, wing-wall, etc.) located within the Clear Zone.
   b. Slopes steeper than 1:3 located within the Clear Zone.
   c. Drop-offs with significant crash history.

~~The clear zone width is defined as follows:~~

- ~~Flush ShoulderRural Ssections - measured from the edge of the outside motor vehicular traveled way~~
- ~~Urban Curbed [JM38]Ssections ≤ 45 mph - measured from the face of the curb~~

~~The minimum permitted widths are provided in Table 3 - 13. These are minimum values only and should be increased wherever practical.~~

~~In rural areas, it is desirable, and frequently economically feasible, to increase the width of the clear zone. Where traffic volumes and speeds are high, the width should be increased. The clear zone on the outside of horizontal curves should be increased due to the possibility of vehicles leaving the roadway at a steeper angle.~~

~~**Table 3 – 15**~~
~~**Minimum Width of Clear Zone**~~

~~Type of Facility~~	~~DESIGN SPEED (mph)~~							
	~~25 and Below~~	~~30~~	~~35~~	~~40~~	~~45~~	~~50~~	~~55~~	~~60 and Above~~
	~~MINIMUM CLEAR ZONE (FEET)~~							
~~Flush Shoulder~~ •	~~6~~	~~6 Local~~ ~~10 Collectors~~ ~~14 Arterials~~	~~6 Local~~ ~~10 Collectors~~ ~~14 Arterials~~	~~10 Collectors~~ ~~14 Arterials~~	~~14 Arterials and Collectors ADT < 1500~~ ~~18 Arterials and Collectors ADT ≥ 1500~~	~~14 Arterials and Collectors ADT < 1500~~ ~~18 Arterials and Collectors ADT ≥ 1500~~	~~18 Arterials and Collectors ADT < 1500~~ ~~24 Arterials and Collectors ADT ≥ 1500~~	~~18 Arterials and Collectors ADT < 1500~~ ~~30 Arterials and Collectors ADT ≥ 1500~~
~~Curbed~~ *	~~1 ½~~	~~4~~ **	~~4~~ **	~~4~~ **	4 ** [JM39] [KM40]	~~N/A~~ ••	~~N/A~~ ••	~~N/A~~ ••

* ~~From face of curb.~~
** ~~On projects where the 4 foot minimum offset cannot be reasonably obtained and other alternatives are deemed impractical, the minimum may be reduced to 1 ½'.~~
• ~~Use rural for urban facilities when no curb and gutter is present. Measured from the edge of through travel lane on rural section.~~
•• ~~Curb and gutter not to be used on facilities with design speed > 45mph.~~

~~NOTE: ADT in Table 3-13 refers to Design Year ADT.~~

C.7.g~~f~~.3~~2~~ Roadside Slopes

The slopes of all roadsides should be as flat as possible to allow for safe traversal by out of control vehicles. A slope of 1:4 or flatter should be used[JM41], desirably 1:6 or flatter[KM42]. The transition between the shoulder and adjacent side slope should be rounded and free from discontinuities. A slope as steep as 1:3 may be used within the clear zone if the clear zone width is adjusted to provide a clear runout area as described in C.7.f.2.~~The adjacent side slope, within the clear zone, shall not be steeper than 1:3.~~ The side slopes should be reduced flatter on the outside of horizontal curves.

Where roadside ditches or cuts require backslope, slopes shall conform to acceptable slope conditions shown in Figures 3-17 and 3-18. ~~these slopes should not exceed 1:3 in steepness within the clear zone.~~ The desirable backslope is 1:4 or flatter. Ditch bottoms should be at least 4 feet wide and can be flat or gently rounded.

C.7.g~~f~~.4~~3~~ Criteria for Guardrail

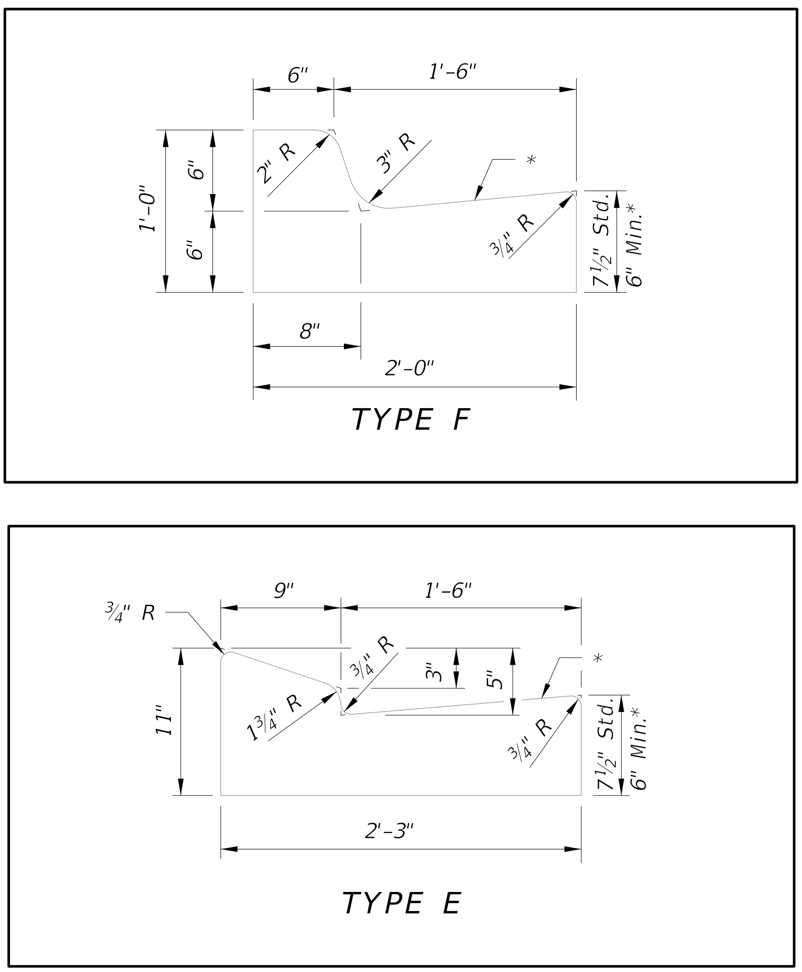
If space and economic constraints are severe, it is permissible, but not desirable, to use guardrails in lieu of the requirements for width and slope of clear zone. Where the previously described requirements for clear zone are not met, guardrails (or other longitudinal barriers) should be considered. Guardrails should also be considered for protection of pedestrian pathways or protection from immovable roadside hazards.

The general policy to be followed is that guardrails should be used if impact with the guardrail is less likely or considered less severe than impact with roadside objects. Further requirements and design criteria for guardrails are given in ***Chapter 4 - Roadside Design***.

C.7.h~~g~~ Curbs

Curbs may be used to provide drainage control and to improve delineation of the roadway. Curbs are generally designed with a gutter to form a combination curb and gutter section. Sloping curbs are used along the outside edge of the roadway to discourage vehicles from leaving the roadway. In Florida, the standard curb of this type is 6 inches in height. See Figure 3. 19 Standard Detail for FDOT Type F and E Curbs for examples of sloping curbs. These curbs are not to be used on facilities with design speeds greater than 45 mph.

Figure 3 - 19 Standard Detail for FDOT Type F and E Curbs



C.7.i~~h~~ Parking

When on-street parking is to be an element of design, parallel parking should be considered. Under certain circumstances, angle parking is an allowable form of street parking. The type of on-street parking selected should depend on the specific function and width of the street, the adjacent land use, traffic volume, as well as existing and anticipated traffic operations.

It can generally be stated that on-street parking decreases through capacity, impedes traffic flow, and increases crash potential. However, where parking is needed, and adequate off-street parking facilities are not available or feasible, on-street parking may be necessary.

C.7.j~~i~~ Right of Way

The acquisition of sufficient right of way is necessary in order to provide space for a safe street or highway. The width of the right of way required depends on the design of the roadway, the arrangement of bridges, underpasses and other structures, and the need for cuts or fills. The right of way acquired should be sufficient to:

- Allow development of the full cross section, including adequate medians and roadside clear zones. Determination of the necessary width requires that adequate consideration also be given to the accommodation of utility poles beyond the clear zone.
- Allow the layout of safe intersections, interchanges, and other access points.
- Allow adequate sight distance at all points, particularly on horizontal curves, at an intersection, and other access points.
- Allow, where appropriate, additional buffer zones to improve roadside safety, noise attenuation, and the overall aesthetics of the street or highway.
- Allow adequate space for placement of pedestrian and bicycle facilities, including curb ramps, bus bays, and transit shelters, where applicable.

- Allow for future lane additions, increases in cross section, or other improvement. Frontage roads should also be considered in the ultimate development of many high volume facilities.

- Allow treatment of stormwater runoff.

- Allow construction of future grade separations or other intersection improvements at selected crossroads.

- Allow corner cuts for upstream corner crossing drainage systems and placement of poles, boxes, and other visual screens out of the critical sight triangle.

- Allow landscaping and irrigation as required for the project.

The acquisition of wide rights of way is costly, but it may be necessary to allow the construction and future improvement of safe streets and highways. The minimum right of way should be at least 50 feet for all two-lane roads. For pre-existing conditions, when the existing right of way is less than 50 feet, efforts should be made to acquire the necessary right of way.

Local cul-de-sac and dead end streets having an ADT of less than or equal to 400 and a length of 600 feet or less, may utilize a right of way of less than 50 feet, if all elements of the typical section meet the standards included in this Manual.

The right of way for frontage roads may be reduced depending on the typical section requirements and the ability to share right of way with the adjacent street or highway facility.

C.7.k~~j~~ Changes in Typical Section

C.7.k~~j~~.1 General Criteria

Changes in cross section should be avoided. When changes in widths, slopes, or other elements are necessary, they should be affected in a smooth, gradual fashion.

C.7.k~~j~~.2 Lane Deletions and Additions

The addition or deletion of traffic or bicycle lanes should be undertaken on tangent sections of roadways. The approach to lane deletions and additions should have ample advance warning and sight distance.

The termination of lanes (including auxiliary lanes) shall meet the general requirements for merging lanes. See Section C.9.c.1 for additional information.

Where additional lanes are intermittently provided on two-lane, two-way highways, median separation should be considered.

C.7.k~~j~~.3 Preferential Lanes

To increase the efficiency and separation of different vehicle movements, preferential use lanes, such as bike lanes and bus lanes, should be considered. These lanes are often an enhancement to corridor safety and increase the horizontal clearance to roadside aboveground fixed objects. The ***MUTCD, Chapter 3D*** provides further information on preferential lane markings. See ***Chapter 9 – Bicycle Facilities*** for information on marking bicycle lanes.

C.7.k~~j~~.4 Structures

The pavement, median, and shoulder width, and sidewalks should be carried across structures such as bridges and box culverts. Shoulder widths for multi-lane rural divided highway bridges may be reduced as shown in Table 3 - 11. The designer should evaluate the economic practicality of utilizing dual versus single bridges for roadway sections incorporating wide medians.

The minimum roadway width for bridges on urban streets with curb and gutter shall be the same as the curb-to-curb width of the approach roadway. Sidewalks on the approaches should be carried across all structures. Curbed sidewalks should not be used adjacent to traffic lanes when design speeds exceed 45 mph. When the bridge rail (barrier wall) is placed between the traffic and sidewalk, it should be offset a minimum distance of 2½ feet from the edge of the travel lane, wide curb lane or bicycle lane. For long (500 feet or greater), and/or high level bridges, it is desirable to provide an offset distance that will accommodate a disabled vehicle. The transition from the bridge to the adjacent roadway section may be made by dropping the curb at the first intersection or well in advance of the traffic barrier, or reducing the curb in front of the barrier to a low sloping curb with a gently sloped traffic face. See ***Chapter 17 – Bridges and Other Structures*** for additional requirements.

C.7.kj.4.(a) Horizontal Clearance[JM43][KM44]

Supports for bridges, barriers, or other structures should be placed at or beyond the required shoulder. Where possible, these structures should be located outside of the required clear zone.

C.7.kj.4.(b) Vertical Clearance

Vertical clearance should be adequate for the type of expected traffic. Freeways and arterials shall have a vertical clearance of at least 16 feet-6 inches (includes 6 inch allowance for future resurfacing). Other streets and highways should have a clearance of 16 feet unless the provision of a reduced clearance is fully justified by a specific analysis of the situation (14 feet minimum). The minimum vertical clearance for a pedestrian or shared use bridge over a roadway is 17 feet. The minimum vertical clearance for a bridge over a railroad is 23 feet; however additional clearance may be required by the rail owner.

C.7.kj.4.(c) End Treatment

The termini of guardrails, bridge railings, abutments, and other structures should be constructed to protect vehicles and their occupants from serious impact. Requirements for end treatment of structures are given in ***Chapter 4 - Roadside Design***.

C.8 Access Control

All new facilities (and existing when possible) should have some degree of access control, since each point of access produces a traffic conflict. The control of access is one of the most effective, efficient, and economical methods for improving the capacity and safety characteristics of streets and highways. The reduction of the frequency of access points and the restriction of turning and crossing maneuvers, which should be primary objectives, is accomplished more effectively by the design of the roadway geometry than by the use of traffic control devices. Design criteria for access points are presented under the general requirements for intersection design.

C.8.a Justification

The justification for control of access should be based on several factors, including safety, capacity, economics, and aesthetics.

C.8.b General Criteria

C.8.b.1 Location of Access Points

All access locations should have adequate sight distance available for the safe execution of entrance, exit, and crossing maneuvers.

Locations of access points near structures, decision points, or the termination of street or highway lighting should be avoided.

Driveways[JM45][KM46] should not be placed near intersections or other points that would tend to produce traffic conflict.

C.8.b.2 Spacing of Access Points

The spacing of access points should be adequate to prevent conflict or mutual interference of traffic flow.

Separation of entrance and exit ramps should be sufficient to provide adequate distance for required weaving maneuvers.

Adequate spacing between access and decision points is necessary to avoid burdening the driver with the need for rapid decisions or maneuvers.

Frequent median openings should be avoided.

The use of a frontage road or other auxiliary roadways is recommended on arterials and higher classifications where the need for direct driveway or minor road access is frequent.

C.8.b.3 Restrictions of Maneuvers

Where feasible, the number and type of permitted maneuvers (crossing, turning slowing, etc.) should be restricted.

The restriction of crossing maneuvers may be accomplished by the use of grade separations and continuous raised medians.

The restriction of left turns is achieved most effectively by continuous medians.

Channelization should be considered for the purposes of guiding traffic flow and reducing vehicle conflicts.

C.8.b.4 Auxiliary Lanes[JM47]

Deceleration lanes for right turn exits (and left turns, where permitted) should be provided on all high-speed facilities. These turn lanes should not be excessive or continuous, since they complicate pedestrian crossings and bicycle/motor vehicle movements.

Storage (or deceleration lanes) to protect turning vehicles should be provided, particularly where turning volumes are significant.

Special consideration should be given to the provisions for deceleration, acceleration, and storage lanes in commercial or industrial areas with significant truck/bus traffic.

C.8.b.5 Grade Separation

Grade separation interchange design should be considered for junctions of high volume arterial streets and highways.

Grade separation (or an interchange) should be utilized when the expected traffic volume exceeds the intersection capacity.

Grade separation should be considered to eliminate conflict or long waiting periods at potentially hazardous intersections.

C.8.b.6 Roundabouts

Roundabouts have proven safety and operational characteristics and should be evaluated as an alternative to conventional intersections whenever practical. Modern roundabouts, when correctly designed, are a proven safety countermeasure to conventional intersections, both stop controlled and signalized. In addition, when constructed in appropriate locations, drivers will experience less delay with modern roundabouts. NCHRP Report 672. Roundabouts: An Informational Guide, is adopted by FHWA and establishes criteria and procedures for the justification, operational and safety analysis of modern roundabouts in the United States. The modern roundabout is characterized by the following:

- A central island of sufficient diameter to accommodate vehicle tracking and to provide sufficient deflection to promote lower speeds
- Entry is by gap acceptance through a yield condition at all legs
- Speeds through the intersection are 25 mph or less

Roundabouts should be considered under the following conditions:

1 New construction

2. Reconstruction

3. Traffic Operations improvements

4. Resurfacing (3R) with Right of Way acquisition

5. Need to reduce frequency and severity of crashes

C.8.c Control for All Limited Access Highways

Entrances and exits on the right side only are highly desirable for all limited access highways. Acceleration and deceleration lanes are mandatory. Intersections shall be accomplished by grade separation (interchange) and should be restricted to connect with arterials or collector roads.

The control of access on freeways should conform to the requirements given in Table 3 - 17~~6~~ Access Control for All Limited Access Highways. The spacing of exits and entrances should be increased wherever possible to reduce conflicts. Safety and capacity characteristics are improved by restricting the number and increasing the spacing of access points.

Table 3 – 176 Access Control for All Limited Access Highways

	URBAN	RURAL
MINIMUM SPACING		
Interchanges	1 to 3 miles	3 to 25 miles[KM48]
MANEUVER RESTRICTIONS		
Crossing Maneuvers	Via Grade Separation Only	
Exit and Entrance	From Right Side Only	
Turn Lane Required	Acceleration Lane at all Entrances Deceleration Lane at all Exits	

C.8.d Control of Urban and Rural Streets and Highways

The design and construction of urban, as well as rural, highways should be governed by the general criteria for access control previously outlined. In addition, the design of urban streets should be in accordance with the criteria listed below:

- The general layout of local and collector streets should follow a branching network, rather than a highly interconnected grid pattern.
- The street network should be designed to reduce, consistent with origin/destination requirements, the number of crossing and left turn maneuvers.
- The design of the street layout should be predicated upon reducing the need for traffic signals.
- The use of a public street or highway as an integral part of the internal circulation pattern for commercial property should be discouraged.
- The number of driveway access points should be restricted as much as possible through areas of strip development.
- Special consideration should be given to providing turn lanes (auxiliary lane for turning maneuvers) where the total volume or truck/bus volume is high.

- Major traffic generators may be exempt from the restrictions on driveway access if the access point is designed as a normal intersection adequate to handle the expected traffic volume.

These are minimum requirements only; it is generally desirable to use more stringent criteria for control of access.

The design of rural highways should be in accordance with the general criteria for access control for urban streets. The use of acceleration and deceleration lanes on all high-speed highways, particularly if truck and bus traffic is significant, is strongly recommended.

C.8.e Land Development

It should be the policy of each agency with responsibility for street and highway design, construction, or maintenance to promote close liaison with utility, lawmaking, zoning, building, and planning agencies. Cooperation should be solicited in the formulation of laws, regulations, and master plans for land use, zoning, and road construction. Further requirements and criteria for access control and land use relationships are given in ***Chapter 2 - Land Development***.

C.9 Intersection Design

Intersections increase traffic conflicts and the demands on the driver, and are inherently hazardous locations. The design of an intersection should be predicated on reducing motor vehicle, bicycle, and pedestrian conflicts, minimizing the confusion and demands on the driver for rapid and/or complex decisions, and providing for smooth traffic flow. The location and spacing of intersections should follow the requirements presented in C.8 Access Control, this chapter. Intersections should be designed to minimize time and distance of all who pass through or turn at an intersection.

The additional effort and expense required to provide a high quality intersection is justified by the corresponding safety benefits. The overall reduction in crash potential derived from a given expenditure for intersection improvements is generally much greater than the same expenditure for improvements along an open roadway. Properly designed intersections increase capacity, reduce delays, and improve safety.

One of the most common deficiencies that may be easy to correct is lack of adequate left turn storage.

The requirements and design criteria contained in this section are applicable to all driveways, intersections, and interchanges. All entrances to, exits from, or interconnections between streets and highways are subject to these design standards.

C.9.a General Criteria

The layout of a given intersection may be influenced by constraints unique to a particular location or situation. The design shall conform to sound principles and criteria for safe intersections. The general criteria include the following:

- The layout of the intersection should be as simple as is practicable. Complex intersections, which tend to confuse and distract the driver, produce inefficient and hazardous operations.

- The intersection arrangement should not require the driver to make rapid or complex decisions.

- The layout of the intersection should be clear and understandable so a proliferation of signs, signals, or markings is not required to adequately inform and direct the driver.

- The design of intersections, particularly along a given street or highway, should be as consistent as possible.

- The approach roadways should be free from steep grades and sharp horizontal or vertical curves.

- Intersections with driveways or other roadways should be as close to right angle as possible.

- Adequate sight distance should be provided to present the driver a clear view of the intersection and to allow for safe execution of crossing and turning maneuvers.

- The design of all intersection elements should be consistent with the design speeds of the approach roadways.

- The intersection layout and channelization should encourage smooth flow and discourage wrong way movements.

- Special attention should be directed toward the provision of safe roadside clear zones.

- The provision of auxiliary lanes should be in conformance with the criteria set forth in C.8 Access Control, this chapter.

- The requirements for bicycle and pedestrian movements should receive special consideration.

C.9.b Sight Distance

Inadequate sight distance is a contributing factor in the cause of a large percentage of intersection crashes. The provision of adequate sight distance at intersections is absolutely essential and should receive a high priority in the design process.

C.9.b.1 General Criteria

General criteria to be followed in the provision of sight distance include the following:

- Sight distance exceeding the minimum stopping sight distance should be provided on the approach to all intersections (entrances, exits, stop signs, traffic signals, and intersecting roadways). The use of proper approach geometry free from sharp horizontal and vertical curvature will normally allow for adequate sight distance.
- The approaches to exits or intersections (including turn, storage, and deceleration lanes) should have adequate sight distance for the design speed and also to accommodate any allowed lane change maneuvers.
- Adequate sight distance should be provided on the through roadway approach to entrances (from acceleration or merge lanes, stop or yield signs, driveways or traffic signals) to provide capabilities for defensive driving. This lateral sight distance should include as much length of the entering lane or intersecting roadway as is feasible. A clear view of entering vehicles is necessary to allow through traffic to aid merging maneuvers and to avoid vehicles that have "run" or appear to have the intention of running stop signs or traffic signals.
- Approaches to school or pedestrian crossings and crosswalks should have sight distances exceeding the minimum values. This should also include a clear view of the adjacent pedestrian pathways or shared use paths.
- Sight distance in both directions should be provided for all entering roadways (intersecting roadways and driveways) to allow entering vehicles to avoid through traffic. See Section C.9.B.4 for further information.
- Safe stopping sight distances shall be provided throughout all intersections, including turn lanes, speed change lanes, and turning roadways.
- The use of lighting (***Chapter 6 - Lighting***) should be considered to improve intersection sight distance for night driving.

C.9.b.2 Obstructions to Sight Distance[MAK49]

The provisions for sight distance are limited by the street or highway geometry and the nature and development of the area adjacent to the roadway. Where line of sight is limited by vertical curvature or obstructions, stopping sight distance shall be based on the eye height of 3.50 feet and an object height of 2.0 feet. At exits or other locations where the driver may be uncertain as to the roadway alignment, a clear view of the pavement surface should be provided. At locations requiring a clear view of other vehicles or pedestrians for the safe execution of crossing or entrance maneuvers, the sight distance should be based on a driver's eye height of 3.50 feet and an object height of 3.00 feet (preferably 1.50 feet). The height of eye for truck traffic may be increased for determination of line of sight obstructions for intersection maneuvers. Obstructions to sight distance at intersections include the following:

- Any property not under the highway agency's jurisdiction, through direct ownership or other regulations, should be considered as an area of potential sight distance obstruction. Based on the degree of obstruction, the property should be considered for acquisition by deed or easement.
- Areas which contain vegetation (trees, shrubbery, grass, etc.) that cannot easily be trimmed or removed by regular maintenance activity should be considered as sight obstructions.
- Parking lanes shall be considered as obstructions to line of sight. Parking shall be prohibited within clear areas required for sight distance at intersections.
- Large (or numerous) poles or support structures for lighting, signs, signals, or other purposes that significantly reduce the field of vision within the limits of clear sight shown in Figure 3 - 11 Departure Sight Triangle in Section C.9.b.4. may constitute sight obstructions. Potential sight obstructions created by poles, supports, and signs near intersections should be carefully investigated.

In order to ensure the provision for adequate intersection sight distance, on-site inspections should be conducted before and after construction, including placement of signs, lighting, guardrails, or other objects and how they impact intersection sight distance.

C.9.b.3 Stopping Sight Distance

The provision for safe stopping sight distance at intersections and on turning roadways is even more critical than on open roadways. Vehicles are more likely to be traveling in excess of the design or posted speed and drivers are frequently distracted from maintaining a continuous view of the upcoming roadway.

C.9.b.3.(a) Approach to Stops

The approach to stop signs, yield signs, or traffic signals should be provided with a sight distance no less than values given in Table 3 - 18~~7~~ Sight Distance for Approach to Stops . These values are applicable for any street, highway, or turning roadway. The driver should, at this required distance, have a clear view of the intersecting roadway, as well as the sign or traffic signal.

Where the approach roadway is on a grade or vertical curve, the sight distance should be no less than the values shown in Figure 3 - 10 Sight Distances for Approach to Stop on Grades. In any situation where it is feasible, sight distances exceeding those should be provided. This is desirable to allow for more gradual stopping maneuvers and to reduce the likelihood of vehicles running through stop signs or signals. Advance warnings for stop signs are desirable.

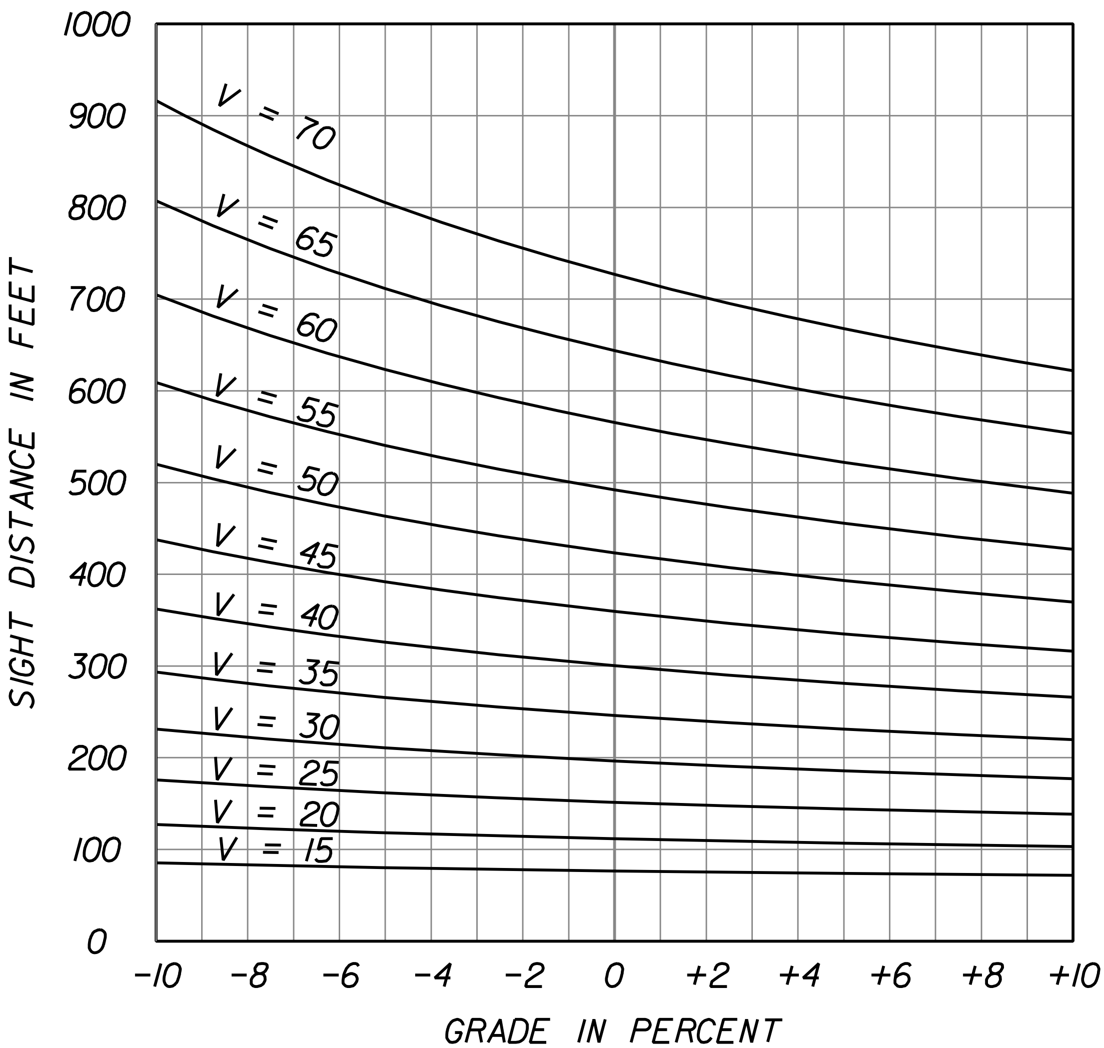
Table 3 – 18~~7~~ Sight Distance for Approach to Stops (Rounded Values[MAK50])

DESIGN SPEED (mph)	20	25	30	35	40	45	50	55	60	65	70
STOPPING SIGHT DISTANCE (feet) (Minimum)	115	155	200	250	305	360	425	495	570	645	730

C.9.b.3.(b) On Turning Roads

The required stopping sight distance at any location on a turning roadway (loop, exit, etc.) shall be based on the design speed at that point. Ample sight distance should be provided since the driver is burdened with negotiating a curved travel path and the available friction factor for stopping has been reduced by the roadway curvature. The minimum sight distance values are given in Table 3 - 18~~7~~ or Figure 3 - 2~~1~~0. Due to the inability of vehicle headlights to adequately illuminate a sharply curved travel path, roadway lighting should be considered for turning roadways.

Figure 3 – ~~1~~20~~0~~
Sight Distances for Approach to Stop on Grades



$$S = 3.675V + \frac{V^2}{30(0.3478 \pm G)}$$

S = Sight Distance
V = Design Speed
G = Grade

C.9.b.4 Sight Distance for Intersection Maneuvers

Sight distance is also provided at intersections to allow the drivers of stopped vehicles a sufficient view of the intersecting street or highway to decide when to enter or cross the intersecting street or highway. Sight triangles, which are specified areas along intersection approach legs and across their included corners, shall, where practical, be clear of obstructions that would prohibit a driver's view of potentially conflicting vehicles. Departure sight triangles shall be provided in each quadrant of each intersection approach controlled by stop signs.

Figures 3 - 2~~1~~1 Departure Sight Triangle(Traffic Approaching from Left or Right) and 3 - 2~~1~~2 Intersection Sight Distance show typical departure sight triangles to the left and to the right of the location of a stopped vehicle on a minor road (stop controlled) and the intersection sight distances for the various movements.

Distance "a" is the length of leg of the sight triangle along the minor road. This distance is measured from the driver's eye in the stopped vehicle to the center of the nearest lane on the major road (through road) for vehicles approaching from the left, and to the center of the nearest lane for vehicles approaching from the right.

Distance "b" is the length of the leg of the sight triangle along the major road measured from the center of the minor road entrance lane. This distance is a function of the design speed and the time gap in major road traffic needed for minor road drivers turning onto or crossing the major road. This distance is calculated as follows:

$$ISD = 1.47V_{major}t_g$$

Where:

ISD=Intersection Sight Distance (ft.) – length of leg of sight triangle along the major road.

V_{major}= Design Speed (mph) of the Major Road

t_g= Time gap (sec.) for minor road vehicle to enter the major road.

Time gap values, t_g, to be used in determination of ISD are based on studies and observations of the time gaps in major road traffic actually accepted by drivers turning onto or across the major road. Design time gaps will vary and depend on the design vehicle, the type of the maneuver, the crossing distance involved in the maneuver, and the minor road approach grade.

For intersections with stop control on the minor road, there are three maneuvers or cases that must be considered. ISD is calculated for each maneuver case that may occur at the intersection. The case requiring the greatest ISD will control. Cases that must be considered are as follows (Case numbers correspond to cases identified in the AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011):

Case B1 – Left Turns from the Minor (stop controlled) Road

Case B2 – Right Turns from the Minor (stop controlled) Road

Case B3 – Crossing the Major Road from the Minor (stop controlled) Road

See Sections C.9.b.4.(c) and (d) for design time gaps for Case B.

For Intersections with Traffic Signal Control see Section C.9.b.4.(e) (AASHTO Case D).

For intersections with all way stop control see Section C.9.b.4.(f) (AASHTO Case E).

For left turns from the major road see Section C.9.b.4.(g) (AASHTO Case F).

Figure 3 – 2~~1~~1
Departure Sight Triangle
(Traffic Approaching from Left or Right)

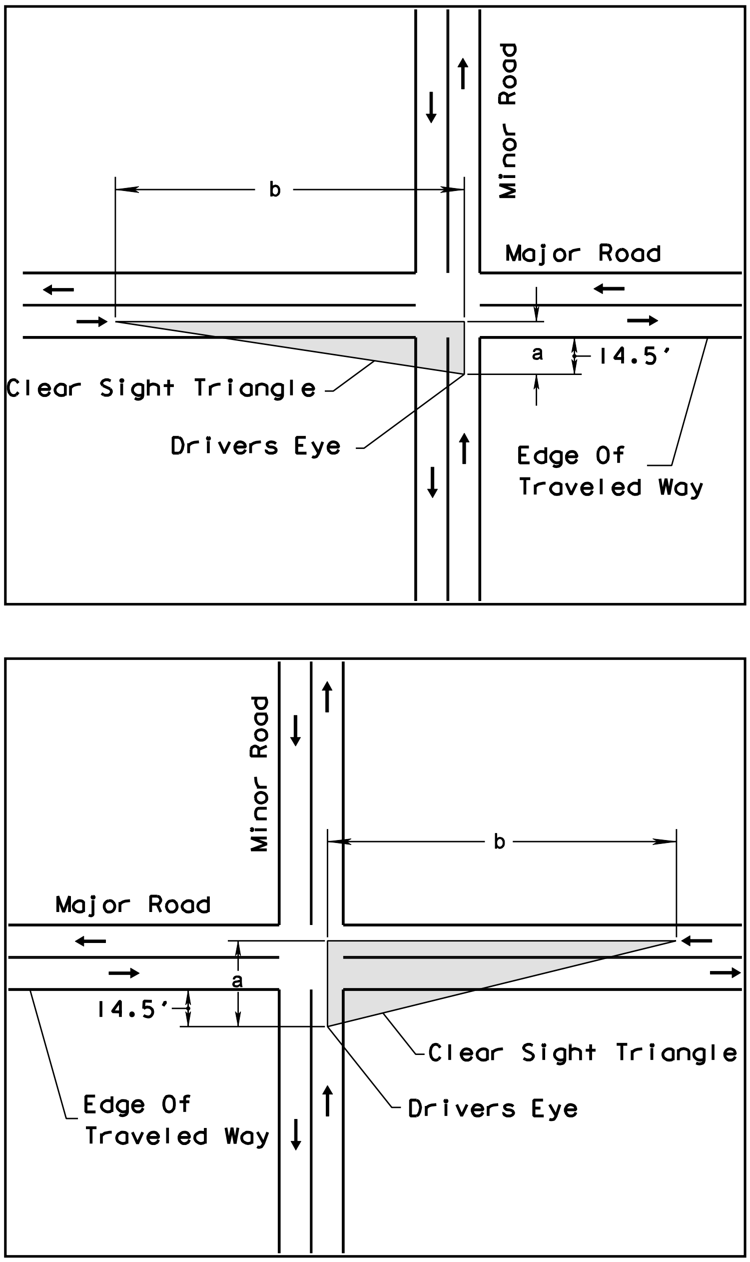
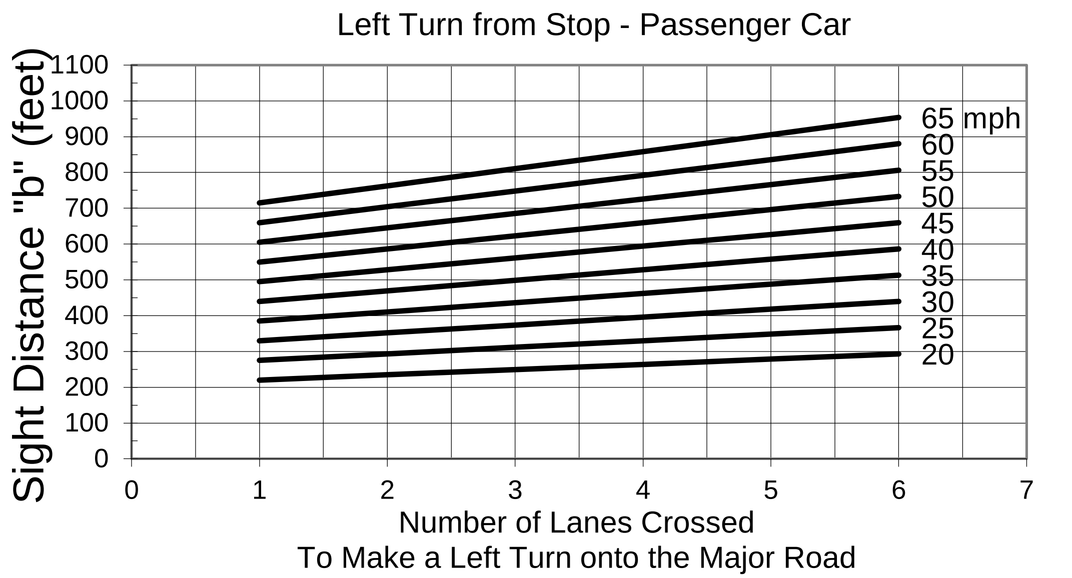
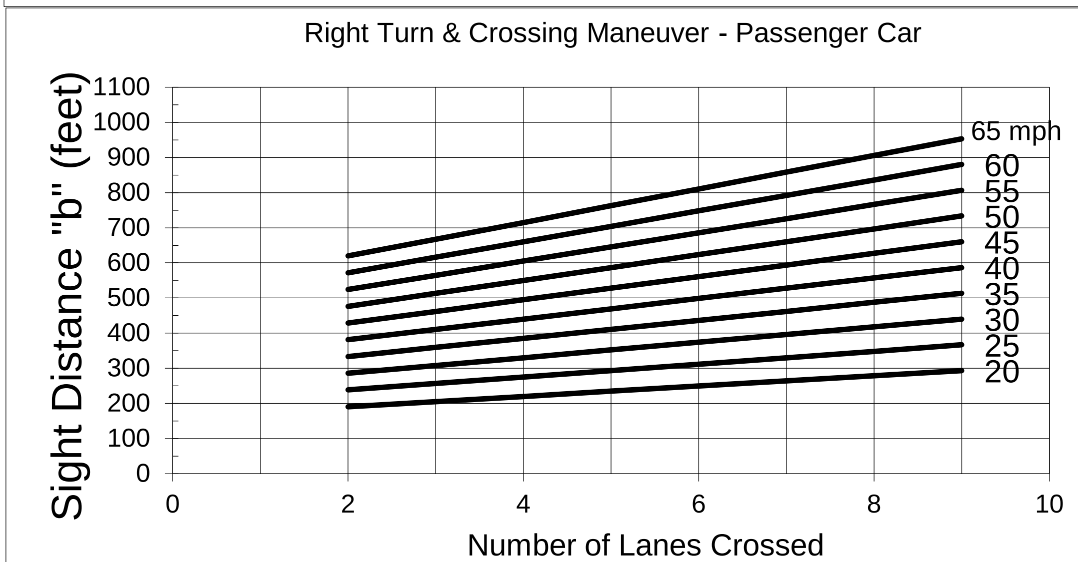


Figure 3 – 2~~1~~2
Intersection Sight Distance[KM51]



A vehicle crosses one lane to make a left turn onto a two lane-two way road; crosses two lanes on a four lane undivided road; and so forth. For divided highways, convert median widths to equivalent number of lanes. For medians 25' and greater a two step maneuver may be considered - see text.



For right turn maneuver use distance based on 2 lanes crossed.
For crossing divided highways, convert median widths to equivalent number of lanes. For medians 25' and greater a two step maneuver may be considered - see text.

C.9.b.4.(a) Driver's Eye Position and Vehicle Stopping Position

The vertex (decision point or driver's eye position) of the departure sight triangle on the minor road shall be a minimum of 14.5 feet from the edge of the major road traveled way. This is based on observed measurements of vehicle stopping position and the distance from the front of the vehicle to the driver's eye. Field observations of vehicle stopping positions found that, where necessary, drivers will stop with the front of their vehicle 6.5 feet or less from the edge of the major road traveled way. Measurements of passenger cars indicate that the distance from the front of the vehicle to driver's eye for the current U.S. passenger car fleet is almost always 8 feet or less.

When executing a crossing or turning maneuver after stopping at a stop sign, stop bar, or crosswalk as required in Section 316.123, Florida Statutes, it is assumed that the vehicle will move slowly forward to obtain sight distance (without intruding into the crossing travel lane) stopping a second time as necessary.

C.9.b.4.(b) Design Vehicle

Dimensions of clear sight triangles are provided for passenger cars, single unit trucks, and combination trucks stopped on the minor road. It can usually be assumed that the minor road vehicle is a passenger car. However, where substantial volumes of heavy vehicles enter the major road, such as from a ramp terminal, the use of tabulated values for single unit or combination trucks should be considered.

C.9.b.4.(c) Case B1 - Left Turns From the Minor Road

Design time gap values for left turns from the minor road onto two lane two way major highway are as follows:

Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	7.5
Single Unit Truck	9.5
Combination Truck	11.5

If the minor road approach grade is an upgrade that exceeds 3 percent, add 0.2 seconds for each percent grade for left turns.

For multilane streets and highways without medians wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane from the left, in excess of one, to be crossed by the turning vehicle. The median width should be included in the width of additional lanes. This is done by converting the median width to an equivalent number of 12 foot lanes.

For multilane streets and highways with medians wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle a two step maneuver may be assumed. Use case B2 for crossing to the median.

C.9.b.4.(d) Case B2 - Right Turns From the Minor Road and Case B3 – Crossing Maneuver From the Minor Road

Design time gap values for a stopped vehicle on a minor road to turn right onto or cross a two lane highway are as follows:

Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	6.5
Single Unit Truck	8.5
Combination Truck	10.5

If the approach grade is an upgrade that exceeds 3 percent, add 0.1 seconds for each percent grade.

For crossing streets and highways with more than 2 lanes, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane to be crossed. Medians not wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle should be included in the width of additional lanes. This is done by converting the median width to an equivalent number of 12 foot lanes.

For crossing divided streets and highways with medians wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle, a two step maneuver may be assumed. Only the number of lanes to be crossed in each step are considered.

C.9.b.4.(e) Intersections with Traffic Signal Control (AASHTO Case D)

At signalized intersections, the first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches. Left turning vehicles should have sufficient sight distance to select gaps in oncoming traffic and complete left turns. Apart from these sight conditions, no other sight triangles are needed for signalized intersections. However, if the traffic signal is to be placed on two-way flashing operation in off peak or nighttime conditions, then the appropriate departure sight triangles for Cases B1, B2, or B3, both to the left and to the right, should be provided. In addition, if right turns on red are to be permitted, then the appropriate departure sight triangle to the left for Case B2 should be provided to accommodate right turns.

C.9.b.4.(f) Intersections with All-Way Stop Control (AASHTO Case E)

At intersections with all-way stop control, the first stopped vehicle on one approach should be visible to the drivers of the first stopped vehicles on each of the other approaches. There are no other sight distance criteria applicable to intersections with all-way stop control.

C.9.b.4.(g) Left Turns from the Major Road (AASHTO Case F)

All locations along a major road from which vehicles are permitted to turn left across opposing traffic shall have sufficient sight distance to accommodate the left turn maneuver. In this case, the ISD is measured from the stopped position of the left turning vehicle (see Figure 3 - 2~~1~~3 Sight Distance for Vehicle Turning Left from Major Road).

Design time gap values for left turns from the major road are as follows:

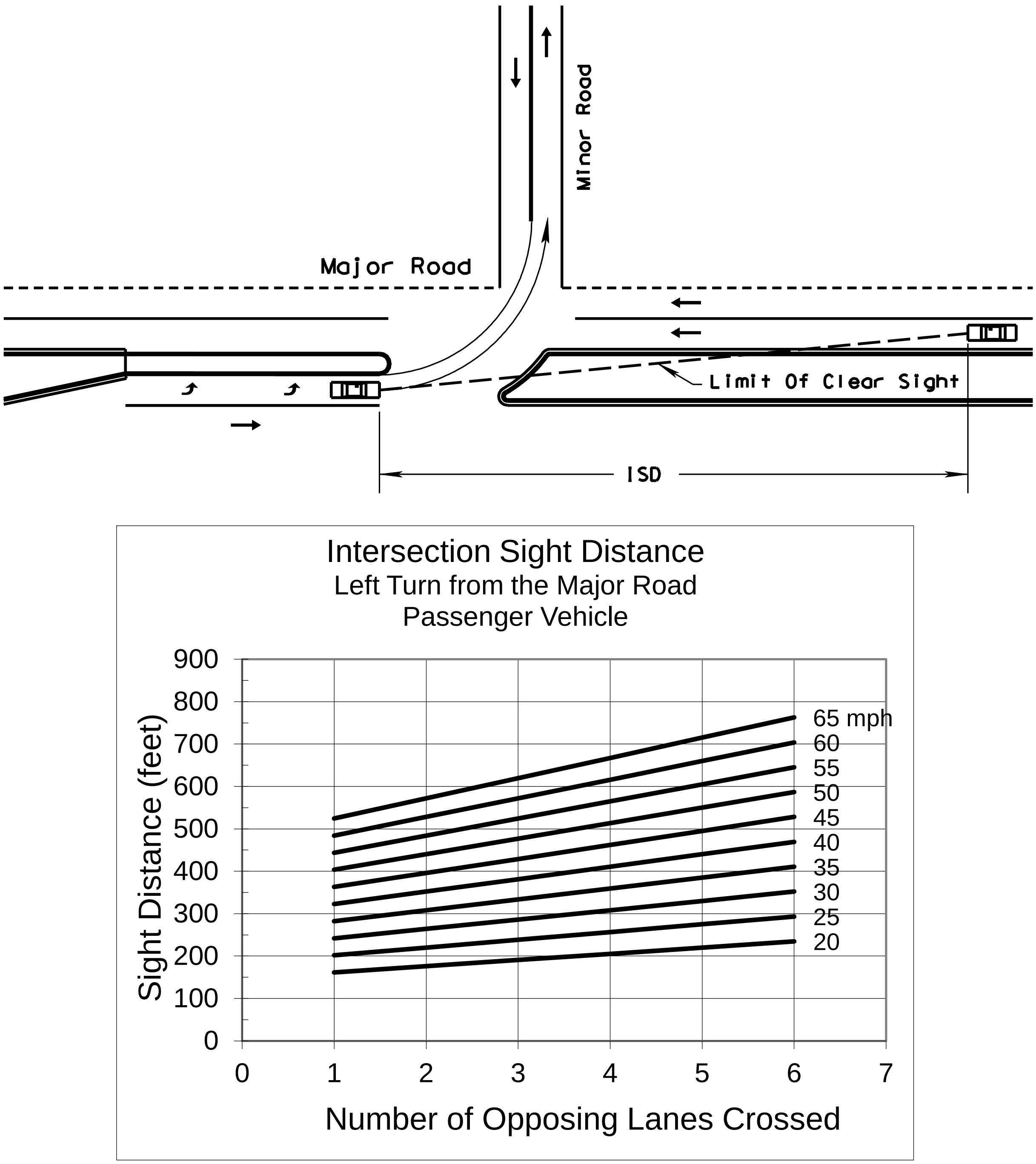
Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	5.5
Single Unit Truck	6.5
Combination Truck	7.5

For left turning vehicles that cross more than one opposing lane, add 0.5 seconds for passenger cars and 0.7 seconds for trucks for each additional lane to be crossed.

C.9.b.4.(h) Intersection Sight Distance References

The Department's Design Standards, Index 546, provides ISD values for several basic intersection configurations based on Cases B1, B2, B3, and D, and may be used when applicable. For additional guidance on Intersection Sight Distance, see the AASHTO Green Book.

Figure 3 – 2~~1~~3
Sight Distance for Vehicle Turning Left from Major Road



C.9.c Auxiliary Lanes

Auxiliary lanes are desirable for the safe execution of speed change maneuvers (acceleration and deceleration) and for the storage and protection of turning vehicles. Auxiliary lanes for exit or entrance turning maneuvers shall be provided in accordance with the requirements set forth in C.8 Access Control, this chapter. The pavement width and cross slopes of auxiliary lanes should meet the minimum requirements shown in Table 8 Minimum Lane Widths.

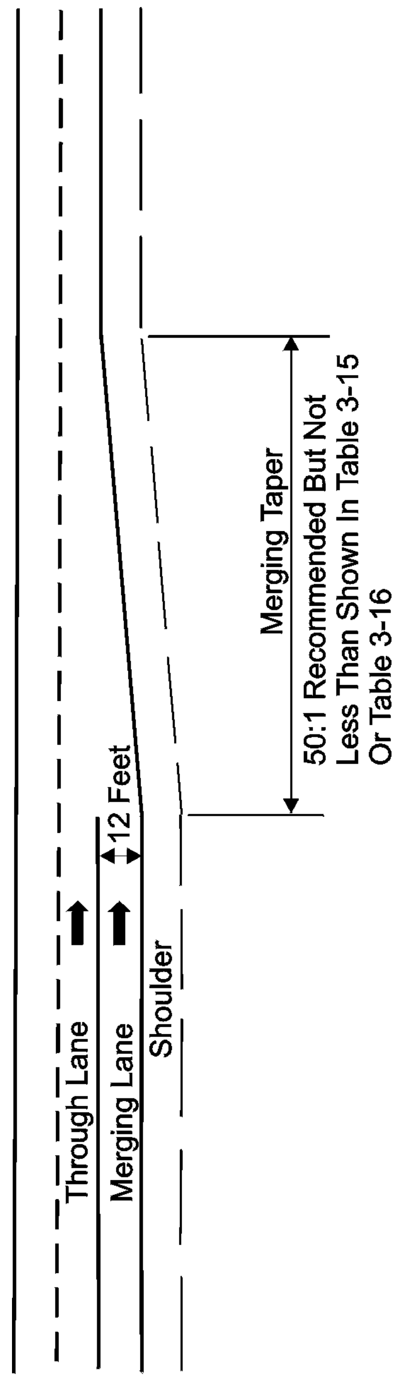
C.9.c.1 Merging Maneuvers

Merging maneuvers occur at the termination of climbing lanes, lane drops, entrance acceleration, and turning lanes. The location provided for this merging maneuver should, where possible, be on a tangent section of the roadway and should be of sufficient length to allow for a smooth, safe transition. The provision of ample distance for merging is essential to allow the driver time to find an acceptable gap in the through traffic and then execute a safe merging maneuver. It is recommended that a merging taper be on a 1:50 transition, but in no case shall the length be less than set forth in Table 3 - 19~~8~~ Length of Taper for Use In Conditions With Full Width Speed Change Lanes. The termination of this lane should be clearly visible from both the merging and through lane and should correspond to the general configuration shown in Figure 3 - 2~~1~~4 Termination of Merging Lanes. Advance warning of the merging lane termination should be provided. Lane drops shall be marked in accordance with ***Section 14-15.010, F.A.C. Manual on Uniform Traffic Control Devices (MUTCD)***.

Table 3 – 19~~8~~ Length of Taper for Use in Conditions with Full Width Speed Change Lanes

DESIGN SPEED (mph)	20	25	30	35	40	45	50	55	60	65	70
LENGTH OF DECELERATION TAPER (feet)	110	130	150	170	190	210	230	250	270	290	300
LENGTH OF ACCELERATION TAPER (feet)	80	100	120	140	160	180	210	230	250	260	280

Figure 3 – 2~~1~~4
Termination of Merging Lanes



C.9.c.2 Acceleration Lanes

Acceleration lanes are required for all entrances to expressway and freeway ramps. Acceleration lanes may be desirable at access points to any street or highway with a large percentage of entering truck traffic.

The distance required for an acceleration maneuver is dependent on the vehicle acceleration capabilities, the grade, the initial entrance speed, and the final speed at the termination of the maneuver. The distances required for acceleration on level roadways for passenger cars are given in Table 3 - 20~~19~~ Design Lengths of Speed Change Lanes Flat Grades. Where acceleration occurs on a grade, the required distance is obtained by using Tables 3 - 20~~19~~ and 3 - 21~~0~~ Ratio of Length of Speed Change Lane on Grade to Length on Level.

The final speed at the end of the acceleration lane, should, desirably, be assumed as the design speed of the through roadway. The length of acceleration lane provided should be at least as long as the distance required for acceleration between the initial and final speeds. Due to the uncertainties regarding vehicle capabilities and driver behavior, additional length is desirable. The acceleration lane should be followed by a merging taper (similar to Figure 3 - 2~~1~~4 Termination of Merging Lanes), not less than that length set forth in Table 3 - 19~~8~~. The termination of acceleration lanes should conform to the general configuration shown for merging lanes in Figure 3 - 2~~1~~4. Recommended acceleration lanes for freeway entrance terminals are given in Table 3 - 22~~1~~ Minimum Acceleration Lengths for Entrance Terminals.

Table 3 – 20~~19~~ Design Lengths of Speed Change Lanes Flat Grades - 2 Percent or Less

Design Speed of turning roadway curve (mph)		Stop Condition	15	20	25	30	35	40	45	50
Minimum curve radius (feet)		---	55	100	160	230	320	430	555	695
Design Speed of Highway (mph)	Length of Taper (feet)*	Total length of DECELERATION LANE, including taper, (feet)								
30	150	385	350	320	290	---	---	---	---	---
35	170	450	420	380	355	320	---	---	---	---
40	190	510	485	455	425	375	345	---	---	---
45	210	595	560	535	505	460	430	---	---	---
50	230	665	635	615	585	545	515	455	405	---
55	250	730	705	690	660	630	600	535	485	---
60	270	800	770	750	730	700	675	620	570	510
65	290	860	830	810	790	760	730	680	630	570
70	300	915	890	870	850	820	790	740	690	640
Design Speed of Highway (mph)	Length of Taper (feet)*	Total length of ACCELERATION LANE, including taper (feet)								
30	120	300	260	---	---	---	---	---	---	---
35	140	420	360	300	---	---	---	---	---	---
40	160	520	460	430	370	280	---	---	---	---
45	180	740	670	620	560	460	340	---	---	---
50	210	930	870	820	760	660	560	340	---	---
55	230	1190	1130	1040	1010	900	780	550	380	---
60	250	1450	1390	1350	1270	1160	1050	800	670	430
65	260	1670	1610	1570	1480	1380	1260	1030	860	630
70	280	1900	1840	1800	1700	1630	1510	1280	1100	860

* For urban street auxiliary lanes, shorter tapers may be used due to lower operating speeds. Refer to Figure 3-16 for allowable taper rates.

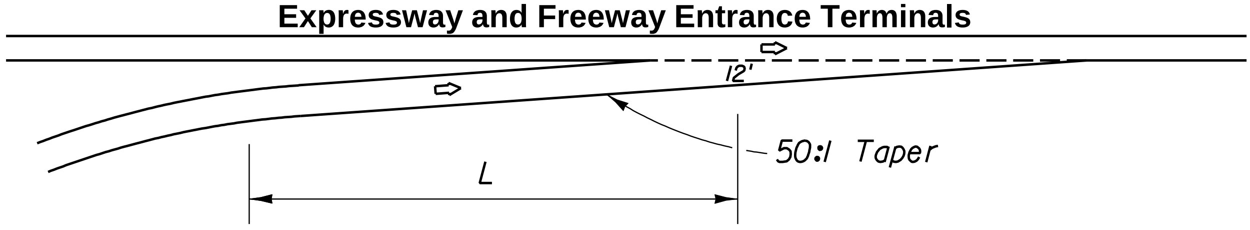
Table 3 – 21~~0~~ Ratio of Length of Speed Change Lane on Grade to Length on Level

DECELERATION LANE			ACCELERATION LANE					
	Design Speed of Turning Roadway (mph)			Design Speed of Turning Roadway (mph)				
Design Speed of Highway (mph)	All Speeds 3% -4% Upgrade	All Speeds 3%-4% Downgrade	Design Speed of Highway (mph)	20	30	40	50	All Speeds
				3% - 4% Upgrade				3% - 4% Downgrade
All Speeds	0.9	1.2	40	1.3	1.3	---	---	0.7
			45	1.3	1.35	---	---	0.675
			50	1.3	1.4	1.4	---	0.65
			55	1.35	1.45	1.45	---	0.625
			60	1.4	1.5	1.5	1.6	0.6
			65	1.45	1.55	1.6	1.7	0.6
			70	1.5	1.6	1.7	1.8	0.6
	5% - 6% Upgrade	5% - 6% Downgrade		5% - 6% Upgrade				5% - 6% Downgrade
All Speeds	0.8	1.35	40	1.5	1.5	---	---	0.6
			45	1.5	1.6	---	---	0.575
			50	1.5	1.7	1.9	---	0.55
			55	1.6	1.8	2.05	---	0.525
			60	1.7	1.9	2.2	2.5	0.5
			65	1.85	2.05	2.4	2.75	0.5
			70	2.0	2.2	2.6	3.0	0.5
Ratios in this table multiplied by the values in Table 3-18 give the length of speed change lane for the respective grade.								

Table 3 – 22~~1~~ Minimum Acceleration Lengths for Entrance Terminals

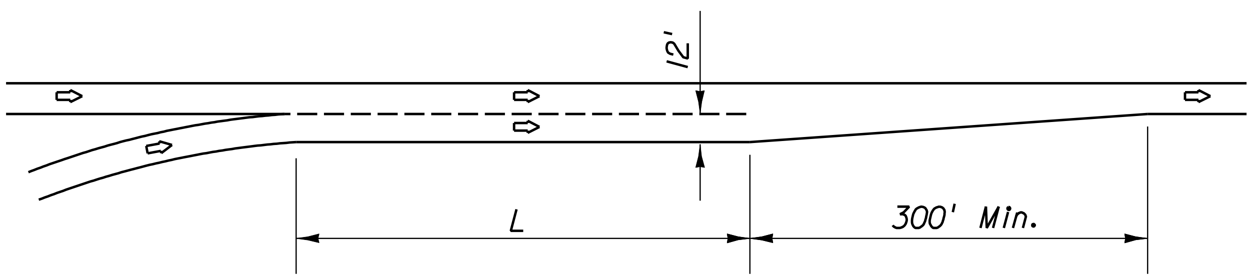
Highway Design Speed (mph)	L = Acceleration Length (feet)								
	For Entrance Curve Design Speed (mph)								
	Stop Condition	15	20	25	30	35	40	45	50
30	180	140	---	---	---	---	---	---	---
35	280	220	160	---	---	---	---	---	---
40	360	300	270	210	120	---	---	---	---
45	560	490	440	380	280	160	---	---	---
50	720	660	610	550	450	350	130	---	---
55	960	900	810	780	670	550	320	150	---
60	1200	1140	1100	1020	910	800	550	420	180
65	1410	1350	1310	1220	1120	1000	770	600	370
70	1620	1560	1520	1420	1350	1,230	1000	820	580

Expressway and Freeway Entrance Terminals



TAPER TYPE

Recommended when design speed at entrance curve is 50 mph or greater.



PARALLEL TYPE

Recommended when design speed at entrance curve is less than 50 mph.

C.9.c.3 Exit Lanes

Auxiliary lanes for exiting maneuvers provide space outside the through lanes for protection and storage of decelerating vehicles exiting the facility.

- Deceleration Lanes - The primary function of deceleration lanes is to provide a safe travel path for vehicles decelerating from the operating speed on the through lanes. Deceleration lanes are required for all freeway exits and are desirable on high-speed (design speed greater than 50 mph) streets and highways.

The distance required for deceleration of passenger cars is given in Table 3 - 20~~19~~.

The required distance for deceleration on grades is given in Tables 3 - 20~~19~~ and 3 - 21~~0~~.

The length of deceleration lanes shall be no less than the values obtained from Tables 3 - 20~~19~~ and 3 - 21~~0~~, and should be increased wherever feasible. The initial speed should, desirably, be taken as the design speed of the highway. The final speed should be the design speed at the exit (e.g., a turning roadway) or zero, if the deceleration lane terminates at a stop or traffic signal. A reduction in the final speed to be used is particularly important if the exit traffic volume is high, since the speed of these vehicles may be significantly reduced.

The entrance to deceleration (and climbing) lanes should conform to the general configuration shown in Figure 3 - 2~~1~~5 Entrance for Deceleration Lane. The initial length of straight taper, shown in Table 3 - 20~~19~~, may be utilized as a portion of the total required deceleration distance. The pavement surface of the deceleration lane should be clearly visible to approaching traffic, so drivers are aware of the maneuvers required. Recommended deceleration lanes for exit terminals are given in Table 3 - 23~~2~~ Minimum Deceleration Lengths for Exit Terminals.

- Storage Lanes - Where exit lanes are required (C.8 Access Control, this chapter), or desirable on low speed streets and highways, storage lanes may be used in place of or in conjunction with deceleration lanes. Storage lanes should be considered on all facilities. Although the primary function of storage lanes is to provide protection and storage for turning vehicles, it is desirable to provide sufficient length to allow for deceleration capabilities. Storage lanes should conform to the general configuration shown in Figure 3 - 2~~1~~6 Typical Storage Lane***[MAK52]*.**

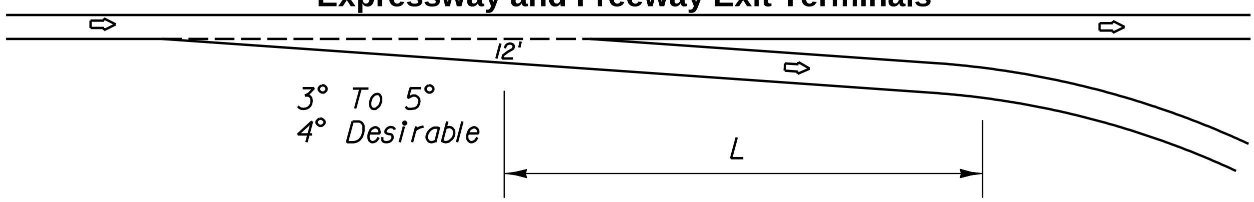
The length of storage lanes for unsignalized intersections may be obtained from the table in Figure 3 - 2~~1~~6. The full width portion of storage lanes should, where possible, be increased to allow for expected storage of vehicles (Table 3 - 2 for vehicle lengths). As a minimum requirement, storage for at least two passenger cars (40 - 50 feet) should be provided.

On collector or arterial streets (design speed 45 mph or less), tapers preceding storage lanes and approaching intersections at grade may be shorter than those given in Table 3 - 20~~19~~ (AASHTO for recommended lengths).

Table 3 – 23~~2~~ Minimum Deceleration Lengths for Exit Terminals

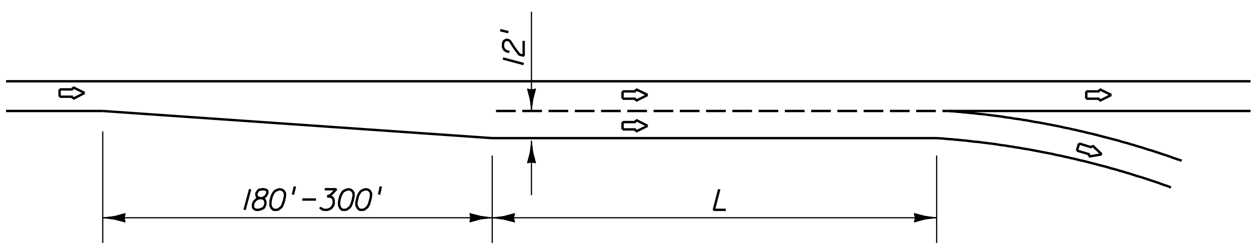
Highway Design Speed (mph)	L = Deceleration Length (feet)								
	For Design Speed of Exit Curve (mph)								
	Stop Condition	15	20	25	30	35	40	45	50
30	235	200	170	140	---	---	---	---	---
35	280	250	210	185	150	---	---	---	---
40	320	295	265	235	185	155	---	---	---
45	385	350	325	295	250	220	---	---	---
50	435	405	385	355	315	285	225	175	---
55	480	455	440	410	380	350	285	235	---
60	530	500	480	460	430	405	350	300	240
65	570	540	520	500	470	440	390	340	280
70	615	590	570	550	520	490	440	390	340

Expressway and Freeway Exit Terminals



TAPER TYPE

Recommended when design speed at exit curve is 50 mph or greater and when approach visibility is good.



PARALLEL TYPE

Recommended when design speed at exit curve is less than 50 mph or when approach visibility is <u>not</u> good.

Figure 3 – 2~~1~~5
Entrance for Deceleration Lane

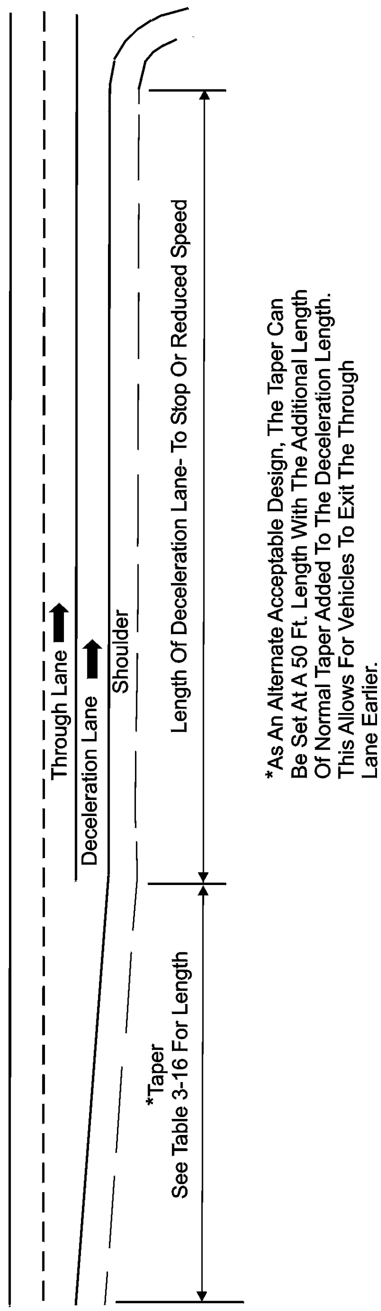
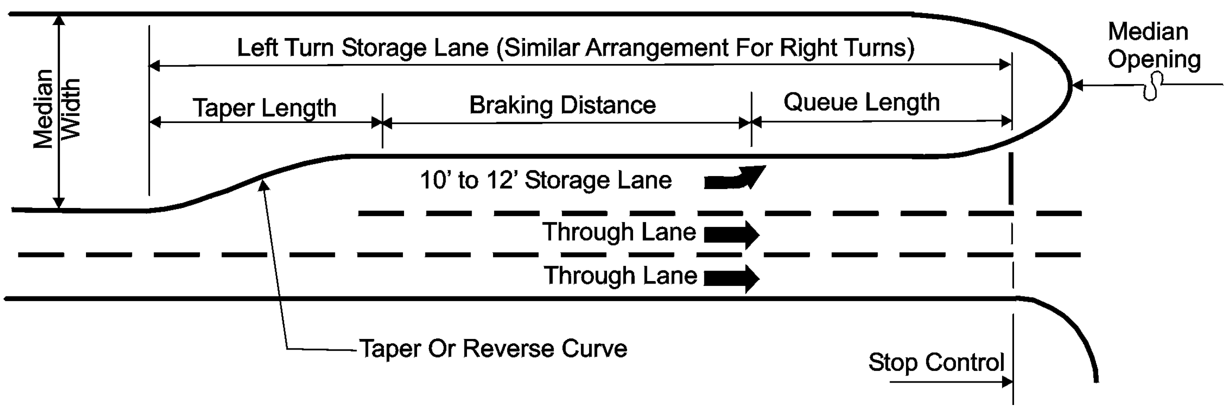


Figure 3 – 2~~1~~6
Typical Storage Lane[MAK53]



Storage Queue Length - Unsignalized Intersections

Turning Vehicles Per Hour	30	60	100	200	300
Required Storage Length (feet)	25	50	100	175	250

At signalized intersections, the required queue length depends on the signal cycle length, the signal phasing arrangement, and rate of arrivals and departures of turning vehicles.

In absence of a turning movement study, it is recommended that 100 ft. of queue length be provided in urban/suburban areas and 50 ft. of queue length be provided in rural/town areas as a minimum.

Taper Length And Braking Distance (feet)

Highway Design Speed (mph)	**Storage Entry Speed* (mph)**	**Taper Length**	**Brake To Stop**	
			Urban**	**Rural*****
35	25	70	75	---
40	30	80	75	---
45	35	85	100	---
50	40/44	105	135	215
55	48	125	---	260
60	52	145	---	310
65	55	170	---	350

* Reaction Precedes Entry
** Minimum Braking Distance, Wet Conditions
*** Customary Braking Distance, Wet Conditions

The storage lane may be in place of or in addition to deceleration length (See Section C.9.c.3).

C.9.d Turning Roadways at Intersections

The design and construction of turning roadways shall meet the same general requirements for through roadways, except for the specific requirements given in the subsequent sections.

C.9.d.1 Design Speed

Lanes for turning movements at grade intersections may, where justified, be based on a design speed as low as 10 mph. Turning roadways with design speeds in excess of 40 mph shall be designed in accordance with the requirements for through roadways.

A variable design speed may be used to establish cross section and alignment criteria for turning roadways that will experience acceleration and deceleration maneuvers.

C.9.d.2 Horizontal Alignment

- Curvature - The minimum permitted radii (maximum degree) of curvature for various values of superelevation are given in Table 3 - 24~~3~~ Superelevation Rates for Curves at Intersections. These should be considered as minimum values only and the radius of curvature should be increased wherever feasible. Further information contained in ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***, should also be considered.

Table 3 – 24~~3~~ Superelevation Rates for Curves at Intersections

	Design Speed (mph)					
	20	**25**	**30**	**35**	**40**	**45**
Minimum Superelevation Rate	0.02	0.04	0.06	0.08	0.09	0.10
Minimum Radius (feet)	90	150	230	310	430	540

The rate of 0.02 is considered the practical minimum for effective drainage across the surface.

Note: Preferably use superelevation rates greater than these minimum values.

- Superelevation Transition - Minimum superelevation transition (runoff) rates (maximum relative gradients) are given in Tables ~~3 - 2~~254 Maximum Rate of Change in Pavement Edge Elevation for Curves at Intersections and 3 - 26~~5~~ Maximum Algebraic Difference in Pavement Cross Slope at Turning Roadway Terminals. Other information given in ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***, should also be considered.

Table 3 – 254 Maximum Rate of Change in Pavement Edge Elevation for Curves at Intersections

Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
Maximum relative gradients for profiles between the edge of two lane pavement and the centerline (percent)	0.74	0.70	0.66	0.62	0.58	0.54	0.50	0.47	0.45	0.43	0.40

Table 3 – 26~~5~~ Maximum Algebraic Difference in Pavement Cross Slope at Turning Roadway Terminals

Design Speed of Exit or Entrance Curve (mph)	Maximum Algebraic Difference in Cross Slope at Crossover Line (percent)
20 and under	5.0 to 8.0
25 and 30	5.0 to 6.0
35 and over	4.0 to 5.0

C.9.d.3 Vertical Alignment

Grades on turning roadways should be as flat as practical and long vertical curves should be used wherever feasible. The length of vertical curves shall be no less than necessary to provide minimum stopping sight distance. Minimum stopping sight distance values are given in Table 3 - 18~~7~~. For additional guidance on vertical alignment for turning roadways, see ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***.

C.9.d.4 Cross Section Elements

- Number of Lanes - One-way turning roadways are often limited to a single traffic lane. In this case, the total width of the roadway shall be sufficient to allow traffic to pass a disabled vehicle. Two-way, undivided turning roadways should be avoided. Medians or barriers should be utilized to separate opposing traffic on turning roadways.
- Lane Width - The width of all traffic lanes should be sufficient to accommodate (with adequate clearances) the turning movements of the expected types of vehicles. The minimum required lane widths for turning roadways are given in Table 3 - 27 Derived Pavement Widths for Turning Roadways for Different Design Vehicles. Changes in lane widths should be gradual and should be accomplished in coordination with adequate transitions in horizontal curvature.
- Shoulders - On one-lane turning roadways, serving expressways and other arterials (e.g., loops, ramps), the right hand shoulder should be at least 6 feet wide. The left hand shoulder should be at least 6 feet wide in all cases. On two-lane, one-way roadways, both shoulders should be at least 6 feet wide. Where guardrails or other barriers are used, they should be placed at least 8 feet from edge of travel lane. Guardrails should be placed 2 feet outside the normal shoulder width.
- Clear Zones - Turning roadways should, as a minimum, meet all open highway criteria for clear zones on both sides of the roadway. The areas on the outside of curves should be wider and more gently sloped than the minimum values for open highways. Guardrails or similar barriers shall be used if the minimum width and slope requirements cannot be obtained.

Further criteria and requirements for roadway design are given in ***Chapter 4 - Roadside Design***.

Table 3 – 27~~4~~ Derived~~sign~~ Pavement Widths ~~of Pavements~~ for Turning Roadways for Different Design Vehicles[KM54]

~~**Pavement Width (feet)**~~

Radius on Inner Edge of Pavement, R (feet)	**Case 1, One-Lane Operation, No Provision for Passing a Stalled Vehicle**												
	P	SU-30	Su-40	City Bus	S-Bus-36	A-Bus	WB-40	WB-62	WB-67	WB-67D	MH	P/T	P/B
50	13	18	21	21	18	22	23	44	57	29	18	19	18
75	13	17	18	19	17	19	20	30	33	23	17	17	17
100	13	16	17	18	16	18	18	25	28	21	16	16	16
150	12	15	16	17	16	17	17	22	23	19	15	16	15
200	12	15	16	16	15	16	16	20	21	18	15	15	15
300	12	15	15	16	15	16	15	18	19	17	15	15	15
400	12	15	15	15	15	15	15	17	18	16	15	15	14
500	12	14	15	15	14	15	15	17	17	16	14	14	14
Target	12	14	14	15	14	15	14	15	15	15	14	14	14

Radius on Inner Edge of Pavement, R (feet)	**Case II, One-Lane, One-Way Operation, with Provision for Passing a Stalled Vehicle by Another of the Same Type**												
	P	SU-30	SU-40	City Bus	S-Bus-36	A-Bus	WB-40	WB-62	WB-67	WB-67D	MH	P/T	P/B
50	20	30	36	38	31	40	39	81	109	50	30	30	28
75	19	27	30	32	27	34	32	53	59	39	27	27	26
100	18	25	27	30	25	30	29	44	48	34	25	25	24
150	18	23	25	27	23	27	26	36	38	29	23	23	23
200	17	22	24	25	23	26	24	32	34	27	22	22	22
300	17	22	22	24	22	24	23	28	30	25	22	22	21
400	17	21	22	23	21	23	22	26	27	24	21	21	21
500	17	21	21	23	21	23	22	25	26	23	21	21	21
Target	17	20	20	21	20	21	20	21	21	21	20	20	20

Table Continued on Next Page

Radius on Inner Edge of Pavement, R (feet)	**Case III, Two-Lane Operation, Either One- or Two-Way (Same Type Vehicle in Both Lanes)**												
	P	SU-30	SU-40	City Bus	S-Bus-36	A-Bus	WB-40	WB-62	WB-67	WB-67D	MH	P/T	P/B
50	26	36	42	44	37	46	45	87	115	56	36	36	34
75	25	33	36	38	33	40	38	59	65	45	33	33	32
100	24	31	33	35	31	36	35	50	54	40	31	31	30
150	24	29	31	33	29	33	32	42	44	35	29	29	29
200	23	28	30	31	29	32	30	38	40	33	28	28	28
300	23	28	28	30	28	30	29	34	36	31	28	28	27
400	23	27	28	29	27	29	28	32	33	30	27	27	27
500	23	27	27	29	27	29	28	31	32	29	27	27	27
Target	23	26	26	27	26	27	28	27	27	27	26	26	26

Source – 2011 AASHTO Greenbook, Table 3-28b Derived Pavement Widths for Turning Roadways for Different Design Vehicle

C.9.e At Grade Intersections

C.9.e.1 Turning Radii

Where right turns from through or turn lanes will be negotiated at low speeds (less than 10 mph), the minimum turning capabilities of the vehicle may govern the design. It is desirable that the turning radius and the required lane width be provided in accordance with the criteria for turning roadways. The radius of the inside edge of traveled way should be sufficient to allow the expected vehicles to negotiate the turn without encroaching the shoulder or adjacent traffic lanes.

Where turning roadway criteria are not used, the radius of the inside edge of traveled way should be no less than 25 feet. The use of three-centered compound curves is also a reasonable practice to allow for transition into and out of the curve. The recommended radii and arrangement of compound curves instead of a single simple curve is given in ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***.

C.9.e.2 Cross Section Correlation

The correlation of the cross section of two intersecting roadways is frequently difficult. A careful analysis should be conducted to ensure changes in slope are not excessive and adequate drainage is provided. At stop-controlled intersections, the through roadway cross section should be carried through the intersection without interruption. Minor roadways should approach the intersection at a slightly reduced elevation so the through roadway cross section is not disturbed. At signalized intersections, it is sometimes necessary to remove part of the crown in order to avoid an undesirable hump in one roadway.

Intersections of grade or cross slope should be gently rounded to improve vehicle operation. Pavement generally should be sloped toward the intersection corners to provide superelevation for turning maneuvers and to promote proper drainage.

Where islands are used for channelization, the width of traffic lanes for turning movements shall be no less than the widths recommended by AASHTO.

C.9.e.3 Median Openings

Median openings should be restricted in accordance with the requirements presented in C.8 Access Control, this chapter. Where a median opening is required, the length of the opening shall be no less than 40 feet. Median curbs should be terminated gradually without the exposure of abrupt curb ends. The termination requirements are given in ***Chapter 4 - Roadside Design***.

C.9.e.4 Channelization

Channelization of at grade intersections is the regulation or separation of conflicting movements into definite travel paths by islands, markings, or other means, to promote safe, orderly traffic flow. The major objective of channelization is to clearly define the appropriate paths of travel and thus assist in the prevention of vehicles deviating excessively or making wrong maneuvers.

Channelization may be used effectively to define the proper path for exits, entrances, and intersection turning movements. The methods used for channelization should be as simple as possible and consistent in nature. The channelized intersection should appear open and natural to the approaching driver. Channelization should be informative rather than restrictive in nature.

The use of low sloping curbs and flush medians and islands can provide adequate delineation in most cases. Islands should be clearly visible and, in general, should not be smaller than 100 square feet in area. The use of small and/or numerous islands should be avoided.

Pavement markings are a useful and effective tool for providing delineation and channelization in an informative rather than restrictive fashion. The layout of all traffic control devices should be closely coordinated with the design of all channelization.

C.9.f Driveways

Direct driveway access within the area of influence of the intersection should be discouraged.

Driveways from major traffic generators (greater than 400 vpd), or those with significant truck/bus traffic, should be designed as normal intersections.

C.9.g Interchanges

The design of interchanges for the intersection of a freeway with a major street or highway, collector/distributor road, or other freeway is a complex problem. The location and spacing of intersections should follow the requirements presented in C.8 Access Control, this chapter. The design of interchanges shall follow the general intersection requirements for deceleration, acceleration, merging maneuvers, turning roadways, and sight distance.

Interchanges, particularly along a given freeway, should be reasonably consistent in their design. A basic principle in the design should be to develop simple open interchanges that are easily traversed and understandable to the driver. Complex interchanges with a profusion of possible travel paths are confusing and hazardous to the motorist and are generally inefficient.

Intersections with minor streets or highways or collector/distributor roads may be accomplished by simple diamond interchanges. The intersection of exit and entrance ramps with the crossroad shall meet all intersection requirements.

The design of freeway exits should conform to the general configurations given in Table 3 - 23~~2~~. Exits should be on the right and should be placed on horizontal curves. Where deceleration on an exit loop is required, the deceleration alignment should be designed so the driver receives adequate warning of the approaching increase in curvature. This is best accomplished by gradually increasing the curvature and the resulting centrifugal force. This increasing centrifugal force provides warning to the driver that he must slow down. A clear view of the exit loop should also be provided. The length of deceleration shall be no less than the values shown in Table 3 - 23~~2~~.

Entrances to freeways should be designed in accordance with the general configurations shown below Table 3 - 22~~1~~. Special care should be taken to ensure vehicles entering from loops are not directed across through travel lanes. The entering roadway should be brought parallel (or nearly so) to the through lanes before entry is permitted. Where acceleration is required, the distances shown in Table 3 - 221 shall, as a minimum, be provided. Exits and entrances to all high-speed facilities (design speed greater than 50 mph), should, where feasible, be designed in accordance with Tables 3 - 23~~2~~ and 3 - 22~~1~~. The lengths obtained from Tables 3 - 23~~2~~ and 3 - 22~~1~~ should be adjusted for grade by using the ratios in Table 3 - 21~~20~~.

The selection of the type and exact design details of a particular interchange requires considerable study and thought. The guidelines and design details given in ***AASHTO "A Policy on Geometric Design of Highways and Streets" - 2011***, should generally be considered as minimum criteria.

C.9.h Clear Zone

The provisions of ample clear zone or proper redirection of energy absorbing devices is particularly important at intersections. Every effort should be made to open up the area around the intersection to provide adequate clear zone for vehicles that have left the traveled way. Drivers frequently leave the proper travel path due to unsuccessful turning maneuvers or due to the necessity for emergency avoidance maneuvers. Vehicles also leave the roadway after intersection collisions and roadside objects should be removed to reduce the probability of second impacts. The roadside areas at all intersections and interchanges should be contoured to provide shallow slopes and gentle changes in grade.

The roadside clear zone of intersecting roadways should be carried throughout intersections with no discontinuities or interruptions. Poles and support structures for lights, signs, and signals should not be placed in medians or within the roadside clear zone.

The design of guardrails or other barriers should receive particular attention at intersections. Impact attenuators should be used in all gore and other areas where structures cannot be removed.

Particular attention should be given to the protection of pedestrians in intersection areas - ***Chapter 8 - Pedestrian Facilities***. Further criteria and requirements for clear zone and protection devices at intersections are given in ***Chapter 4 - Roadside Design***.

C.10 Other Design Factors

C.10.a Pedestrian Facilities

The layout and design of the street and highway network should include provisions for pedestrian traffic in urban areas. All pedestrian crossings and pathways within the road right of way should be considered and designed as in integral part of any street or urban highway.

C.10.a.1 Policy and Objectives - New Facilities

The planning and design of new streets and highways shall include provisions for the safe, orderly movement of pedestrian traffic. Provisions for pedestrian traffic outside of the road right of way should be considered.

The overall objective is to provide a safe, secure, continuous, convenient, and comfortable trip continuity and access environment for pedestrian traffic.

C.10.a.2 Accessibility Requirements

Pedestrian facilities, such as walkways and sidewalks, shall be designed to accommodate physically disabled persons whose mobility is dependent on wheelchairs and other devices. In addition to the design criteria provided in this chapter, the ***2006 Americans with Disabilities Act Standards for Transportation Facilities*** as required by 49 C.F.R 37.41 or 37.43 and the ***2012 Florida Accessibility Code for Building Construction*** as required by 61G20-4.002 impose additional requirements for the design and construction of pedestrian facilities.

C.10.a.3 Sidewalks

Sidewalks should provide a safe, comfortable space for pedestrians. The width of sidewalks is dependent upon the roadside environment, volume of pedestrians, and the presence of businesses, schools, parks, and other pedestrian attractors. The minimum width for sidewalks is covered in ***Chapter 8 – Pedestrian Facilties*** and Section C.7.d of this chapter. To ensure compliance with federal and state accessibility requirements:

- Sidewalks less than 60 inches wide must have passing spaces of at least 60 inches by 60 inches, at intervals not to exceed 200 feet.
- The minimum clear width may be reduced to 32 inches for a short distance. This distance must be less than 24 inches long, and separated by 5-foot long sections with 48 inches of clear width.
- Sidewalks not constrained within the roadway right of way with slopes greater than 1:20 are considered ramps and must be designed as such.

Sidewalks 5 feet wide or wider will provide for two adults to walk comfortably side by side.

C.10.a.4 Curb Ramps

In areas with sidewalks, curb ramps must be incorporated at locations where crosswalks adjoin the sidewalks. The basic curb ramp type and design application depends on the geometric characteristics of the intersection or other crossing location.

Typical curb ramp width shall be a minimum of 4 feet with 1:10 curb transitions on each side when pedestrians must walk across the ramp[KM55][KM56][KM57]. Ramp slopes shall not exceed 1:10 and shall have a firm, stable, slip resistant surface texture. Ramp widths equal to crosswalk widths are encouraged.

Curb ramps at marked crossings shall be wholly contained within the crosswalk markings excluding any flared sides.

If diagonal ramps must be used, any returned curbs or other well-defined edges shall be parallel to the pedestrian flow. The bottom of diagonal curb ramps shall have 48-inch minimum clear space within the crosswalk. Curb ramps whose sides have returned curbs provide useful directional cues where they are aligned with the pedestrian street crossing and are protected from cross travel by landscaping or street, street furniture, or railings.

It is important for persons using the sidewalk that the location of the ramps be as uniform as possible. Detectable warnings are required at all curb ramps and flush transitions where sidewalks or shared use paths meet a roadway.

The Department's ***Design Standards, Index 304***, provides additional information on the design of accessible sidewalks and shared use paths. Designers should keep in mind there are many variables involved, possibly requiring each street intersection to have a unique design.

Two ramps per corner are preferred to minimize the problems with entry angle and to decrease the delay to pedestrians entering and exiting the roadway.

C.10.a.5 Additional Considerations

For additional information on pedestrian facilities design, including physical separation from the roadway, over- and underpasses, pedestrian crossings, traffic control, sight distance and lighting, refer to ***Chapter 8 – Pedestrian Facilities***.

C.10.b Bicycle Facilities

Provisions for bicycle traffic should be incorporated into the street or highway design. All new roadways and major corridor improvements, except limited access highways, should be designed and constructed under the assumption they will be used by bicyclists. Roadway conditions should be favorable for bicycling. This includes appropriate drainage grates, pavement markings, and railroad crossings, smooth pavements, and signals responsive to bicycles. In addition, facilities such as bicycle lanes, shared use paths, and paved shoulders, should be included to the fullest extent feasible. All flush shoulder arterial and collector roadway sections should be given consideration for the construction of 4-foot or 5-foot paved shoulders. In addition, all curb and gutter arterial and collector sections should be given consideration for bicycle lanes.

For additional information on bicycle facilities design and the design of shared use paths, refer to ***Chapter 9 – Bicycle Facilities***.

C.10.c Bridge Design Loadings

The minimum design loading for all new and reconstructed bridges shall be in accordance with ***Chapter 17 – Bridges and Other Structures***.

C.10.d Dead End Streets and Cul-de-Sacs

The end of a dead end street should permit travel return with a turn around area, considering backing movements, which will accommodate single truck or transit vehicles without encroachment upon private property. Recommended treatment for dead end streets and cul-de-sacs is given in Figure 5-1 Types of Cul-de-Sacs and Dead-End Streets of ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***.

C.10.e Bus Benches and Transit Shelters

Bus benches should be set back at least 10 feet from the travel lane in curbed sections with a design speed of 45 mph or less, and outside the clear zone (Table 3 - 15) in flush shoulder sections.

Any bus bench or transit shelter adjacent to a sidewalk within the right of way of any street or highway shall be located so as to leave at least 48[KM58] inches of clearance for pedestrians and persons in wheelchairs. An additional one foot of clearance is required when any side of the sidewalk is adjacent to a curb or barrier. Such clearance shall be measured in a direction perpendicular to the centerline of the road. A separate bench pad or sidewalk flareout that provides a 30 inch wide by 48 inch deep wheelchair space adjacent to the bench shall be provided. Transit shelters should be set back, rather than eliminated during roadway widening.

Additional information on the design of transit facilities is found in ***Chapter 13 – Public Transit*** and ***Rule Chapter 14-20.003, Florida Administrative Code*** and ***Rule Chapter 14-20.0032, F.A.C***.

C.10.f Traffic Calming

Often there are community concerns with controlling travel speeds impacting the safety of a street or highway such as in areas of concentrated pedestrian activities, those with narrow right of way, areas with numerous access points, on street parking, and other similar concerns. Local authorities may elect to use traffic calming design features that could include, but not be limited to, the installation of speed humps, speed tables, chicanes, or other pavement undulations. Roundabouts are also another method of dealing with this issue at intersections. For additional details and traffic calming treatments, refer to ***Chapter 15 – Traffic Calming***.

C.11 Reconstruction

C.11.a Introduction

The reconstruction (improvement or upgrading) of existing facilities may generate equal or greater safety benefits than similar expenditures for the construction of new streets and highways. Modifications to increase capacity should be evaluated for the potential effect on the highway safety characteristics. The long-range objectives should be to bring the existing network into compliance with current standards.

C.11.b Evaluation of Streets and Highways

The evaluation of the safety characteristics of streets and highways should be directed towards the identification of undesirable features on the existing system. Particular effort should be exerted to identify the location and nature of features with a high crash potential. Methods for identifying and evaluating hazards include the following:

- Identification of any geometric design feature not in compliance with minimum or desirable standards. This could be accomplished through a systematic survey and evaluation of existing facilities.
- Review of conflict points along a corridor.
- Information from maintenance or other personnel.
- Review of crash reports and traffic counts to identify locations with a large number of crashes or a high crash rate.
- Review for expected pedestrian and bicycle needs.

C.11.c Priorities

A large percentage of street and highway reconstruction and improvements is directed toward increasing efficiency and capacity. The program of reconstruction should be based, to a large extent, upon priorities for the improvement of safety characteristics.

The priorities for safety improvements should be based on the objective of obtaining the maximum reduction in crash potential for a given expenditure of funds. Elimination of conditions that may result in serious or fatal crashes should receive the highest priority in the schedule for reconstruction.

Specific high priority problem areas that should be corrected by reconstruction include the following:

- Obstructions to sight distance which can be economically corrected. The removal of buildings, parked vehicles, vegetation, large poles or groups of poles that significantly reduce the field of vision, and signs to improve sight distance on curves and particularly at intersections, can be of immense benefit in reducing crashes. The purchase of required line of sight easements is often a wise expenditure of highway funds. The establishment of sight distance setback lines is encouraged.

- Roadside and median hazards which can often be removed or relocated farther from the traveled way. Where removal is not feasible, objects should be shielded by redirection or energy absorbing devices. The reduction of the roadside hazard problem generally provides a good return on the safety dollar. Details and priorities for roadside hazard reduction, which are presented in ***Chapter 4 - Roadside Design***, should be incorporated into the overall priorities of the reconstruction program.

- Poor pavement surfaces which have become hazardous should be maintained or reconstructed in accordance with the design criteria set forth in ***Chapter 5 - Pavement Design And Construction***, and ***Chapter 10 – Maintenance And Resurfacing***.

- Specific design features which could be applied during reconstruction to enhance the operations and safety characteristics of a roadway include the following:

    - Addition of lighting.

    - Frontage roads may be utilized to improve the efficiency and safety of streets and highways with poor control of access.

    - Widening of pavements and shoulders. This is often an economically feasible method of increasing capacity and reducing traffic hazards. Provision of median barriers (***Chapter 4 - Roadside Design***) can also produce significant safety benefits.

    - The removal, streamlining, or modification of drainage structures.

    - Alignment modifications are usually extensive and require extensive reconstruction of the roadway. Removal of isolated sharp curves is a reasonable and logical step in alignment modification. If major realignment is to be undertaken, every effort should be made to bring the entire facility into compliance with the requirements for new construction.

- The use of traffic control devices. This is generally an inexpensive method of alleviating certain highway defects.
- Median opening modifications.
- Addition of median, channelized islands, and mid-block pedestrian crossings.
- Auxiliary lanes.
- Existing bridges that fail to meet current design standards which are available to bicycle traffic, should be retrofitted on an interim basis as follows: As a general practice, bridges 125 feet in length or longer, bridges with unusual sight problem, steep gradients (which require the cyclist longer time to clear the span) or other unusual conditions should display the standard W11-1 caution sign with an added sign "On Bridge" at either end of the structure. Special care should be given to the right most portion of the roadway, where bicyclists are expected to travel, assuring smoothness, pavement uniformity, and freedom from longitudinal joints, and to ensure cleanliness. Failure to do so forces bicyclists farther into the center portion of the bridge, reducing traffic flow and safety.
- Addition of bicycle facilities.
- Addition of transit facilities, sidewalks, crosswalks, and other pedestrian features.

C.12 Design Exceptions

See ***Chapter 14 - Design Exceptions*** for the process to use when the standard criteria found in this Manual cannot be met.

C.13 Very Low-Volume Local Roads (ADT ≤ 400)

Where criteria is not specifically provided in this section, the design guidelines presented in Chapter 4 of the ***AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400), 1st Edition (2001)*** may be used in lieu of the policies in Chapter 5 of the AASHTO Policy on Geometric Design of Highways and Streets*.* See Table 3-10 for lane widths for very low volume roads*.*

C.13.a Bridge Width

Bridges are considered functionally obsolete when the combination of ADT and bridge width is used in the National Bridge Inventory Item 68 for Deck Geometry to give a rating of 3 or less. To accommodate future traffic and prevent new bridges from being classified as functionally obsolete, the minimum roadway width for new two lane bridges on very low-volume roads with 20 year ADT between 100 and 400 vehicles/day shall be a minimum of 22 feet. If the entire roadway width (traveled way plus shoulders) is paved to a width greater than 22 feet, the bridge width should be equal to the total roadway width. If significant ADT increases are projected beyond twenty years, a bridge width of 28 feet should be considered. One-lane bridges may be provided on single-lane roads and on two-lane roads with ADT less than 100 vehicles/day where a one-lane bridge can operate effectively. The roadway width of a one-lane bridge shall be 15 ft. One-lane bridges should have pull-offs visible from opposite ends of the bridge where drivers can wait for traffic on the bridge to clear.

C.13.b Roadside Design

Bridge traffic barriers on very low-volume roads must have been successfully crash tested to a Test Level 2 (minimum) in accordance with NCHRP Report 350 or Manual for Assessing Safety Hardware (MASH).

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CHAPTER 14

DESIGN EXCEPTIONS

EXHIBITS

CHAPTER 14

DESIGN EXCEPTIONS

A GENERAL

Uniform minimum standards for design, construction, and maintenance ~~of~~ for streets and highways are contained in this Manual and meet or exceed the minimum values established by AASHTO. Consequently, the values given govern the design process. When it becomes necessary to deviate from the Manual's criteria, early documentation and approval are required.

Documentation in the form of a Design Exception is required whenever the following 13 controlling elements cannot be met:

1. Design Speed
2. Lane Widths
3. Shoulder Widths
4. Bridge Widths
5. Structural Capacity
6. Vertical Clearance
7. Grades
8. Cross Slopes
9. Superelevation
10. Horizontal Alignment
11. Vertical Alignment
12. Stopping Sight Distance
13. Lateral Offset

~~Design Exceptions are required when any of the Manual's criteria for the 13 controlling Design Elements listed in Section B cannot be met.~~ This chapter provides the process for documentation and approval of Design Exceptions. ~~When the Manual's criteria are met, no Design Exception is required.~~ To expedite the approval of these deviations, it is important that the correct approval process be followed. The design project file should clearly document the action taken and approval given.

When proposed design elements other than the 13 controlling Design Elements do not meet the criteria contained in this Manual, sufficient detail and justification of such deviations should~~all~~ be documented by the Responsible Professional Engineer and provided to the maintaining agency. The level of detail included in the documentation is at the discretion of the maintaining agency.

~~B DESIGN EXCEPTIONS~~[HMJ1]

~~Design Exceptions are required when any of the Manual's criteria for the 13 controlling Design Elements listed below cannot be met.~~

1. ~~Design Speed~~
2. ~~Lane Widths~~
3. ~~Shoulder Widths~~
4. ~~Bridge Widths~~
5. ~~Structural Capacity~~
6. ~~Vertical Clearance~~
7. ~~Grades~~
8. ~~Cross Slopes~~
9. ~~Superelevation~~
10. ~~Horizontal Alignment~~
11. ~~Vertical Alignment~~
12. ~~Stopping Sight Distance~~
13. ~~Horizontal Clearance~~
13. ~~Lateral Offset~~

If the county or municipality has adopted by ordinance design criteria for local subdivision roads and/or residential streets, compliance with those regulations is an approved ~~design~~ Design ~~exception~~Exception.

~~C~~B RECOMMENDATIONS FOR AND APPROVAL OF DESIGN EXCEPTIONS

Design Exceptions are recommended by the Professional Engineer responsible for the project design elements (Responsible Professional Engineer). A public or private utility may submit to the maintaining authority a completed exception package for work designed by the utility's forces. However, if the design is by others, the package must be submitted, signed and sealed by a professional engineer licensed in the State of Florida.

All Design Exceptions require approval from the maintaining authority's (county or municipality) designated Professional Engineer representative with project oversight or general compliance responsibilities.

Any Design Exception that involves a state or federal facility must be processed through the Department's ~~local~~ district that has jurisdiction. The District Design Engineer ~~who~~ will then follow Department processes as specified in the Department's ***Plans Preparation Manual***, for concurrence and approval by FHWA, if necessary. The Department's ***Utility Accommodation Manual*** provides guidance on exceptions with respect to utilities.

~~D~~C COORDINATION OF DESIGN EXCEPTIONS

In order to allow time to research alternatives and begin the analysis and documentation activities, it is critical that Design Exceptions be identified as early in the process as possible. This is preferably done during the planning phases of projects or as soon as possible in the initial design efforts.

When the need for a Design Exception has been determined, the Responsible Professional Engineer must coordinate with the maintaining authority and the Department (if applicable), to obtain conceptual concurrence providing any required documentation requested. The Department will be involved only if the proposed design on the local (Non-SHS) roadway is part of a Department project. For example, a Department project for a roadway on the SHS includes work on the adjacent local roads, or a Department project is exclusively on a local (Non-SHS) roadway. In these cases, the District Design Engineer will be listed in the Design Exception request letter, for "concurrence".

~~E~~D JUSTIFICATION AND DOCUMENTATION OF DESIGN EXCEPTIONS

The objective of the justification of Design Exceptions is to demonstrate that the impacts on the operation and safety of the facility are acceptable compared to the impacts and added benefits of meeting the criteria. All Design Exception requests shall include documentation sufficient to justify the request and independently evaluate the operational and safety impacts.

When preparing a Design Exception, the Responsible Professional Engineer should consider potential mitigation strategies that may reduce the adverse impacts to highway safety and traffic operations. Please refer to t~~T~~he FHWA ***Mitigation Strategies for Design Exceptions*** for ~~provides the following~~ examples of mitigation strategies.~~:~~

- ~~Provide advance notice to the driver of the condition,~~
- ~~Enhance the design of another geometric element to compensate for a potentially adverse action,~~
- ~~Implement features designed to lessen the severity of an incident or action.~~[HMJ2]

Any request for a Design Exception for a controlling design element should address the following issues applicable to the element in question:

Description:

a) Project description (general information, typical section, etc.)

b) Description of Design Exception (specific project conditions related to Design Exception, controlling design element, acceptable Manual value, and proposed value for project)

c) The compatibility of the design and operation with the adjacent sections

Operational Impacts:

a) Amount and character of traffic using facility

b) Effect on capacity of the deviation (proposed criteria vs. Manual using an acceptable capacity analysis procedure and calculate reduction for design year, level of service)

Safety Impacts:

a) Crash history and analysis (location, type, severity, relation to the Design Exception element)

b) Impacts associated with proposed criteria (annualized value of expected economic loss associated with crashes)

Benefit/Cost Analysis:

Calculate a benefit/cost analysis which estimates the cost effectiveness of correcting or mitigating a substandard design feature. The benefit is the expected reduction in future crash costs and the cost is the direct construction and maintenance costs associated with the design. These costs are calculated and annualized so that direct comparison of alternate designs can be made.

A benefit/cost ratio equal to or greater than 1.0 indicates it may be cost effective to implement a particular design; however, the final decision is a management decision which considers all factors. The key factors in the analysis are:

a) Evaluation of crashes by type and cause

b) Estimate of crash costs (based on property damage and severity of injuries)

c) Selection of a crash reduction factor

d) Selection of a discount rate

e) Estimate of construction and maintenance costs

f) Selection of life of the improvements

g) Period of time over which the benefits will be realized

NOTE: ~~Chapter 2 of the AASHTO Roadside Design Guide and the FHWA Technical Advisory titled "Motor Vehicle Accident Costs" dated October 31, 1994,~~ ***Volume 1, Chapter 23*** of the Department's ***Plans Preparation Manual*** provides guidance for the benefit/cost analysis, and may be considered.

Conclusion and Recommendation:

a) The cumulative effect of other deviations from design criteria

b) Safety mitigating measures considered and provided

c) Summarize specific course of action

~~F~~E FINAL PROCESSING OF DESIGN EXCEPTIONS

After conceptual approval has been obtained from the maintaining authority's designee and the documentation justifying the Design Exception is signed by the Responsible Professional Engineer and forwarded as per the sample request letter Exhibit~~XHIBIT~~ 14 - A Sample Request Letter for Design Exception to the maintaining authority's designated Professional Engineer, the Design Exception will be reviewed for completeness and adherence to the requirements of Sections D and E, this Chapter.

If the Design Exception satisfies all requirements, the approval will be signed by the maintaining authority's designated Professional Engineer; and, if applicable, forwarded to the Department's District Design Engineer for concurrence.

When all signatures are obtained, the Design Exception will be returned to the Responsible Professional Engineer. A copy will be retained by the maintaining agency and the Department, if applicable.

E~~XHIBIT~~xhibit 14 – A Sample Request Letter for Design Exception

TO: ______________________________ DATE:__________________

SUBJECT: **DESIGN EXCEPTION**

Local road number or street name:____
Project description (limits): ____
Type construction (new, rehabilitation, adding lanes, resurfacing, etc.)____________
State and/or Federal road number (if applicable): ______________________________
FDOT Financial Project ID No. (if applicable): ________________________________

DESIGN EXCEPTION FOR THE FOLLOWING ELEMENT:

( ) Design speed
( ) Structural capacity
( ) Superelevation
( ) Stopping sight distance
( ) Lane widths
( ) Vertical clearance
( ) Horizontal alignment
( ) ~~Horizontal clearance~~Lateral Offset
( ) Shoulder widths
( ) Grades
( ) Vertical alignment
( ) Bridge widths
( ) Cross slope

Include a brief statement concerning the project and items of concern.

Attach all supporting documentation to this exhibit in accordance with **SECTION 14 - ~~E~~D**.

____

Recommended by:____
(Responsible Professional Engineer)

Approval:____
(Maintaining authority's designated Professional Engineer)

Concurrence:____
FDOT~~/FHWA~~ (if applicable)

Concurrence: ____
FHWA (if applicable)

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15. SCHOOL ZONES[HG6] – *highlighted text is currently in Speed Zone Manual*

A school zone is that portion of a street or highway located within a school area that is subject to a reduced speed limit at certain times of the day. A school zone is defined by traffic control devices and normally adjacent to the school property. It may be established at other locations when justified by an engineering study. School zones are not to be applied in a blanket manner for all streets and highways within a school area.

A school area are those streets and highways abutting the grounds of an active educational institution that includes school property. Only streets and highways that are adjacent to a school are included in the school area.

A school crossing is an official school student crossing on an adopted school route plan of a school safety program. Any crossing not so officially designated is termed a "pedestrian crossing."

Establishment of reduced ~~lowered~~ speed limits ~~zones~~ for schools shall be in accordance with ~~to~~ ***Section 316.1895, F.S.*** Traffic control devices, including ~~School zone traffic~~ signs and pavement markings are described in Part ***7*** of the ***MUTCD***, and are referred in ***Section 316.189, F.S.***

15.1 SCHOOL ZONE SPEED REGULATION

As stated in ***Section 316.1895(5), F.S.***, "A school zone speed limit may not be less than 15 miles per hour except by local regulation. No school zone speed limit shall be more than 20 miles per hour in an urbanized area, as defined in Section 334.03, F.S. such speed limit may be in force only during those times 30 minutes before, during, and 30 minutes after the periods of time when pupils are arriving at a regularly scheduled breakfast program or a regularly scheduled school session and leaving a regularly scheduled school session."

School zone speeds are selected on the basis of an engineering analysis of the specific site. The analysis should include a ***Vehicle Spot Speed Study*** and a ***Pedestrian Group Size Study***. Also a ***Vehicle Gap Size Study*** should be done to document the length of time needed for adequate gaps in traffic and the number of adequate gaps occurring when children are present at the crossing under review.

When school speed zones are warranted, a speed regulation should be established in accorandance with the ***Traffic Regulation Approval Process, FDOT Topic Number 750-010-011***. [HG7]

Upon a request from the local government, a reduced speed zone will be used at school crossings at signalized intersections at locations adjacent to or near school property if justified by an engineering study.

Most commonly used at school zones, a special lowered speed limit during specific time periods is based on considerations other than the **85th** percentile speed. The speed limit selection decision depends on such things as:

- Age of children
- Normal approach speed of traffic
- Sight distance
- Number of vehicles
- Width of street
- Presence of other traffic control devices
- Use of adult and/or school children crossing guards, etc.

Electronic Feedback Speed signs (see **Section 15.4**) may be used in conjunction with the school zone time period speed signs provided they meet the guidelines set forth in ***MUTCD*** and this ***Manual***. Electronic Feedback Speed signs used at school zones shall only be activated during the hours when the reduced school speed is in effect.

15.2 SCHOOL AREA, ZONE, AND CROSSING STUDY RESPONSIBILITIES

Florida law places the basic responsibility for school site planning and an annual review of school sites for proper traffic control and safety devices with each local school board in cooperation with the appropriate municipal, county, regional, or state agencies.

Before the start of the school year local agencies should arrange for an annual inspection by an appropriate expert in traffic control, of school zones under their jurisdiction. This person should be a representative of the city or county engineering department who fully understands Florida Department of Transportation standards for signing and pavement markings for school zones.

15.3 IMPLEMENTATION

The design, application, and installation of traffic control devices in school areas, zones, and crossings shall comply with the ***Department's Design Standards, Index 17344***[HG8]. The typical application of signs, markings, and signals contained therein must comply with the ***Chapter 7 of MUTCD***.

In rural areas, where approach speeds are higher, flashing beacons should be used to increase the conspicuity of school zones.

Notwithstanding the provisions of ***Section 316.1895(7), F.S.***, portable signs designating school zones, school zone speed limits, or school crossings are specifically prohibited in accordance with the ***MUTCD***.

In lieu of portable signs, school officials may use approved 36-inch traffic cones or 28-inch school zone vertical panels within the roadway, during approved school hours, when the need to emphasize a school zone or school crossing exists. These devices shall be placed in both directions on the centerline at the advance school zone crossing sign when accentuation is needed. On multilane divided roadways, these devices may be placed on each lane line of the school zone or school crossing. The legend "SCHOOL" may be printed on the cone in four inch black vertical lettering.

Traffic cones used for the above purpose must be used in accordance with ***Section 6F.59 of the MUTCD***.

School speed zones should be kept as short as practical and should not necessarily extend along the entire highway frontage of the school property. They should only be used where students are crossing or are in close proximity to the roadway.

If schools are located such that reduced speed zones for each school appear to run together, with less than 300 feet of separation between reduced speed zones, one longer school zone may be used. This option may extend the length of time measures are effective, but will minimize motorist confusion.
School zones and signalized intersections are independent control techniques, and the use of one neither requires nor precludes the use of the other. Whenever possible, if a school crossing is warranted, it should be located at a signalized intersection. However, all traffic control signal installations must meet one or more of the ***MUTCD's*** signal warrants. A school zone should not be established simply because a signalized intersection exists near a school.

When a school crossing is located at a signalized intersection, the traffic engineer should determine if traffic movement restrictions are needed. Permissive left turns may be restricted during school zone operating hours and right-turn-on-red may have to be disallowed at some intersections. Field observations of all such crossings are recommended.

School zones shall be maintained by the respective government entity having responsibility per ***Section 316.1895, F.S.*** Maintenance and replacement of traffic control devices shall be done in a timely manner.

~~15.~~ 16. OTHER SPEED SIGNS AND TERMS

In addition to the speed zoning procedures and speed signs discussed in this manual, there are several other speed signs that merit inclusion and acknowledgement. They fall into three~~four~~ main categories; ~~Time Period Speed (Regulatory),~~ Advisory Speed (Warning), Road or Bridge Special Temporary Speed Restrictions (Regulatory), and Electronic Feedback Speed (Regulatory).

~~15.1 TIME PERIOD SPEED (REGULATORY)~~