AGENDA (Draft)

FLORIDA GREENBOOK ADVISORY COMMITTEE MEETING

Thursday, March 28, 2019, 8:00 AM – 5:00 PM

Friday, March 29, 2019, 8:00 AM – 12:00 PM

Florida's Turnpike Orlando Headquarters, Auditorium A
Turkey Lake Service Plaza, Milepost 263
Ocoee, FL 34761

Go-To-Meeting Information if you are not able to attend in person.

https://global.gotomeeting.com/join/492299933

You can also dial in using your phone.
United States: +1 (408) 650-3123, Access Code: 492-299-933
Audio PIN: Shown after joining the meeting

Thursday, March 28, 2019

8:00 – 8:30 Sign-In at Turnpike, Distribute Meeting Materials

8:30 – 9:30 Introductions and General Information

- Welcome and Introductions (Michael Shepard)
- Handouts and Green Ring Binders
- Committee and Associate Member Changes (Mary Anne Koos)
- March 2018 Meeting Minutes & Approval (Mary Anne Koos)
- Contact Information, Subcommittee Assignments, Chapter Chairs (Mary Anne Koos)
- CEU for Professional Engineers (Mary Anne Koos)
- Greenbook Training (Mary Anne Koos)

9:30 – 10:00 Rulemaking and Sunshine Law

- Sunshine Law (Susan Schwartz))
- Rulemaking Plans for 2018 Florida Greenbook (Susan Schwartz, Mary Anne Koos)
- Timeline for Greenbook Tasks

1000 – 10:15 ***Morning Break***

10:15 – 12:00 Presentation and Vote on Proposed Revisions for 2020 Greenbook (Major New Changes)

- Introduction and Definitions (Rick Hall)
- Chapter 1 – Planning (Rick Hall)
- Chapter 3 – Geometric Design (Andy Garganta)
- Chapter 5 – Pavement Design and Construction (Margaret Smith)
- Chapter 10 – Maintenance and Resurfacing (Allan Urbonas)

12:00 – 1:00 Lunch

1:00 – 2:45 Presentation of Proposed Revisions for 2020 Greenbook

- Chapter 19 – Traditional Neighborhood Design (Rick Hall)
- Chapter 20 – Drainage (Andy Tilton)

2:45 – 3:00 ***Afternoon Break***

3:00 – 3:45 Subcommittee Meetings for Final Drafting of Proposed 2020 Revisions (To be determined)

- ________________________________ (Jeremy Fletcher, Auditorium)
- ________________________________ (Katey Earp, Room 2131)
- ________________________________ (Ben Gerrell, Auditorium)

3:45 – 4:30 Chapter Report and Vote on 2020 Chapter Revisions (To Be Determined)

- _________________________________ (Chapter Chairs, Mary Anne Koos)
- _________________________________ (Chapter Chairs, Mary Anne Koos)
- _________________________________ (Chapter Chairs, Mary Anne Koos)
- _________________________________ (Chapter Chairs, Mary Anne Koos)

4:30 – 5:00 Open Discussion/Parking Lot Items

- _________________________________ (______________________)
- _________________________________ (______________________)
- _________________________________ (______________________)

5:00 ***Adjourn***

Friday, March 29, 2019

8:00 – 8:30 Sign-In at Turnpike

8:30 – 9:00 Future Greenbook Revisions (2020)

- Parking Lot Topics (Michael Shepard)
- Next Meeting Date and Location
- Establish Goals and Select Topics for Future Work (Michael Shepard)
  a) Some suggestions include:
    - Chapter 1 – Planning (Road Diets/Repurposing)
    - Chapter 2 – Land Development
    - Chapter 3 – Geometric Design (Reorganization of Greenbook, Controlling Criteria, On-Street Parking)
    - Chapter 8 – Pedestrian Facilities (Curb Extensions, Ranges rather than minimums for Context Based Design)
    - Chapter 9 – Bicycle Facilities (Protected Bike Lanes
    - Chapter 11 – Work Zone Safety (More focus on entire system, not just roadways)
    - Chapter 15 – Traffic Calming (Speed Management)
    - Chapter 18 – Signs and Markings (School Zones, other low speed zones)
    - Chapter 19 – Traditional Neighborhood Design (Intersection Sight Distance, On-Street Parking)
    - Chapter 20 – Drainage (Green Street Stormwater Practices)
    - Others?
- Subcommittee Membership, Chapter Chair Opportunities (Mary Anne Koos)

9:15 – 9:45 *Group Photo/Break*

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

- ______________________________ (Auditorium, Mary Anne)
- ______________________________ (Room 2131, Jeremy Fletcher)
- ______________________________ (Auditorium, Ben Gerrell)

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

11:30 – 12:00 Closing Remarks

12:00 *Adjourn*

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

Minutes (Draft)

FLORIDA GREENBOOK ADVISORY COMMITTEE MEETING

Thursday, March 29, 2018, 8:00 AM – 5:00 PM
Friday, March 30, 2018, 8:00 AM – 12:00 PM

Florida's Turnpike, Orlando Headquarters, Auditorium A
Turkey Lake Service Plaza, Milepost 263
Ocoee, FL 34761

Thursday, March 29, 2018

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**

  Bernie Masing, Shane Parker, Andy Tilton, Alexandrea Davis-Shaw, Kathy Thomas, Richard Tornese, Gene Howerton; John Veilleux, Rodney Chamberlain, Rick Hall, Keith Bryant, Robert Behar, Richard Szpyrka, Gail Woods, Billy Hattaway, Gaspar Miranda, Juvenal Santana, Richard Moss, Richard Diaz, Milton Martinez, Margaret Smith, Mario Bizzio, and Mark Van Hala.

- **Associate Members**

  Mark Massaro, Charles Ramdatt, and Faith Alkhatib.

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

  Tim Lattner, Michael Shepard, Mary Anne Koos, Jeremy Fletcher, John Olson (for Steve Braun), George Borchik, Paul Hiers, Alan El-Urfali, Gabe Matthews, Susan Schwartz, Derwood Sheppard, William Corbett, Jeremy Crowe, Christine Lofye, Cristina Pichardo-Cruz, and Robert Brown.

Introductions and General Information

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

  Michael Shepard, Chair, of the Florida Greenbook Committee welcomed members and the public to the 2018 Florida Greenbook Committee meeting. Mary Anne Koos summarized changes in membership for the Committee due to retirement or new positions for former members and new members were introduced. New members include Richard Tornese, Broward County (urban local government for District 4), Mario Bizzio, FDOT District 5 and Mark Van Hala (rural local government for District 5).

George Webb (Palm Beach County) has retired from public service and enjoying his retirement. Richard Baier is now working for The Villages and Annette Brennan as the Modal Development Manager for District 5, FDOT.

- **Review February 2017 Meeting Minutes (Mary Anne Koos)**

The draft minutes were distributed and reviewed. Milton Martinez moved to approve the minutes and then seconded by Andy Tilton; approved unanimously.

- **Continuing Education Credits**

The Florida Board of Professional Engineers has approved 4 hours of continuing education credits for members of the Florida Greenbook Advisory Committee for their participation in the work to update the Greenbook. Charles Ramdatt asked if we could explore whether credits for those who also have AICP certification can be awarded. *(Mary Anne Koos followed up with the American Planning Association and they agreed to award credits for pro bono planning services. Members should follow the self-reporting process and requirements found on the APA website.)*

- **FDOT Roadway Design Updates**

Michael Shepard updated the Committee on recent activities of the Roadway Design Office. An updated edition of the AASHTO Greenbook has been reviewed, along with a new edition of AASHTO's Roadway Lighting Design Guide. The Department released new or revised design criteria this year, including the Design Manual, Drainage Manual and Handbook, Flexible and Rigid Pavement Design Manuals, and Standard Plans. Everyone is encouraged to register themselves in the Contact Management Database to receive information on criteria updates and opportunities for training. FDOT's Transportation Symposium will be June 18 – 20, 2018 in Orlando. The Symposium web site has the agenda, a link for registration, and hotel information. Continuing education credits will be offered and there is no registration fee.

- **Rulemaking (Mary Anne Koos, Susan Schwartz)**

Following this meeting, the approved revisions will be incorporated into a draft 2018 Florida Greenbook and begin the rulemaking process. The process should take from 6 months to a year to complete. The final draft will be posted on the Greenbook webpage. Included in the meeting package is a flow chart of the rule making process.

- **Sunshine Law (Mary Anne Koos, Susan Schwartz)**

Mary Anne 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 and they cannot meet or discuss business through an intermediary. A copy of Florida's Sunshine law was included in the meeting package.

Presentation of Proposed Revisions for 2018 Florida Greenbook

All revisions shown are anticipated for publication in 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; blue highlighted text has been previously approved but due to further updates, has now been struck. Yellow highlights are notes that will be deleted in the final format or are areas that need follow up discussion.

- **Introduction (Mary Anne Koos, Andy Garganta)**

  Mary Anne Koos presented the proposed changes to the chapter on behalf of Andy Garganta, as shown in the draft, dated March 28, 2018. New definitions for Low Speed and Shared Street were added. The following revisions were made by the committee:

  - Shared Street was revised to read "Street that includes a shared zone where pedestrians, bicyclists, and motor vehicles mix in the same space. The design supports slower vehicle speeds and lower motor vehicle volumes. It lacks design elements that suggest motor vehicle priority or segregates modes; and includes elements that suggest a pedestrian priority (e.g. gathering areas, seating, lighting, art, special plantings).

  Keith Bryant moved to accept the revised Chapter, seconded by Gail Woods. The Committee voted unanimously to accept the changes.

- **Chapter 3 – Geometric Design (Mary Anne Koos, Andy Garganta)**

  Mary Anne Koos presented the proposed changes to the chapter, as shown in the draft, dated March 27, 2018. The primary goal of this chapter is to update criteria to be consistent with the 2011 AASHTO Greenbook. Major revisions included clarifying that the posted speed shall be less than or equal to design speed, revising the table for stopping sight distance to include adjustments for grade, and updating the section on decision sight distance.

  Criteria for maximum deflections in alignments without horizontal curves was added. The superelevation section was revised to be consistent with values used in the Department's Design Manual (FDM), new tables were added for each type of roadway, and criteria for the transitions between level and super elevated sections was added. A section was also added for sight distance in horizontal curves.

  The table for widening of the traveled way was revised to use the WB-62 design vehicle, and the criteria for two-way left turn lanes, shoulder and median widths was revised. New figures illustrating channelized islands, refuge islands, and pedestrian crossings were added. The section on auxiliary lanes at intersections was revised to be consistent with taper and storage lengths found in the Department's Standard Plans and Design Manual.

The following revisions were made during review of the Chapter:

- Suggest adding in values for 20 and 25 mph to Table 3 – 4 Decision Sight Distance. Use equations 3-4 and 3-5 from the AASHTO Greenbook.
- The notes in Table 3 – 19 Minimum Lane Widths are to be renumbered and were revised to read as follows:
  - New footnote 6. Turn lane width in raised or grass medians shall not exceed 14 feet. Two-way left turn lanes should be 11 – 14 feet wide and may only be used on 3- and 5-lane typical sections with design speeds ≤ 40 mph. On projects with right of way constraints, the minimum width may be reduced to 10 feet. Two-way left turn lanes shall include sections of raised or restrictive median for pedestrian refuge.
  - New footnote 10. Table applies to both divided and undivided facilities.
- The notes in Table 3 – 22 Minimum Median Widths were revised as follows:
  - Footnote 2. On projects where right of way is constrained, the minimum width may be reduced to 19.5 ft. for design speeds = 45 mph, and to 15.5 ft. for design speeds ≤ 40 mph.
- Revise the Section C.7.f.3 Refuge Islands to add in a chart from the MUTCD for determining distance A in Figures 3 – 12 and 3 – 13.
- Revise Table 3 – 30 Turn Lanes – Curbed and Uncurbed Medians to include a value for ≤ 30 mph.

Gaspar Miranda moved to accept the revised Chapter, seconded by Richard Tornese. The Committee voted unanimously to accept the changes.

- **Chapter 4 – Roadside Design (Robert Behar)**

Robert Behar and Mary Anne Koos presented the proposed changes to the chapter, as shown in the draft, dated March 27, 2018. The primary goal of this chapter is to update criteria to reduce the likelihood and consequences of crashes by vehicles that have left the traveled way.

Major revisions included addition of new descriptions and diagrams to better explain roadside slopes and clear zones, criteria for lateral offsets, requirements for the design of and shielding required for drainage features. A section on roadside safety features and crash test criteria was added, including teste levels for barriers, end terminals, crash cushions, breakaway devices, and work zone traffic control devices.

Lateral off-set criteria for signs, signals, lighting supports, utility poles, trees, drop-offs and miscellaneous devices was added. Information on shielding for above ground hazards and warrants for median barriers and clear zone width requirements for work zones was added.

A new section on barrier types, including guardrail, concrete barriers, high tension cable barriers, and temporary barriers was added.

The following revisions were made during review of the Chapter:

- Restored the paragraph in Section D.8 beginning with "In accordance with Section 337.403 F.S., existing utility poles…. Needs further review to determine if the language is correct and applies to local roads.

Andy Tilton moved to accept the revised Chapter, seconded by Robert Behar. The Committee voted unanimously to accept the changes.

**** Lunch Break 12:00 – 1:00 PM ****

- **Chapter 6 – Lighting (Bernie Masing, Mary Anne Koos)**

Bernie Masing and Mary Anne Koos presented the proposed changes for the 2018 Greenbook, as shown in the draft dated March 27, 2018. The primary goal of this chapter was to update the types of lighting most commonly used today (LED), and improve the understanding of the differences between luminance and illuminance. Criteria was revised for the lighting of underpasses and overpasses, roundabouts, aesthetic lighting, midblock crosswalks and thresholds for overhead sign lighting requirements.

The following revisions were made during review of the Chapter:

- Revise Section E to clarify when the luminance versus illuminance methods are used in roadway lighting plans and how roadway surface types affect the calculated values. Add an illustration of luminance versus illuminance.
- Move Table 6 – 2 Road Surface Classifications to earlier in chapter, above lighting values.
- Revise Section K Roundabouts to read "Roundabouts should be supplemented with roadway lighting. Where pedestrians are…roundabout.
- Add a figure to Section L Midblock Crosswalks to illustrate where the grid points for lighting measurements should be taken.
- Add a sentence to Section N Light Poles to clarify that the National Electrical Code requires a 3' clear space around the access panels in light poles.
- Add the National Electrical Code as a reference in Section O References.

Gail Woods moved to accept the revised Chapter, seconded by Richard Tornese. The Committee voted unanimously to accept the changes.

- **Chapter 18 – Signing and Marking (Gail Woods, Mary Anne Koos)**

Gail Woods and Mary Anne Koos presented the proposed changes for the 2018 Greenbook, as shown in the draft dated March 26, 2018. The chapter has been updated to add a reference for the recently revised Manual on Speed Zoning for Highways, Roads, and Streets in Florida (2017). Information was added on the minimum maintained retro reflectivity for overhead signs as established by the MUTCD, requirements for sign sizes on streets, highways, and shared use paths, and new guidance on when to use both longitudinal and transverse audible and vibratory treatments.

- Section C.6 Design Details for Signs was revised to read "Shared use path sign sizing for traffic control shall follow the "Shared-Use Path" sizing and height shown in the MUTCD. See Chapter 9 – Bicycle Facilities for additional requirements on the signing of shared use paths."

Keith Bryant moved to accept the revised Chapter, seconded by Shane Parker. The Committee voted unanimously to accept the changes.

- **Minor Edits for Chapters 1, 5, 8, 9, 11, 14, 17, 20 (Rick Hall, Richard Moss, Mario Bizzio, Keith Bryant, Andre Pavlov, Mary Anne Koos)**

The Committee reviewed minor edits to the following chapters that were provided in the meeting package:

- Chapter 1 – Planning. Section C.8 Community and Social Impact was revised to add Sections 4 (f) (parks, refuges, and historic sites) and replace 5(f) with 6(f) properties.
- Chapter 5 – Pavement Design and Construction was revised to update the reference to FHA's Gravel Roads Construction and Maintenance Guide, August 2015. Guidance for pavement design in high groundwater conditions was added,
- Chapter 8 – Pedestrian Facilities was revised to clarify the minimum unobstructed sidewalk width and requirements in scoping existing driveways for accessibility. Figure 8 – 2 Sidewalk with Guardrail was moved to Chapter 4. A reminder was added to seek FHWA Interim Approval for the use of RRFB's.
- Chapter 9 – Bicycle Facilities was revised to include a new figure for green bike lanes at channelized right turn lanes and a reference to Chapter 8 for information on when and how longitudinal guardrails should be utilized.
- Chapter 11 – Work Zone Safety was revised to include a reference to Chapter 4 for traffic control and protection elements and Chapter 18 for guidance on the use of transverse rumble strips.
- Chapter 14 – Design Exceptions and Variations was revised to include a reference to the Department's Design Manual, Chapter 122 and Benefit Cost Analysis Spreadsheet Tool.

- Chapter 17 – Bridges and Other Structures was updated to include a reference to the 2018 AASHTO's LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. A reference to FDOT's policy Bridge and Other Structures Reporting Manual 850-010-030 for the reporting of bridge load ratings.
- Chapter 20 – Drainage was updated to include a reference to the Department's Drainage Manual (2018) for Manning's Values for Artificial Channels and Maximum Velocities for Different Soil Types and Lining Types. Section D.6 Hydraulic Openings has been revised to include other hydraulic openings and protective treatments.

Gaspar Miranda moved to accept the revised Chapters, seconded by Keith Bryant. The Committee voted unanimously to accept the changes.

Subcommittee Meetings for Final Drafting of Proposed 2018 Revisions

The Committee decided not to break out into chapter subcommittee groups since they were able to make the desired changes during the initial presentation of the chapter revisions.

Interim RRFB Guidance and Manual for Speed Zoning for Highways (Alan El-Urfali, FDOT Traffic Operations Office)

Alan El-Urfali reported on FHWA's new Interim Approval 21 for the use of RRFB's at pedestrian crossings. Newly installed devices would use a revised flash pattern that is non-proprietary. Local governments are still required to contact FHWA to receive approval for their use on local roads. A list of locations will need to be maintained.

Alan El-Urfali discussed the recently adopted Manual for Speed Zoning for Highways. The Manual requires the installation of beacons at all school zones, clarifies when overhead signs are required and when dual post mounted signs can be used instead.

Further Discussion of Proposed Revisions for 2018 Florida Greenbook

The Committee reopened discussion on Chapter 3 Geometric Design regarding Table 3 – 19 Minimum Lane Widths. Note 6 was revised to allow 11 – 14 feet wide two way left turn lanes as the standard, with 10 feet wide allowed when right of way is constrained.

Gail Woods moved to accept the revision to Chapter 3, seconded by Billy Hattaway. The Committee voted unanimously to accept the changes.

The Greenbook Committee adjourned for the day at 5:00 PM.

Friday, March 30, 2018

Complete Streets Implementation Status (Paul Hiers, FDOT Roadway Design Office)

The meeting began with a presentation by Paul Hiers on the Department's efforts to implement Complete Streets for the State Highway System. Complete Streets applies to all modes, Design criteria will be presented in the FDOT Design Manual, which is replacing the Department's Plans Preparation Manual. The Design Standards are also being revised, and will be known as Standard Plans. In addition to Florida, Pennsylvania, Wisconsin, Virginia, Massachusetts, and Washington are implementing Complete Streets.

The Committee discussed how land development patterns will influence the context classification of streets, and expectations for maintaining roadway landscaping to accomplish some of the goals of Complete Streets. It's expected that landscaping will be maintained through agreements with local governments.

The Committee also discussed the new Manual for Speed Zoning for Highways, and how the 85^{th} percentile requirements for determining appropriate posted speeds affects their efforts to support Complete Streets. They would like to see flexibility in the Manual.

Further Discussion of Proposed Revisions for 2018 Florida Greenbook

The Committee reopened discussion on Chapter 17 – Bridges and Other Structures regarding inspections and how bridges are defined. The Chapter was revised to include a reference to FDOT's policy Bridge and Other Structures Reporting Manual 850-010-030 for the reporting of bridge load ratings. The Committee recommended further work to define bridges and documenting load ratings. The implementation of FDOT's mast arm program was also discussed and the maintenance responsibilities for mast arms.

Richard Tornese moved to accept the revision to Chapter 17, seconded by Billy Hattaway. The Committee voted unanimously to accept the changes.

Contact Information and Subcommittee Assignments (Mary Anne Koos)

The Committee Membership list was circulated for everyone to update their contact information. The list of current chairs for the chapter subcommittees was reviewed and a signup sheet was circulated so that members could update their subcommittee membership preferences. Andy Tilton agreed to chair the Drainage Chapter, Margaret Smith agreed to chair the Residential Street Design Chapter, and Richard Tornese agreed to chair the Land Development Chapter.

Group Photo

A group photo was taken of all Committee members, technical advisors, and support staff.

Future Greenbook Revisions (Mary Anne Koos)

The Committee discussed what topics they should consider for future improvements to the Greenbook for a 2020 edition. The following were suggested:

- **Complete Streets and Context Based Design – Introduction, Chapter 1 – Planning and Chapter 19 – Traditional Neighborhood Design (Rick Hall)**

  Complete Streets updates would likely initiate changes in other chapters in addition to those already identified. It's likely that Chapters 2, 3, 4, 8, 9, 10, 13, 15, 16, and 20 will need to be revised. Once the initial work is completed in identifying context classifications to be used, relationship to existing functional classifications and how the Greenbook might be reorganized, work on the secondary chapters can follow. Existing materials such as the Complete Streets Handbook should be incorporated in the Greenbook.

- **Chapter 8 – Pedestrian Facilities and Chapter 9 – Bicycle Facilities (Mario Bizzio)**

  With emphasis on implementing context based design, the pedestrian and bicycle facilities chapters will need to be updated to include more detailed criteria for sidewalks and bicycle facilities located in various contexts. Protected bike lanes could be added to Chapter 9, using he guidance form FHWA's new manual on protected bike lanes and AASHTO's updated Bicycle Facilities Design Guide.

- **Chapter 15 – Traffic Calming (Billy Hattaway)**

  Since managing speed is an important element of a successful context based design approach, this chapter will need special attention to incorporate information on speed management, target speeds and the more successful traffic calming strategies.

- **Chapter 20 – Drainage (Andy Tilton)**

  Sustainable storm water management such as green streets, bio-swales, Silva cells and other innovative strategies have recently been implemented by local governments. The drainage chapter should be revised to include these strategies and changes that have occurred in how stormwater can be managed and treated and partnerships with local governments.

Although breakout sessions for the new focus chapters were planned, the Committee decided to stay together and further discuss Complete Streets. It was decided that the Chapter 19 – Traditional Neighborhood Design Committee would be the lead on the Complete Streets effort. Billy Hattaway offered to assist Rick Hall as co-chair. Richard Tornese, Milton Martinez, John

Veilleux, Juvenal Santana and Margaret Smith also asked to be added to the Chapter 19 subcommittee. Meetings will be set by Doodle poll and begin in May.

Chapter Chair Opportunities (Mary Anne Koos)

Due to retirements and changes in membership of the Committee, there are several vacancies in the Chapter Chair positions. Richard Tornese agreed to chair Chapter 2 – Land Development, Margaret Smith agreed to chair Chapter 16 – Residential Street Design, and Andy Tilton agreed to chair Chapter 20 – Drainage.

Closing Remarks (Michael Shepard)

Michael. Shepard thanked the group for their continued service on the Greenbook Committee.

The Greenbook Committee adjourned at 12:00 PM.

FLORIDA'S GOVERNMENT-IN-THE SUNSHINE LAW

1. THE LAW

Florida's Sunshine Law is found in Article I, Section 24, Florida Constitution and Chapter 286, Florida Statutes (F.S.), and applies to state agencies. The Sunshine Law is to be liberally construed; its exemptions are to be narrowly construed. Two or more people who are tasked with making a decision or recommendation constitute a "Board or Commission" under the Sunshine Law and are subject to its provisions. Section 286.011(1), F.S., states:

> All meetings of any board or commission of any state agency . . . at which official acts are to be taken are declared to be public meetings open to the public at all times, and no resolution, rule, or formal action shall be considered binding except as taken or made at such meeting. **Members may discuss such business matters only at a public meeting**. . . .

The use of third persons or other means to evade the Sunshine Law is prohibited. The Sunshine Law does not generally apply to individual decision makers, fact finding, or general staff meetings.

2. BASIC PUBLIC MEETING REQUIREMENTS

A. Open, Accessible, Non-Discriminatory, Technology.
1) Pursuant to Section 286.26, F.S., public meetings must be open to the public, made accessible to individuals with physical handicaps, and held at locations that are easy to reach.

2) Pursuant to Section 286.011(6), F.S., public meetings are prohibited from being held at any location that discriminates on the basis of sex, race, age, creed, color, origin, or economic status, or operates in a manner as to unreasonably restrict public access.

3) Public meetings may include the use of teleconference, video, webinar, or other technology, but the public must be provided points of access. See Rule Chapter 28-109, F.A.C., regarding conducting proceedings by communications media technology.

B. Reasonable Notice. Pursuant to Section 286.011(1), F.S., reasonable notice of public meetings must be provided. Public meeting notices are published on the agency's website and other sources needed to reach affected persons. Less than 24 hours will not be considered reasonable notice except for emergency actions. Pursuant to Section 286.0105, F.S., notices of meetings must advise the public that a record of the meeting is required for an appeal of any decision made at the meeting, and that the person who wants to appeal a decision may need to ensure there is a verbatim record of the meeting. Meetings subject to Chapter 120, F.S., the Administrative Procedures Act, must also be published in the Florida Administrative Register no less than 7 days in advance. An agenda and recording is advisable.

C. Minutes. Pursuant to Section 286.011(2), F.S., minutes of public meetings must be taken, promptly recorded, and available for public inspection. The minutes may be posted or provided upon request. Recordings or transcripts are not required, but persons attending are permitted to record or videotape the meeting.

3. EXEMPTIONS

There are a limited number of exemptions to public meetings requirements under Section 286.0113, F.S.:

A. Meetings in which all or part of a security system plan would be revealed.

B. Procurements under Section 287.057, F.S., in which there are negotiations with a vendor or there are oral questions and answers of a vendor. As required by Section 286.0113(2), F.S., a complete recording of the negotiations or oral presentations must be made and no portion may be off the record. The recordings will be exempt from the public records requirement of Section 119.071(3)(a), F.S., until a notice of decision or intended decision is provided or 30 days after the bids, proposals, or final replies are opened.

4. CONSEQUENCES OF SUNSHINE LAW VIOLATIONS

There are a number of consequences for failure to comply with the Sunshine Law:

A. Noncriminal penalties. A violation constitutes a noncriminal infraction and violators are subject to the imposition of a fine not to exceed $500. Section 286.011(3)(a), F.S.

B. Criminal penalties. A knowing violation, occurring either within or outside the state, is a second degree misdemeanor, punishable under Section 775.082 or 775.083, F.S., which provide for up to 60 days in jail or a fine of $500. Sections 286.011(3)(b) and (c), F.S.

C. Attorney’s fees. In an action to enforce the Sunshine Law or to invalidate actions taken in violation of the Sunshine Law, attorney’s fees will be assessed against the agency and may be assessed against individual members of the board or commission, including attorney’s fees on appeal. Anyone filing such an action found to have done so in bad faith may also be assessed with attorney’s fees. Section 286.011(4), F.S.

D. Injunctions. Circuit courts have jurisdiction to issue injunctions to enforce the Sunshine Law. Section 286.011(2), F.S.

E. Action Void. Actions taken at a meeting where the Sunshine Law was violated are void. Section 286.011(1), F.S. Only a full open hearing, meeting, or workshop can cure a Sunshine Law violation; a perfunctory ratification of actions taken will not suffice.

F. Removal from office. Section 112.52, F.S.

G. Loss of public confidence.

RULEMAKING – 2019

PROCESS

Notice of Development of Rulemaking
-Advised publish NDR in FAR at least 21 days before publishing NPR – in case workshop is requeted

NDR / NRD MUST INCLUDE (120.54(2)(a)):
-Subject area to be addressed
-Explain purpose and effect of proposed rule
-Specific legal authority
-Text of rule (if avail), or statement how to get a copy
-Agency contact person
-Place, date, time of Workshop
Courtesy copy to JAPC

WORKSHOP REQUIREMENTS:
- If Requested OR if Agency elects to hold workshop, at least 14 days notice published in FAR
-Agency staff available to answers questions about the draft rule
-Convenient, accessible location – possibility for video or teleconferencing.

1. NOTICE OF PROPOSED RULE
-Agency head approval required (120.54(3))
-Publish in the FAR (120.54(2)(a))
-Docs to be sent to JAPC (120.54(3)(a)4.)
-Schedule rule hearing (i.e., public meeting) if requested (120.54(2)(c))

NPR MUST INCLUDE (120.54(3)(a)1.):
-A short, plain explanation of the purpose and effect of the proposed rule
-Full text of proposed rule or amendment, and a summary
-Reference to rulemaking authority
-Reference. to statute being implemented / interpreted
-A statement of estimated regulatory costs (SERC) (120.541(2), F.S.) **OR** a statement that the Agency has determined a SERC is not required (rule not expected to increase regulatory costs in excess of $200,00 in first year) **and** a statement whether legislative ratification is required
- Statement inviting interested persons to provide additional SERC info (within 21 after pub. of the notice)
-Process for requesting a public hearing on the proposed rule
-Reference to date that NRD was published

2. NOTICE OF CHANGE
Notice of Change / Withdrawal
-Based on public comments or JAPC comments
-Pub. in the FAR at least **21 days before Adoption**
-Agency may modify draft as recommended by JAPC, withdraw entire rule, or refuse to modify the rule 120.54(3)(d)1.

OTHER NOTES:
- Possible to incorporate material in rule by reference. 120.54(1)(i)
- "Negotiated rulemaking" an option. 120.54(2)(d)
- Rule may be challenged in a DOAH hearings as vague, arbitrary or outside legislative authority.

3. ADOPTION
Notice of Adoption
-Agency head approval required (120.54(3)(e)1.)
-Rule becomes effective 20 days after filing (120.54(3)(e)6.)

FILE WITH DEPARTMENT OF STATE:
-Three copies of the rule plus 1 CD copy
-One copy of materials incorporated by reference in the rule (e.g., forms), certified by the agency
-Summary of the rule
-Summary of any hearings held on the rule
-Written summary of facts and circumstances justifying the rule 120.54(3)(e)1., F.S.

TIMELINE

EO 11-72 OFFAR Review of Notices and Pre-Approval Required

1. NOTICE OF PROPOSED RULE

- Agency may schedule a hearing in the NPR
- Public May Request a Hearing **within 21 days** of the posting. 120.54(2)(c) and (3)(c)1.

- **JAPC Comments** / Objections Received
- Agency Response to JAPC Comments – **30 Days**. 120.545(3).

2. NOTICE OF CHANGE

If changes are warranted based on public hearing, comments from the public, or JAPC comments or objection, modify draft via **Notice of Change**. Scope of allowable changes limited. 120.54(3)(d)1.

Advance Notice mailed to Requestors **14 days** before adoption date, and file with JAPC **7 days** before adoption date. 120.54(3)(a)3 and (3)(d)1.

File with JAPC **at least 21 days before proposed adoption date**: Rule copy, materials incorporated by reference, rule justification, SERC, Fed / other rule relation statement, and NPR notice. 120.54(3)(a)4

21 Days

14 Days

3. NOTICE OF RULE ADOPTION FILED

RULE MAY NOT BE FILED FOR ADOPTION:
1. Less than 28 days after posting of the NPR or more than 90 days after posting of the NPR (62 day window)
2. Until 21 days after the Notice of Change (if any)
3. Until 14 days after the final public hearing (if any)
4. Until 21 days after a SERC required under 120.541, F.S., has been provided to all persons who submitted a lower cost regulatory alternative and made available to the public
5. Until the ALJ has rendered a decision under 120.56(2)

WHICHEVER APPLIES. 120.54(3)(e)2., F.S.

EVENTS THAT IMPACT TIME RULES MAY BE FILED FOR ADOPTION:
120.54(3)(e)2., F.S.
- If a notice of change is filed the time to file for adoption is extended to 45 days after the date of publication, but not file sooner than 21 days. 120.54(3)(d)1.
- Filing of a Public Hearing (i.e., Public Meeting)
- Administrative hearing

PURPOSE~~INTRODUCTION~~[KM1]

The purpose of this Manual is to provide uniform minimum standards and criteria for the design, construction, and maintenance of all ~~public streets~~ transportation facilities off the State Highway System (SHS[KM2]), 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(3~~4~~)(a), 316.0745, 334.044(10)(a),*** and ***336.045, F.S***[KM3]**.**

The Florida Greenbook encourages context-based transportation planning and design. Context-based planning and design offers a diverse approach using existing tools in creative ways to improve the transportation system and meet the needs of users of all ages and abilities. This includes pedestrians, bicyclists, transit riders, motorists, and freight handlers. Planning and design of streets and highways must be based on the surrounding development patterns for existing and planned land development patterns. The approach also considers community needs, trade-offs between those needs, and alternatives to achieve multiple objectives. Context-based design principles help to promote safety, quality of life, and economic development.

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 316.0745, F.S. Uniform signals and devices. –**
>
> **(1)** The Department of Transportation shall adopt a uniform system of traffic control devices for use on the streets and highways of the state. The uniform system shall, insofar as is practicable, conform to the system adopted by the American Association of State Highway Transportation Officials and shall be revised from time to time to include changes necessary to conform to a uniform national system or to meet local and state needs. The Department of

Transportation may call upon representatives of local authorities to assist in the preparation or revision of the uniform system of traffic control devices.

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[KM4].

(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.

Standards established by this Manual are intended for use on all transportation facilities 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 Department's Local Agency Program Manual for further information. Information on roadways included in the NHS is found at the Department's website: ***National Highway System Maps***.

Standards are provided for the design of new ~~and resurfacing~~[KM5] 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 projects, there may be practical reasons a certain standard is not met. A process is provided in ***Chapter 14 – Design Exceptions and Variations*** 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.~~

The Federal Highway Administration's ***Manual on Uniform Traffic Control Devices, 2009 Edition (MUTCD)***, has been adopted by ***Rule 14 – 15.010, F.A.C***., and establishes a uniform system of traffic control devices. The ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May 2012, MUTCD)*** includes additional requirements.

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.

POLICIES AND OBJECTIVES~~Y~~

Specific policies governing the activities of planning, design, construction, reconstruction, maintenance, or operation of streets and highways are listed throughout this Manual. This manual uses a context-based design approach that considers the mobility, convenience, accessibility and safety of all road users; and places an emphasis on the most vulnerable users of a given transportation facility. Decisions should be predicated upon meeting the following objectives: ~~All agencies and individuals involved in these activities shall be governed by the following general policies:~~

A. Specifies all users - Provide streets and highways with operating characteristics that support users of all ages and abilities[KM6][KM7].

- ✓ Incorporate appropriate context based design elements when planning and designing the transportation network.
- ✓ Draw on all sources of transportation funding to implement context based design.
- ✓ Seek input from a variety of local stakeholders when designing or revising transportation projects to promote equity and meet the diverse needs of system users.

B Applies to all projects - Each transportation agency should establish and maintain a program to promote context based design in all activities on streets and highways under its jurisdiction.

- ✓ Planning, design, construction, and maintenance activities are all essential activities for implementing context-based design.

C Procedure for exceptions and variations – When proposed design elements do not meet the criteria contained in this Manual, sufficient detail and justification of such deviations must be documented.

- ✓ Sufficient detail and explanation must be given to justify approval to those reviewing the request
- ✓ Consider potential mitigation strategies that may reduce the adverse impacts to highway safety and traffic operations.

D Creates a network - Design, operate, and maintain a transportation system that provides a highly connected and diverse network of streets that accommodate all intended modes of travel.

- ✓ Place a priority on connecting communities with economic and employment centers and visitor destinations.
- ✓ Prioritize non-motorized connectivity improvements to services, schools, parks, civic uses, regional connections, and commercial uses.
- ✓ Identify routes for freight traffic that provide access to industrial centers, warehouses, airports, and ports and consider the "last mile" delivery needs of freight handlers.
- ✓ Seek opportunities to repurpose or and add new rights of way to enhance connectivity for pedestrians, bicyclists, and transit or shift freight traffic to more appropriate corridors.

E Adoptable by all agencies - A well-connected, diverse transportation system supports Florida's existing and future economic development.

- ✓ Increase productivity by improving the accessibility of people and businesses to reach jobs, services, goods, and activities.
- ✓ Increase level of accountability for metropolitan, regional, and local agencies to demonstrate the need, economic impact, and return of transportation investments.
- ✓ Strengthen local policies, ordinances to require new development or redevelopment to provide interconnected street networks with small blocks that connect to existing or planned streets on the perimeter.
- ✓ Support regional land use, economic development goals, and regional vision

F. Latest and best design criteria - Provide uniformity and consistency in the design and operation of streets and highways.

- ✓ Strive to design and maintain facilities that are consistent with the local context, through single projects or incremental improvements over time.

- ✓ Document conditions that may preclude achieving full multi-modal design, such as environmental, historical or cultural constraints, limited right of way, or disproportionate cost.

- ✓ Anticipate needs of connected and autonomous vehicles and other emerging technologies.

G Context-sensitive - Transportation investments should align with land use, and support a community's quality of life. A context-based approach helps communities and regions make sound decisions which support their long-term vision.

- ✓ Harmonize the transportation system with adjacent existing or proposed context such as neighborhoods, business districts, commercial areas, and public services (schools, parks, health and entertainment centers).

- ✓ Design streets with a strong sense of place; use architecture, landscaping, streetscaping, public art, and signage to reflect the community, neighborhood, history, and natural setting.

- ✓ Highlight natural features such as waterways, trees, scenic views, slopes, and preserved lands and minimize impacts.

H Establishes performance measures - Develop and maintain a transportation system that provides the safest practicable environment.

- ✓ Understand that children, elderly adults, and persons with disabilities may require appropriate accommodations.

- ✓ Establish and maintain procedures for construction, maintenance, utility, and emergency operations that provide for safe operating conditions during these activities.

- ✓ Use existing street pavement widths as efficiently as possible to accommodate all modes of transportation, recognizing that allocating designated space by mode is preferred, but shared facilities may be the most practical solution in some cases.

I Includes specific next steps for implementation

- ✓ Understand the issues by reaching out to stakeholders, collect data, synthesize issues and opportunities, and define context classifications.

✓ Define the project's purpose, needs and evaluation measures (person throughput, network completeness, street connectivity, access to jobs, housing, retail, public facilities).

✓ Define and evaluate alternatives.

- ~~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 on 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.

Border Area[KM8][KM9] The border area provides space for roadside design components (e.g., signing, drainage features, sidewalks, and traffic control devices), a buffer between vehicles and pedestrians, and permitted public utilities. It also provides space for construction and maintenance of the facility.

Bridge A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway, having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of the openings for multiple boxes; it may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening[KM10][KM11].

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.~~

Context Classification System Broadly identifies the various built environments in Florida, based upon existing and future land use characteristics, development patterns, network scale, and roadway connectivity of an area.

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

Cross Slope The transverse slope and/or superelevation described by the roadway section geometry.

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 User	Anticipated users of a roadway (including pedestrians, bicyclists, transit riders, motorists, and freight handlers) that form the basis for each roadway's design.
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 or Limited Access Highway	An expressway with full control of access.
Frontage Road or 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.
~~**Horizontal Clearance**~~	~~Lateral distance from edge of motor vehicle travel lane to a roadside object or feature.~~
Intersection	The general area where two or more streets or highways join or cross.
Lateral Offset	The lateral distance from the edge of the traveled way or when applicable, face of curb, to a roadside object or feature.
Low Speed	Speeds less than or equal to 45 mph.
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.~~ 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.

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 district 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 or Must

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

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 Street

Street that includes a shared zone where pedestrians, bicyclists, and motor vehicles mix in the same space. The design ~~Specially designed residential or commercial street where space is shared by all users and alignment~~ supports slower vehicle speeds and lower motor vehicle volumes. It lacks design elements that suggest motor vehicle priority or segregates modes; and includes elements that suggest a pedestrian priority (e.g. gathering areas, seating, lighting, art, special plantings[KM12]). ~~the perception of shared space~~[KM13]~~.~~

Shared Use Path or Multi - Use Trail

A facility with a firm, stable, slip-resistant surface physically separated from motorized vehicular traffic by an open space or barrier with minimal cross flow by motor vehicles. Users may include pedestrians, bicyclists, skaters, and others. Special design and approval is needed when travelers use vehicles such as golf carts.

~~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 redevelop-ment 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 and bicycle lanes~~, berms, sidewalks and parking lanes~~[KM14].

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 feet 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.

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CHAPTER 1

PLANNING

TABLES

CHAPTER 1

PLANNING

A CONTEXT-BASED PLANNING AND DESIGN ~~INTRODUCTION~~[KM1]

In 1996, the Federal Highway Administration (FHWA) released guidance encouraging context-based transportation planning and design. Since then, many regional and local transportation agencies in Florida and throughout the U.S. have adopted context-based planning and design policies and practices. Context-based planning and design offers a flexible approach using existing tools in creative ways to address multimodal needs in different contexts. The approach also considers community needs, trade-offs between those needs, and alternatives to achieve multiple objectives.

The Florida Greenbook's Context-Based Design policy captures three core concepts:

- Serve the needs of transportation system users of all ages and abilities, including pedestrians, bicyclists, transit riders, motorists, and freight handlers.

- Base street and highway design on local and regional land development patterns and reflect existing and future context.

- Promote safety, quality of life, and economic development.

This Context Based approach builds on flexibility and innovation to ensure that all streets and highways are developed based on their context classification, as determined by the local jurisdiction to the maximum extent feasible. With a Context Based approach, every non-limited access transportation project, including those on the Strategic Intermodal System (SIS), is uniquely planned and designed to serve the context of that roadway and the safety, comfort, and mobility of all users.

In a high-speed rural context, where higher truck traffic is anticipated and walking and bicycling are infrequent, wider travel lanes with paved shoulders are appropriate. Shared use paths as part of a regional trail system or for access to schools or parks may also be needed. In urban contexts, where high volumes of pedestrians, bicyclists, and transit users are expected or desired, a roadway should include features such as wide sidewalks, bicycle facilities, transit stops, and frequent, pedestrian crossing opportunities.

Limited-access highways may incorporate elements of context-based design where they connect to the non-limited-access system. The Florida Greenbook is not intended for use on the limited-access system itself[KM2].

~~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

Designs for transportation projects are based on established design controls for the various elements of the project such as width, side slopes, horizontal and vertical alignment, drainage, accessibility and intersection considerations.

The design criteria presented in this manual are based on:

- Functional Classification
- Context Classification
- Design Speed

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

B.1 Functional Classification

Functional classification is the grouping of highways by the character of service and connectivity they provide in relation to the total road network. Table 1 –.1 Functional Classification Types summarizes the primary characteristics of each functional classification.

Functional r~~R~~oad classifications for Florida 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.~~ The ***AASHTO*** publication ***A Policy on Geometric Design of Highways and Streets (2011)*** presents an excellent discussion on highway functional classifications.

~~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:~~

Table 1 – 1 Functional Classification Types

Functional Classification	Primary Characteristics
Limited Access Facilities	• Limited access • Through traffic movements • Primary freight routes • Guided by FHWA Design Standards[KM3] for Highways (NHS)
Principal Arterial	• Through traffic movements • Longer distance traffic movements • Primary freight routes • Access to public transit • Pedestrian and bicycle travel
Minor Arterial	• Connections between local areas and network principal arterials • Connections for through traffic between arterial roads • Access to public transit and through movements • Pedestrian and bicycle travel
Collector	• Carry traffic with trips ending in a specific area • Access to commercial and residential centers • Access to public transit • Pedestrian and bicycle travel
Local Roads	• Direct property access—residential and commercial • Pedestrian and bicycle travel

B.2 Context Classification[KM4][KM5]

Projects are uniquely planned and designed to be in harmony with the surrounding land use characteristics and the intended uses of the street or highway. To this end, a context based classification system comprising eight context classifications has been adopted. Table 1 – 2 Context Classifications describes the context classifications that will determine key design criteria elements. Criteria for limited access facilities are independent of the adjacent land uses; therefore, context classifications shown in Table 1.2 do not apply to these facilities.

Urban and rural are based on population density gathered from the 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.

Additional information on context classifications and guidance on the determination of the context classification is provided in the ***FDOT Context Classification Document***.

Table 1~~.~~ – 2 Context Classifications[KM6]

Context Classification		Description of Adjacent Land Use
C1	Natural	Lands preserved in a natural or wilderness condition, including lands unsuitable for settlement due to natural conditions.
C2	Rural	Sparsely settled lands; may include agricultural land, grassland, woodland, and wetlands.
C2T	Rural Town	Small concentrations of developed areas immediately surrounded by rural and natural areas; includes many historic towns.
C3R	Suburban Residential	Mostly residential uses within large blocks and a disconnected or sparse roadway network.
C3C	Suburban Commercial	Mostly non-residential uses with large building footprints and large parking lots. Buildings are within large blocks and a disconnected or sparse roadway network.
C4	Urban General	Mix of uses set within small blocks with a well-connected roadway network. May extend long distances. The roadway network usually connects to residential neighborhoods immediately along the corridor or behind the uses fronting the roadway.
C5	Urban Center	Mix of uses set within small blocks with a well-connected roadway network. Typically concentrated around a few blocks and identified as part of the community, town, or city of a civic or economic center.
C6	Urban Core	Areas with the highest densities and with building heights typically greater than four floors~~. within FHWA FDOTclassified~~[KM7] ~~Large Urbanized Areas (population >1,000,000)~~. Many are regional centers and destinations. Buildings have mixed uses, are built up to the roadway, and are within a well-connected transportation ~~roadway~~network.

B.3 Design Speed

See Chapter 3, Section C.1 Design Speed for information on establishing appropriate design speeds.

~~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~~[KM8]

~~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~~[KM9]

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~~[KM10]

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[KM11]

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~~	~~-~~

~~**, most recent**B.2.b.1 Urban~~[KM12]

~~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.

C CONSIDERATIONS 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

Functional and context classification play an important role in setting expectations and measuring outcomes for safety. Since agencies consider the type of street or highway in evaluating the significance of crash rates, classification can be used as part of evaluating relative safety and the implementation of safety improvements and programs.

~~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 impacts and the~~ir effect upon~~ ~~highway~~ quality and cost of the project.

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 that don't support the community's vision.~~ with permanent hazards.~~ Reconstruction or modification under traffic may~~i~~ be ~~s~~ expensive, inconvenient, or~~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 Requirements

Degree and type of access permitted on a given facility is dependent upon its intended function and context 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. 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.

~~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 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 for each travel mode. 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, 6th Edition*** provides further information on assessing the traffic and environmental effects of highway projects.

C.5~~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.6~~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.7~~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.8~~7~~ Environmental Impact[KM13]

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.9~~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)** (parks, refuges and historic sites)
- ***Section*** ~~***and***~~ ***6*** ~~***5***~~***(f)*** properties~~if federally funded~~
- Visual Impacts

C.10~~9~~ Landscaping and Aesthetics~~Modes of Transportation~~

New section?~~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[KM14][KM15]

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 . Do for March 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 and Resurfacing***. 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 Department ~~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 Department ~~FDOT~~ publications, current approved technical publications such as ***AASHTO's Policy on Geometric Design of Highways and Streets (2011)*** 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[KM16]:

- FDOT Design ~~Plans Preparation~~ Manual, ~~Volume I~~ (Topic No. 625-000-002~~7~~) ~~and Volume II (Topic No. 625-000-008)~~
  http://www.fdot.gov/roadway/FDM/

- ~~http://www.dot.state.fl.us/rddesign/PPMManual/PPM.shtm~~

- ~~Design~~ Standard Plans for Road and Bridge Construction~~s (Standard Indexes)~~ (Topic No. 625-010-003)
  http://www.fdot.gov/design/standardplans/

- FDOT Standard Specifications for Road and Bridge Construction
  http://www.fdot.gov/programmanagement/Specs.shtm

- Project Development and Environment Manual Part 1 and Part 2 (Topic No. 650-000-001)
  http://www.fdot.gov/environment/pubs/pdeman/pdeman1.shtm

- ~~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/

- ~~https://bookstore.transportation.org/collection_detail.aspx?ID=33~~

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

- ~~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~~

- ~~AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition (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~~

- Quality/Level of Service Handbook (FDOT, 2013)
  http://www.fdot.gov/planning/systems/programs/sm/los/default.shtm

- ~~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)~~
- ~~Accessing Transit Design Handbook for Florida Bus Passenger Facilities~~

CHAPTER 3

GEOMETRIC DESIGN

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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 specific criteria ~~is~~are not provided in this Manual and 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 ***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)***, also known as the ***AASHTO Greenbook (2011)*** 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.

~~*AASHTO's A Policy on Geometric Design of Highways and Streets (2011)* may be referenced for a more thorough discussion of design speed.~~

~~Recommended~~ Minimum and maximum values for design speed are given~~provided~~ in Table 3 – 1 Minimum and Maximum ~~Recommended~~ Design Speed. ~~These values should be considered as general guidelines only~~[KM1].

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. The posted speed shall be less than or equal to the design speed.

The ***AASHTO Greenbook (2011)*** provides additional information on design speed.

Table 3 – 1 Minimum and Maximum ~~Recommended~~ Design Speed (mph)

Facility[1]		AADT (vpd)	Terrain	Design Speed (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	3~~4~~0 – 5~~6~~0 ~~(30 mph min for AADT < 250)~~
			Rolling	2~~3~~0 – 4~~6~~0 ~~(20 mph min for AADT < 50~~[KM2]~~)~~
	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. 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.

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. Additional information on the maximum width, height and length of vehicles in Florida can be found in ***Section 316.515, F.S. Motor Vehicles; Maximum width, height, length.***

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[KM3][KM4][KM5][MAK6][KM7]

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
~~Intermediate Semitrailer~~	~~WB-50~~	~~14.6+35.4=50~~	~~3~~	~~2~~	~~55~~	~~8.5~~	~~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][KM9]	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[KM10].

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

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

*** The term “Interstate” does not imply the vehicle is restricted ~~only limited~~ to interstate and limited access highways only.

The minimum turning radii of design vehicles is presented in Table 3 – 3 Minimum Turning Radii of Design Vehicles. The principal dimensions affecting design are the minimum centerline turning radius, the out-to-out track width, the wheelbase, and the path of the inner rear tire. The speed of the turning vehicle is assumed to be less than 10 mph.

The boundaries of the turning path of each design vehicle for its sharpest turns are established by the outer trace of the front overhang and path of the inner rear wheel. This sharpest turn assumes that the outer front wheel follows the circular arc defining the minimum centerline turning radius as determined by the vehicle steering mechanism.

Figures illustrating the minimum turning radii for a variety of vehicles along with additional information can be found in the ***AASHTO Greenbook (2011), Chapter 2 – Design Controls and Geometrics.***

Table 3 – 3 Minimum Turning Radii of Design Vehicles[KM11]

DESIGN VEHICLE		DIMENSIONS IN FEET		
Type	Symbol	Minimum Design Turning Radius	Centerline Turning* Radius	Minimum Inside Radius
Passenger Car	P	23.8	21.0	14.4
Single Unit Truck	SU-30	41.8	38.0	28.4
Single Unit Truck – 3 Axle	SU-40	51.2	47.4	36.4
City Transit Bus	CITY-BUS	41.6	37.8	24.5
Conventional School Bus (65 passenger)	S-BUS 36	38.6	34.9	23.8
Articulated Bus	A-BUS	39.4	35.5	21.3
Motor Home	MH	39.7	36.0	26.0
Car & Camper Trailer	P/T	32.9	30.0	18.3
Car & Boat Trailer	P/B	23.8	21.0	8.0
Intermediate Semitrailer	WB-40	39.9	36.0	19.3
Interstate Semitrailer	WB-62	44.8	41.0	7.4
Florida Interstate Semitrailer***	WB-62FL	44.8	41.0	7.4
"Double-Bottom"-Semitrailer/Trailer Combination	WB-67D	44.8	40.9	19.1

Source: 2011 AASHTO Greenbook, Design Controls and Criteria, Table 2-2b[KM12][KM13].

* The turning radius assumed by a designer when investigating possible turning paths and is set at the centerline of the front axle of a vehicle. If the minimum turning path is assumed, the CTR approximately equals the minimum design turning radius minus one-half the front width of the vehicle.

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 – 4~~3~~ Minimum Stopping Sight Distance for level and rolling roadways.

Table 3 – 4~~3~~ Minimum Stopping Sight Distance~~s~~

~~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 Stopping Sight Distance on Level Roadways.~~

Design Speed (mph)	Stopping Sight Distance (feet)						
	Level (≤ 2%)	Downgrades			Upgrades		
		3%	6%	9%	3%	6%	9%
20	115	116	120	126	109	107	104
25	155	158	165	173	147	143	140
30	200	205	215	227	200	184	179
35	250	257	271	287	237	229	222
40	305	315	333	354	289	278	269
45	360	378	400	427	344	331	320
50	425	446	474	507	405	388	375
55	495	520	553	593	469	450	433
60	570	598	638	686	538	515	495
65	645	682	728	785	612	584	561
70	730	771	825	891	690	658	631

Source: 2011 AASHTO Greenbook, Table 3-1 Stopping Sight Distance on Level Roadways and Table 3-2 Stopping Sight Distance on Grades.

~~Table 3 – 4 Minimum Passing Sight Distances~~[MAK14]

~~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 Passing Sight Distance for Design of Two-Lane Highways.~~

C.3.b~~c~~ Decision Sight Distance ~~at Decision Points~~[KM15]

Decision sight distance is the distance needed for a driver to detect an unexpected or otherwise difficult to perceive information source or condition in a roadway environment that may be visually cluttered. It allows the driver to recognize the condition or its potential threat, select an appropriate speed and path, and initiate and complete complex maneuvers. ~~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.~~

Examples of critical locations where additional sight distance is needed include interchange and intersections locations, where unusual or unexpected maneuvers are needed, changes in typical sections such as toll plazas or lane drops, and areas of concentrated demand where there is visual noise from competing sources of information, such as roadway elements, traffic, traffic control devices and advertising signs.

The decision sight distances in Table 3 – 5~~4~~ Decision Sight Distance may be used (1) to provide values for sight distances that may be appropriate at critical locations, and (2) serve as criteria for evaluating the suitability of the available sight distances at these locations. If it is not practical to provide decision sight distance because of horizontal or vertical curvature or if relocation of decision points is not practical, special attention should be given to using appropriate traffic control devices providing advance warning of the conditions that are likely to be encountered.

Table 3 – 5 Decision Sight Distance

Design Speed (mph)	Decision Sight Distance (feet) Level Avoidance Maneuver				
	A	B	C	D	E
20[KM16][KM17][KM18][KM19]	130	305	300	355	410
25	170	395	375	445	515
30	220	490	450	535	620
35	275	590	525	625	720
40	330	690	600	715	825
45	395	800	675	800	930
50	465	910	750	890	1030
55	535	1030	865	980	1135
60	610	1150	990	1125	1280
65	695	1275	1050	1220	1365
70	780	1410	1105	1275	1445

Source: 2011 AASHTO Greenbook, Table 3 - 3 Decision Sight Distance

Notes:
1. Avoidance Maneuver A: Stop on rural road – t = 3.0 s
2. Avoidance Maneuver B: Stop on urban road – t = 9.1 s
3. Avoidance Maneuver C: Speed/path/direction change on rural road – t varies between 10.2 and 11.2 s
4. Avoidance Maneuver D: Speed/path/direction change on suburban road – t varies between 12.1 and 12.9 s
5. Avoidance Maneuver E: Speed/path/direction change on urban road – t varies between 14.0 and 14.5 s

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.3.c~~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 – 6~~54~~ Minimum Passing Sight Distances.

Table 3 – 64 Minimum Passing Sight Distance

(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 Passing Sight Distance for Design of Two-Lane Highways.

~~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.

C.4.b Maximum Deflections in Alignment without Curves

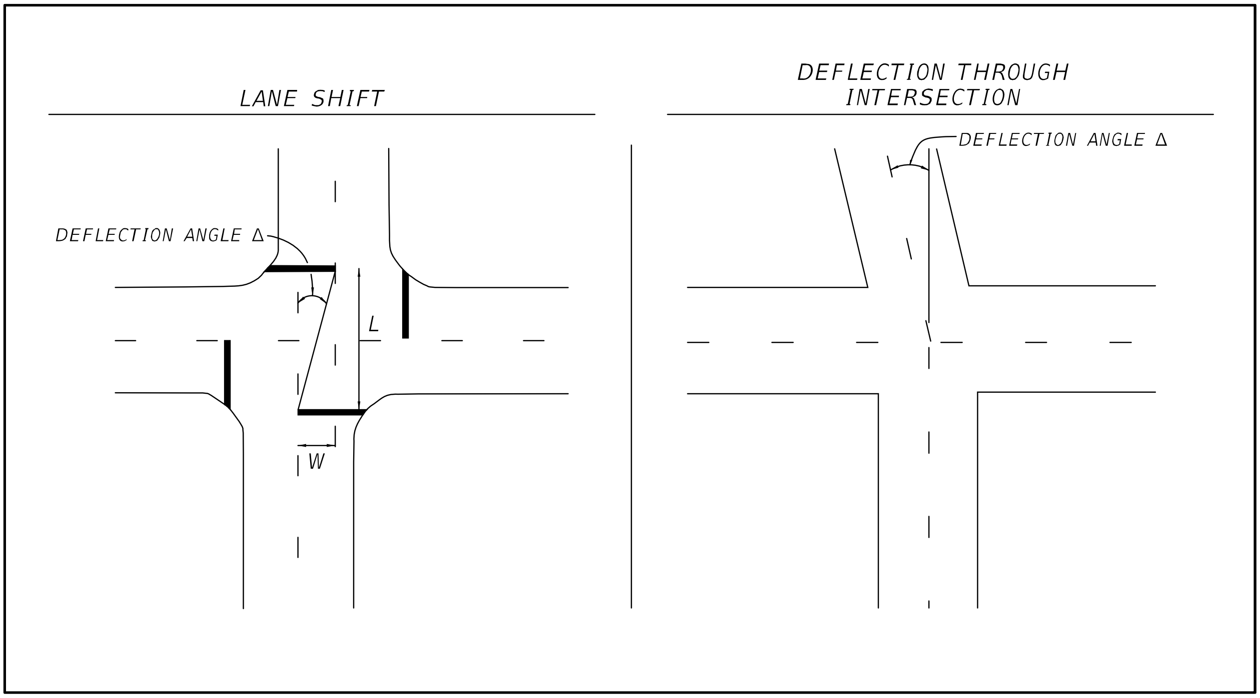
The point where tangents intersect is known as the point of intersection (PI). Although the use of a PI with no horizontal curve is discouraged, there may be conditions where it is necessary. The maximum deflection without a horizontal curve are as follows:

- **Flush shoulder and curbed roadways with design speed 40 mph and less is 2o00’00”.**
- **Flush shoulder roadways with design speed 45 mph and greater is 0o45’00”.**
- **Curbed roadways with design speed 45 mph and greater is 1o00’00”.**
- **High speed curbed roadways with design speed 50 mph and greater is 0o45’00”.**

Although deflections thru intersections are discouraged, there may be conditions where it is necessary. The maximum deflection angles at intersections to be used in establishing the horizontal alignment are given in Table 3 – 76 Maximum Deflection Angle Through Intersection.

Table 3 – 7 Maximum Deflection Angle Through Intersection

Design Speed (mph)					
≤ 20	**25**	**30**	**35**	**40**	**45**
16° 00'	**11° 00'**	**8° 00'**	**6° 00'**	**5° 00'**	**3° 00'**



Notes 1. The deflection angle used is not to cause a lane shift (W) of more than 6 feet from stop bar to stop bar.

~~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.~~

Curves on main roadways should be sufficiently long to avoid the appearance of a kink. Gently flowing alignment is generally more pleasing in appearance, as well as, superior from a safety standpoint. Flatter curvature with shorter tangents is preferable to sharp curves connected by long tangents; i.e., avoid using minimum horizontal curve lengths. Table 3-8~~7~~ Minimum Lengths of Horizontal Curves provides minimum horizontal curve lengths that should be used in establishing the horizontal alignment.

Table 3 – 8 Minimum Lengths of Horizontal Curves

Curve Length Based on Design Speed										
Design Speed (mph)	25	30	35	40	45	50	55	60	65	70
Arterials, Collectors (Length in feet = 15 x Design Speed, but not less than 400 feet)	400	450	525	600	675	750	825	900	975	1050
Freeways - Mainline (Length in feet = 30 x Design Speed)	--	--	--	--	--	1500	1650	1800	1950	2100

Curve Length Based on Deflection Angle					
Deflection Angle (degrees)	5°	4°	3°	2°	1°
Curve Length (feet)	500	600	700	800	900

Notes:

1. Horizontal curve length should be the greater of the lengths based on design speed and length based on deflection angle.
2. If the curve lengths for arterials and collectors cannot be attained, provide the greatest attainable length possible, but not less than 400 feet.
3. If the curve lengths for mainline freeways cannot be attained, provide the greatest attainable length possible, but not less than the lengths used for arterials and collectors.
4. Curve length shall provide for full superelevation within the curve of not less than 200 ft. (Rural) or 100 ft. (Urban).

Compound curves are sometimes used for turning roadways at intersections. For turning roadways and intersections a ratio of 2:1 (where the flatter radius precedes the sharper radius in the direction of travel) is acceptable. The arc lengths of compound curves for turning roadways when followed by a curve of one half radius or preceded by a curve of double radius should be as shown in Table 3 – 98 Length of Compound Curves on Turning Roadways.

Table 3 – 9 Length of Compound Curves on Turning Roadways

Radius (feet)	**100**	**150**	**200**	**250**	**300**	**400**	**≥ 500**
Desirable Arc Length (feet)	65	70	100	120	150	180	200
Minimum Arc Length (feet)	40	50	65	85	100	120	150

C.4.cb 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 terms Rural and Urban used in this section reflect the location of the project. In addition to the criteria provided below, additional information regarding superelevation given in the Department's FDOT Design Manual, and A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)**, may be considered.**

C.4.c.1 Rural Highways, Urban Freeways and High Speed Urban Highways

The superelevation rates for high speed (50 mph or greater) roadways ~~rural highways, urban freeways, and high speed urban highways~~ are ~~shown~~ provided in Table 3 – 109

Superelevation Rates for Rural Highways, Urban Freeways and High Speed Urban Highways (e max =0.10)~~Figure 3 – 1 Rural Highways, Urban Freeways and High Speed Urban Highways and Table 35~~. These rates are based on Method 5 from the 2011 AASHTO Greenbook using 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.~~Table 3 – 10~~95~~ also provides the minimum radius required for normal crown without superelevation.

~~Additional superelevation details, given in the Department's Design , may be considered.~~

C.4.c.2 Low Speed Urban Roadways

~~Although superelevation is advantageous for traffic operations~~For low speed (45 mph and less) roadways in urban areas~~, various factors combine to make its use~~superelevation difficult, if not ~~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~~

Superelevation rates for low speed urban roadways therefore rely more heavily on side friction than rates used for high speed roadways and the maximum superelevation rate is set at 0.05 foot per foot. Separate criteria are provided for low speed Local Roads vs. low speed Arterials and Collectors as follows:

~~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 A Policy on Geometric Design of Highways and Streets (AASHTO, 2011), may be considered.~~**Low Speed Urban Arterials and Collectors: Superelevation rates for low speed urban arterials and collectors are provided in Table 3 – 11~~06~~ Superelevation Rates for Low Speed Arterials and Collectors (emax = 0.05). These rates are based on the Department's superelevation criteria for low speed arterials and collectors. Table 3 – 11~~06~~ also provides the minimum radius required normal crown without superelevation.**

Low Speed Local Roads: Minimum radii for design superelevation rates for low speed local roads are provided in Table 3 – 12~~17~~ Minimum Radii (feet) for Design Superelevation Rates, Low Speed Local Roads (emax = 0.05). These rates are based on Method 2 from the 2011 AASHTO Greenbook. Table 3 – 12~~17~~ also provides the minimum radius required for normal crown (-0.02 ft/ft) without superelevation.

~~**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.**~~

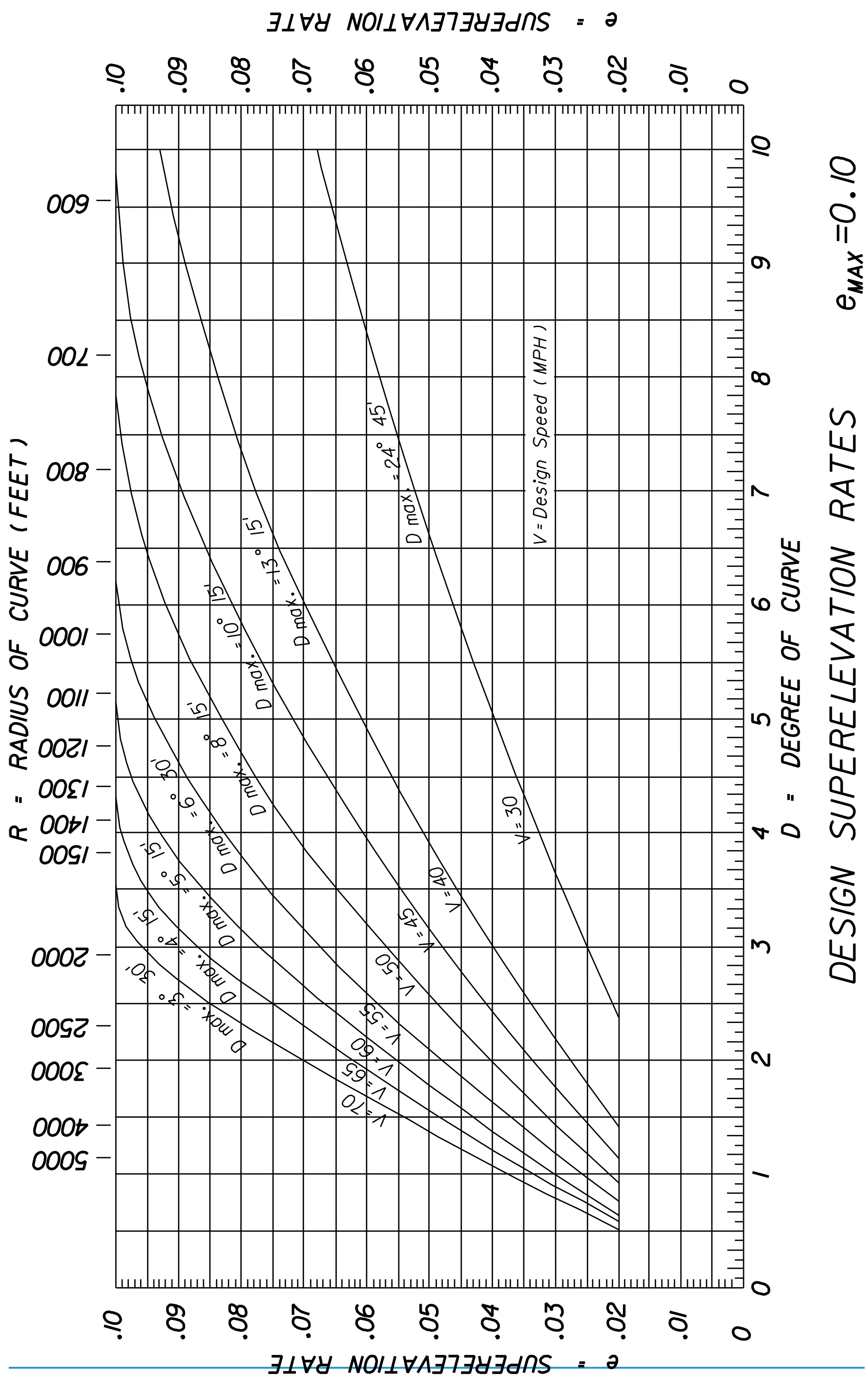
Additional[KM20] ~~**information regarding superelevation, given in the Department's Design Standards, and** A Policy on Geometric Design of Highways and Streets (AASHTO, 2011), **may be**~~

~~considered.~~

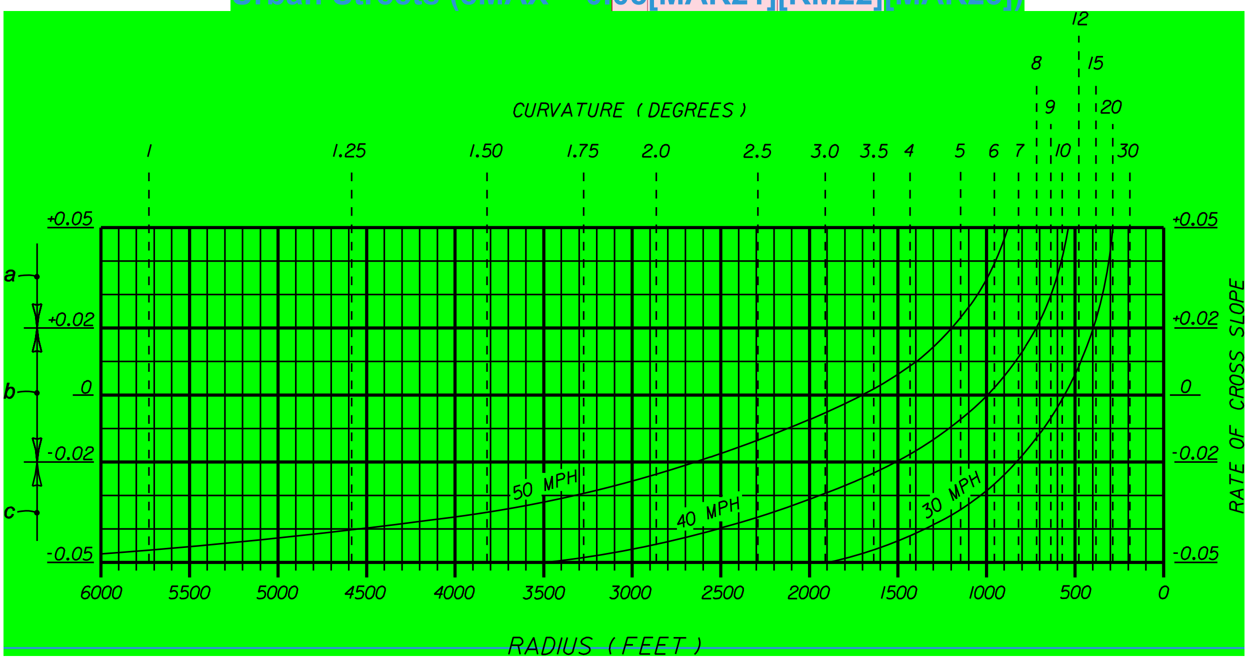
C.4.d~~c~~ Maximum Curvature/Minimum Radius

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~~or minimum radius for the maximum superelevation rates are provided in Tables 3 – 10~~95~~, 3 – 11~~06~~ and 3 – 12~~17~~. 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 or minimum radius is a significant value in alignment design.

~~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 (eMAX =0.05[MAK21][KM22][MAK23])~~



~~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[MAK24][KM25][KM26]~~

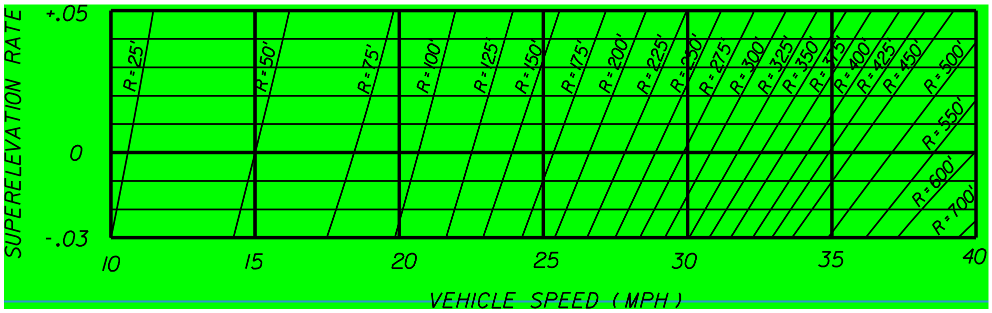

SUPERELEVATION RATE
+.05
0
-.03
10
15
20
25
30
35
40
VEHICLE SPEED (MPH)
R=25'
R=50'
R=75'
R=100'
R=125'
R=150'
R=175'
R=200'
R=225'
R=275'
R=300'
R=325'
R=350'
R=375'
R=400'
R=425'
R=450'
R=500'
R=550'
R=600'
R=700'

Table 3 – 10~~5~~ Superelevation Rates for Rural Highways, Urban Freeways and High Speed Urban Highways (e_{max} = 0.10)[KM27]

Tabulated Values										
Degree of Curve *D*	Radius *R* (ft.)	Design Speed (mph)								
		30	35	40	45	50	55	60	65	70
0° 15'	22,918	NC	NC	NC	NC	NC	NC	NC	NC	NC
0° 30'	11,459	NC	NC	NC	NC	NC	NC	RC	RC	RC
0° 45'	7,639	NC	NC	NC	NC	RC	RC	0.023	0.025	0.028
1° 00'	5,730	NC	NC	NC	RC	0.021	0.025	0.030	0.033	0.037
1° 15'	4,584	NC	NC	RC	0.022	0.026	0.031	0.036	0.041	0.046
1° 30'	3,820	NC	RC	0.021	0.026	0.031	0.037	0.043	0.048	0.054
	*R_{NC}									
2° 00'	2,865	RC	0.022	0.028	0.034	0.040	0.048	0.055	0.062	0.070
	*R_{RC}									
2° 30'	2,292	0.021	0.028	0.034	0.041	0.049	0.058	0.067	0.075	0.085
3° 00'	1,910	0.025	0.032	0.040	0.049	0.057	0.067	0.077	0.087	0.096
3° 30'	1,637	0.029	0.037	0.046	0.055	0.065	0.075	0.086	0.095	0.100
4° 00'	1,432	0.033	0.042	0.051	0.061	0.072	0.083	0.093	0.099	Dmax = 3° 30'
5° 00'	1,146	0.040	0.050	0.061	0.072	0.083	0.094	0.098	Dmax = 4° 15'	
6° 00'	955	0.046	0.058	0.070	0.082	0.092	0.099	Dmax = 5° 15'		
7° 00'	819	0.053	0.065	0.078	0.089	0.098	Dmax = 6° 30'			
8° 00'	716	0.058	0.071	0.084	0.095	0.100				
9° 00'	637	0.063	0.077	0.089	0.098	Dmax = 8° 15'				
10° 00'	573	0.068	0.082	0.094	0.100					
11° 00'	521	0.072	0.086	0.097	Dmax = 10° 15'					
12° 00'	477	0.076	0.090	0.099						
13° 00'	441	0.080	0.093	0.100						
14° 00'	409	0.083	0.096	Dmax = 13° 15'						
15° 00'	382	0.086	0.098							
16° 00'	358	0.089	0.099							
18° 00'	318	0.093	Dmax = 17° 45'							
20° 00'	286	0.097								
22° 00'	260	0.099								
24° 00'	239	0.100								
		Dmax = 24° 45'								

* NC/RC and RC/e Break Points (Radius in feet)									
Break Points	DESIGN SPEED (mph)								
	30	35	40	45	50	55	60	65	70
R_{NC}	3349	4384	5560	6878	8337	9949	11709	13164	14714
R_{RC}	2471	3238	4110	5087	6171	7372	8686	9783	10955
e = NC *if* R ≥ R_{NC}				e = RC *if* R < R_{NC} *and* R ≥ R_{RC}					

NC = Normal Crown (-0.02) RC = Reverse Crown (+0.02)

R_{NC}= Minimum Radius for NC R_{RC} = Minimum Radius for RC

Rates for intermediate D and R's are to be interpolated.

Table 3 – 11~~6~~ Superelevation Rates for Low Speed Arterials and Collectors (e_{max} = 0.05)

Degree of Curve D	Radius R (ft.)	Tabulated Values Design Speed (mph) 30	35	40	45
2° 00'	2,865	NC	NC	NC	NC
2° 15'	2,546				
2° 45'	2,083				NC
3° 00'	1,910				RC
3° 45'	1,528			NC	
4° 00'	1,432			RC	
4° 45'	1,206				
5° 00'	1,146		NC		
5° 15'	1,091		RC		
5° 30'	1,042				
5° 45'	996				
6° 00'	955				RC
6° 15'	917				0.022
6° 30'	881				0.024
6° 45'	849				0.027
7° 00'	819	NC			0.030
7° 15'	790	RC			0.033
7° 30'	764				0.037
7° 45'	739				0.041
8° 00'	716			RC	0.045
8° 15'	694			0.022	0.050
8° 30'	674			0.025	Dmax = 8° 15'
8° 45'	655			0.027	
9° 00'	637			0.030	
9° 30'	603			0.034	
10° 00'	573			0.040	
10° 30'	546		RC	0.047	
11° 00'	521		0.023	Dmax = 10° 45'	
11° 30'	498		0.026		
12° 00'	477		0.030		
13° 00'	441		0.036		
14° 00'	409	RC	0.045		
15° 00'	382	0.023	Dmax = 14° 15'		
16° 00'	358	0.027			
17° 00'	337	0.032			
18° 00'	318	0.038			
19° 00'	302	0.043			
20° 00'	286	0.050			
		Dmax = 20° 00'			

NC = Normal Crown (-0.02) RC = Reverse Crown (+0.02)

Rates for intermediate D and R's are to be interpolated.

Table 3 – 12~~7~~ Minimum Radii (feet) for Design Superelevation Rates Low Speed Local Roads (e_{max} = 0.05[KM28][KM29][KM30])

e - ft/ft	Design Speed (mph)							
	10	15	20	25	30	35	40	45
0.05	16	41	83	149	240	355	508	675
0.045	16	41	85	152	245	363	520	692
0.04	16	42	86	154	250	371	533	711
0.035	16	42	87	157	255	380	547	730
0.03	16	43	89	160	261	389	561	750
0.025	16	43	90	163	267	398	577	771
0.02	17	44	92	167	273	408	593	794
0.015	17	45	94	170	279	419	610	818
0.01	17	45	95	174	286	430	627	844
0.005	17	46	97	177	293	441	646	871
0	18	47	99	181	300	454	667	900
-0.01	18	48	103	189	316	480	711	964
-0.02	19	50	107	198	333	510	762	1038
-0.03[1]	19	52	111	208	353	544	821	1125
-0.04[1]	20	54	116	219	375	583	889	1227
-0.05[1]	20	56	121	231	400	628	970	1350

1. Negative superelevation values beyond -0.02 ~~foot~~feet per foot should be used only for unpaved surfaces such as gravel, crushed stone, and earth[KM31].

~~**Figure 3 – 4 Sight Distance on Curves**~~

~~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.~~

~~In urban areas, the density of adjacent development or possibility of congestion act to restrict speeds.~~

~~Table 3 – 5~~ ~~Horizontal Curvature~~[HMJ32][KM33]

~~RURAL~~ ~~Based on e_{MAX} = 0.10~~			~~URBAN~~ Arterials and Collectors ~~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° 30'~~	~~75~~	~~---~~	~~---~~	~~---~~
~~25~~	~~45° 15'~~	~~130~~	~~---~~	~~---~~	~~---~~
~~30~~	~~28° 30'~~	~~200~~	~~30~~	~~23° 45'~~	~~245~~
~~35~~	~~19° 30'~~	~~295~~	~~35~~	~~16° 00'~~	~~360~~
~~40~~	~~13° 45'~~	~~415~~	~~40~~	~~11° 15'~~	~~510~~
~~45~~	~~10° 30'~~	~~540~~	~~45~~	~~8° 15'~~	~~680~~
~~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~~[KM34] Local				
~~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° 45'~~	~~85~~	~~53° 30'~~	~~110~~
~~25~~	~~38° 30'~~	~~150~~	~~28° 45'~~	~~200~~
~~30~~	~~23° 45'~~	~~240~~	~~17° 00'~~	~~335~~

~~**(TABLE CONTINUES ON NEXT PAGE)**~~

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

Superelevation runoff is the general term denoting the length of street or highway needed to ~~accomplish~~ transition the change in cross slope from a section with the adverse crown removed (level) to the 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 standard superelevation transition places 80% of the transition on the tangent and 20% on the curve. In transition sections where the travel lane(s) cross slope is less than 1.5 %, one of the following grade criteria should be applied:

- Maintain a minimum profile grade of 0.5%, or
- Maintain a minimum edge of pavement grade of 0.2% (0.5% for curbed roadways ~~and gutter~~).

When superelevation is required for curves in opposite directions on a common tangent (reverse curves), a suitable distance is required between the curves. This suitable tangent length should be determined as follows:

- 80% of the transition for each curve should be located on the tangent.
- The suitable tangent length is the sum of the two 80% distances, or greater.
- Where alignment constraints dictate a less than desirable tangent length between curves, an adjustment of the 80/20 superelevation transition treatment is allowed (where up to 50% of the transition may be placed on the curve).

Superelevation transition slope rates used to compute transition lengths are provided in Table 3 ~~-~~–13~~2~~ Superelevation Transition Slope Rates. The 2011 AASHTO Greenbook provides ~~may be referenced for~~ additional information on superelevation transition design.

The Department's ~~Design Standards~~ ***Standard Plans for Road and Bridge Construction*** ~~show in~~ provide additional information on ~~detail~~ superelevation transitions for various sections and methods for determining length of transition.

Table 3 – 13 Superelevation Transition Slope Rates

Number of Lanes in One Direction	High Speed Roadways				Low Speed Roadways		
	Design Speed (mph)				Design Speed (mph)		
	25-40	45-50	55-60	65-70	25-35	40	45
1-Lane & 2-Lane	1:175	1:200	1:225	1:250			
3-Lane	---	1:160	1:180	1:200	1:100	1:125	1:150
4-Lane or more	---	1:150	1:170	1:190			

High Speed Roadways:

1. The length of superelevation transition is to be determined by the relative slope rate between the travel[KM35][KM36] way edge of pavement and the profile grade, except that the minimum length of transition is 100 feet.
2. For additional information on transitions, see the ***Standard Plans, Index 000-510***.

Low Speed Roadways:

1. The length of superelevation transition is to be determined by the relative slope rate between the travel way edge of pavement and the profile grade, except that the minimum length of transition is 50 feet for design speeds 25-35 mph and 75 ft. for design speeds 40-45.
2. A slope rate of 1:125 may be used for 45 mph under restricted conditions.
3. For additional information on transitions, see ***Standard Plans, Index 000-511***.

Spiral curves may~~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. For additional information on the use of spiral curves, see the ***2011 AASHTO Greenbook***.

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

C.4.f Sight Distance on Horizontal Curves[KM37]

Where there are sight obstructions (such as walls, cut slopes, buildings, and longitudinal barriers) on the inside of curves or the inside of the median lane on divided highways and their removal to increase sight distance is impractical, a design may need adjustment in the normal highway cross section or alignment. With sight distance for the design speed as a control, make the appropriate adjustments to provide adequate stopping sight distance. Figure 3 – 1A Design Controls for Stopping Sight Distance on Horizontal Curves ~~(emax ≤ 0.02)~~ and Figure 3 – 1B ~~Diagram Illustrating Components for Determining Horizontal Sight Distance~~ Horizontal Sight Line Offset Distances for Stopping Sight Distance on Horizontal Curves shows the horizontal sight line offsets needed for clear sight areas that satisfy stopping sight distance criteria. ~~presented in~~ Table 3 – 4 ~~Minimum Stopping Sight Distances for horizontal curves of radii~~ Horizontal Sight Line Offset Distances To Obstructions for Minimum Radius Curves (e = 0.10) on flat grades is based on Figures 3-1A and 3-1B and provides horizontal line of sight offset distances measured from the edge of a 12 foot wide travel lane.

The horizontal sight line offset (HSO) values in Figure 3-1A are derived from the curve geometrics depicted in Figure 3-1B and the following formula:

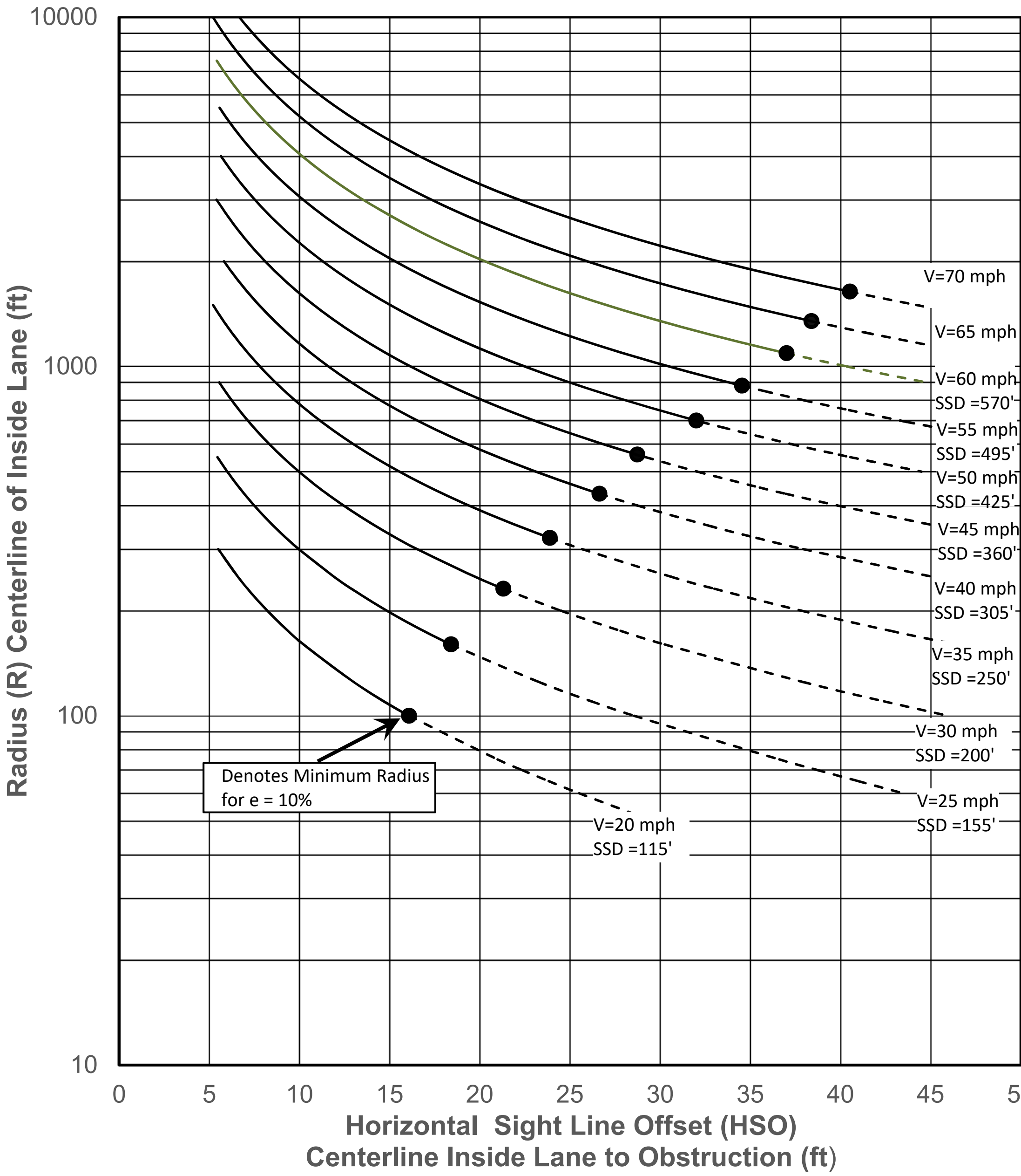
$$HSO = R\left(1 - \cos\left(\frac{28.65S}{R}\right)\right)$$

Where:

HSO = Horizontal Sight Line Offset, ft
S = Stopping Sight Distance, ft
R = Radius of Curve, ft

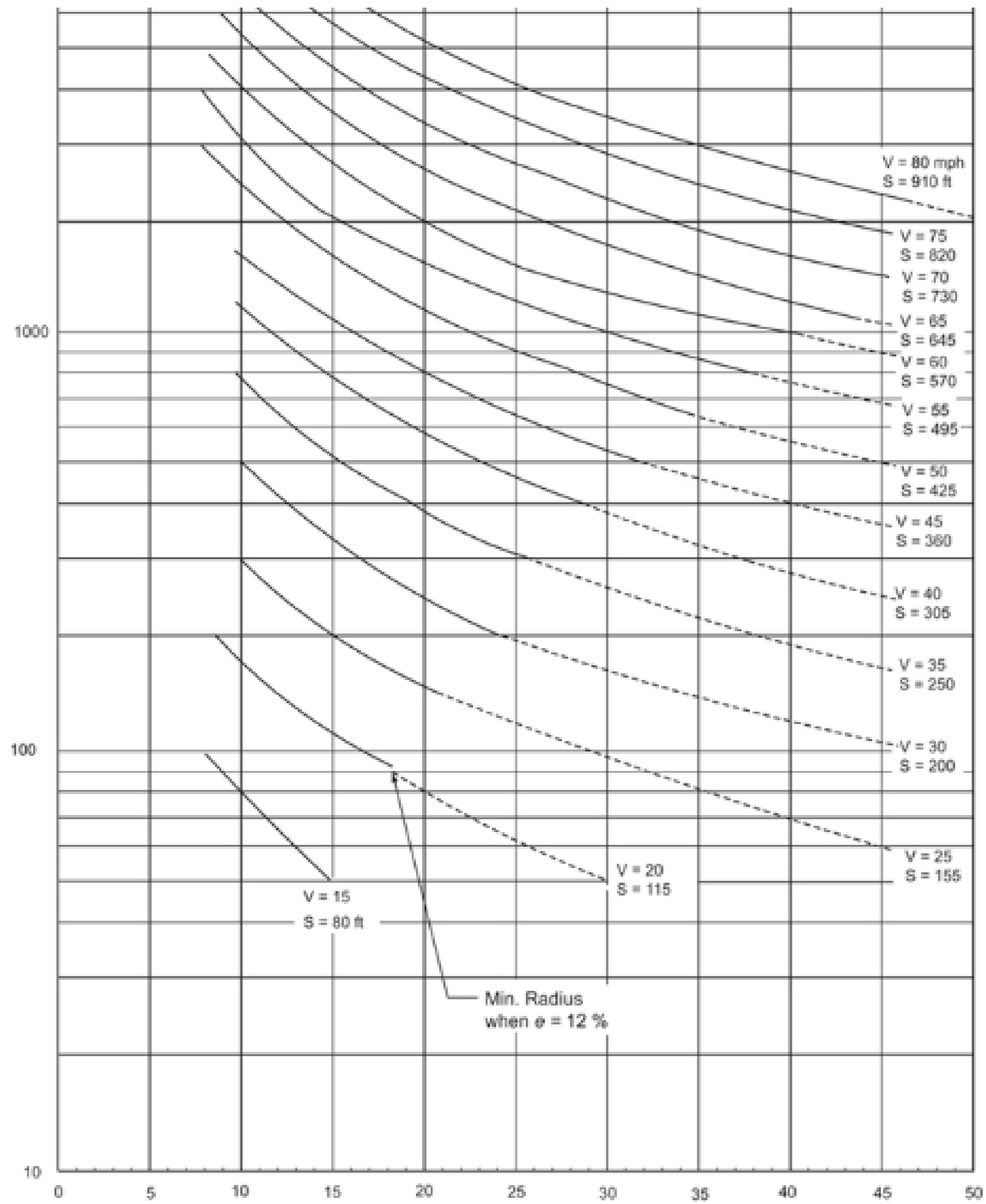
This equation applies only to circular curves longer than the sight distance for the applicable design speed. When either the vehicle or the sight obstruction are located beyond the limits of the simple curve, or are located on compound curves or spiral curves, the values obtained are only approximate. When Figure 3-1B is not applicable, the design should be checked using graphical procedures or by using an appropriate computational method. The 2011 AASHTO Greenbook may be referenced for additional guidance.

Figure 3 – 1A Horizontal Sight Line Offset Distances for Stopping Sight Distance on Horizontal Curves[KM38]



~~Figure 3 – 1A4 Design Controls for Stopping Sight Distance on Horizontal~~ Curves[KM39][KM40] ~~(emax ≤ 0.02)~~

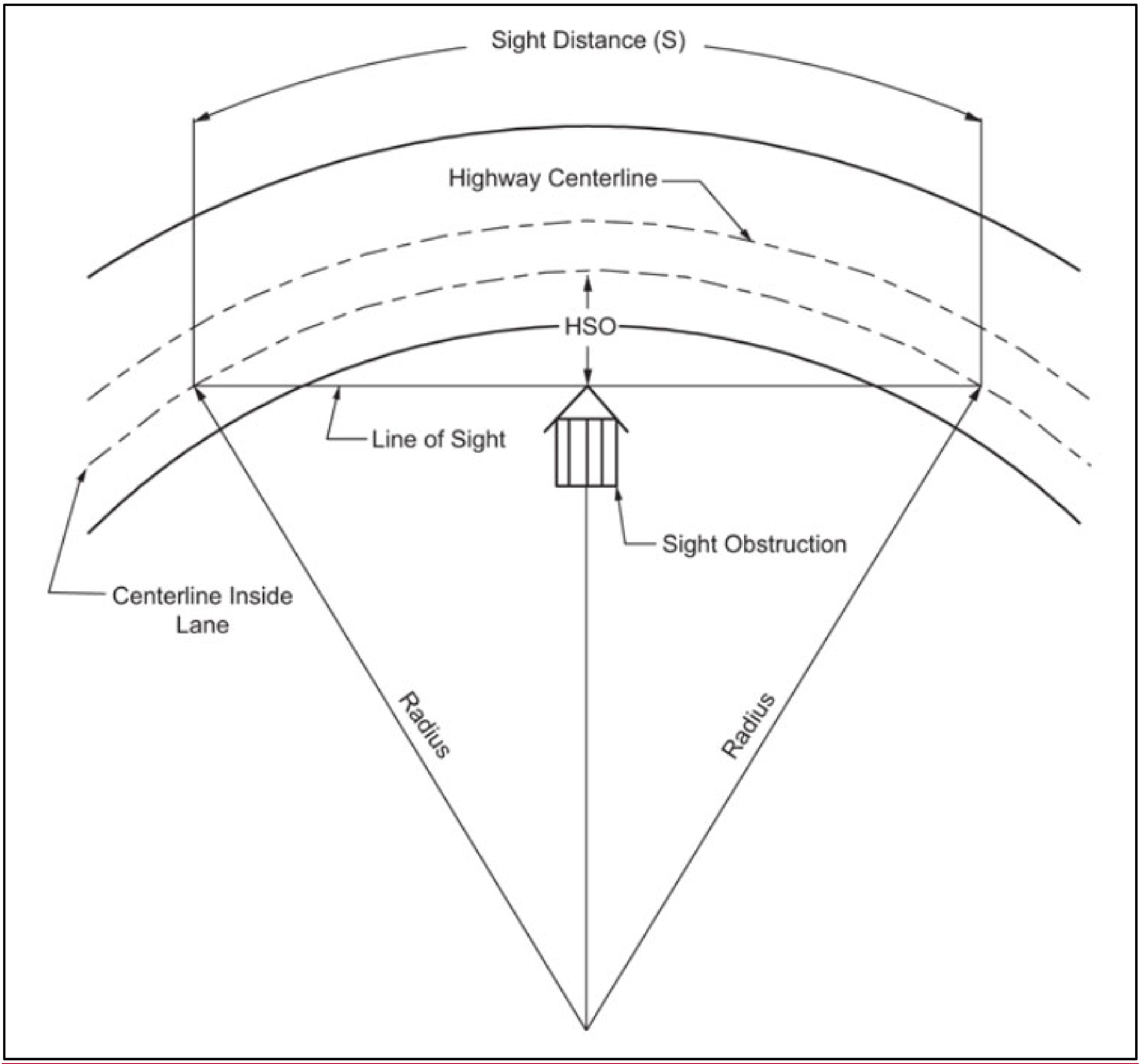
~~Radius, R, Centerline of Inside Lane (feet)~~



~~Horizontal Sight Line Offset, (HSO), Centerline Inside Lane to Obstruction (feet)~~

~~Source: 2011 AASHTO Greenbook, Figure 3 – 22b. Design Controls for Stopping Sight Distance on Horizontal Curves.~~

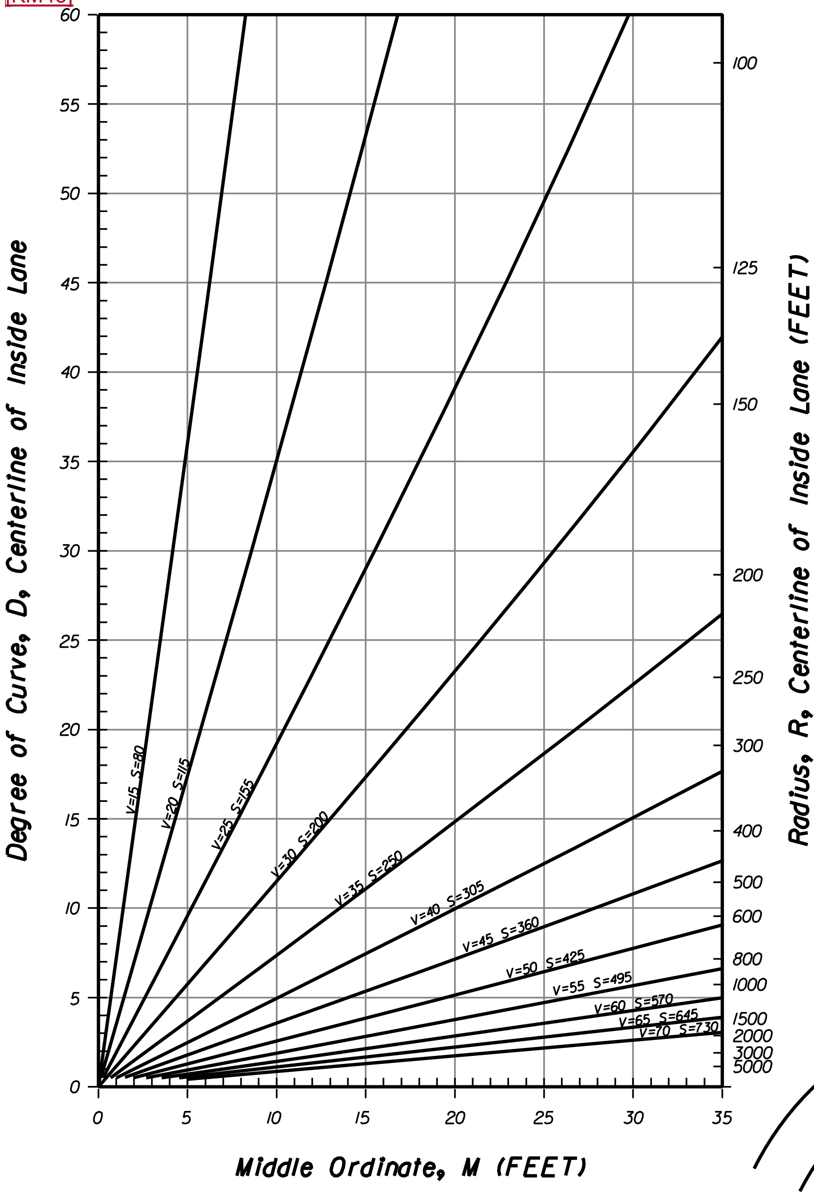
Figure 3 – 1B Diagram Illustrating Components for Determining Horizontal Sight Distance[KM41][KM42]



HSO – ~~Horizonatl~~Horizontal Sight Distance

Source: 2011 AASHTO Greenbook, Figure 3 – 23. Diagram Illustrating ~~Componenets~~Components for Determining Horizontal Sight Distance

[KM43]



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

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

$$M = R\,(1-\mathrm{Cos}\,\theta)$$

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

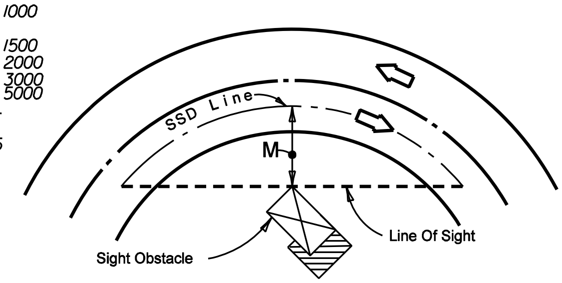
Where

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.

Table 3 – 14~~5~~ Horizontal Curvature[KM44][KM45][KM46]
~~(Continued)~~

Lateral Clearance From Edge Of Traveled Way 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~~79~~° 45~~30~~'	11~~5~~[KM47][KM48][HMJ49][KM50]
25	36~~45~~° 15'	13~~7~~
30	24~~28~~° 45~~30~~'	16~~8~~
35	17~~19~~° 45~~30~~'	19~~20~~
40	13° 30~~45~~'	21~~2~~
45	10° 15~~30~~'	23~~4~~
50	8° 15'	27
55	6° 30'	29
60	5° 15'	31
65	4° 15'	33
70	3° 30'	35

Table 3-14
Horizontal Sight Line Offset Distances To Obstructions for Minimum Radius Curves (e = 0.10)

Design Speed (mph)	Curvature		Offset Distance from Centerline of Lane (feet)	Offset Distance from Edge of 12' Lane (feet)
	Maximum Curvature (degrees)	Minimum Radius (feet)		
20	57° 45'	99	16	10
25	36° 15'	158	18	12
30	24° 45'	231	21	15
35	17° 45'	323	24	18
40	13° 30'	432	27	21
45	10° 15'	559	29	23
50	8° 15'	694	32	26
55	6° 30'	881	35	29
60	5° 15'	1091	37	31
65	4° 15'	1348	38	32
70	3° 30'	1637	41	35

C.4.g~~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 – 15~~16~~A Calculated and Design Values for Traveled Way Widening on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way and 3 – 15~~16~~B 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 – 15~~6~~A 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.							Roadway width = 22 feet.							Roadway width = 20 feet.						
	Design Speed (mph)							Design Speed (mph)							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	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.7	1.7	1.8	1.8	1.9	2.0	2.0
6500	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.7	1.8	1.8	1.9	2.0	2.0	2.1
6000	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	2.0	2.1
5500	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.8	1.9	1.9	2.0	2.1	2.1	2.2
5000	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.9	0.9	1.0	1.1	1.1	1.2	1.3	1.9	1.9	2.0	2.1	2.1	2.2	2.3
4500	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.9	1.0	1.1	1.1	1.2	1.3	1.4	1.9	2.0	2.1	2.1	2.2	2.3	2.4
4000	0.0	0.1	0.2	0.2	0.3	0.4	0.5	1.0	1.1	1.2	1.2	1.3	1.4	1.5	2.0	2.1	2.2	2.2	2.3	2.4	2.5
3500	0.1	0.2	0.3	0.4	0.5	0.5	0.6	1.1	1.2	1.3	1.4	1.5	1.5	1.6	2.1	2.2	2.3	2.4	2.5	2.5	2.6
3000	0.3	0.4	0.4	0.5	0.6	0.7	0.8	1.3	1.4	1.4	1.5	1.6	1.7	1.8	2.3	2.4	2.4	2.5	2.6	2.7	2.8
2500	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.5	2.6	2.7	2.8	2.9	3.0	3.1
2000	0.7	0.9	1.0	1.1	1.2	1.3	1.4	1.7	1.9	2.0	2.1	2.2	2.3	2.4	2.7	2.9	3.0	3.1	3.2	3.3	3.4
1800	0.9	1.0	1.1	1.3	1.4	1.5	1.6	1.9	2.0	2.1	2.3	2.4	2.5	2.6	2.9	3.0	3.1	3.3	3.4	3.5	3.6
1600	1.1	1.2	1.3	1.5	1.6	1.7	1.8	2.1	2.2	2.3	2.5	2.6	2.7	2.8	3.1	3.2	3.3	3.5	3.6	3.7	3.8
1400	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.3	2.5	2.6	2.7	2.9	3.0	3.1	3.3	3.5	3.6	3.7	3.9	4.0	4.1
1200	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	4.1	4.2	4.4	4.5
1000	2.1	2.3	2.4	2.6	2.7	2.9	3.0	3.1	3.3	3.4	3.6	3.7	3.9	4.0	4.1	4.3	4.4	4.6	4.7	4.9	5.0
900	2.4	2.6	2.7	2.9	3.1	3.2		3.4	3.6	3.7	3.9	4.1	4.2		4.4	4.6	4.7	4.9	5.1	5.2	
800	2.7	2.9	3.1	3.3	3.5	3.6		3.7	3.9	4.1	4.3	4.5	4.6		4.7	4.9	5.1	5.3	5.5	5.6	
700	3.2	3.4	3.6	3.8	4.0			4.2	4.4	4.6	4.8	5.0			5.2	5.4	5.6	5.8	6.0		
600	3.8	4.0	4.2	4.4	4.6			4.8	5.0	5.2	5.4	5.6			5.8	6.0	6.2	6.4	6.6		
500	4.6	4.9	5.1	5.3				5.6	5.9	6.1	6.3				6.6	6.9	7.1	7.3			
450	5.2	5.4	5.7					6.2	6.4	6.7					7.2	7.4	7.7				
400	5.9	6.1	6.4					6.9	7.1	7.4					7.9	8.1	8.4				
350	6.8	7.0	7.3					7.8	8.0	8.3					8.8	9.0	9.3				
300	7.9	8.2						8.9	9.2						9.9	10.2					
250	9.6							10.6							11.6						
200	12.0							13.0							14.0						

Source: 2011 AASHTO Greenbook, Table 3 – 26b Calculated and Design values for Traveled Way Widening on Open Highway Curves.

Notes: 1. Values shown are for WB-62~~50~~[JM51][KM52] design vehicle and represent widening in feet. For other design vehicles, use adjustments in Table 3-14~~6~~B.

Table 3 – 15~~6~~B
Adjustments for Traveled Way Widening Values on Open Highway Curves
(Two-Lane Highways, One-Way or Two-Way[KM53])

Radius of Curve (FEET)	Design Vehicle						
	SU-30	WB-40	~~WB-62~~	~~WB-65~~	~~WB-627FLD~~	WB-67~~100T~~	WB-67~~109~~D
7000	-1.~~1~~2	-1.2~~1~~	~~0.1~~	~~0.1~~	~~0.0~~	0.1~~0~~	-0.1~~3~~
6500	-1.3~~1~~	-1.2~~1~~	~~0.1~~	~~0.1~~	~~0.0~~	0.1	-0.1~~3~~
6000	-1.3~~2~~	-1.2~~1~~	~~0.1~~	~~0.2~~	~~0.0~~	0.1	-0.2~~3~~
5500	-1.3~~2~~	-1.2~~1~~	~~0.1~~	~~0.2~~	~~0.0~~	0.1	-0.2~~4~~
5000	-1.3~~2~~	-1.3~~1~~	~~0.1~~	~~0.2~~	~~0.0~~	0.1	-0.2~~4~~
4500	-1.4~~2~~	-1.3~~1~~	~~0.1~~	~~0.2~~	~~0.0~~	0.1	-0.2~~5~~
4000	-1.4~~2~~	-1.3~~2~~	~~0.2~~	~~0.2~~	~~-0.1~~	0.1	-0.2~~5~~
3500	-1.5~~3~~	-1.4~~2~~	~~0.2~~	~~0.3~~	~~-0.1~~	0.1	-0.3~~6~~
3000	-1.6~~3~~	-1.4~~2~~	~~0.2~~	~~0.3~~	~~-0.1~~	0.1	-0.3~~7~~
2500	-1.7~~4~~	-1.5~~2~~	~~0.3~~	~~0.4~~	~~-0.1~~	0.2~~1~~	-0.4~~8~~
2000	-1.8~~5~~	-1.6~~3~~	~~0.3~~	~~0.5~~	~~-0.1~~	0.2	-0~~1~~.5~~0~~
1800	-1.9~~5~~	-1.7~~3~~	~~0.4~~	~~0.5~~	~~-0.1~~	0.2	-0~~1~~.5~~1~~
1600	-2~~1~~.0~~6~~	-1.8~~4~~	~~0.4~~	~~0.6~~	~~-0.1~~	0.2	-0~~1~~.6~~3~~
1400	-2~~1~~.2~~7~~	-1.9~~4~~	~~0.5~~	~~0.6~~	~~-0.2~~	0.3~~2~~	-0~~1~~.6~~5~~
1200	-2~~1~~.4~~8~~	-2~~1~~.1~~5~~	~~0.5~~	~~0.8~~	~~-0.2~~	0.3	-0~~1~~.8~~7~~
1000	-2.7~~0~~	-2~~1~~.3~~6~~	~~0.6~~	~~0.9~~	~~-0.2~~	0.4~~3~~	-0~~2~~.9~~0~~
900	-2.8~~1~~	-2~~1~~.4~~7~~	~~0.7~~	~~1.0~~	~~-0.2~~	0.4	-1~~2~~.0~~3~~
800	-3~~2~~.1~~2~~	-2~~1~~.6~~8~~	~~0.8~~	~~1.1~~	~~-0.3~~	0.5~~4~~	-1~~2~~.1~~6~~
700	-3~~2~~.4	-2~~1~~.9	~~0.9~~	~~1.3~~	~~-0.3~~	0.6~~5~~	-1~~2~~.3~~9~~
600	-3~~2~~.8~~6~~	-3~~2~~.2~~0~~	~~1.1~~	~~1.5~~	~~-0.4~~	0.7~~6~~	-1~~3~~.5~~4~~
500	-4~~2~~.3~~9~~	-3~~2~~.6~~2~~	~~1.3~~	~~1.8~~	~~-0.4~~	0.8~~7~~	-1~~4~~.8~~1~~
450	-4~~3~~.7~~2~~	-3~~2~~.9~~4~~	~~1.4~~	~~2.0~~	~~-0.5~~	0.9~~7~~	-2~~4~~.0~~6~~
400	-5~~3~~.2~~4~~	-4~~2~~.3~~5~~	~~1.6~~	~~2.3~~	~~-0.5~~	1~~0~~.0~~8~~	-2~~5~~.3~~1~~
350	-5~~3~~.8	-4~~2~~.7~~8~~	~~1.9~~	~~2.6~~	~~-0.6~~	1.1~~0~~	-2~~5~~.6~~9~~
300	-6~~4~~.6~~3~~	-5~~3~~.4~~0~~	~~2.2~~	~~3.0~~	~~-0.7~~	1.3~~1~~	-3~~6~~.0~~9~~
250	-7~~4~~.7~~9~~	-6~~3~~.3~~5~~	~~2.6~~	~~3.7~~	~~-0.9~~	1.6~~4~~	-3~~8~~.6~~3~~
200	-9~~5~~.4~~9~~	-7~~4~~.6~~1~~	~~3.3~~	~~4.6~~	~~-1.1~~	2~~1~~.0~~7~~	-4~~10~~.6~~5~~

Source: 2011 AASHTO Greenbook, Table 3 - 27 Adjustments for Traveled Way Widening Values on Open Highway Curves.

Notes:
1. Adjustments are applied by adding to or subtracting from the values in Table 3-6A.
2. Adjustments depend only on radius and design vehicle; they are independent of traveled way width and design speed.
3. For 3-lane roadways, multiply above values by 1.5.
4. 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[KM54] 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 – 1657 ~~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 – 25 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 – 16~~7~~ ~~Recommended~~ Maximum Grades (in Percent[KM55])

Type of Roadway		Level 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[1]		---	---	---	---	---	---	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
	Urban	---	---	8	7	7	6	6	5	5	---	---	---	---	9	8	8	7	7	6	6	---	---
Collector[2] ~~*~~	Rural	7	7	7	7	7	7	6	6	5	---	---	10	10	9	9	8	8	7	7	6	---	---
	Urban	9	9	9	9	9	8	7	7	6	---	---	12	12	11	10	10	9	8	8	7	---	---
Local[3]~~*~~	Rural	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~~	~~—~~	~~—~~

Source: 2011 AASHTO Greenbook, Tables 5–2, 6 –2~~1~~, 6 –8, 7 –2, 7 –4, 8 –1.

Notes: 1. Grades 1% steeper than the value shown may be provided in urban areas with ~~where~~ right of way ~~is~~ constraints~~ed~~.

2. Short lengths of grade ~~in rural areas~~ (≤ 500 feet in length), one-way downgrades, and grades on low volume ~~rural~~ collectors may be up to 2% steeper than the grades shown above.

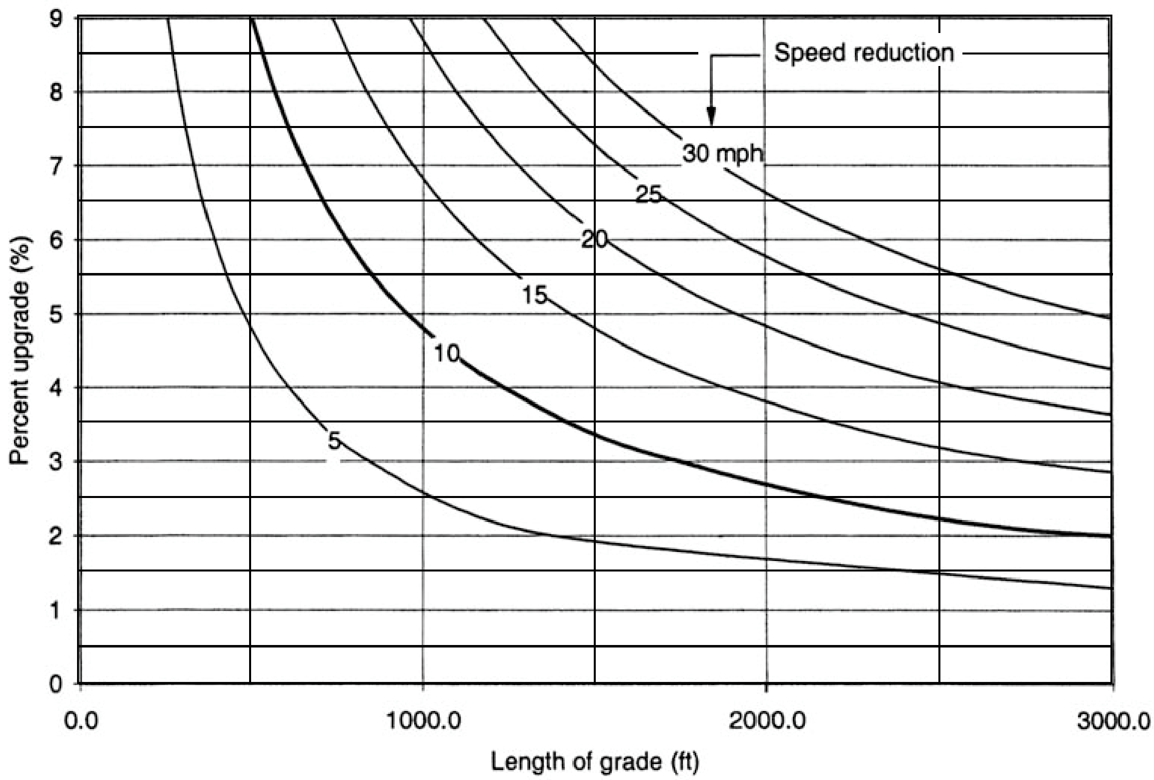
3. Residential street grade should be as level as practical, consistent with surrounding terrain, and less than 15%. Streets in commercial or industrial areas should have grades less than 8%, and flatter grades should be encouraged.

~~* May be increased by 32 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 – 2~~5~~ Critical Length Versus Upgrade



Critical Lengths of Grade for Design[JM56][KM57]**, Assumed Typical Heavy Truck of 200 lb/hp, Entering Speed = 70 mph**

Source: 2011 AASHTO Greenbook, ~~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 – 17~~68~~ Maximum Change in Grade Without Using Vertical Curve. Table 3 – 18~~79~~ 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 – 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 – 4~~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 - 5~~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 – 17~~8~~ Maximum Change in Grade Without Using Vertical Curve[KM58][KM59]

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 – 18~~9~~ Rounded K Values for Minimum Lengths Vertical Curves[MAK60]

~~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

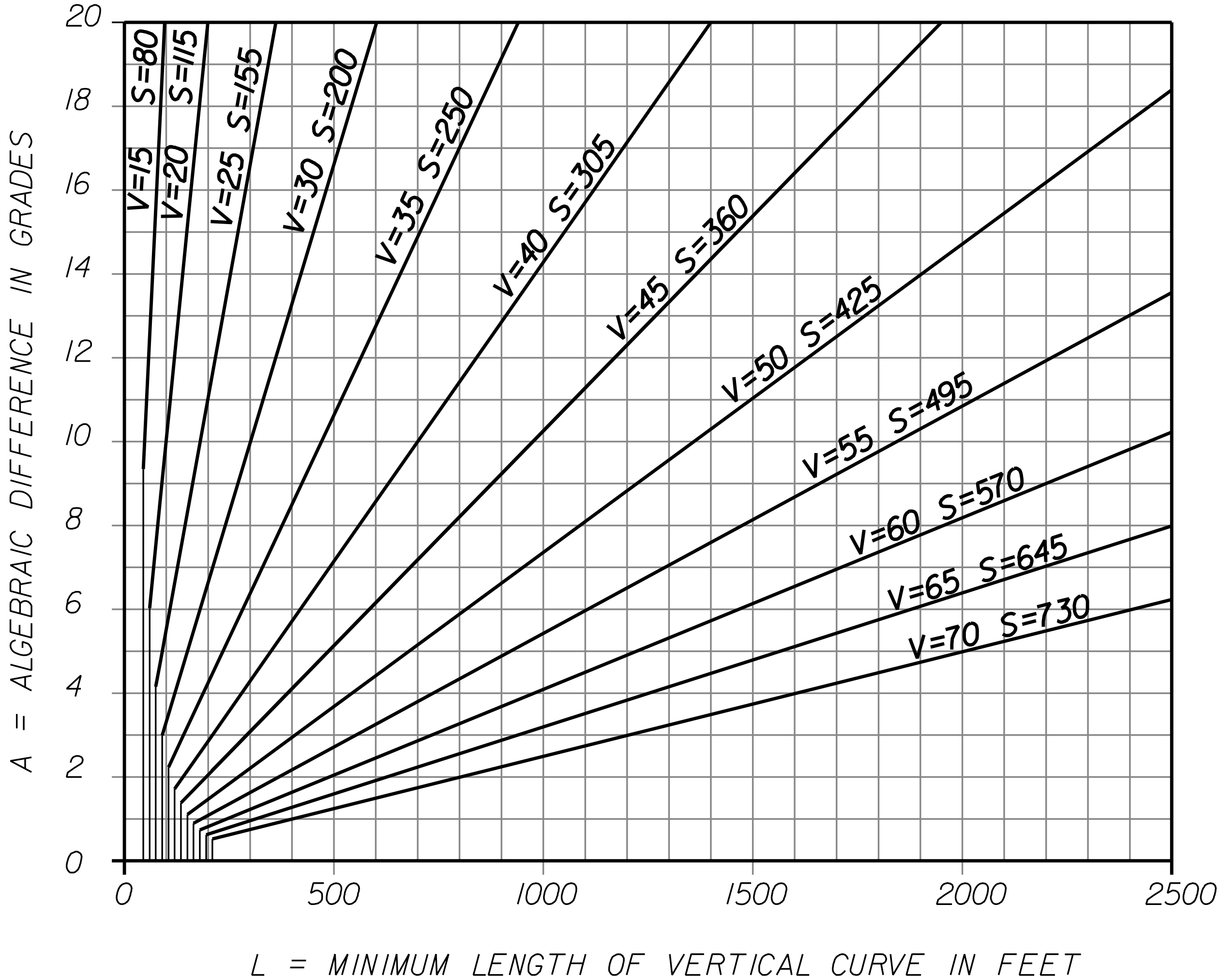
Design Speed (mph)		20	25	30	35	40	45	50	55	60	65	70
K Values for Crest Vertical Curves		7	12	19	29	44	61	84	114	151	193	247
K Values for Sag Vertical Curves		17	26	37	49	64	79	96	115	136	157	181

- 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

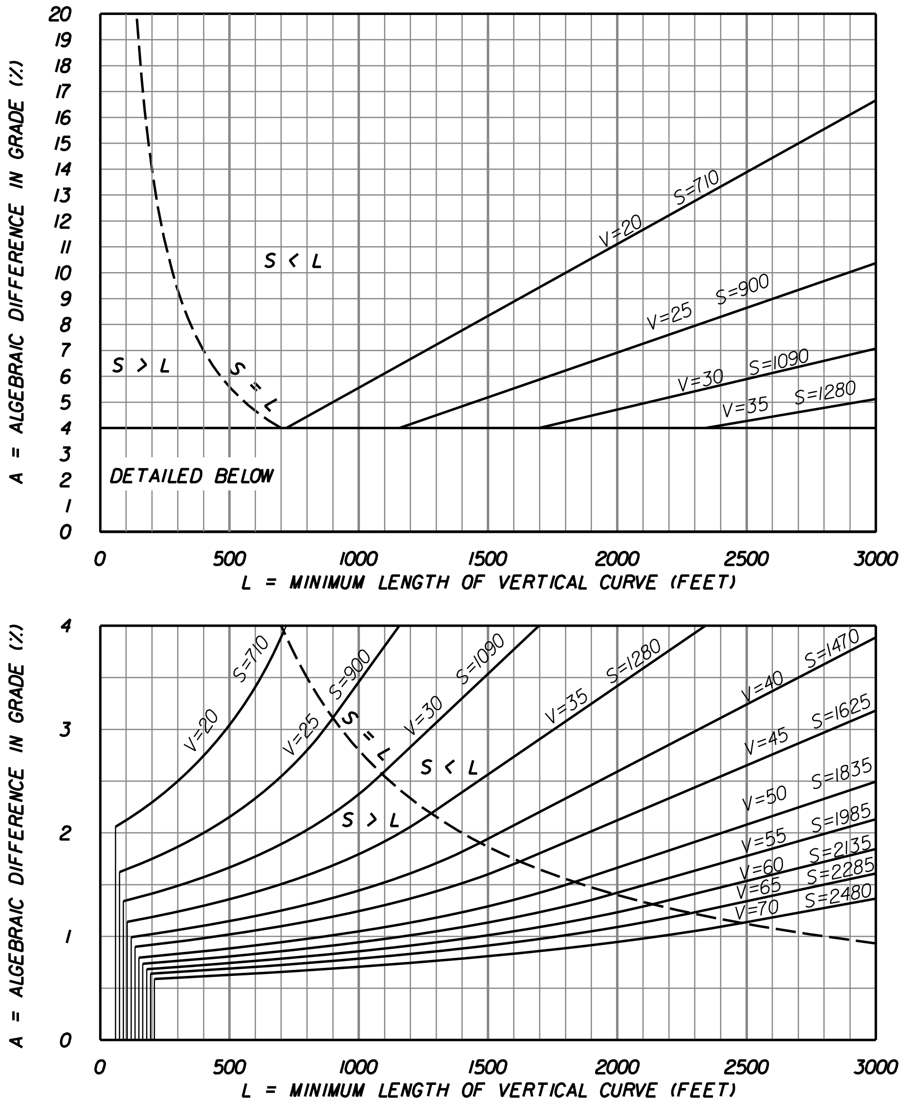
Figure 3 – 3~~6~~ Length of Crest Vertical Curve
(Stopping Sight Distance)



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 – 4~~7~~ Length of Crest Vertical Curve (Passing Sight Distance[KM61])



The sight distance is computed from the following formulas:

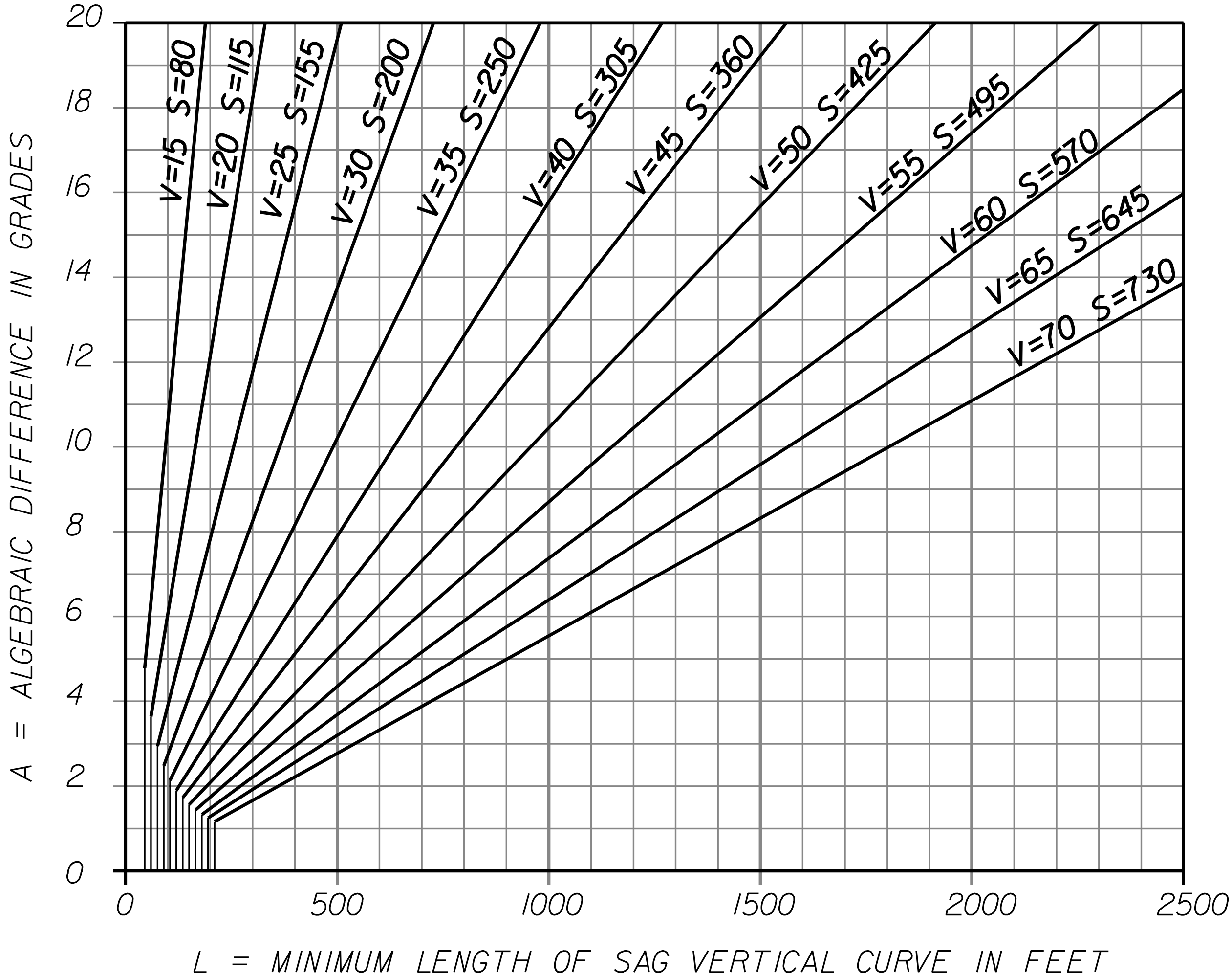
$$S < L,\quad L = \frac{AS^2}{2800} \qquad S > L,\quad L = 2S - \frac{2800}{A}$$

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

Figure 3 – 58 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. See ***Chapter 4 – Roadside Design*** for design criteria for roadside design, clear zone, lateral offset, and roadside ditches located within the clear zone.

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. (***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011***), and the ~~current~~ ***Highway Capacity Manual (TRB, 2010***).

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[MAK62]

Minimum lane widths for travel lanes, speed change lanes, turn lanes and passing lanes are provided in Table 3 – 1970 Minimum Lane Widths. The table applies to both divided and undivided facilities. For Information on parking lanes, see Section C.7.h Parking of this Chapter.

On existing multilane ~~urban~~ curbed ~~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 – 19~~0~~ Minimum Lane Widths[KM63]

Facility		ADT (vpd)	Design Speed (mph)	~~Divided/ Undivided~~	Lane Width ~~-~~ – (feet)~~FT~~ Travel Lanes[1]	~~Speed Change Lanes~~ [KM64]	Turn Lanes[6~~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[9~~8~~]	12[9~~8~~]
	Urban	All	≥~~>~~ 50~~45~~	~~All~~	12	~~12~~	12	12
		All	≤ 45	~~Undivided~~	11[3, 4]	~~11[3]~~	11[3, 4, 7~~6~~]	11[3, 4]
				~~Divided~~	~~11[3]~~	~~11[3]~~	~~11[3, 6]~~	~~11[3]~~
Collector	Rural	> 1500	All	~~All~~	12[8]	~~12[8]~~	12[8]	12[9~~8~~]
		400 to 1500	All	~~All~~	11[3, 4]	~~11[3]~~	11[3, 4]	--
		< 400	≥~~>~~ 50~~45~~	~~All~~	11	~~11~~	11[7~~6~~]	--
			≤ 45	~~All~~	10	~~10~~	10	--
	Urban	All	All	~~All~~	11[2, 3, 4]	~~11[2, 3]~~	11[2, 7~~6~~]	--
Local	Rural	> 1500	All	~~All~~	12[8]	~~12[8]~~	12[9~~8~~]	12[9~~8~~]
		400 to 1500	All	~~All~~	11[3, 4]	~~--~~	11[3, 4]	--
		< 400	≥~~>~~ 55~~50~~	~~All~~	11[3]	~~--~~	11[3, 4]	--
			45 to 50	~~All~~	10	~~--~~	10	--
			≤~~<~~ 40~~45~~	~~All~~	9	~~--~~	9	--
	Urban	All	All	~~All~~	10[2,~~4~~ 5]	~~--~~	10[8~~7~~]	--

See Footnotes on next page

Footnotes[KM65]

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 is constrained~~severely limited~~.
3. In constrained areas where truck ~~and bus~~ volumes are low and speeds are ≤~~less than~~ 35[KM66] mph, 10' lanes may be used.
~~3.~~4. On roadways with ~~In constrained areas with~~ a transit route, a minimum of 11' outside lane width is~~s are~~ required.
~~4.~~5. In residential areas where right of way is severely limited, 9' may be used.
~~5.~~6. Turn lane width in raised or grass m~~M~~edians ~~turn lane widths~~ shall not exceed 14' ~~15~~[KM67]~~'~~. Two-way left turn lanes should be 11 – 14' wide and may only be used on 3- and 5-lane typical sections with design speeds ≤ 40 mph. On projects ~~existing curb locations are fixed~~ with right of way constraints, the minimum width may be reduced to 10'. Two-way left turn lanes shall include sections of raised or restrictive median for pedestrian refuge[KM68].
~~6.~~7. Turn Lane width should be same as Travel Lane width. May be reduced to 10' where right of way is constrained.
~~7.~~8. Turn Lane width should be same as Travel Lane width. May be reduced to 9' where truck volumes are low.
9. For design speeds below 50 mph, lane widths of 11 feet are acceptable.
~~8.~~10. ~~Table applies to both divided and undivided faciltlies~~

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[KM69]

A shoulder is the portion of the roadway contiguous with the traveled way that accommodates stopped vehicles, emergency use, and provides lateral support of subbase, base and surface courses. In some cases, the shoulder may also accommodate pedestrians or bicyclists. Shoulders may be surfaced either full or partial width and include turf, gravel, shell, and asphalt or concrete pavements. ~~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 minimum width of outside and median shoulders is provided in Table 3 – 20~~19~~ Minimum Shoulder Widths for Flush Shoulder Highways. S~~s~~houlders for two-lane, two-way highways~~roadwaysshoulders~~ are based upon traffic volumes~~shall not be less than the values given in Table 3 – 11 Shoulder Widths for Rural Highways~~. Shoulder widths for multi-lane highways are based upon the number of travel lanes in each direction. Where bicyclists or pedestrians are to be accommodated on the shoulder~~s~~, a minimum usable width of 4 feet is required (5 feet if adjacent to a barrier). On approaches ~~to narrow bridges~~ where the paved shoulder is reduced, the Department's ***Standard Plans Index 700-106*** provides information on signing and marking the approaching shoulder.

~~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 – 20~~11~~ Minimum Shoulder Widths for Flush Shoulder ~~Rural~~ Highways[KM70]

Two Lane Undivided

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

Multilane Divided

Number of Lanes Each Direction	Shoulder Width (feet)			
	Outside		Median	
	Roadway	Bridge	Roadway	Bridge
2	8~~10~~ (min.)	8~~10~~	4~~6~~ (min.)	4~~6~~
3 or more	10 (min.)	10	6~~10~~ (min.)	6~~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 – 21~~12~~ Shoulder Cross Slope.

Table 3 – 21~~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,~~ traffic characteristics, pedestrian volume, roadway type, ~~characteristics of vehicular traffic~~, and other design elements. ***Chapter 8 - Pedestrian Facilities*** of this Manual and ***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)***, 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***, ~~–~~ ***Chapter 10 – Maintenance and Resurfacing*** and ***Section C.10.a.3 – Sidewalks and Curb Ramps*** of this chapter~~*Chapter 8 – Pedestrian Facilities*~~ 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***). Each crossing should have separate curb ramps, perpendicular with the curb, and landing within the crosswalk.~~parallel with the direction of travel.~~ 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 – 22~~013~~ Minimum Median Width~~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 also given in Table 3 – 22~~014~~ Minimum Median Width[KM71] ~~Median Width for Urban and Rural Multilane Streets and Highways (Multilane Facilities)~~. On urban streets, the median widths shall not be less than the values given in Table 3 – 22~~014~~. 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~~[JM72] ~~Minimum Median Width for Freeways (Urban and Rural~~[KM73]~~)~~

~~Design Speed (mph)~~	~~Without Barrier Minimum Permitted Median Width (feet)~~	~~With Barrier (feet)~~
~~60 and Over~~	~~60 1**~~	~~26 2~~
~~Under 60~~	~~40 *~~	~~26 2~~

~~* Applicable for urban areas ONLY.~~

~~Notes:~~

~~**1. Applicable for new construction ONLY.~~
~~(40 feet minimum allowed when lanes added to median).~~
~~2. Based on 2 ft. median barrier and 12 ft. shoulder.~~

~~Table 3 – 14 Minimum Median Width for Streets and Highways Rural and Urban Streets and Highways~~

~~(Multilane Rural Facilities)~~

~~DesignESIGN SpeedPEED (mph)~~	~~MINIMUM WidthIDTH (feet)~~
~~504555 and Over~~	~~40~~
~~Under 504555~~	~~22 3~~

~~Median Width for (Multilane Urban Streets)~~[JM74][KM75]

~~Design SpeedESIGN SPEED (mph)~~	~~MINIMUM WidthIDTH (feet)~~
~~50~~	~~19.5~~
~~45 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.~~

Table 3 – 22~~13~~ Minimum Median Width[KM76]

Type of Facility	Width (feet)
Freeways	
~~Interstate[KM77], Without Barrier~~	~~64 [1]~~
Freeways, Without Barrier	---
Design Speed ≥ 60 mph	60
Design Speed < 60 mph	40
All, With Barrier, All Design Speeds	26 [1]
Arterial and Collectors	
Design Speed ≥ 50~~45~~ mph[KM78][KM79]	40
Design Speed ≤~~<~~ 45 mph	22 [2]
Paved and Painted for Left Turns	See Table 3 – 17 Minimum Lane Widths[MAK80] ~~12 [3]~~

Median width is the distance between the inside (median) edge of the travel lane of each roadway.

Footnotes:

1. Based on 2 ft. wide, concrete median barrier and 12 ft. shoulder.

2. On ~~reconstruction~~ projects where right of way is constrained~~existing curb locations are fixed due to severe right of way constraints~~, the minimum width may be reduced to 19.5 ft. for design speeds = 45 mph, and to 15.5 ft. for design speeds ≤ 40 mph.

3~~. Restricted to 5-lane sections with design speeds ≤ 4 mph. On reconstruction projects where existing curb locations are fixed due to severe right of way constraints, the minimum width may be reduced to 10 ft. These flush medians are to include sections of raised or restrictive median for pedestrian refuge[KM81].~~

C.7.e.3 Median Slopes

A vehicle should be able to tra~~ns~~verse 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.~~ See ***Chapter 4 – Roadside Design*** for ~~additional~~criteria on ~~for~~ median barriers. The ***AASHTO Roadside Design Guide*** provides additional information and guidelines on the use of median barriers.

~~The median barrier should not be placed closer than 4 feet~~10 feet[JM82][KM83][KM84] ~~from the inside~~ edge ~~of traveled way~~[JM85]. ~~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;

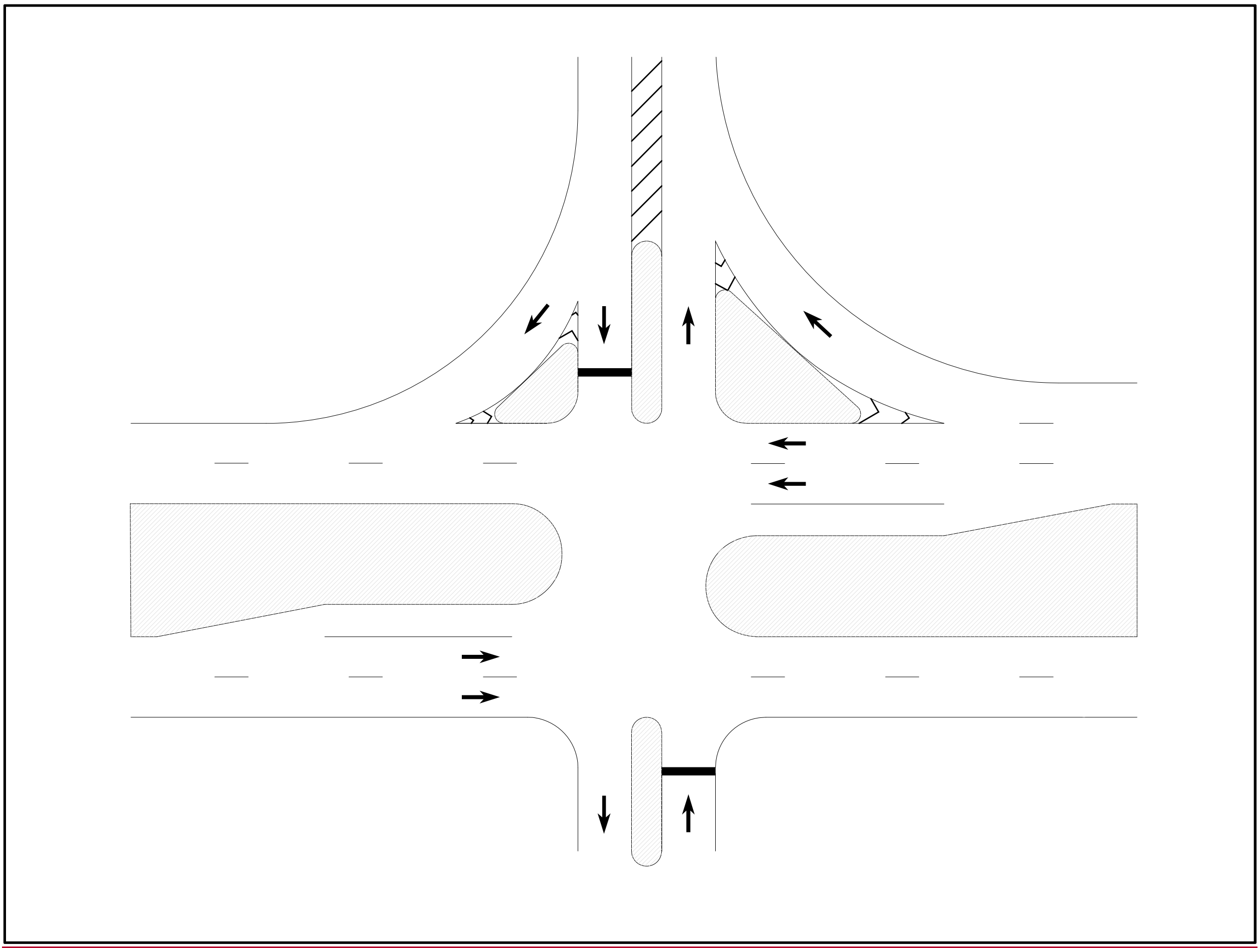
2. Division — To divide opposing or same direction traffic streams, usually through movements; and

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.

The dimensions and details depend on the ~~particular intersection~~intersection design as illustrated in Figure 3 – 6~~9~~ General Types and Shapes of Islands and Medians. They should conform to the general principles that follow.

Figure 3 – 6~~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
- Areas 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~~ T~~t~~he Department's ***Design Manual, Chapter 212 Intersections*** ~~***Design Standards***~~ provides additional information on designing landscaping in medians or at intersections.

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 may be 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 Chapter 4, Roadside Design Table 4~~3~~ – 2~~16~~ Lateral Offset shall be provided. Mast arm ~~bases and~~ foundation diameters ~~shafts~~vary~~in width, ranging~~ from 3.5 feet to ~~4.5~~ 5.0 feet~~in~~ diameter[KM86][KM87]. 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[KM88].

Details of curbed corner island designs used in conjunction with turning roadways are shown in Figures 3-8~~10~~ and 3-9~~11~~ Details of Corner Island for Turning Roadways (Curbed~~ 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 ***Standard Plans, Index 711-001***~~***Design Standards***~~.

Figure 3 – 7~~xx~~ Channelization Island for Pedestrian Crossings (Curbed ~~and Gutter~~)

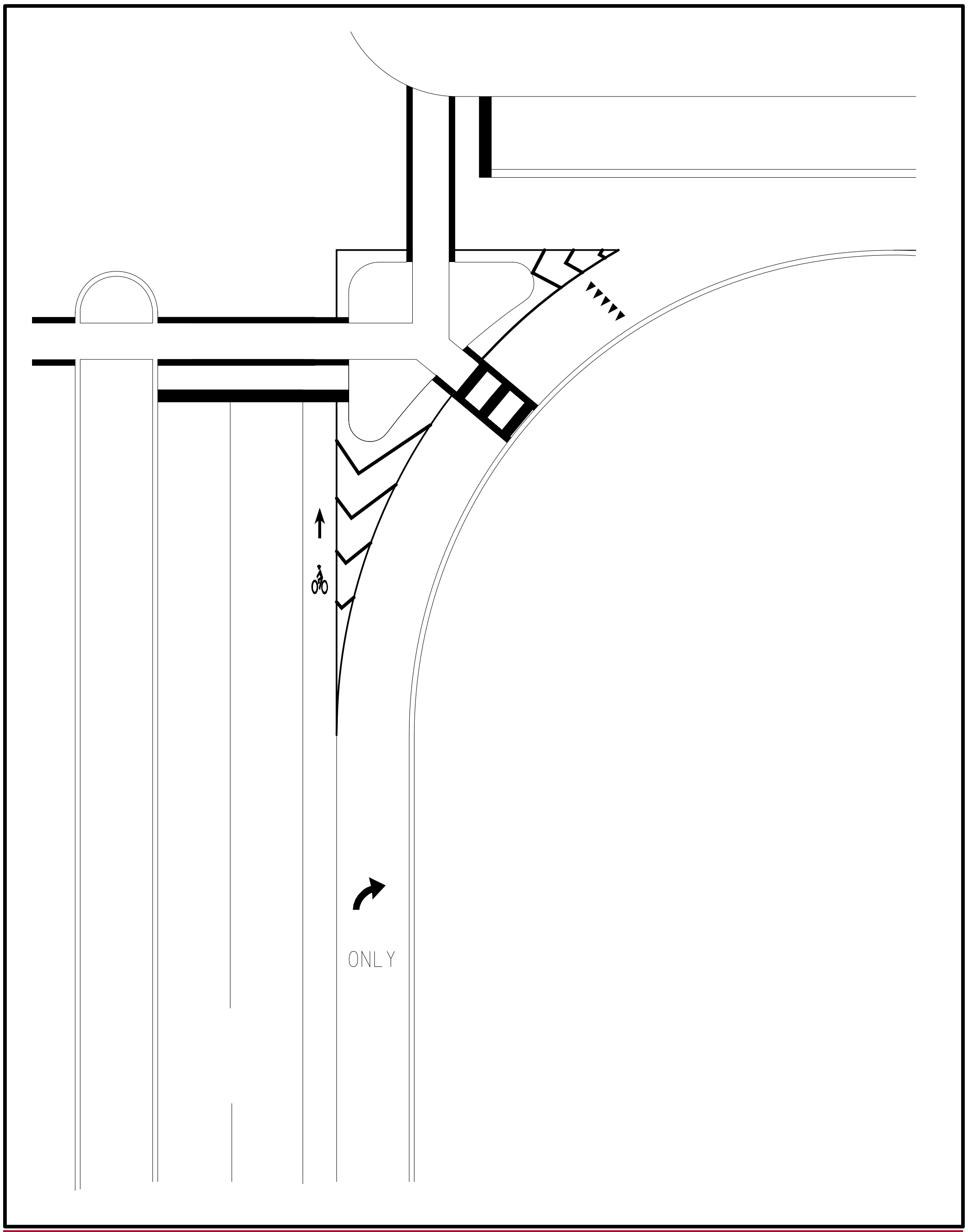


Figure 3 – 8~~10~~ Details of Corner Island for Turning Roadways (Curbed ~~and Gutter~~[KM89])

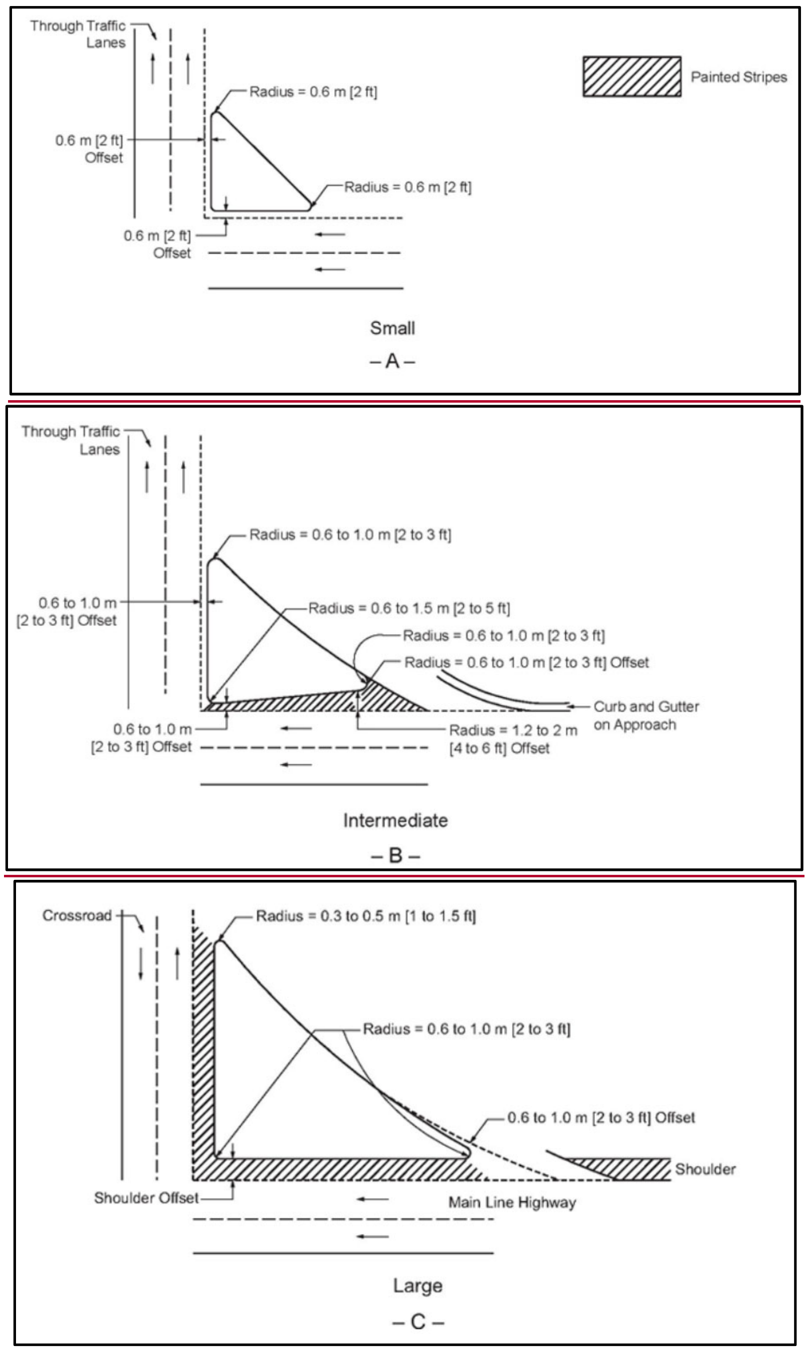
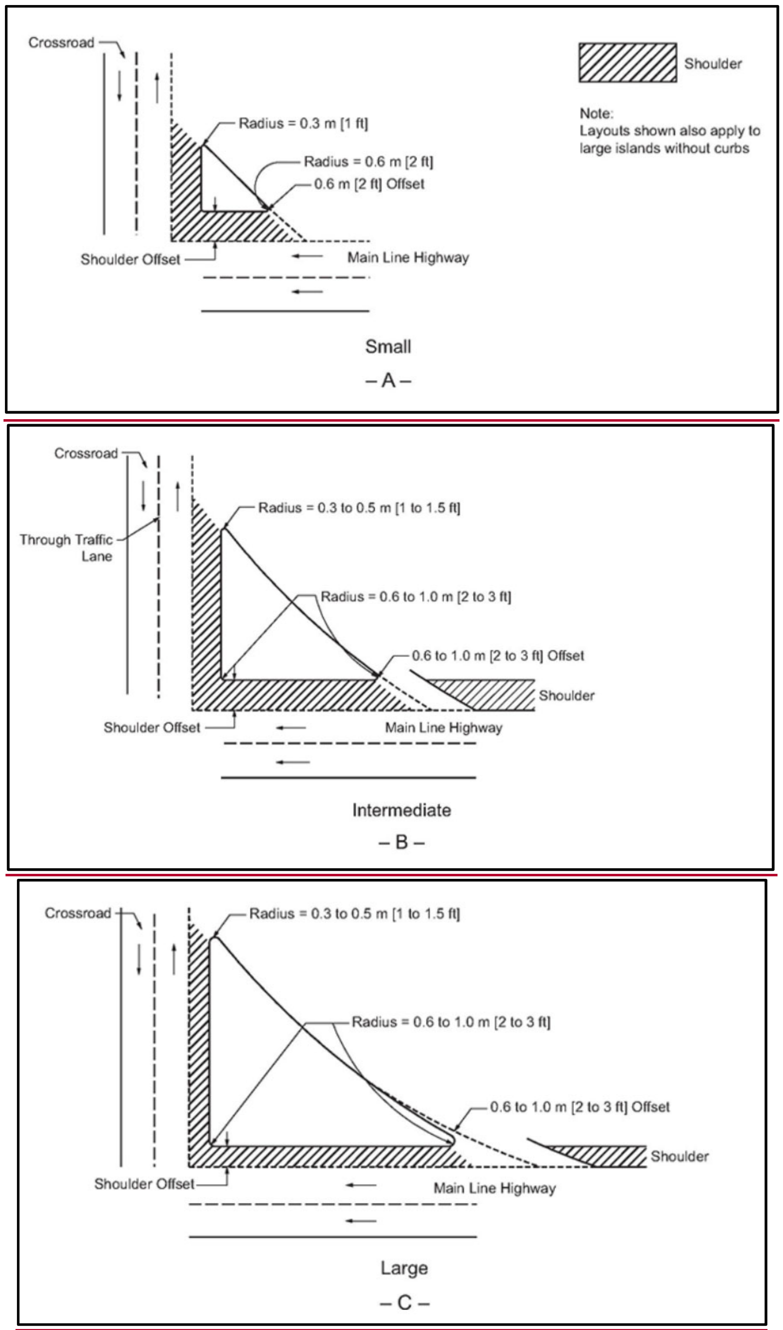


Figure 3 – 9~~11~~ Details of Corner Island for Turning Roadways (Flush Shoulder)



C.7.f.2 Divisional Islands

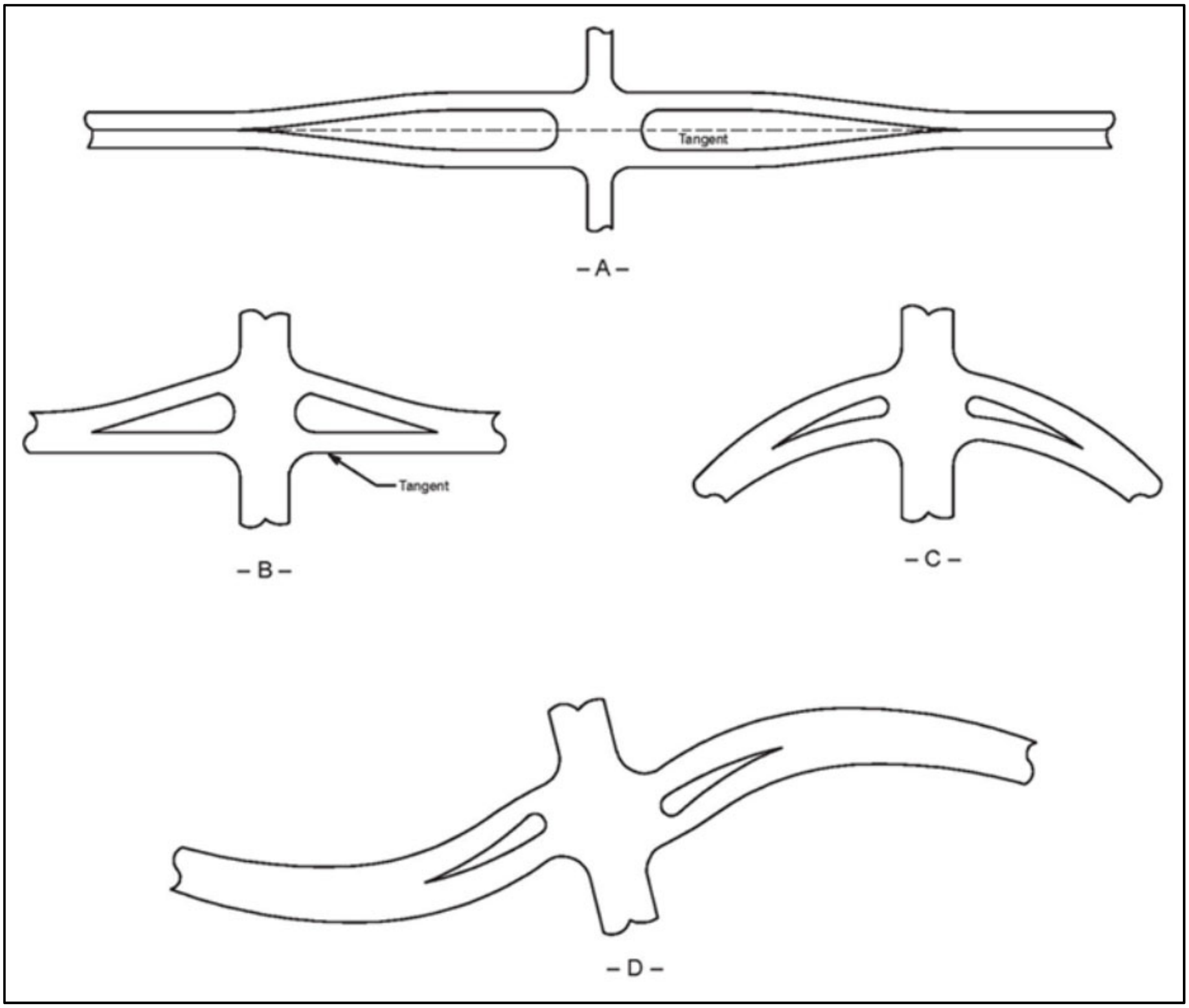
Divisional islands often are introduced on undivided highways at intersections. They alert drivers to the crossroad ahead and regulate traffic through the intersection. These islands are particularly advantageous in controlling left turns at skewed intersections and at locations where separate roadways 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[KM90].

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 - 34~~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 – 34~~27~~ may be used

Figure 3 – 10~~2~~ 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 pedestrians 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 – 11~~3~~ Pedestrian Refuge Island, Figure 3 – 12 Pedestrian

Crossing with Refuge Island (Yield Condition), and Figure 3 – 13 Pedestrian Crossing with Refuge Island (Stop Condition) show~~s a~~ divisional islands that support~~s~~ a midblock crosswalk with stop and yield conditions ~~between transit stops~~. The distance A shown in the figures is based upon the ***MUTCD***.[KM91]

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 – 11~~3~~ Pedestrian Refuge Island[KM92]

North Main Street, Gainesville, FL

Figure 3 – 12 Pedestrian Crossing with Refuge Island (Yield Condition[KM93])

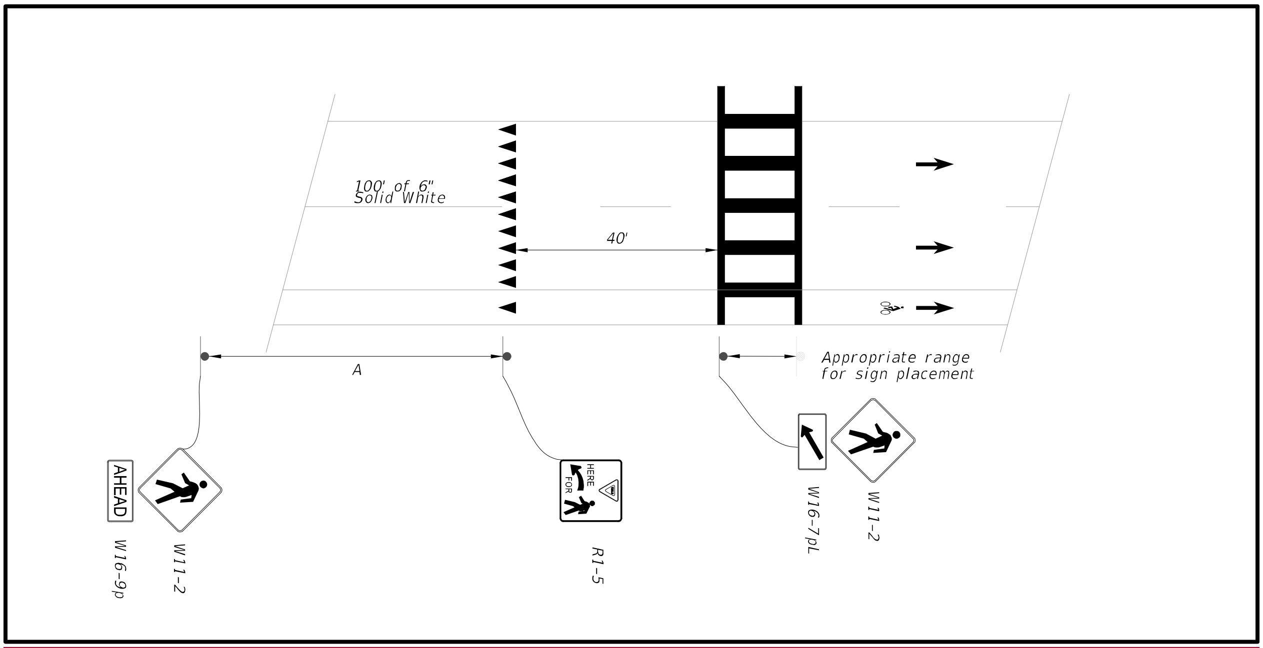
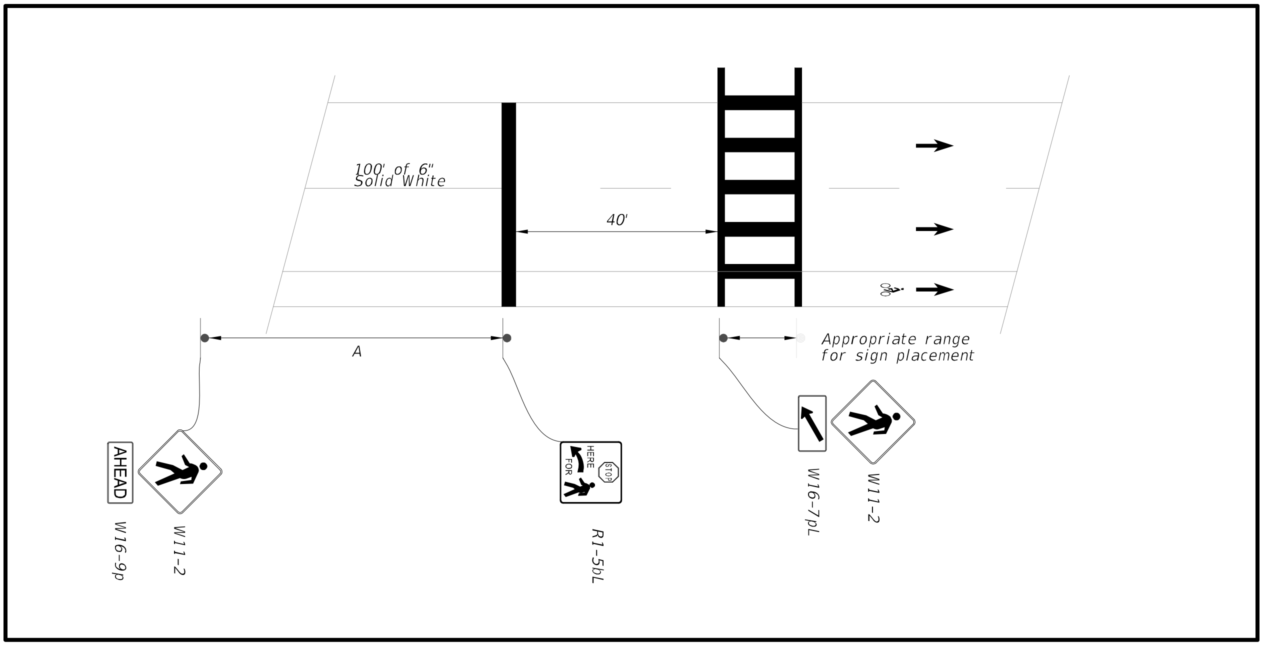


Figure 3 – 13 Pedestrian Crossing with Refuge Island (Stop Condition)



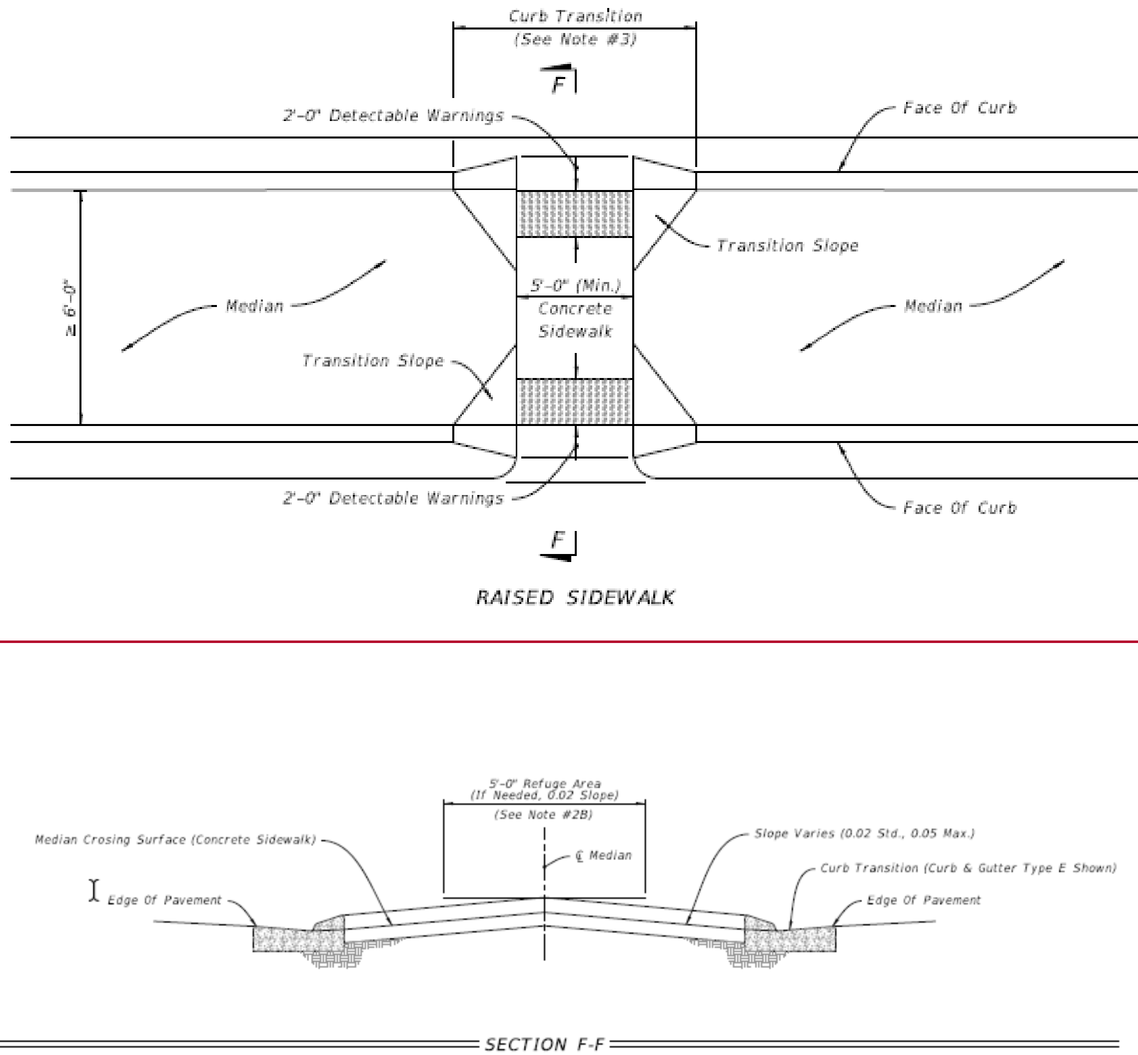
The distance A shown in Figures 3 – 12 and 3 – 13 for the advance warning sign should be[KM94]:

Posted Speed	Advance Placement Distance (feet)
25 or Less	100
26 to 35	100
36 to 45	175

Source: 2009 MUTCD, with 2012 Revisions, Tale 2C-4. Guidelines for Advance Placement of Warning Signs. Typical condition is the warning of a potential stop condition.

An example of a pedestrian crossing through a refuge island is shown in Figure 3 – 14 Pedestrian Crossing in Refuge Island. Other options are shown in the Department's ***Standard Plans 522-002 Detectable Warnings and Sidewalk Curb Ramps***.

Figure 3 – 14 Pedestrian Crossing in Refuge Island



[KM95]

~~C.7.gf Roadside Slopes, 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.1 Clear Zone**~~[KM96]

~~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 Department's **_Standard Plans, FDOT Design 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.~~

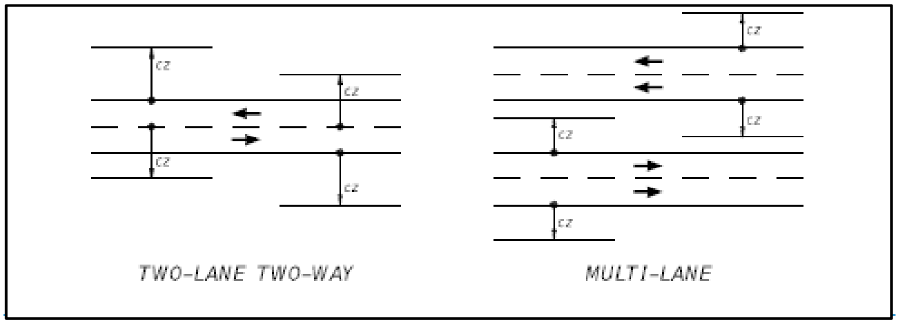
~~Table 3 – 17 Minimum Width of Clear Zone~~

~~Clear Zone Widths – Feet~~						
~~Design Speed mph~~	~~AADT ≥ 1500~~			~~AADT < 1500~~[1]		
	~~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~~

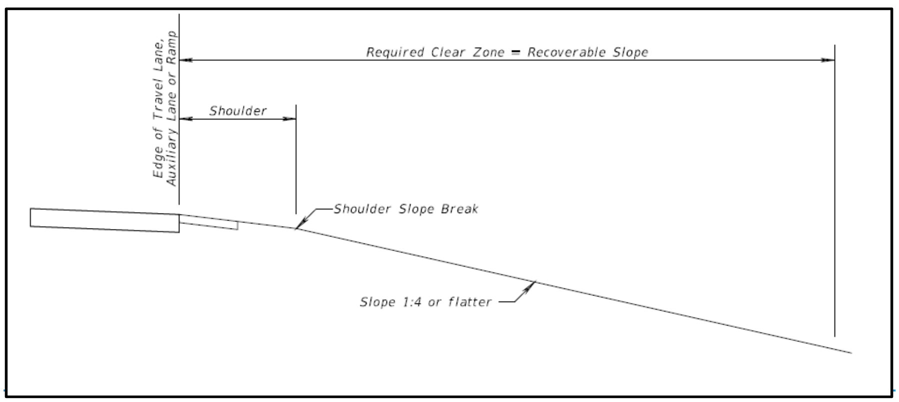
~~1. Clear Zone for roads functionally classified as Local Roads with a design AADT ≤ 400 vehicles per day~~[KM97][KM98]~~:~~
   ~~a. A clear zone of 6 feet or more in width must be provided if it can be done so with minimum social/environmental impacts.~~
   ~~b. Where constraints of cost, terrain, 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.~~

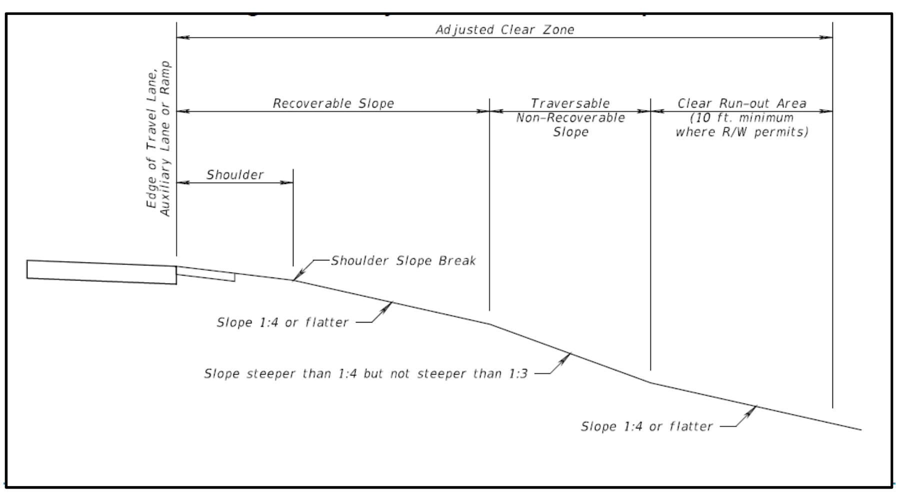
~~Figure 3 – 13 Clear Zone Plan View~~



~~Figure 3 – 14 Basic Clear Zone Concept~~

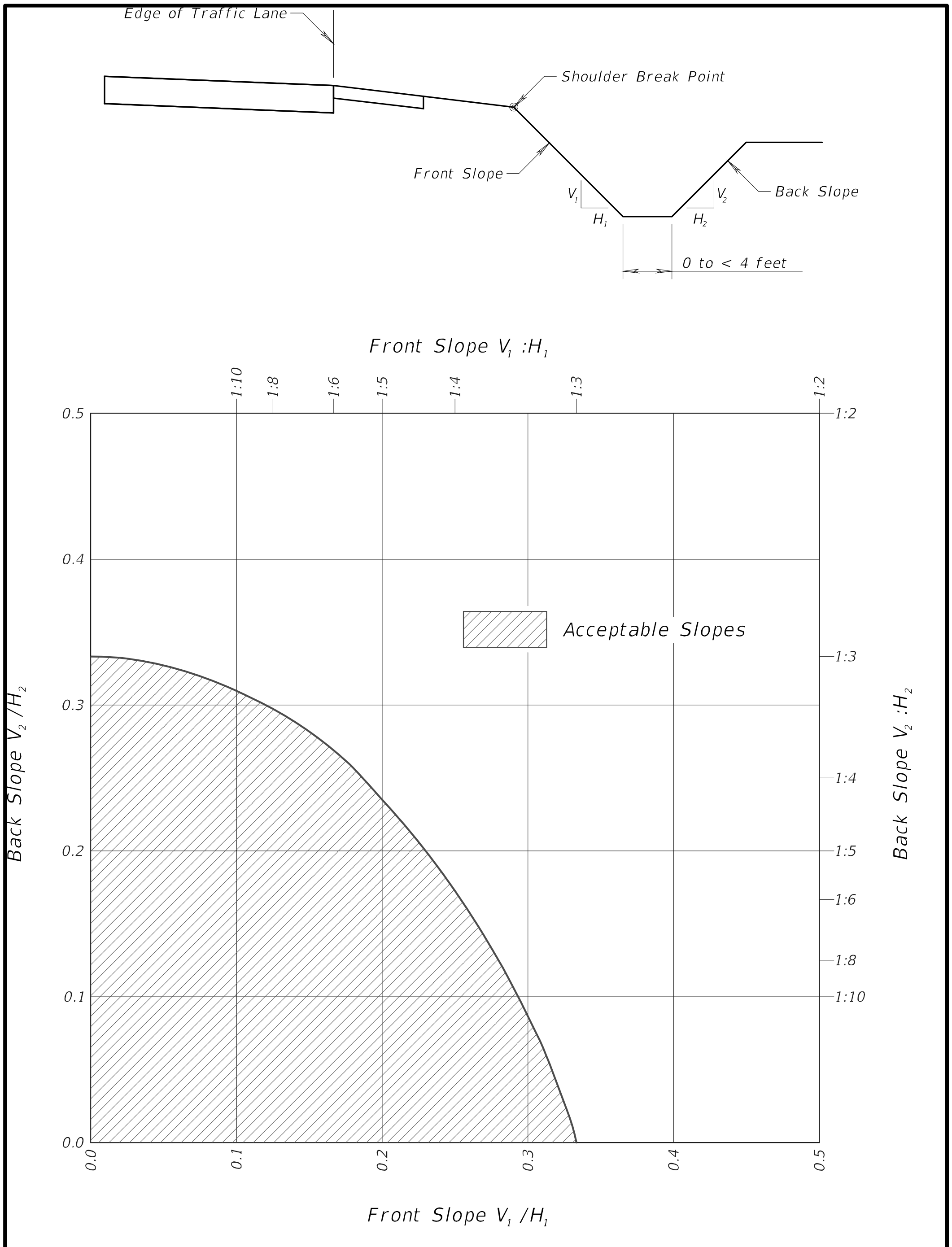


~~Figure 3 – 15 Adjusted Clear Zone Concept~~



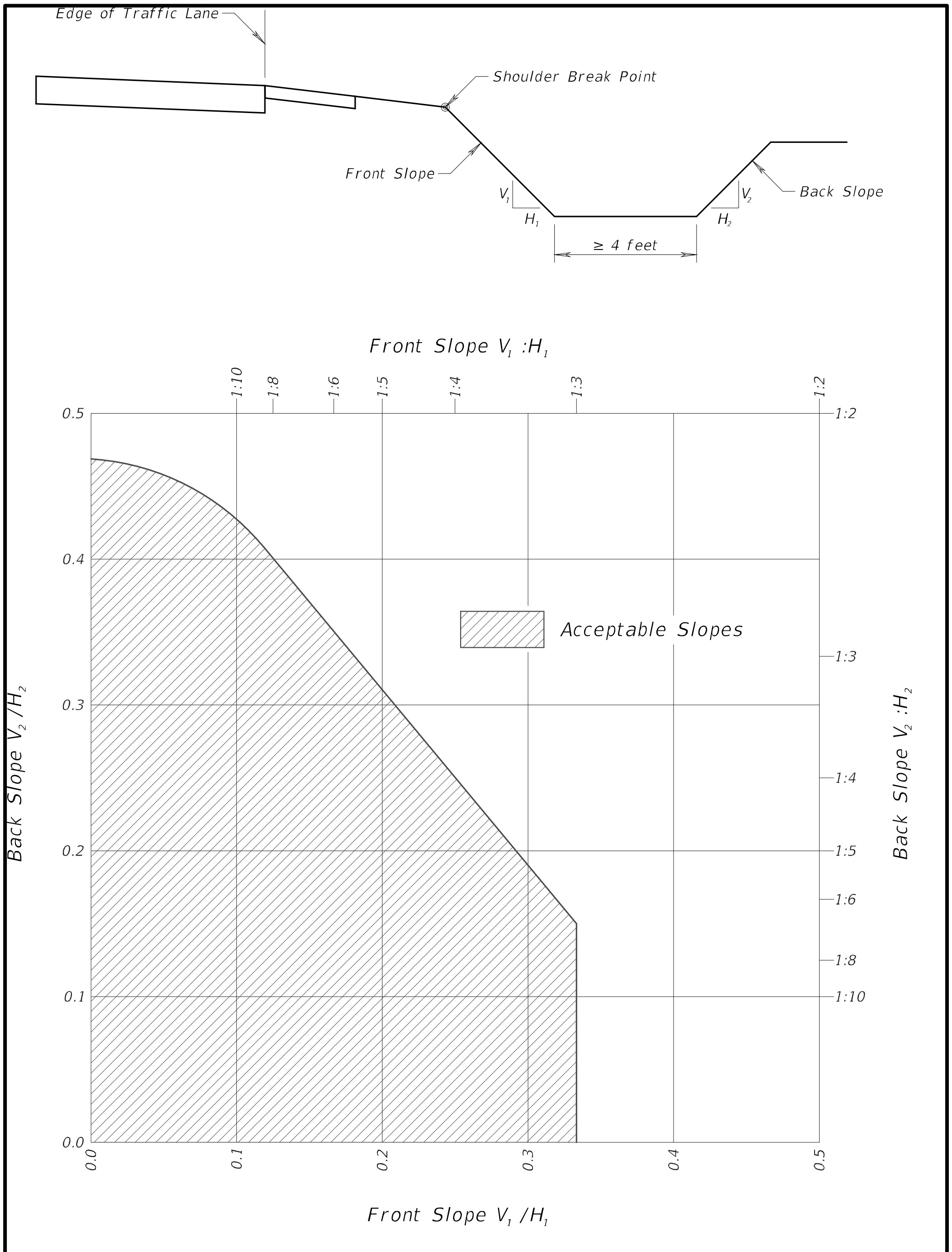
~~Roadside ditches may be included within the clear zone if properly designed to be traversable. Acceptable cross section slope criteria for roadside ditches within the clear zone is provided in Figure 3 – 17 Roadside Ditches – Bottom Width 0 to 4 Feet and Figure 3 – 18. These roadside ditch configurations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

~~Figure 3 – 16 Roadside Ditches – Bottom Width < 4 Feet~~



Ref: Figure 3-6, 2011 AASHTO Roadside Design Guide, 4th Edition

~~Figure 3 – 17 – Roadside Ditches – Bottom Width ≥ 4 Feet~~



Ref: Figure 3-6, 2011 AASHTO Roadside Design Guide, 4th Edition

~~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 – 18 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 [JM99]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 ** [JM100] [KM101]	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.3 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[JM102], desirably 1:6 or flatter[KM103]. 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 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. 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.gf.43 Criteria for Guardrail~~

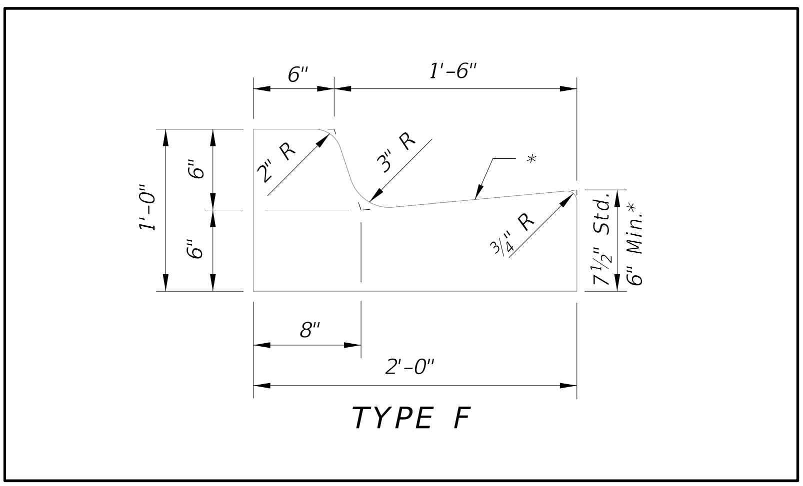
~~If space and economic constraints are severe, it is permissible, but not desirable, to use guardrails in lieu of the requirements for width and slope of clear zone. Where the previously described requirements for clear zone are not met, guardrails (or other longitudinal barriers) should be considered.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

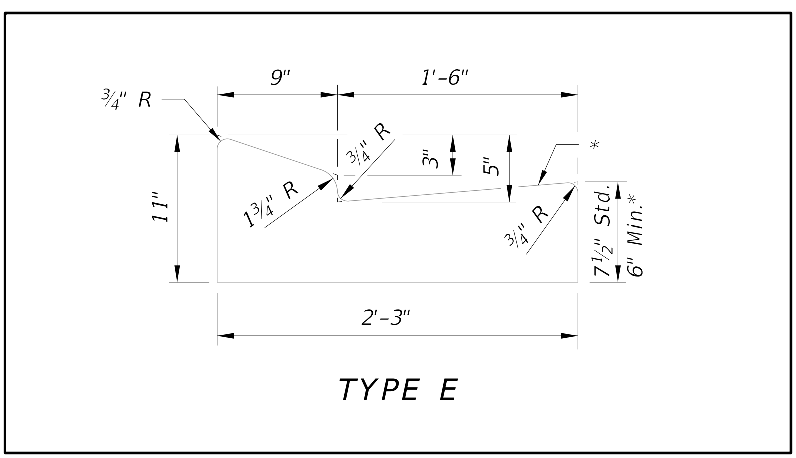
~~The general policy to be followed is that guardrails should be used if impact with the guardrail is less likely or considered less severe than impact with roadside objects. Further requirements and design criteria for guardrails are given in ***Chapter 4 - Roadside Design***.~~

C.7.g~~hg~~ Curbs[KM104]

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 – 15~~9~~ 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. See ***Chapter 4 – Roadside Design*** for additional design criteria on the use of curbs.

Figure 3 – 15~~9~~ Standard Detail for FDOT Type F and E Curbs





C.7.h Parking[KM105][KM106][KM107]

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. On-street parking is allowed on facilities with posted speeds of 35 mph or less.

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.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.j Changes in Typical Section

C.7.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.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.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.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 – 20~~18~~ Minimum Shoulder Widths for Flush Shoulder Rural Highways~~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.j.4.(a) Lateral Offset~~Horizontal Clearance~~

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. See ***Chapter 4 – Roadside Design*** for additional information on lateral offsets for structures.

C.7.j.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.j.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.

Additional information on access management can be found in ***Rule Chapter 14-97 State Highway System Access Control Classification System, Florida Administrative Code.*** The ***Department's Driveway Information Guide*** ~~*(2008)*~~ and ***Median Handbook*** ~~*(2014)*~~ provide further information on designing roadways and connections to support access management[KM108].

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[JM109][KM110] should not be placed within~~near~~ the influence zone of 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[JM111]

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 20 - 25 mph or less[KM112], consider urban, suburban, rural, single vs, multilane.

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 – 23~~1171~~~~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 – 23176 Access Control for All Limited Access Highways

	Urban	Rural
Minimum Spacing		
Interchanges	1 to 3 miles	3 to 25 miles[KM113][KM114]
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 Section 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 Section 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[MAK115]

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 – 17~~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 – 24~~2~~ Minimum Stopping Sight Distance (Rounded Values)~~Table 3 - 187~~ 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~~Figure 3 - 16~~0~~ 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.

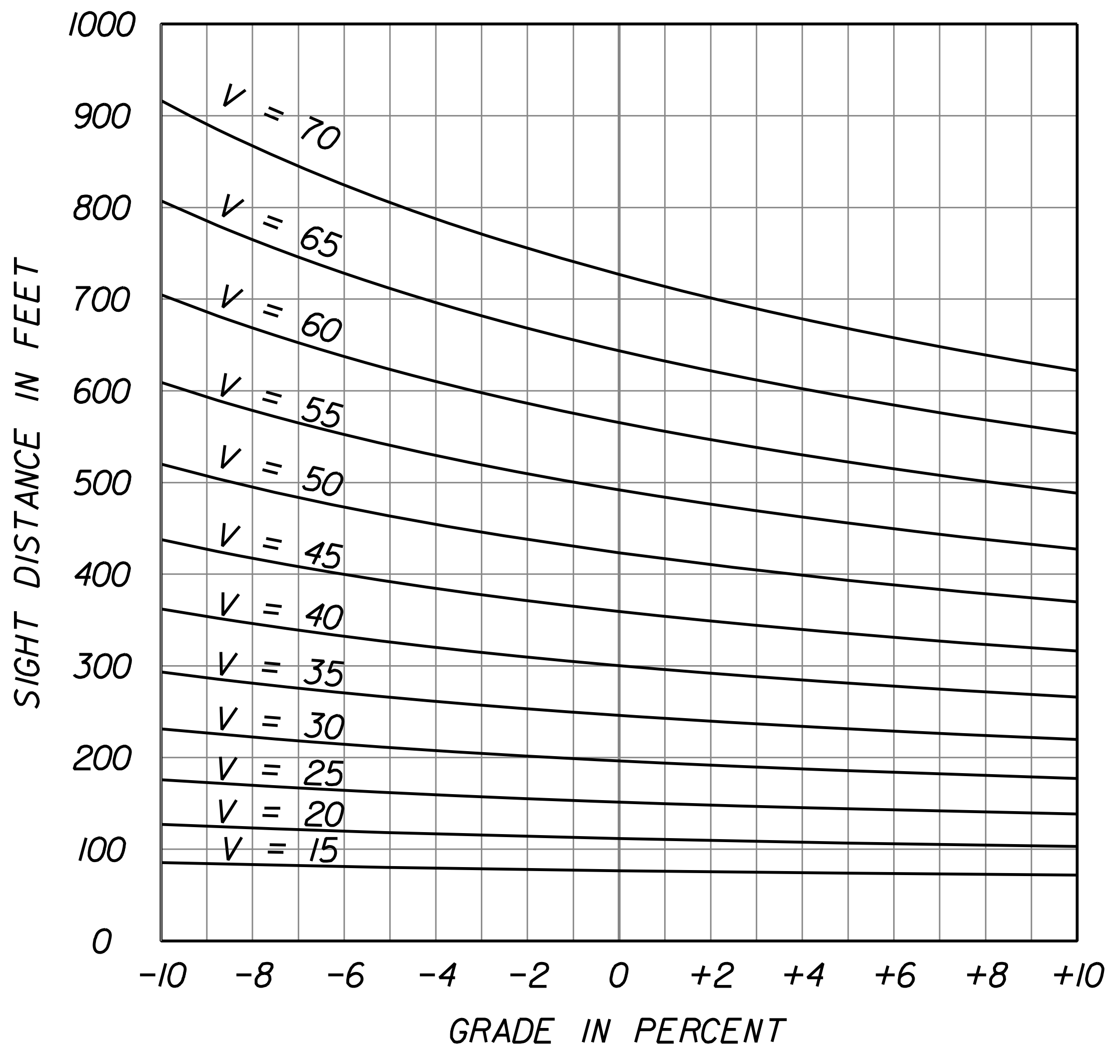
Table 3 – 24~~187~~ Minimum Stopping Sight Distance ~~Sight Distance for Approach to Stops~~ (Rounded Values[MAK116][KM117])

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 – 24~~2~~ Minimum Stopping Sight Distance (Rounded Values)~~Table 3 - 187~~ or Figure 3 – 16 Sight Distances for Approach to Stop on Grades~~Figure 3 - 210~~. 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 – 16~~1~~200
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 - 17 Departure Sight Triangle (Traffic Approaching from Left or Right) and 3 - 18~~212~~ 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:

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

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

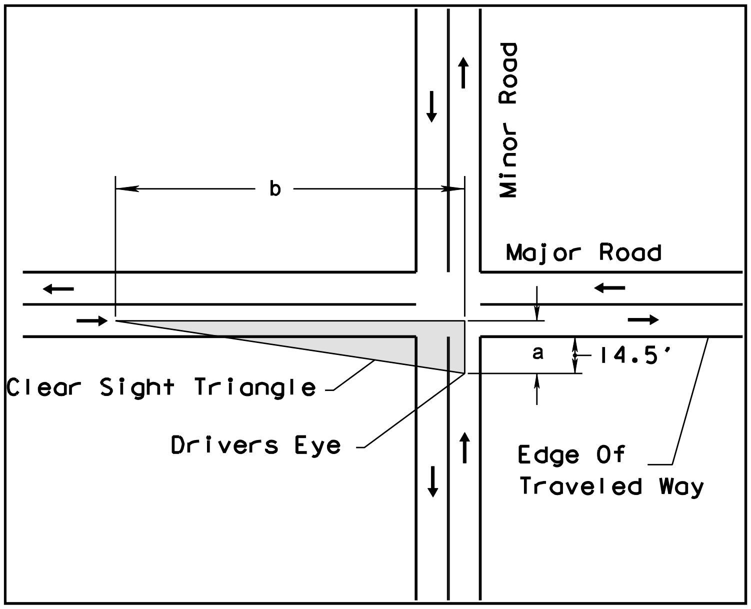
See Sections C.9.b.4.(c) and (d) for design time gaps for Case B.

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 – 17~~211~~
Departure Sight Triangle
(Traffic Approaching from Left or Right)



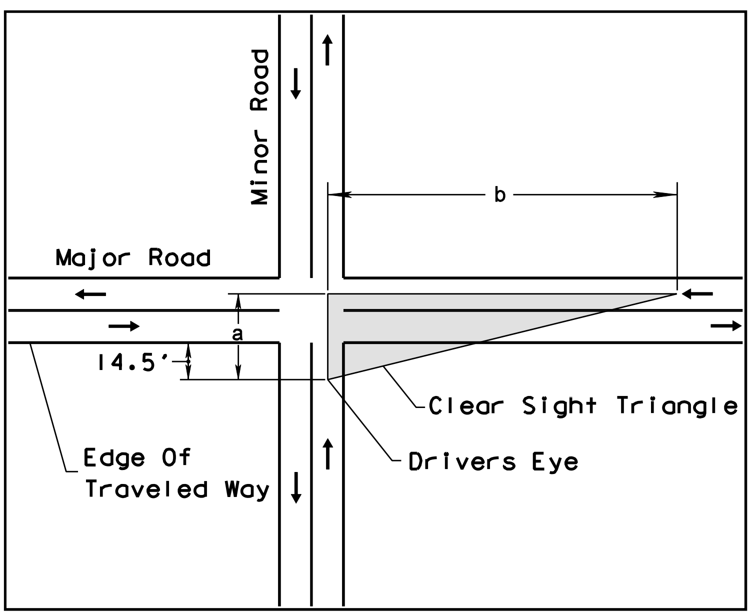
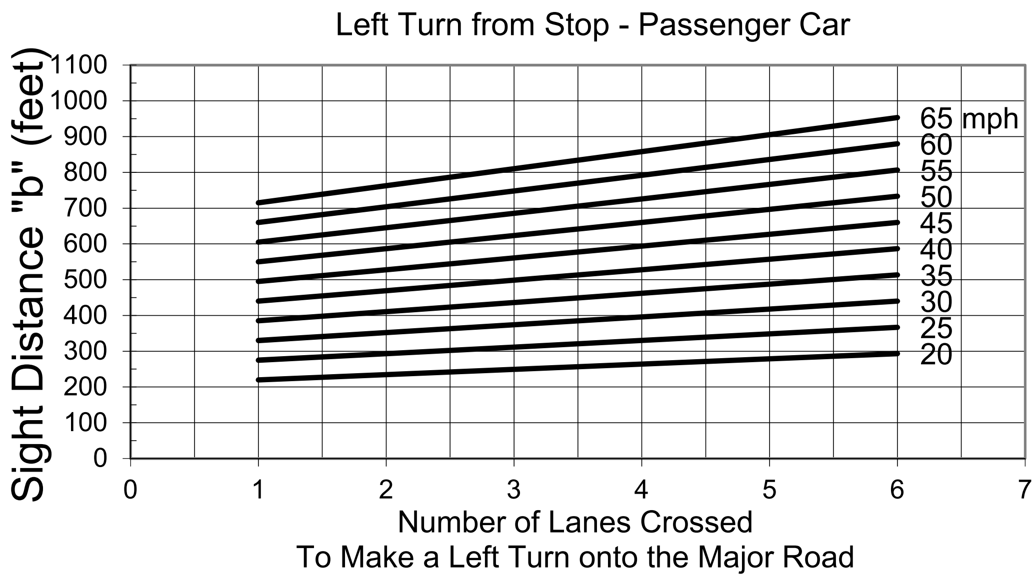
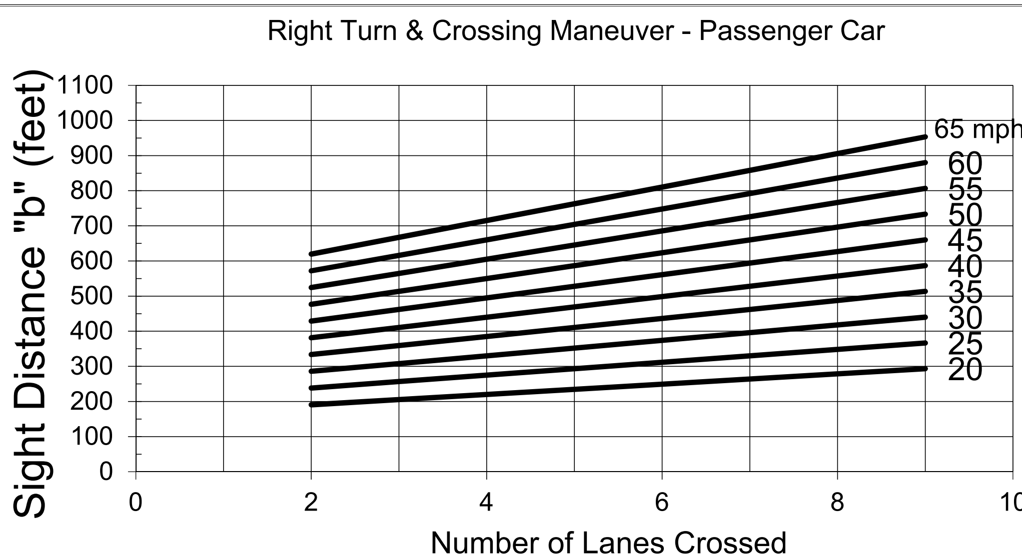


Figure 3 – 18~~212~~
Intersection Sight Distance[KM118]



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 - 19~~213~~ Sight Distance for Vehicle Turning Left from Major Road).

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

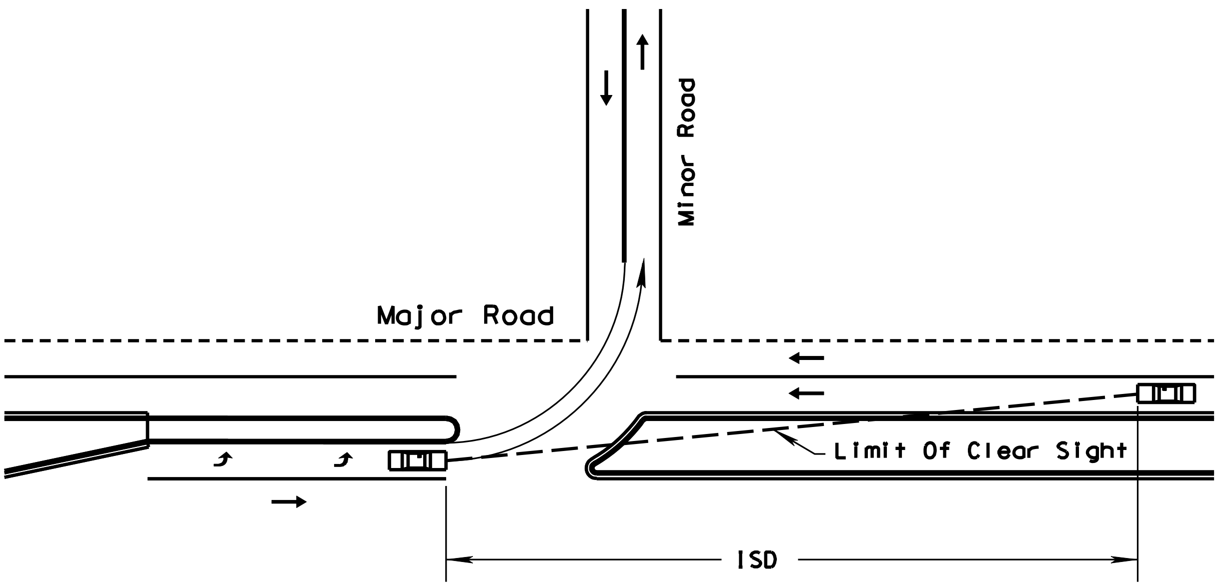
Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	5.5
Single Unit Truck	6.5
Combination Truck	7.5

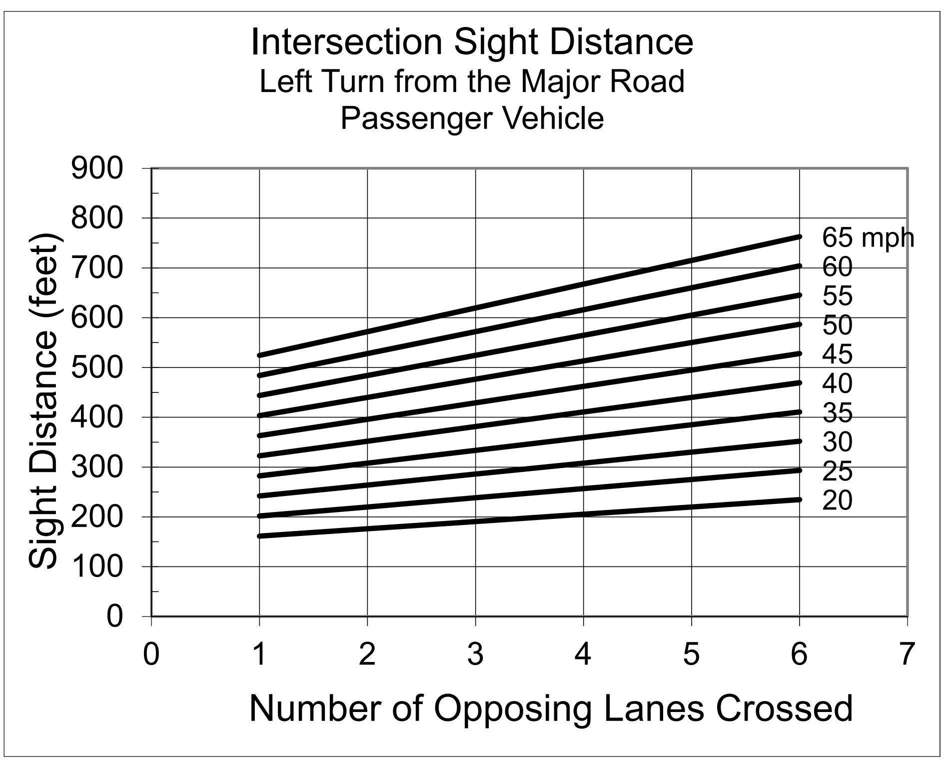
For left turning vehicles that cross more than one opposing lane, add 0.5 seconds for passenger cars and 0.7 seconds for trucks for each additional lane to be crossed.

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

The Department's ***Design Manual, Chapter 212 Intersections*** ~~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 – 19~~213~~
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 3~~8~~-19~~7~~ Minimum Lane Widths.

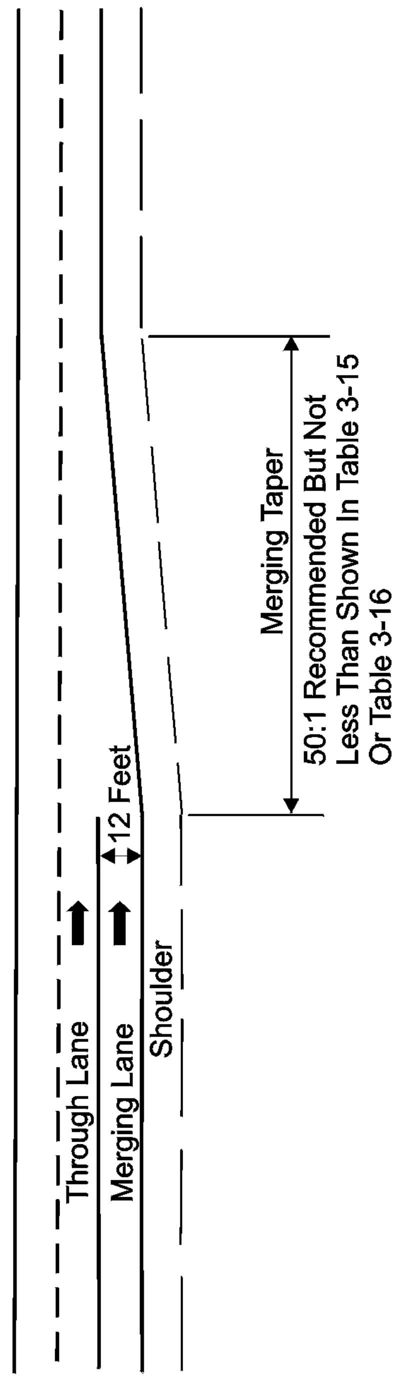
C.9.c.1 Merging Maneuvers

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 - 25~~31~~98 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 - 20~~14~~ 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 – 25~~1~~98 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 – 20~~14~~
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 - 26~~4019~~ Design Lengths of Speed Change Lanes Flat Grades. Where acceleration occurs on a grade, the required distance is obtained by using Tables 3- 27~~5019~~ and ~~3 -~~ 26~~10~~6~~10~~ Ratio of Length of Speed Change Lane on Grade to Length on Level and 3 -28 Minimum ~~Accelration~~Acceleration Lengths for Entrance Terminals~~.~~.

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 - 20~~14~~ Termination of Merging Lanes), not less than that length set forth in Table 3 - 25~~3198~~ Length of Taper for Use in Conditions with Full Width Speed Change Lanes. The termination of acceleration lanes should conform to the general configuration shown for merging lanes in Figure 3 - 20~~14~~. Recommended acceleration lanes for freeway entrance terminals are given in Table 3 - 28~~621~~ Minimum Acceleration Lengths for Entrance Terminals.

Table 3 – 26~~019~~ 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.

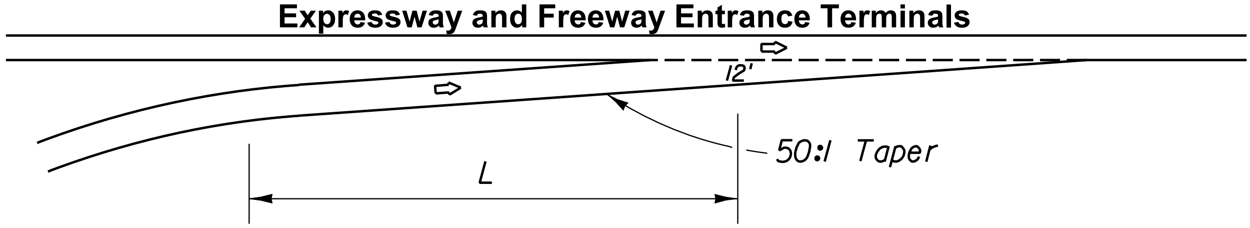
Table 3 – 27~~10~~ Ratio of Length of Speed Change Lane on Grade to Length on Level

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 – 26~~18~~ give the length of speed change lane for the respective grade.								

Table 3 – 28~~21~~ Minimum Acceleration Lengths for Entrance Terminals

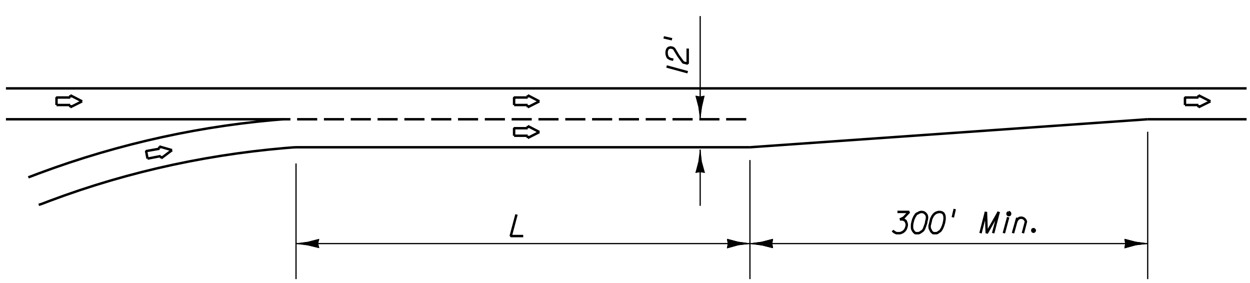
Highway Design Speed (mph)	L = Acceleration Length (feet)								
	For Entrance Curve Design Speed (mph)								
	Stop Condition	15	20	25	30	35	40	45	50
30	180	140	---	---	---	---	---	---	---
35	280	220	160	---	---	---	---	---	---
40	360	300	270	210	120	---	---	---	---
45	560	490	440	380	280	160	---	---	---
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 - 29~~7019~~ . Minimum Deceleration Lengths for Exit Terminals.

The required distance for deceleration on grades is given in Tables 3 - 26~~4019~~ and 3 - 27~~510~~.

The length of deceleration lanes shall be no less than the values obtained from Tables 3 - 26~~4019~~ and 3 - 27~~510~~, 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 - 21~~15~~ Entrance for Deceleration Lane. The initial length of straight taper, shown in Table 3 - 28~~6019~~, 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 - 29~~732~~ 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 – 216 Typical Storage Lane~~*[MAK110]*~~.~~

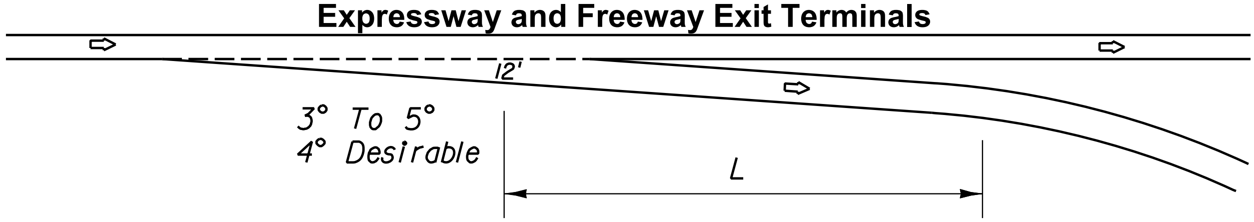
- ~~The length of storage lanes for unsignalized intersections may be obtained from the table in Figure 3 – 216. The full width portion of storage lanes should, where possible, be increased to allow for expected storage of vehicles (Table 3 – 2 for vehicle lengths). As a minimum requirement, storage 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 – 2019 (AASHTO for recommended lengths).~~

Table 3 – 29~~32~~ Minimum Deceleration Lengths for Exit Terminals

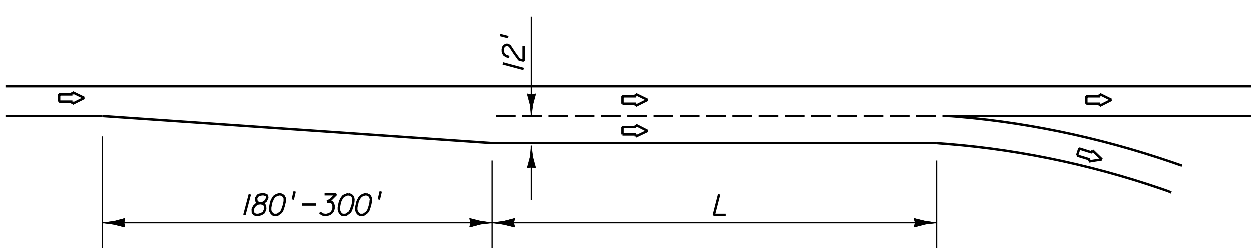
Highway Design Speed (mph)	L = Deceleration Length (feet)								
	For Design Speed of Exit Curve (mph)								
	Stop Condition	15	20	25	30	35	40	45	50
30	235	200	170	140	---	---	---	---	---
35	280	250	210	185	150	---	---	---	---
40	320	295	265	235	185	155	---	---	---
45	385	350	325	295	250	220	---	---	---
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

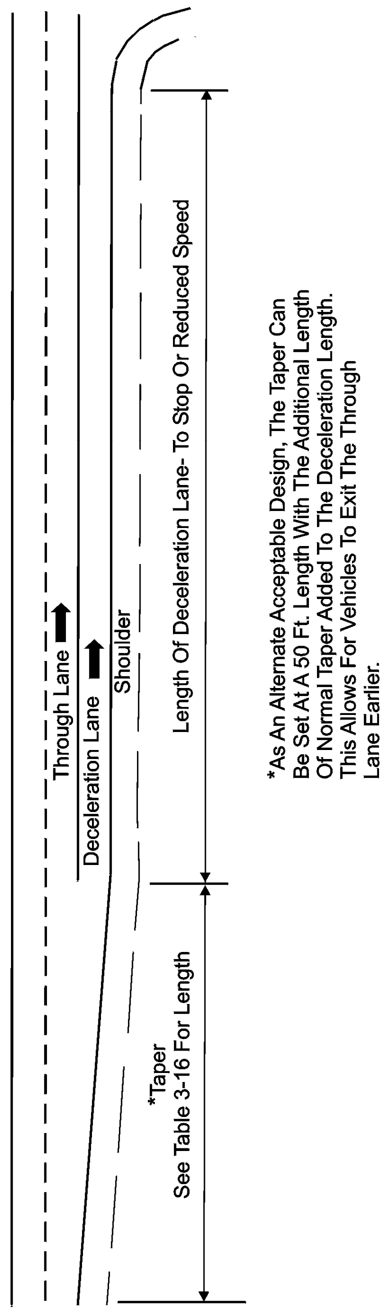
Recommended when design speed at exit curve is 50 mph or greater and when approach visibility is good.



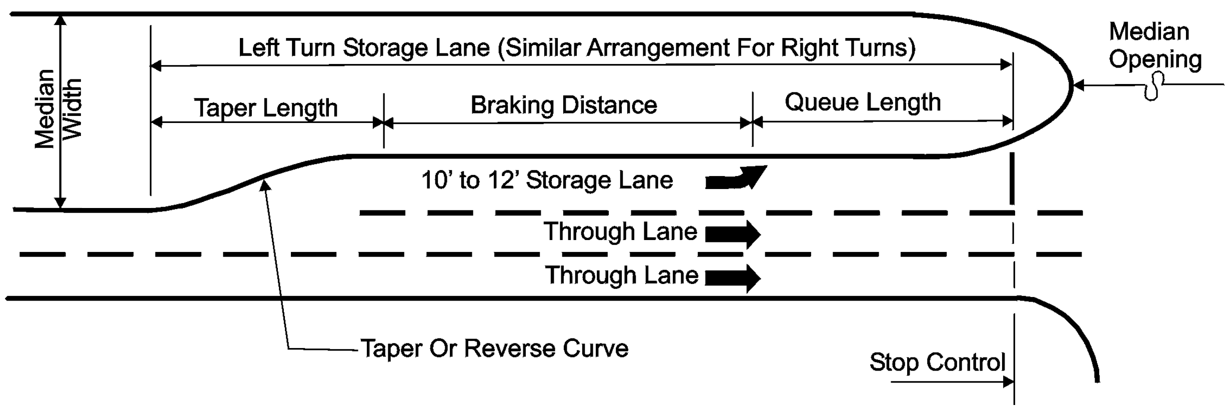
PARALLEL TYPE

Recommended when design speed at exit curve is less than 50 mph or when approach visibility is not good.

Figure 3 – 21~~15~~
Entrance for Deceleration Lane



~~Figure 3 – 216~~
~~Typical Storage Lane~~[MAK120]



~~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.c.4 Auxiliary Lanes at Intersections

The primary function of auxiliary lanes at intersections is to accommodate speed changes and maneuvering of turning traffic. They are typically added to increase capacity and/or reduce crashes at an intersection. Auxiliary lanes for deceleration and storage of queuing vehicles are used preceding intersections and median openings for left-turning and right-turning movements. In some cases, auxiliary lanes for acceleration are used following right-turning movements.

C.9.c.4.(a) Widths of Auxiliary Lanes

The minimum widths for auxiliary lanes are given in Table 3 ~~-~~– 19~~70~~ Minimum Lane Widths.

C.9.c.4.(b) Lengths of Auxiliary Lanes for Deceleration

Recommended lengths for auxiliary lanes for deceleration (turn lanes) at intersections are provided in Figure 3 ~~-~~– 22~~6~~ Auxiliary Lanes for Deceleration at Intersections (Turn Lanes) and Table 3 – 30 Turn Lanes – Curbed and Uncurbed Medians. These lengths are based on the Department's criteria. As shown in Figure 3 ~~-~~– 22~~6~~, the total length of turn lanes consists of three components, (1) Deceleration Length, (2) Storage or Queue Length and (3) Entering Taper. It is common practice to accept a moderate amount of deceleration within the through lanes and to consider the taper as part of the deceleration length. The length criteria for each of the auxiliary lane components are explained as follows:

Deceleration Length

The required total deceleration length is that needed for a safe and comfortable stop from the design speed of the highway. Minimum deceleration lengths (including taper) for auxiliary lanes are provided in Figure 3 ~~-~~– 22~~6~~ and are based on minimum stopping sight distance.

Storage (Queue) Length

The auxiliary lane should be sufficiently long to store the number of vehicles likely to accumulate during a critical period. The storage length should be sufficient to avoid the possibilities of turning vehicles stopping in the through lanes or the entrance to the auxiliary lane being blocked by vehicles queuing in the through lanes.

At unsignalized intersections the storage length, exclusive of taper, may be based on the number of turning vehicles likely to arrive in an average two-minute period within the peak hour. For low volume intersections where a traffic study is not justified, a minimum 50-foot queue length (2 vehicles) should be provided on rural highways. A minimum 100-foot queue length (4 vehicles) should be provided in urban areas. Locations with over 10% truck traffic should accommodate at least one car and one truck.

At signalized intersections, the required storage length is determined by traffic study and depends on the signal cycle length, the signal phasing arrangement and the rate of arrivals and departures of turning vehicles. The storage length is a function of the probability of occurrence of events and should be based on 1.5 to 2 times the average number of vehicles that would store per cycle that is predicted in the design volume.

Where dual turning lanes are used, the required storage length is reduced to approximately one-half of that required for single-lane operation.

Approach End Taper

The Department's criteria for approach end taper lengths for turn lanes are 50 feet for a single turn lane and 100 feet for a double turn lane, as shown in Figure 3 - 22 Auxiliary Lanes for Deceleration at Intersections (Turn Lanes) and Table 3 – 30~~28~~ Turn Lanes – Curbed and Uncurbed Medians. These taper lengths apply to all design speeds and are recommended for use on turn lanes on all roads. Short taper lengths are intended to provide approaching road users with positive identification of an added auxiliary lane and results in a longer full width auxiliary lane than use of longer taper lengths based on the path that road users actually follow. The clearance distances L_1 and L_3 account for the full transition lengths a road user will use to enter the auxiliary lane for various speed conditions assumed for design.

It is acceptable to lengthen the taper up to L_1 for single left turns and L_3 for double left turns where traffic study can establish that left turn queue vehicles are adequately provided for within the design queue length and through vehicle queues will not block access to the left turn lane(s).

Figure 3 – 22~~6~~ Auxiliary Lanes for Deceleration at Intersections (Turn Lanes)

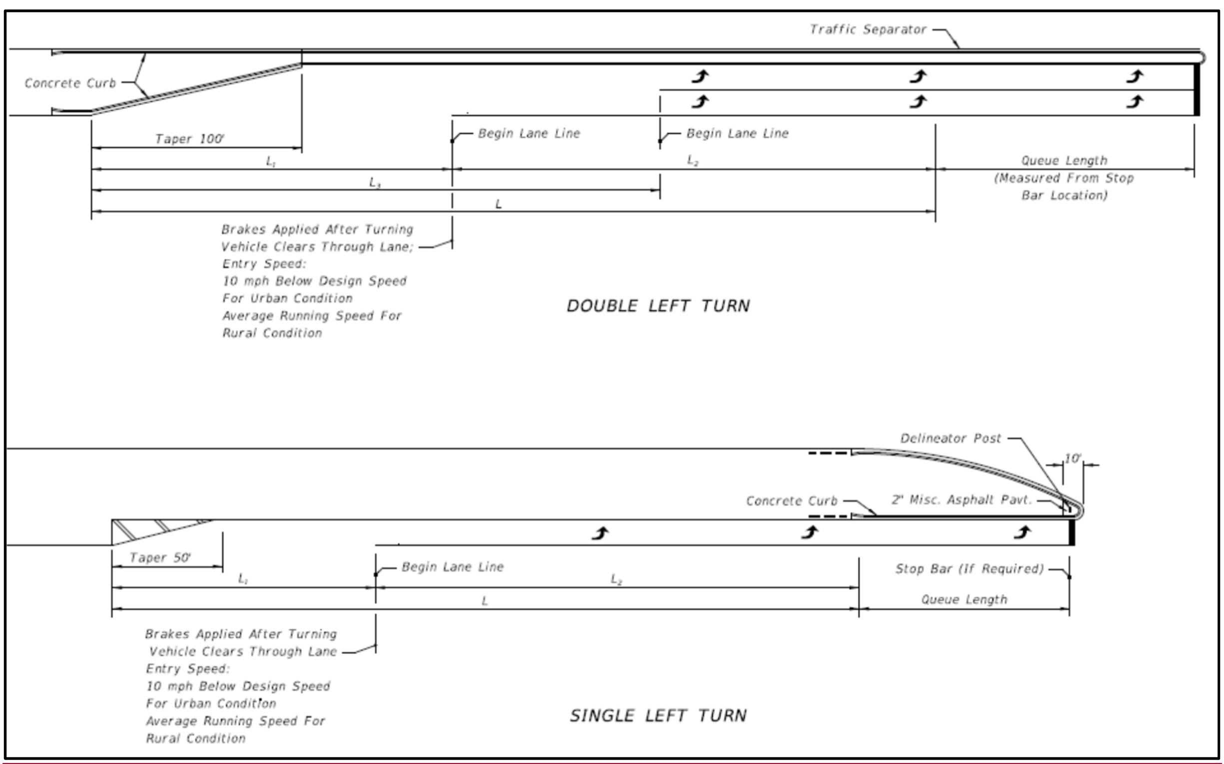


Table 3 – 30~~2~~ Turn Lanes – Curbed and Uncurbed Medians[KM121][KM122]

Design Speed (mph)	Entry Speed (mph)	Clearance Distance L_1 (feet)	Urban Conditions			Rural Conditions		
			Brake to Stop Distance L_2 (feet)	Total Decel. Distance L (feet)	Clearance Distance L_3 (feet)	Brake to Stop Distance L_2 (feet)	Total Decel. Distance L (feet)	Clearance Distance L_3 (feet)
≤ 30	≤ 25	60	75	135	100			
35	25	70	75	145	110	----	----	----
40	30	80	75	155	120	----	----	----
45	35	85	100	185	135	----	----	----
50	40/44	105	135	240	160	185	290	160
55	48	125	----	----	----	225	350	195
60	52	145	----	----	----	260	405	230
65	55	170	----	----	----	290	460	270

Notes: Right turn lane tapers and distances are identical to left turn lanes under stop control conditions. For free flow or yield control conditions, taper lengths and distances are site specific.

C.9.c.4~~3~~.(c) Lengths of Auxiliary Lanes for Acceleration

Acceleration lanes similar to those used for freeways and expressways are sometimes used at intersections. They are not always desirable at stop-controlled intersections where entering drivers can wait for an opportunity to merge without disrupting through traffic. Acceleration lanes are advantageous on roads without stop control and on all high-volume roads even with stop control where openings between vehicles in the peak-hour traffic streams are infrequent and short. When used, acceleration lanes at intersections should be designed using the criteria provided in Section C.9.c.2

Acceleration Lanes.

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 - 31~~2943~~ 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 – 31~~243~~ 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 - 32~~0~~24 Maximum Rate of Change in Pavement Edge Elevation for Curves at Intersections and 3 - 33~~1~~265 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 – 32~~25~~4 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 – 33~~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 - 43~~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[KM123]

- 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 - 34~~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 – 34~~274~~ Derived~~sign~~ Pavement Widths ~~of Pavements~~ for Turning Roadways for Different Design Vehicles[KM124]

~~**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 - 29~~732~~. 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 - 29~~732~~.

Entrances to freeways should be designed in accordance with the general configurations shown below Table 3 - 28~~621~~. 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 - 28~~62~~1 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 - 29~~732~~ and 3 - 28~~621~~. The lengths obtained from Tables 3 - 29~~732~~ and 3 - 28~~621~~ should be adjusted for grade by using the ratios in Table 3 - 27~~5120~~.

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, shared use paths and transit boarding and alighting areas shall be designed to accommodate people with disabilities~~physically disabled persons whose mobility is dependent on wheelchairs and other devices~~. In addition to the design criteria provided in this Manual~~chapter~~, the ***Department of Transportation ADA Standards for Transportation Facilities (2006)*** and ***Department of Justice ADA Standards (2010)*** as required by 49 C.F.R 37.41 or 37.43; and the ***2017~~2~~ Florida Building Code – Accessibility, 6th Edition~~Accessibility Code for Building Construction~~*** as required by ***Rule Chapter 61G20-4.002, Florida Administrative Code*** 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 Facilities*** 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 and shared use paths, curb ramps must be incorporated at locations where crosswalks adjoin the sidewalk or path~~s~~. The basic curb ramp type and design application depends on the geometric characteristics of the intersection or other crossing location.

Typical curb ramp width on sidewalks shall be a minimum of 4 feet with 1:10 curb transitions on each side when pedestrians must walk across the ramp[KM125][KM126][KM127][KM128]. Curb ramps on shared use paths shall be the full width of the path. Ramp slopes shall not exceed 1:12~~0~~[KM129] 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 ***Standard Plans, Index 522-002*** ~~***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 curbed ~~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. See Chapter 4 – Roadside Design, Table 4 – 2 Lateral Offset for further information.

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~~to leave at least 48[KM130] 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 flare out 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***.[KM131]

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 3-17~~0~~ 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 5

PAVEMENT DESIGN AND CONSTRUCTION

FIGURES

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CHAPTER 5

PAVEMENT DESIGN AND CONSTRUCTION

A INTRODUCTION

The function of the pavement or roadway surface is to provide a safe and efficient travel path for vehicles using the street or highway. The pavement should provide a good riding surface with a minimum amount of distraction to the driver. The pavement friction characteristics should be such that adequate longitudinal and lateral forces between the vehicle tires and the pavement can be developed to allow a margin of safety for required vehicle maneuvers. These characteristics should be provided at the highest reasonable level for the expected pavement surface, weather conditions, and the anticipated operational characteristics of the facility. Resurfacing of the existing pavement is discussed and included under ***Chapter 10 – Maintenance and Resurfacing*** of this~~e~~ manual.

In order for the pavement to perform its function properly, the following objectives shall be considered in the design and construction of the pavement:

- Provide sufficient pavement structure and the proper pavement material strength to prevent pavement distress prior to the end of the design period.

- Develop and maintain adequate skid resistance qualities to allow for safe execution of braking, cornering, accelerating, and other vehicle maneuvers.

- Provide drainage to promote quick drying and to reduce the likelihood of hydroplaning and splashing.

- ~~Provide a Safety Edge treatment adjacent to the travel lane on roadways without curb or paved shoulders and with posted speed 45 mph or greater.~~

B PAVEMENT DESIGN

B.1 Pavement Type Selection

For new construction and major reconstruction projects, the designer should determine the type of pavement to be constructed utilizing formal analysis of existing and anticipated conditions. High volume roadways where a significant amount of truck traffic (>10%) exists may warrant consideration for special asphalt pavement designs and for rigid pavement designs. The Department has a documented procedure patterned after the 1993 ***AASHTO Guide for Design of Pavement Structures, Appendix B***. This procedure may be found in the Department's ***Pavement Type Selection Manual (2013)***[KM1].

B.1.a Unpaved Roadway Material Selection

The material chosen should be locally available when possible. Frequency of grading and replacement of material from loss due to erosion should be evaluated. A life cycle economic analysis should be performed to determine suitable material type. For example: Reclaimed ~~Un-recycled~~ asphalt pavements (~~Un-~~RAP) from milling operations provide for a suitable all weather material and can be considered for unpaved roads.

The material chosen should exhibit low potential for losses due to wind, traffic and water erosion. EPA's publication AP-42 contains methodology for estimating the dust generation potential for unpaved road surfaces. Proper gradation of the chosen material is critical for its success. Designers should consider flexible or rigid pavements where runoff from unpaved roads may impact surface waters.

Designers may consult with AASHTO's~~FHWA's publications "~~***Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400), 2001***~~"~~ and FHWA's ***Gravel Roads Construction and Maintenance Guide, August 2015*** for further guidance regarding material selection.

B.2 Structural Design

The pavement shall be designed and constructed so the required surface texture is maintained and its structure retains an adequate level of serviceability for the design period. The strength of the pavement materials shall be sufficient to maintain the desired roadway cross section without the formation of ruts or other depressions which would impede drainage. Subgrade strength and subgrade drainage are major factors to be considered in pavement design. Where high ground water conditions are present, adequate clearance to the bottom of the pavement base is necessary for good pavement performance and to achieve the required compaction and stability during construction operations.

The Department's pavement design manuals, including the ***Flexible Pavement Design Manual, January 2018*** and ***Rigid Pavement Design Manual, January 2018,*** are recommended as a guide for both flexible and rigid pavement design. Other design procedures are available including the ***AASHTO Guide for Design of Pavement Structures, 1993***; and procedures which have been developed by the Portland Cement Association, the American Concrete Pavement Association, and the Asphalt Institute. The selection of the design procedure and the development of the design data must be managed by professional personnel competent to make these evaluations.

B.3 Skid Resistance

Pavements shall be designed and constructed ~~so as~~ to maintain adequate skid resistance for as long a period as the available materials, technology, and economic restraints will permit, thus eliminating cost and hazardous maintenance operations.

The results of relevant experience and testing (i.e., tests conducted by the Department's Materials Office) should be used in the selection of aggregate and other materials, the pavement mix design, the method of placement, and the techniques used for finishing the pavement surface. The design mixes should be monitored by continuous field testing during construction. Changes to the design mix or construction procedures must be made by qualified pavement designers and laboratory personnel ONLY.

The use of transverse grooving in concrete pavements frequently improves the wet weather skid resistance and decreases the likelihood of hydroplaning. This technique should be considered for locations requiring frequent vehicle maneuvers (curves, intersections, etc.) or where heavy traffic volumes or high speeds will be encountered. The depth, width, and spacing of the grooves should be such that control of the vehicle is not hindered.

B.4 Drainage

Adequate drainage of the roadway and shoulder surfaces should be provided. Factors involved in the general pavement drainage pattern include: pavement longitudinal and cross slopes, shoulder slopes and surface texture, curb placement, and the location and design of collection structures. The selection of pavement cross slopes should receive particular attention to achieve the proper balance between drainage requirements and vehicle operating requirements. The use of curbs or other drainage controls adjacent to the roadway surface should be avoided, particularly on high speed facilities. Specific requirements for cross slopes and curb placement are given in ***Chapter 3 – Geometric Design***.

B.4.a Unpaved Roadway Drainage

Properly graded unpaved roadways require less maintenance and suffer less material loss. Designers should strive to provide adequate cross slope, shoulder and swale profiles wherever possible. Typical cross slopes should be 2% with 1.5% minimum. During maintenance grading, the operator should ensure that the shoulder does not become higher than the travel lane edge to prevent ponding of water on the roadway.

Designers may consult with AASHTO's~~FHWA's~~ publication~~s:~~ ***Guidelines for Geometric Design of Very Low-Volume Roads (ADT < 400), 2001*** and FHWA's ~~"~~***Gravel Roads Construction & Maintenance Guide~~and Design Manual~~, August 2015~~2000~~***~~"~~ for further guidance regarding proper profiles for unpaved roads.

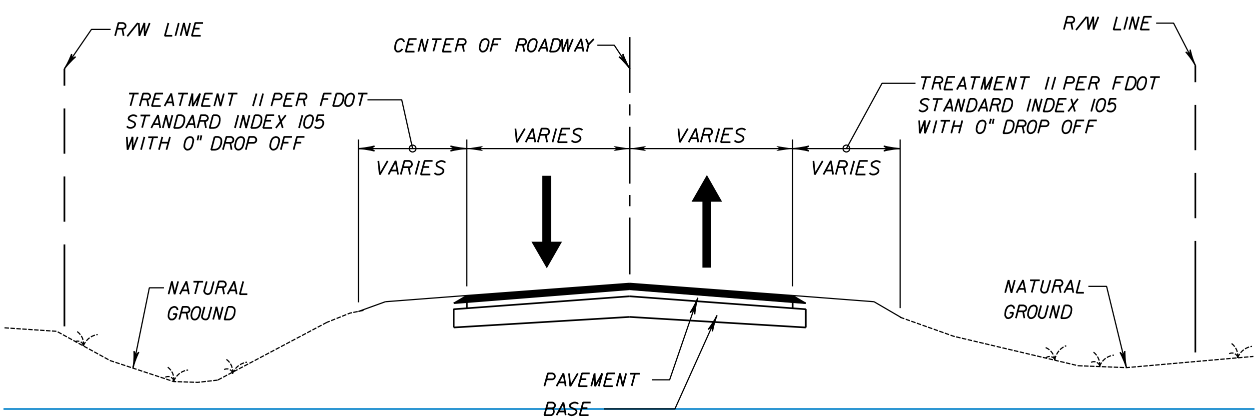
B.5 Shoulder Treatment

The primary function of the shoulder is to provide an alternate travel path for vehicles in an emergency situation. Shoulders should be capable of providing a safe path for vehicles traveling at roadway speed, and should be designed and constructed to provide a firm and uniform surface capable of supporting vehicles in distress. Particular attention shall be given to provide a smooth transition from pavement to shoulder. Shoulder pavement may be provided to improve drainage of the roadway, to serve bicycles, pedestrians and transit users, and to minimize shoulder maintenance. See ***Chapter 3 – Geometric Design*** for additional information and criteria for shoulders.

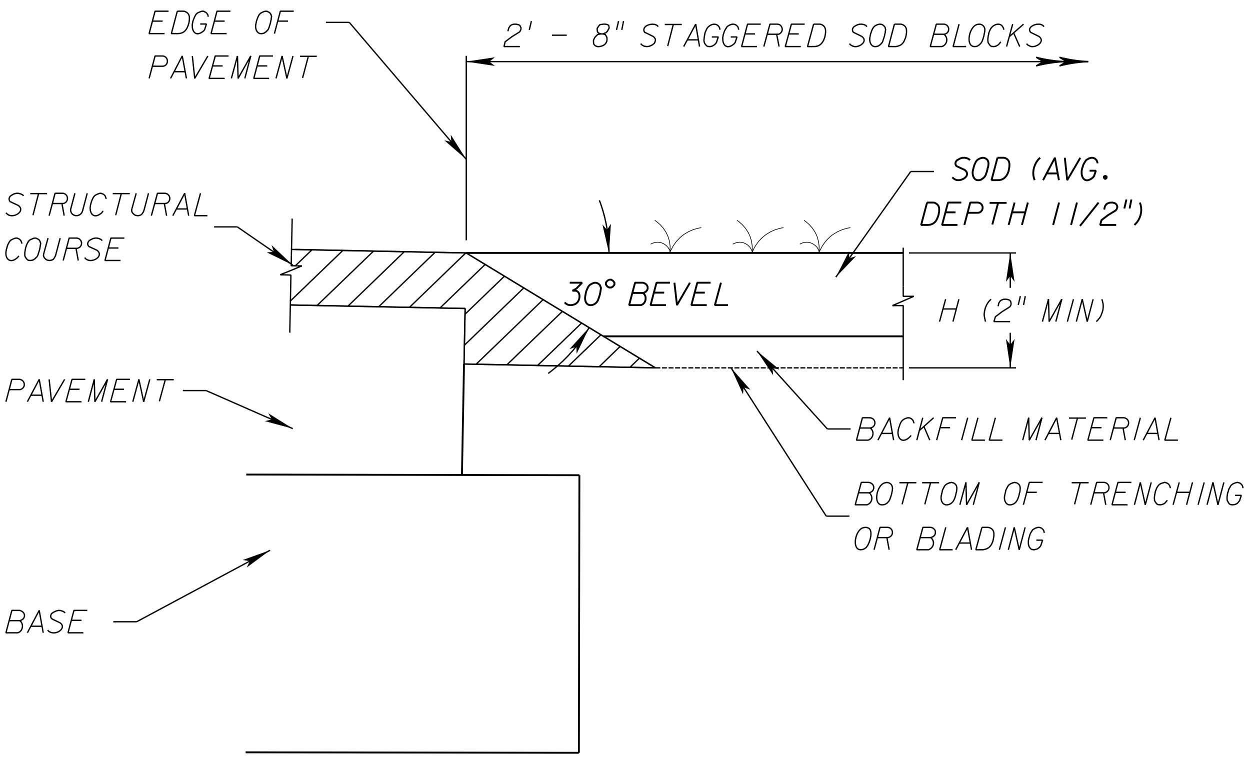
Safety Edge is a technology that mitigates vertical drop offs. The Safety Edge provides a higher probability of a vehicle returning safely to the travel lane when it drifts off the pavement. ~~The wedge shape eliminates tire scrubbing and improves vehicle stability as it crosses a drop-off.~~ For further information on Safety Edge, please see ***Chapter 10 – Maintenance and Resurfacing, Section C.3.a Pavement Safety Edge.***

~~Details for the Safety Edge are included in Figures 5 – 1 and 5 – 2.~~

~~Figure 5 – 1~~
~~Two Lane Road With Safety Edge~~



~~Figure 5 – 2~~
~~Safety Edge Detail (No Paved Shoulders)~~



FOR 2" ≤ H ≤ 5"

SINGLE LIFT
~~SAFETY EDGE DETAIL~~

~~Shoulder pavement may be provided to improve drainage of the roadway, to serve bicycles, pedestrians and transit users, and to minimize shoulder maintenance.~~

C PAVEMENT CONSTRUCTION

A regular program of inspection and evaluation should be conducted to ensure the pavement criteria are satisfied during the construction process. Any regular inspection program should include the following:

- The use of standard test procedures, such as AASHTO and the American Society for Testing and Materials (ASTM).
- The use of qualified personnel to perform testing and inspection.
- The use of an independent assurance procedure to validate the program.

After construction, the pavement surface shall be inspected to determine the required surface texture was achieved and the surface has the specified slopes. Spot checking skid resistance by approved methods should be considered. Periodic reinspection should be undertaken in conformance with the guidelines described in ***Chapter 10 – Maintenance and Resurfacing***.

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CHAPTER 10

MAINTENANCE AND RESURFACING

FIGURES

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CHAPTER 10

MAINTENANCE AND RESURFACING

A INTRODUCTION

In order to provide for the safe and efficient movement of all modes of traffic, it is essential to maintain all aspects of the road and right of way at the highest reasonable level of safety. Improvements consistent with upgrading safety standards or accommodating changes in traffic are also required to maintain the facility in a quality condition. Maintenance and resurfacing are costly operations; therefore, every effort should be made to provide the maximum safety benefit from each operation. The fact that a major portion of the maintenance effort is necessary to merely preserve the economic investment in a facility should not be considered as justification for sacrificing the requirements for maintaining or improving the safety characteristics of a street or highway.

B MAINTENANCE

B.1 Objectives

The major objectives of a maintenance program include the following:

- Maintain all highway features and components in the best possible condition.
- Improve sub-standard features, with the ultimate goal to at least meet minimum standards.
- Provide for minimum disruptions and hazards to traffic during maintenance operations.
- Location and reporting of inadequate safety features.

B.2 Policy

Each highway agency responsible for maintenance shall develop and maintain a program of highway maintenance for the entire highway network under its jurisdiction. This program should include the following activities:

- Identify needs
- Establish priorities
- Establish procedures
- Establish and maintain a regular program of maintenance for all aspects

The program should be regularly evaluated and suitably modified to promote the maintenance of streets and highways that result in the best practicable condition.

B.3 Identification of Needs

The identification of maintenance needs is the first stage in the development of a successful maintenance program, and is required when any portion of the highway system is in a sub-standard condition. Action is also required to correct any situation which is hazardous or may become hazardous in the near future. This may be accomplished by both regular inspection of the highway network and proper analysis of crash records.

B.3.a Inspection

Periodic and systematic inspection of the entire highway network under each agency's jurisdiction is required to identify situations requiring improvements, and corrections or repairs. These inspections should be conducted by maintenance or traffic operations personnel, or other qualified personnel who are trained in the aspects of highway maintenance requirements.

B.3.b Crash Records

A regular program of crash investigations, record keeping, and analysis should be established to provide information for recommended highway modification and corrective maintenance requirements. Cooperation among maintenance, traffic operations, and police agencies is required, and activities of these agencies should be coordinated in accordance with the guidelines set forth in the ***National Highway Traffic Safety Administration (NHTSA) Program Guideline No. 21 (II), Identification and Surveillance of Crash Locations***. Inspection of the highway network and analysis of crash records should be utilized to provide feedback for modification of design and construction procedures.

B.4 Establishment of Priorities

The maintenance activities determined to be necessary by the identification program should be carried out on a priority basis. The establishment of priorities should be based, to a large extent, upon the objective of promoting highway safety. A high priority should be given to the improvement or correction of situations that may result in fatal or serious crashes. Preservation of highway investment and promotion of efficient traffic operations are important maintenance objectives. Every effort should be made to ensure the highest safety payoff from the maintenance dollar.

B.5 Establishment of Procedures

Standard procedures and methods for maintenance operations should be established for efficient, rapid, and safe completion of the required work. All maintenance work shall be conducted in accordance with the Standards set forth in ***Chapter 11 – Work Zone Safety***. Each maintenance agency should develop its own Maintenance Manual or utilize the Maintenance Manuals of the Department. Such manuals should specify the methods, procedures, equipment, personnel qualifications, and other aspects of the work necessary to ensure successful completion of maintenance operations. Procedures should be developed for emergency, routine, and special operations.

B.5.a Emergency Maintenance

Emergency maintenance operations are those required to immediately restore the highway to a safe condition. Emergency maintenance work should be carried out by personnel who are specially trained and qualified. Work units, which should be available on a twenty-four hour basis, should be connected with the emergency response communications system. Emergency operations would include the following:

1. The removal of debris from crashes, cargo spillage, or other causes. This activity should be conducted in accordance with the guidelines set forth in the ***NHTSA Program Guideline No. 16, Debris Hazard Control and Cleanup***.
2. Replacement of inoperative traffic control devices.
3. Repair or replacement of damaged highway safety components such as lighting, traffic control devices, redirection devices, and energy absorbing devices.

4. Repair or correction of any situation that provides an immediate or unexpected hazard to the public.
5. Assistance in any activity during emergency response operations.

B.5.b Routine Maintenance

Routine maintenance operations are those that may be predicted and planned in advance. These operations, which may be preventive or corrective in nature, should be conducted on a regularly scheduled basis using standard procedures. Proper scheduling of these operations should be utilized to provide minimum disruptions and hazards to the driving public. Routine maintenance may include operations such as:

1. Cleaning and debris removal from the pavement, shoulders, and roadside clear zones.
2. Mowing and other vegetation control operations to provide a smooth recovery area and to maintain proper sight distance.
3. Cleaning and inspection of gutters, ditches, and other drainage structures.
4. Structural inspection and preventive maintenance on bridges and other structures.
5. Cleaning, replacement, and maintenance of roadway lighting fixtures.
6. Replacement and maintenance of traffic control devices.
7. Inspection and maintenance of redirection and energy absorbing devices (***Chapter 4 – Roadside Design***).
8. Inspection and maintenance of emergency response communication systems and access facilities.
9. Inspection and maintenance of pavement and shoulders, with particular emphasis on maintaining shoulders flush with the pavement (***Chapter 5 – Pavement Design and Construction***).
10. Inspection and maintenance of all highway components and safety features.
11. Inspection and maintenance of pedestrian pavements, crossings, etc., with particular emphasis on sidewalk cracks, joint separations, accumulated debris, adjacent landscape materials, etc.).

12. Thin pavement overlay that is intended to preserve the pavement, retard its future deterioration and maintain its functional condition.

B.5.c Special Maintenance

Special maintenance operations are defined as those projects that are neither urgent nor routine in nature, but are occasionally required to improve or maintain a street or highway in a quality condition. Since these projects can be planned in advance of the initiation of any work, procedures that provide for efficient, rapid, and safe operations can be developed. To avoid continuing disruptions of traffic, the quality and durability of these improvements, corrections, and repairs should be maintained at the highest practicable level. Special maintenance should include the upgrading of the highway safety features, as well as the repair or replacement of damaged or deteriorated highway components. These operations should be designed to upgrade or maintain the street or highway in accordance with the Standards presented in this Manual.

B.5.d Pavement Maintenance

The primary purpose of pavement maintenance is to ensure the pavement characteristics prescribed in ***Chapter 5 – Pavement Design And Construction***, are reasonably maintained. Each agency with responsibility for maintenance of streets and highways shall establish a meaningful pavement maintenance system (including shoulders and drainage structures) for the entire system under its jurisdiction. This program should include:

1. A process that monitors the serviceability of the existing streets and highways and identifies the pavement sections that are inadequate.

2. A systematic plan of maintenance activities designed to correct structural deficiencies and to prevent rapid deterioration.

3. A preservation program, with assigned priorities, designed to resurface, reconstruct, or replace pavements when they are no longer structurally serviceable.

Pavement maintenance requires a substantial portion of the total maintenance budget for streets and highways. It is necessary to ensure highway safety. The reduction of hydroplaning and splashing is essential for promoting safe and efficient operation during wet weather conditions.

The elimination of driving discomfort, and vehicle damage caused by deteriorated pavements, provides additional economic justification for maintaining the pavement in a fully serviceable condition.

It is recognized that a comprehensive preservation program is expensive. Adequate financing is required to successfully carry out these activities. The establishment of appropriate budget priorities and careful planning can assist in developing and conducting a pavement maintenance and preservation program that will, within a reasonable number of years, bring substandard pavements up to the required level of serviceability and will maintain the adequacy of the entire system.

C RESURFACING

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 ***2017~~2~~ Florida Accessibility Code for Building Construction*** as required by 61G20-4.002 impose additional requirements for the design and construction of resurfacing projects[KM1].

C.1 Accessibility Requirements

If new sidewalk and driveway construction or reconstruction is included on resurfacing projects they shall be designed to meet the requirements of ***Section C.7.d*** of ***Chapter 3 – Geometric Design*** and ***Chapter 9 – Pedestrian Facilities***. Project design should include an evaluation of existing driveways to determine if it is feasible to upgrade nonconforming driveways.

Existing detectable warnings and curb ramps shall be brought into compliance. This includes installing new detectable warnings for both flush shoulder and curbed roadway connections and signalized driveways where none exist or do not meet current requirements. New curb ramps shall be provided on curbed roadways where none exist and existing substandard curb ramps shall be replaced. Existing ramps not meeting detectable warning requirements which otherwise comply with orientation, slope and width criteria shall be retrofitted with detectable warnings.

Where existing right of way is inadequate or conflicts occur with existing features that cannot be practicably relocated or adjusted (e.g. driveways, drainage inlets, signal poles, pull boxes, utility poles, etc.), pedestrian accessibility shall be provided to the maximum extent feasible, with appropriate documentation signed and sealed by a Professional Engineer (EOR). Other than meeting detectable warning and curb ramp requirements, existing sidewalks and driveways are not required to be upgraded for the sole purpose of meeting requirements for accessibility unless included in the project scope.

C.2 Railroad-Highway Grade Crossing Near or Within Project Limits

Federal-aid projects must be reviewed to determine if a railroad-highway grade crossing is within the limits of or near the terminus of the project. If such railroad-highway grade crossing exists, the project must be upgraded to meet the requirements of the ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May 2012) (MUTCD)*** in accordance with ***Title***

23, United States Code (U.S.C), Chapter 1, Section 109(e) and ***23 C.F.R. 646.214(b)***. Please refer to Section C of ***Chapter 7 – Rail-Highway Crossings*** for further information.

C.3 Safety Improvements

Local agencies should strive to upgrade the safety of their facilities during scheduled maintenance intervals especially during pavement resurfacing projects. Particular attention should be paid to improving pedestrian and bicyclist safety using strategies such as crosswalks and bicycle facilities. Investments should also be made in improved guardrail end treatments and bridge-end transitions on high speed facilities.

C.3.a Pavement Safety Edge

Many low-cost strategies exist to improve the long-term safety of streets and highways. One such strategy is the pavement Safety Edge. The Safety Edge provides a higher probability of a vehicle returning safely to the travel lane when it drifts off the pavement. It ~~The Safety Edge~~ is a wedge-shaped transition of the structural pavement to the unpaved shoulder. The wedge shape eliminates tire scrubbing against the pavement edge and improves vehicle stability as it crosses a drop-off.

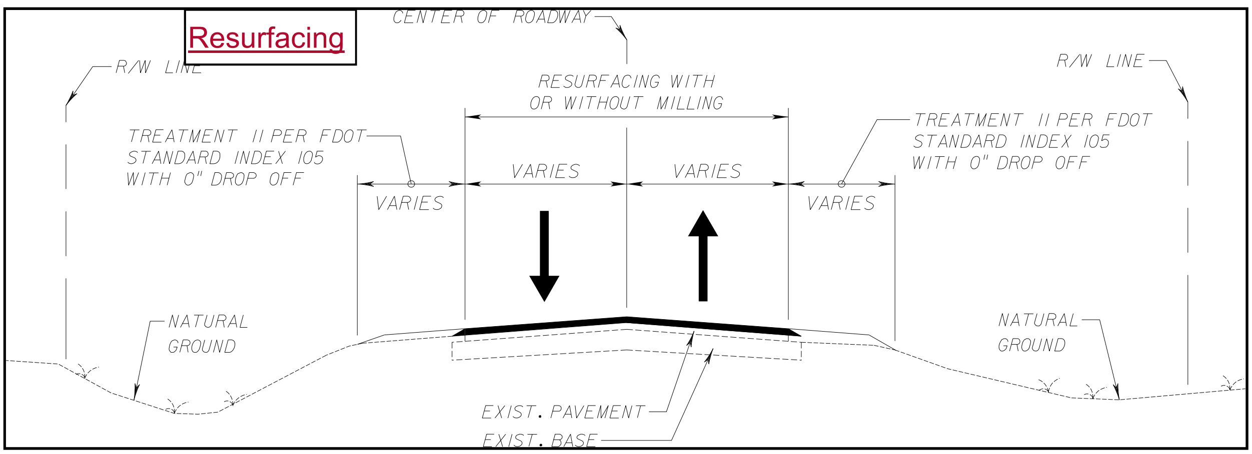
The Safety Edge is particularly effective when providing a smooth transition from pavement to shoulder when vertical drop-offs exceed 2 inches. Construction of the Safety Edge typically includes initially pulling the unpaved shoulder for pavement structural course, and then backfilling onto the Safety Edge with installation of sod or turf. The Safety Edge is very effective in mitigating the severity of road-departure crashes should the unpaved shoulder erode away between maintenance intervals.

Provide a Safety Edge treatment adjacent to the travel lane on roadways without curb or paved shoulders, with a posted speed of 45 mph or greater, and have a history of lane departure crashes.

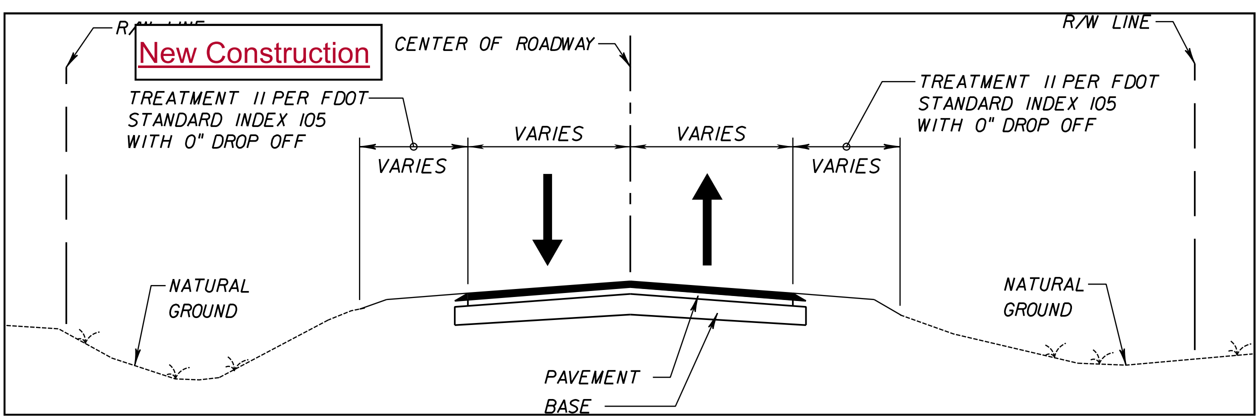
Details for the Safety Edge are included in Figures 10 – 1 Two Lane Road with Safety Edge and 10 – 2 Safety Edge Detail (No Paved Shoulder). ~~Safety Edge is most beneficial whenshould be constructed adjacent to the pavement edge on rural roadways with no paved shoulder and posted speeds 45 mph and above~~[KM2]~~.~~

Additional information on Safety Edge can be found at ***FHWA's Center for Accelerating Innovation – Safety Edge***, including a Design and Construction Guide, Guide Specification, ~~and~~ Safety Evaluation Tech Brief and Case Studies.~~.~~ ***FHWA's Crash Modification Factors Clearinghouse*** also provides information on the performance of safety edge. ~~Also, t~~The Department has a ***Developmental Specification for Safety Edge – Dev330 Safety Edge*** on the Department's web site which may be used if approved by the agency having jurisdiction.

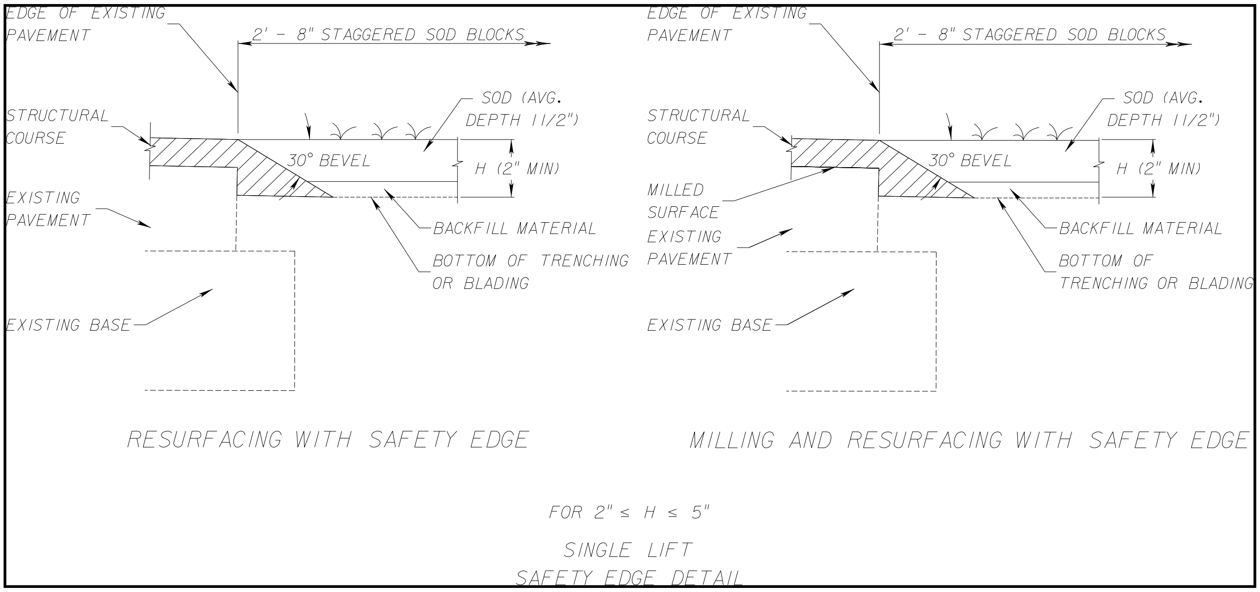
Figure 10 – 1
Two Lane Road with Safety Edge[KM3][KM4]



Or

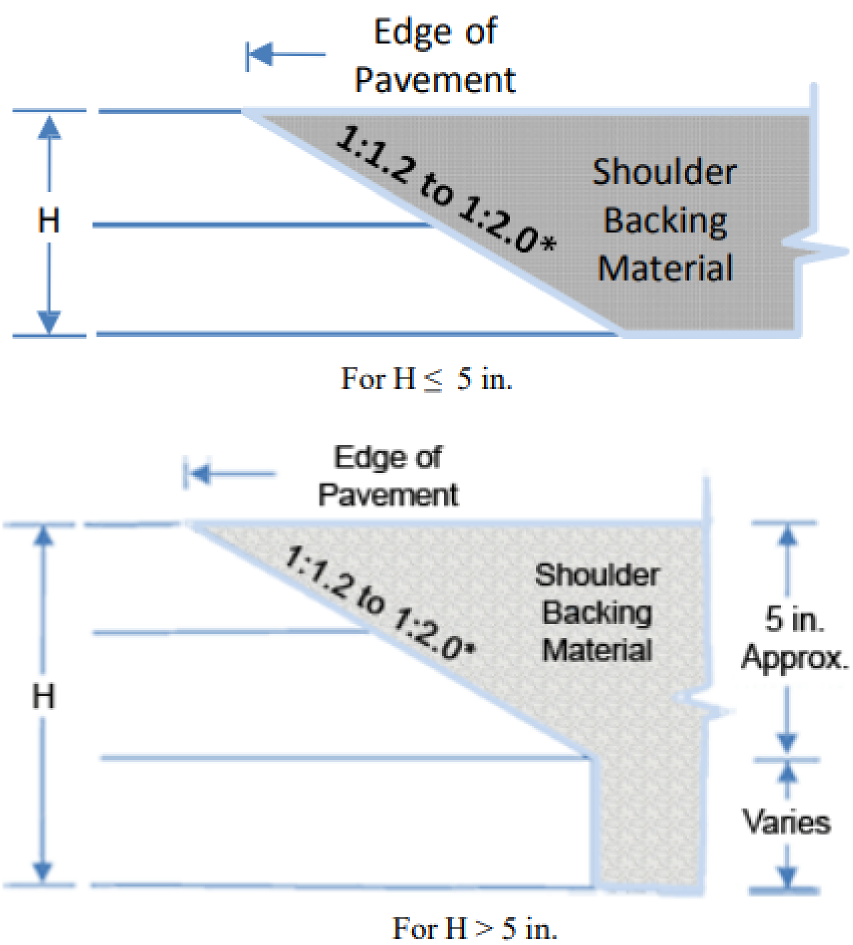


[KM5]Figure 10 – 2
Safety Edge Detail (No Paved Shoulders)



Or

Option for Safety Edge Detail from FHWA



* *Note, Recommended Rise to Run ratio range 1:1.2 to 1:2.0. The range of slope is equal to 26° to 40°.*

Figure 10. Recommended Safety Edge$_{SM}$ configuration for AC pavements and overlays.

C.4 Federal Aid Project Requirements

The following are the minimum requirements that a local highway resurfacing project scope must contain for federal-aid assistance including projects in the Local Agency Program (LAP):

1. Rework shoulders to be flush with the pavement and establish turf along the pavement edge.

2. Upgrade or replace existing roadside hardware (guardrail) as necessary for compliance with Federal criteria for 3R projects (as summarized in the ~~*Florida Department of Transportation's Plans Preparation Manual, Volume 1, Chapter 4*~~ ***Department's Design Manual, Chapter 215 Roadside Safety***).

3. Meet the latest ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May 2012) (MUTCD)*** standards for signing and pavement marking.

4. Construct or reconstruct, as appropriate, curb cuts and ramps to meet current accessibility requirements.

5. Upgrade the safety of the project by mitigating the impact of crashes involving vehicles, bicycles and pedestrians.

   Note: The local agency may contact the FDOT District Safety Office and determine locations within the project with crash rates higher than average for similar facility type. The local agency may then identify the causes of the crashes from a review of crash report data provided by the FDOT District Safety Office. Based on this analysis, the local agency may then specify the appropriate crash mitigation measures (additional guardrail, signing, vibratory/audible pavement marking, designated crosswalks or other prudent safety-enhancing strategies).

6. Upgrade railroad crossings to meet the latest ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May 2012) (MUTCD)*** requirements in accordance with ***Title 23, United States Code (U.S.C), Chapter 1, Section 109(e)*** and ***23 C.F.R. 646.214(b)***. Please refer to ***Section C*** of ***Chapter 7 – Rail-Highway Crossings*** for further information.

D REFERENCES FOR INFORMATIONAL PURPOSES

The following is a list of publications that may be referenced for further guidance:

- ~~*Source: AASHTO Standing Committee on Highways, 1997*~~

- FHWA Pavement Preservation Definitions, HIAM-20, September 12, 2005, http://www.fhwa.dot.gov/pavement/preservation/091205.cfm

- NCHRP Synthesis 417: Geometric Design Practices for Resurfacing, Restoration, and Rehabilitation,
  http://www.nap.edu/

- FHWA Center for Accelerating Innovation – Safety Edge
  https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/safetyedge.cfm

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CHAPTER 19

TRADITIONAL NEIGHBORHOOD DEVELOPMENT

TABLES

FIGURES

CHAPTER 19[KM1]

TRADITIONAL NEIGHBORHOOD DEVELOPMENT

A INTRODUCTION

~~Florida is a national leader in planning, design and construction of~~ Traditional Neighborhood Development (TND) ~~communities, and in the renovation of downtown neighborhoods and business districts. 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 worship within walking distances of residences.

~~They represent patterns of development aligned with the state's growth management, smart growth and sprawl containment goals.~~ This approach, with its greater focus on pedestrian, bicycle and transit mobility; is distinct from Conventional Suburban Development (CSD). CSDs are comprised largely of subdivision and commercial strip development.

TND communities rely on a strong integration of land use and transportation. A TND has clearly defined characteristics and design features that are necessary to achieve the goals for compact and livable development patterns reinforced by a context-sensitive transportation network. The treatment of land use, development patterns and transportation networks necessary for successful TND communities is a major ~~departure from those same elements currently utilized in other Greenbook~~ goal of this chapter~~s~~.

~~To provide a design that accomplishes the goals set out in this chapter, designers will be guided by the context of the built environment, established or desired, for a portion of the communities because~~ TND communities rely on a stronger integration of land use and transportation than CSD communities. This chapter provides criteria that may be used for the design of streets within a TND. ~~when such features are desired, appropriate and feasible. This involves providing a balance between mobility and livability.~~ This chapter may be used in planning and designing new construction, urban infill, and redevelopment projects.

Section B of this chapter discusses the primary objectives of TND in more detail to aid the designer in the selection of proper criteria. Section C sets forth specific design criteria for the transportation system within TND.

The Department's Traditional Neighborhood Development Handbook (2011) ~~following link~~ provides ~~a handbook containing essential information to provide~~ designers guidance in the successful application of this Chapter.~~:~~

~~http://www.dot.state.fl.us/rddesign/FloridaGreenbook/TND-Handbook.pdf~~

B APPLICATION[KM2]

A project or community plan may be considered a TND when at least the first seven of the following principles are included:

1. Has a compact, pedestrian-oriented scale that can be traversed in a five to ten-minute walk from center to edge.
2. Is designed with low speed, low volume, interconnected streets with short block lengths, 150 to 500 feet, and cul-de-sacs only where no alternatives exist. Cul-de-sacs, if necessary, should have walkway and bicycle connections to other sidewalks and streets to provide connectivity within and to adjacent neighborhoods.
3. Orients buildings at the back of sidewalk, or close to the street with off-street parking located to the side or back of buildings, as not to interfere with pedestrian activity.
4. Has building designs that emphasize higher intensities, narrow street frontages, connectivity of sidewalks and paths, and transit stops to promote pedestrian activity and accessibility.
5. Incorporates a continuous bike and pedestrian network with wider sidewalks in commercial, civic, and core areas, but at a minimum has sidewalks at least five feet wide on both sides of the street. Accommodates pedestrians with short street crossings, which may include mid-block crossings, bulb-outs, raised crosswalks, specialty pavers, or pavement markings.
6. Uses on-street parking adjacent to the sidewalk to calm traffic, and offers diverse parking options, but planned so that it does not obstruct access to transit stops.
7. Varies residential densities, lot sizes, and housing types, while maintaining an average net density of at least eight dwelling units per acre, and higher density in the center.
8. Integrates at least ten percent of the developed area for nonresidential and civic uses, as well as open spaces.
9. Has only the minimum right of way necessary for the street, median, planting strips, sidewalks, utilities, and maintenance that are appropriate to the adjacent land uses and building types.
10. Locates arterial highways, major collector roads, and other high-volume corridors at the edge of the TND and not through the TND.

The design criteria in this chapter shall only be applicable within the area defined as TND.

C PLANNING CRITERIA

Planning for TND communities occurs at several levels, including the region, ~~the~~ city/town, ~~the~~ community, ~~the~~ block, and, finally, ~~the~~ street and building. Planning should be holistic, looking carefully at the relationship between land use, buildings, and transportation in an integrated fashion. This approach, and the use of form based codes, can create development patterns that balance pedestrian, bicycling, and transit with motor vehicle transportation.

C.1 LAND USE

In addition to its importance in calculating trip generation, the Institute of Transportation Engineers (ITE) recognizes land use as fundamental to establishing context, design criteria, cross-section elements, and right of way allocation. The pedestrian travel ~~that is~~ generated by the land uses is also important to the design process ~~for various facilities~~.

A well-integrated, or “fine grained”, land use mix within buildings and blocks is essential. These buildings and blocks aggregate into neighborhoods, which should be designed with a mix of uses to form a comprehensive planning unit that aggregates into larger villages, towns, and regions. Except at the regional scale, each of these requires land uses to be designed at a pedestrian scale and to be served by “complete streets” that safely and attractively accommodate many modes of travel.

The proposed land uses, residential densities, building size and placement, proposed parking (on-street and off-street) and circulation, the location and use of open space, and the development phasing are all considerations in facility design for TNDs. ITE recommends a high level of connectivity, short blocks that provide many choices of routes to destinations, and a fine-grained urban land use and lot pattern. Higher residential density and nonresidential intensity, as measured by floor area ratios of building area to site area, are required for well-designed TNDs.

C.2 NETWORKS

Urban networks are frequently characterized as either traditional or conventional. Traditional networks are typically characterized by a relatively non-hierarchical pattern of short blocks and straight streets with a high density of intersections that support all modes of travel in a balanced fashion.

Figure 19 – 1 Traditional Network

New York, NY **Savannah, GA**

(Source: VHB)

The typical conventional street network, in contrast, often includes a framework of widely-spaced arterial roads with limited connectivity provided by a system of large blocks, curving streets and a branching hierarchical pattern, often terminating in cul-de-sacs.

Figure 19 – 2 Conventional Network

Walnut Creek, CA

(Source: VHB)

Traditional and conventional networks differ in three easily measurable respects: (1) block size, (2) degree of connectivity and (3) degree of curvature. While the last does not significantly impact network performance, block size and connectivity create very different performance characteristics.

Advantages of traditional networks include:

1. Distribution of traffic over a network of streets, reducing the need to widen roads;
2. A highly interconnected network providing a choice of multiple routes of travel for all modes, including emergency services;
3. More direct routes between origin and destination points, which generate fewer vehicle miles of travel (VMT) than conventional suburban networks;
4. Smaller block sizes in a network that is highly supportive to pedestrian, bicycle, and transit modes of travel;
5. A block structure that provides greater flexibility for land use to evolve over time.

It is important in TND networks to have a highly interconnected network of streets with smaller block sizes than in conventional networks. There are several ways to ensure that these goals are achieved.

One method is based upon the physical dimensions used to layout streets and blocks. The following list identifies those parameters:

1. Limit block size to an average perimeter of approximately 1,320 feet.
2. Encourage an average intersection spacing for local streets of 300 - 400 feet.
3. Limit maximum intersection spacing for local streets to approximately 600 feet.
4. Limit maximum spacing between pedestrian/bicycle connections to approximately 300 feet (that is, it creates mid-block paths and pedestrian shortcuts).

D OBJECTIVES

The basic objectives of a Traditional Neighborhood Development are:

1. Safety
2. Mobility of all users (motor vehicles, pedestrians, bicyclists and transit)
3. Compact and livable development patterns
4. Context-sensitive transportation network

TND features are based upon the consideration of the following concepts. These concepts are not intended as absolute criteria since certain concepts may conflict. The concepts should therefore be used for the layout of proper street systems.

1. Strong integration of land use and transportation.
2. Very supportive of pedestrian, bicycle, and transit modes.
3. Smaller block sizes to improve walkability, and to create a fine network of streets accommodating bicyclists and pedestrians, and providing a variety of routes for all users.
4. On-street parking is favored over surface parking lots.
5. Limited use of one-way streets.
6. Speeds for motor vehicles are ideally kept in the range of 20-35 mph through the design of the street, curb extensions, use of on-street parking, the creation of enclosure through building and tree placement.
7. Street geometry (narrow streets and compact intersections), adjacent land use, and other elements within a TND must support a high level of transit, pedestrian and bicycle activity.
8. Provide access to emergency services, transit, waste management, and delivery trucks.
9. Provide access to property.

This approach to street design requires close attention to the operational needs of transit, fire and rescue, waste collection, and delivery trucks. ~~For this reason, ~~E~~e~~arly coordination with transit, fire and rescue, waste collection, and other stakeholder groups is essential. For fire and rescue, determination of the importance of that corridor for community access should be determined, e.g. primary or secondary access.

More regular encroachment of turning vehicles into opposing lanes will occur at intersections. Therefore, frequency of transit service, traffic volumes, and the speeds at those intersections must be considered when designing intersections.

When designing features and streets for TND communities, creativity and careful attention to safety for pedestrians and bicyclists must be balanced with the operational needs of motor vehicles.

Finally, it is very important when designing in TND communities to ensure that a continuous network is created for pedestrians, bicyclists, and transit throughout the community to create higher levels of mobility that are less dependent on automobile travel.

E DESIGN ELEMENTS

The criteria provided in this chapter shall require written ~~the~~ approval of the maintaining authority's designated ~~Professional Engineer~~ representative with project oversight or general compliance responsibilities. Approval may be given for ~~based upon a~~entire roadways, ~~-~~specific segments, ~~-~~or a specific area where appropriate.

The criteria provided in this chapter are generally[KM3] in agreement with AASHTO guidelines with a special emphasis on urban, low-speed environments. Design elements within TND projects not meeting the requirements of this chapter are subject to the requirements for Design Exceptions and Variations found in ***Chapter 14*** of this manual.

E.1 Design Controls

E.1.a Design Speed

The application of design speed for TND communities is philosophically different than for conventional transportation and CSD communities. ~~Traditionally, the approach for setting design speed was to use as high a design speed as practical.~~

~~In contrast to this approach, the goal for TND communities is to establish a design speed that creates a safer and more comfortable environment for pedestrians and bicyclists, and is appropriate for the surrounding context.~~

Design speeds of 20 to 35 mph are desirable for TND streets. Alleys and shared streets~~narrow roadways intended to function as shared spaces~~ may have design speeds as low as 10 mph[KM4].

E.1.b Movement Types[KM5]

Movement types are used to describe the expected user~~driver~~ experience on a given thoroughfare, and the design speed for ~~pedestrian~~ safety and mobility established for each of these movement types. They are also used to establish the components and criteria for design of streets in TND communities.

Yield: Has a design speed of less than 20 mph. Drivers must proceed slowly with extreme care, and must yield to pass a parked car or approaching vehicle. This is the functional equivalent of traffic calming. This type should accommodate bicycle travel~~routes~~ through the use of shared lanes.

Slow: Has a design speed of 20 - 25 mph. Drivers can proceed carefully, with an occasional stop to allow a pedestrian to cross or another car to park. Drivers should feel uncomfortable exceeding design speed due to the presence of landscaping, parked cars, ~~enclosure,~~ tight turn radii, and other design elements. This type should accommodate bicycle travel ~~routes through the use of~~using shared lanes or bicycle lanes.

Low: Has a design speed of 30 - 35 mph. Drivers can expect to travel generally without delay at the design speed, and street design supports safe pedestrian movement~~ at the higher design speed~~. This type is appropriate for thoroughfares designed to traverse longer distances, or that connect to higher intensity locations. This type should accommodate bicycle travel~~routes~~ by including ~~through the use of~~ bicycle~~ke~~ lanes.

Design speeds higher than 35 mph should not normally be used in TND communities.~~ due to the concerns for pedestrian and bicyclist safety and comfort.~~ There may be locations where planned TND communities border, or are divided by, existing corridors with posted/design speeds higher than 35 mph. In those locations, coordination with the maintaining ~~regulating~~ agency should occur with a goal to re-design the corridor and reduce the speed to 35 mph or less. The increase in motorist travel time due to the speed reduction is usually insignificant because TND communities are generally compact.

When the speed reduction cannot be achieved, measures to improve pedestrian and bicyclist safety ~~for those crossing the corridor~~ should be evaluated and installed when appropriate.

E.1.c Design Vehicles

There is a need to understand that street design with narrow streets and compact intersections requires designers to pay close attention to the operational needs of transit, fire and rescue, waste collection, and delivery trucks. For this reason, early coordination with transit, fire and rescue, waste collection, and other stakeholder groups is essential.

Regular encroachment of larger turning vehicles into opposing lanes will occur at intersections. Therefore, frequency of transit service, traffic volumes, and the speeds at those intersections must be considered when designing intersections. For fire and rescue, determination of the importance of the street for community access should be determined, e.g. primary or secondary access.

The designer should evaluate intersections using turning templates or turning movement analysis software to ensure that adequate operation of vehicles can occur. Provision ~~Treatment~~ of on-street parking around intersections should be evaluated during this analysis to identify potential conflicts between turning vehicles and on-street parking.

E.2 Sight Distance

See ***Chapter 3 – Geometric Design, C.3 Sight Distance.***

E.2.a Stopping Sight Distance

See ***Chapter 3 – Geometric Design, C.3.a Stopping Sight Distance***.

E.2.b Passing Sight Distance

Due to the importance of low speeds and concerns for pedestrian and bicyclist comfort and safety, passing should be discouraged or prohibited.

E.2.c Intersection Sight Distance[KM6][KM7]

Sight distance should be calculated in accordance with ***Chapter 3, Section C.9.b***, using the appropriate design speeds for the street being evaluated.

When executing a crossing or turning maneuver after stopping at a stop sign, stop bar, or crosswalk, as required in ***Section 316.123, F.S***., it is assumed that the vehicle will move slowly forward to obtain sight distance (without[FJ8] intruding into the crossing travel lane) stopping a second time as[KM9] necessary[KM10].

Therefore, when curb extensions are used, or on-street parking is in place, the vehicle can be assumed to move forward on the second step movement, stopping just shy of the travel lane, increasing the driver's potential to see further than when stopped at the stop bar. The resulting increased sight distance provided by the two step movement allows parking to be located closer to the intersection.

The ***MUTCD*** requires that on-street parking be located at least 20 feet from crosswalks (marked and unmarked) at intersections and 30 feet from the crosswalk at a signalized intersection. ~~The minimum stopping sight distance is 60 feet for low volume (< 400 ADT) streets~~[KM11]. Parking at mid-block crosswalks may not be placed within 20 feet of the crosswalk. ***Florida Statutes 316.195*** provides additional information on the location of on-street parking spaces near fire hydrants and fire stations.~~.~~

~~The minimum stopping sight distance is 60 feet for low volume (< 400 ADT) streets~~[KM12]Even on slow speed, low volume urban streets, the combination of curb return, crosswalk width and 20-foot setback to the first parking space may not meet the minimum stopping distance. ~~Justification for locating parking spaces 20 feet from crosswalks may be achieved based on community history with existing installations~~[KM13][KM14]~~.~~

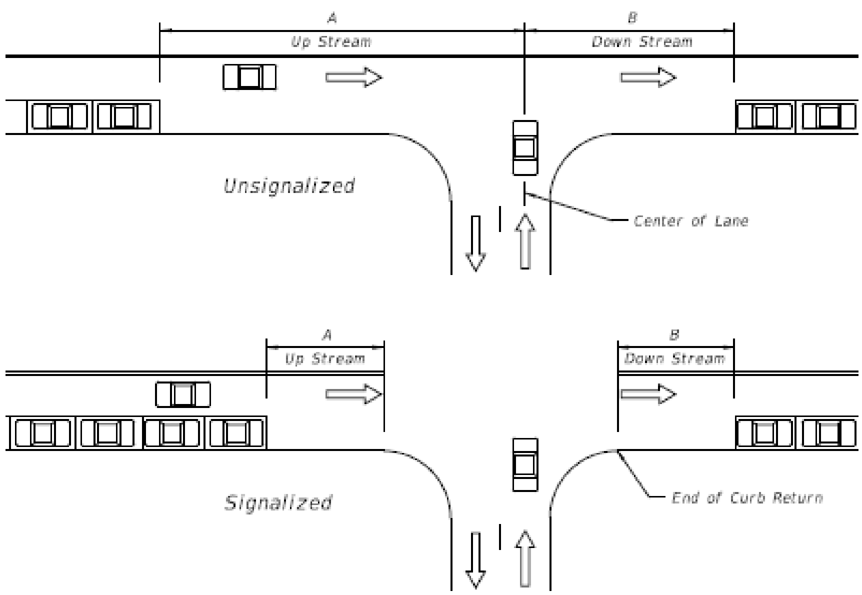
Table 19 – 1 Parking Restrictions for Driveways and Intersections provides up-stream and down-stream parking restrictions at driveways and intersections; including mid-block crossings and roundabout approaches.

Table 19 – 1 Parking Restrictions for Driveways and Intersections

Topic #625-000-002
FDOT Design Manual January 1, 2019

Table 212.11.2 Parking Restrictions for Driveways and Intersections

Control Type	Posted Speed (mph)	A - Up Stream (ft)	B – Down Stream (ft)	
			2-Lane	4-Lane or more
Unsignalized	< 35	90	60	45
	35	105	70	50
Signalized	< 35	30	30	30
	35	50	50	50



Notes:

(1) For entrances to one-way streets, the downstream restriction (B) may be reduced to 20 feet.

(2) Do not place parking within 20 feet of a marked crosswalk.

AASHTO 2011 Greenbook has the following:

Table 9-8 Design Intersection Sight Distance—Case B2, Right Turn from Stop, and Case B3, Crossing Maneuver

Metric				U.S. Customary			
Design Speed (km/h)	Stopping Sight Distance (m)	Intersection Sight Distance for Passenger Cars		Design Speed (mph)	Stopping Sight Distance (ft)	Intersection Sight Distance for Passenger Cars	
		Calculated (m)	Design (m)			Calculated (ft)	Design (ft)
20	20	36.1	40	15	80	143.3	145
30	35	54.2	55	20	115	191.1	195
40	50	72.3	75	25	155	238.9	240
50	65	90.4	95	30	200	286.7	290
60	85	108.4	110	35	250	334.4	335
70	105	126.5	130	40	305	382.2	385
80	130	144.6	145	45	360	430.0	430
90	160	162.6	165	50	425	477.8	480
100	185	180.7	185	55	495	525.5	530
110	220	198.8	200	60	570	573.3	575
120	250	216.8	220	65	645	621.1	625

E.3 Horizontal Alignment

E.3.a Minimum Centerline Radius

See ***Chapter 3 – Geometric Design, C.4 Horizontal Alignment*** and Table 3 ~~-~~ – 12~~3~~ Minimum Radii (feet) for Design Superelevation Rates Low Speed Local Roads ((e_{max} = 0.05) ~~Horizontal Curvature, Low-Speed Urban Streets~~.

E.3.b Minimum Curb Return Radius

Curb return radii should be kept small to keep intersections compact. The use of on-street parking and/or bike lanes increases the effective size of the curb radii, further improving the ability of design vehicles to negotiate turns without running over the curb return.

Table 19 – 2~~1~~ Curb Return Radii

Movement Type	Design Speed	Curb Radius w/Parallel Parking*
Yield	Less than 20 mph	5-10 feet
Slow	20-25 mph	10-15 feet
Low	30-35 mph	15-20 feet

* Dimensions with parking on each leg of the intersection. Both tangent sections adjacent to the curb return must provide for on-street parking or else curb radii must be evaluated using "design vehicle" and either software or turning templates.

E.4 Vertical Alignment

See ***Chapter 3 – Geometric Design, C.5 Vertical Alignment***.

E.5 Cross Section Elements

E.5.a Introduction

As discussed earlier in this chapter, TND street design places importance on how the streets are treated since they are part of the public realm. The street portion of the public realm is shaped by the features and cross section elements used in creating the street. For this reason, it is necessary the designer pay more attention to what features are included, where they are placed, and how the cross section elements are assembled.

E.5.b Lane Width

Travel lane widths should be based on the context and desired speed for the area where the street is located. Table 19-2 shows travel lane widths and associated appropriate speeds. It is important to note that in low speed urban environments, lane widths are typically measured to the curb face instead of the edge of the gutter pan. Consequently, when curb sections with gutter pans are used, the motor vehicle and parking lanes include the width of the gutter pan.

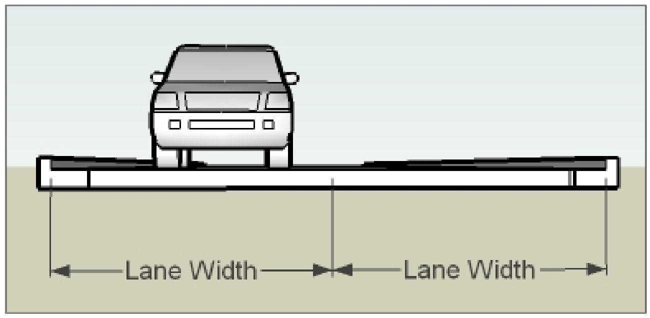
Table 19 – 3~~2~~ Minimum Lane Width[KM15]

Movement Type	Design Speed	Travel Lane Width
Yield*	Less than 20 mph	~~N/A~~18 feet total width
Slow	20-25 mph	9-10 feet
Low	30-35 mph	10-11 feet

* Yield streets are typically residential two-way streets with parking on one or both sides. When the street is parked both sides, the remaining space between parked vehicles (10 feet minimum) is adequate for one vehicle to pass through. Minimum width for a yield street with parking on both sides should be 24 feet curb face to curb face. Minimum width for a yield street with parking on one side should be 20 feet curb face to curb face, allowing for two 10-foot lanes when the street is not parked.

Figure 19 – 3 Lane Widths shows a typical measurement.

Figure 19 – 3 Lane Width



(Source: VHB)

In order for drivers to understand the appropriate driving speeds, lane widths should create some level of discomfort when driving too fast. The presence of on-street parking is important in achieving the speeds shown in Table 19 – 2 Minimum Lane Widths. When bicycle lanes or multi-lane configurations are used, there is more room for vehicles, such as buses, to operate. However, car drivers may feel more comfortable driving faster than desired.

Alleys and narrow roadways that act as shared spaces can have design speeds as low as 10 mph, as noted in ***Chapter 16 – Residential Street Design***.

Alleys can be designed as either one way or two way. Right of way width should be a minimum of 20 feet with no permanent structures within the right of way that would interfere with vehicle access to garages or parking spaces, access for trash collection, and other operational needs. Pavement width should be a minimum of 12 feet. Coordination with local municipalities on operational requirements is essential to ensure that trash collection and fire protection services can be completed.

E.5.c Medians

Medians used in low-speed urban thoroughfares provide for access management, turning traffic, safety, pedestrian refuge, landscaping, lighting, and utilities. These medians are usually raised with raised curb.

Landscaped medians can enhance the street or help create a gateway entrance into a community. Medians can be used to create tree canopies over travel lanes for multi-lane roadways contributing to a sense of enclosure.

Medians vary in width depending on available right of way and function. Because medians require a wider right of way, the designer must weigh the benefits of a median with the issues of pedestrian crossing distance, speed, context, and available roadside width.

Table 19 – 4~~3~~ Recommended Median Width[KM16]

Median Type	Minimum Width	Recommended Width
Median for access control	4 feet[KM17]	6 feet
Median for pedestrian refuge	6 feet	8 feet
Median for trees and lighting	6 feet [1]	10 feet [2]
Median for single left turn lane	10 feet [3]	14 feet [4]

Table Notes:

[1] Six feet measured curb face to curb face is generally considered the minimum width for the proper growth of small caliper trees (less than 4 inches),

[2] Wider medians provide room for larger caliper trees and more extensive landscaping,

[3~~] A ten foot lane provides for a turn lane without a concrete traffic separator~~[KM18]~~,~~

[4] ~~Fourteen feet provides for a turn lane with a concrete traffic separator.~~

E.5.d Turn Lanes

The need for turn lanes for vehicle mobility should be balanced with the need to manage vehicle speeds and the potential impact on the border width, such as sidewalk width. Turn lanes tend to allow through vehicles to maintain higher speeds through intersections, since turning vehicles can move over and slow in the turn lane.

Left turn lanes are considered to be acceptable in an urban environment since there are negative impacts to roadway capacity when left turns block the through movement of vehicles. The installation of a left turn lane can be beneficial when used to perform a road diet such as reducing a four lane section to three lanes with the center lane providing for turning movements. In urban areas, no more than one left turn lane should be provided.

Right turns from through lanes do not block through movements, but do create a reduction in speed due to the slowing of turning vehicles. Right turn lanes are used to maintain speed through intersections, and to reduce the potential for rear end crashes. However, the installation of right turn lanes increases the crossing distance for pedestrians and the speed of vehicles, therefore the use of exclusive right turn lanes are rarely used except at "T" intersections.

E.5.e Parking

On-street parking is important in the urban environment for the success of those retail businesses that line the street, to provide a buffer for the pedestrian, and to help calm traffic speeds. When angle parking is proposed for on-street parking, designers should consider the use of back in angle parking in lieu of front in angle parking.

Table 19 – 5~~4~~ Parking Lane Width

Movement Type	Design Speed	Parking Lane Width
Slow	20-25 mph	(Angle) 17-18 feet
Slow	20-25 mph	(Parallel) 7 feet
Low	30-35 mph	(Parallel) 7-8 feet

E.6 Cul-de-sacs and Turnarounds

Cul-de-sacs should only be used where no other alternatives exist. Cul-de-sacs should have walkway or bicycle connections to other sidewalks and streets to provide connectivity within and to adjacent neighborhoods.

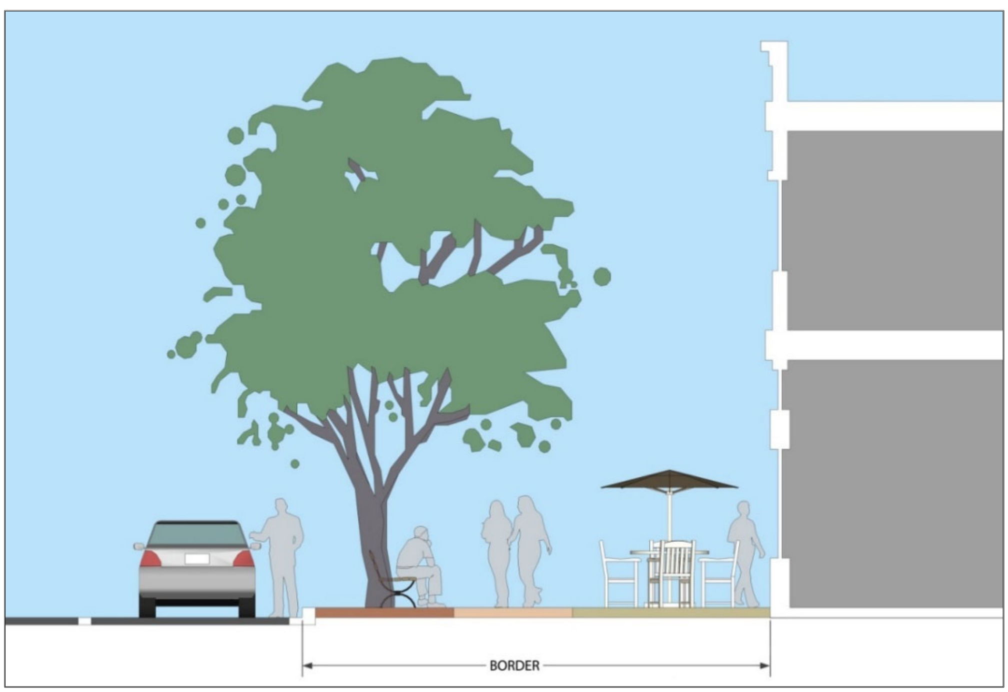
E.6.a Turning Area

A residential street open at one end only should have a special turning area at the closed end. A residential street more than 100 feet long and open at one end only shall have a special turning area at the closed end. This turning area should be circular and have a radius appropriate to the types of vehicle expected. The minimum outside radius of a cul-de-sac shall be 30 feet. In constrained circumstances, other turning configurations such as a "hammerhead" may be considered.

E.7 Pedestrian Considerations

In urban environments, the "border," or area between the face of a building or right of way line and the curb face, serves as the pedestrian realm because it is the place for which pedestrian activity is provided, including space to walk, socialize, places for street furniture, landscaping, and outdoor cafes. In an urban environment, the border consists of the furniture, walking and shy zones.

Figure 19 – 4 Border



(Source: VHB)

E.7.a Furniture Zone

The furniture zone can be located adjacent to the building face, but more commonly is adjacent to the curb face. The furniture zone contains parking meters, lighting, tree planters, benches, trash receptacles, magazine and newspaper racks, and other street furniture. The furniture zone is separate from the walking/pedestrian and shy zones to keep the walking area clear for pedestrians, including proper access to transit stops.

E.7.b Walking/Pedestrian Zone

Chapter 8 addresses considerations for pedestrians. In a properly designed urban environment, where buildings are at the back of the sidewalk and vehicle speeds are low, the separation from traffic is normally provided by on-street parking, which also helps to calm traffic. The width of the walking/pedestrian zone should be at least four feet and should be increased based on expected pedestrian activity.

E.7.c Shy Zone

The shy zone is the area adjacent to buildings and fences that pedestrians generally “shy” away from. A minimum of one foot is provided as part of the sidewalk width. This space should not be included in the normal walking zone of the sidewalk.

E.7.d Mid-Block Crossings

Properly designed TND communities will not normally require mid-block crossings due to the use of shorter block size. When mid-block crossings are necessary, the use of curb extensions or bulbouts should be considered to reduce the crossing distance for pedestrians.

E.7.e Curb Extensions

Curb extensions are helpful tools for reducing the crossing distance for pedestrians, providing a location for transit stops, managing the location of parking, providing unobstructed access to fire and rescue, and increasing space for landscaping and street furniture.

Designers should coordinate with public works staff to ensure that street cleaning can be achieved with their equipment, and adequate drainage can be provided to avoid ponding at curb extensions.

E.8 Bicyclist Considerations

E.8.a Bicycle Facilities

Chapter 9 contains information on bicycle facilities. This section is directed to designing bike facilities in TND communities. Designing for bicycles on thoroughfares in TND communities should be as follows: bicycles and motor vehicles should share lanes on thoroughfares with design speeds of twenty five mph or less. It is important to recognize that the addition of bike lanes does increase roadway widths and can increase the tendency for drivers to speed.

When bicycle lanes are used in TND communities, they should be a minimum of 5 feet wide and designated as bike lanes. On curb and gutter roadways, a minimum 4-foot width measured from the lip of the gutter is required. The gutter width should not be considered part of the rideable surface area, but this width provides useable clearance to the curb face. Drainage inlets, grates, and utility covers are potential problems for bicyclists. When a roadway is designed, all such grates and covers should be kept out of the bicyclists' expected path. If drainage inlets are located in the expected path of bicyclists, they should be flush with the pavement, well seated, and have bicycle compatible grates.

Where parking is present, the bicycle lane should be placed between the parking lane and the travel lane, and have a minimum width of 5 feet. Designers should consider increasing the bicycle lane to 6 feet in lieu of increasing parallel parking width from 7 to 8 feet. This helps encourage vehicles to park closer to the curb, and provides more room for door swing, potentially reducing conflict with bicyclists.

Shared lane markings, or "sharrows," can be used instead of bicycle lanes adjacent to on-street parking. The sharrow allows the bicyclist to occupy the lane and therefore avoids placing bicyclists in the "door zone", and does not require an increase in lane width or ROW width for the thoroughfare. Guidance for use of the shared lane marking is included in ***Chapter 9 – Bicycle Facilities*** and the ~~***2009***~~ ***MUTCD***. See Figure 9 –243 – Shared Lane Marking in ***Chapter 9*** for a detailed drawing of a shared lane marking.

E.8.b Shared Use Paths

Greenways, waterfront walks, and other civic spaces should include shared use paths, and provide for bicycle storage or parking. Bicycle storage or parking should also be included in areas near transit facilities to maximize connectivity between the modes.

E.9 Transit

See ~~"~~***Accessing Transit, Design Handbook for Florida Bus Passenger Facilities, Version III, 2013***~~08"~~ for information.

~~: http://www.dot.state.fl.us/transit/NewTransitPlanning.shtm~~

E.10 Clear Zone

In urban areas, horizontal clearances, based on clear zone requirements for rural highways, are not practical because urban areas are characterized by lower speed, more dense abutting development, closer spaced intersections and accesses to property, higher traffic volumes, more bicyclists and pedestrians, and restricted right of way. The minimum horizontal clearance shall be 1.5 feet measured from the face of curb.

Streets with curb, or curb and gutter, in urban areas where right of way is restricted do not have roadsides of sufficient widths to provide clear zones; therefore, while there are specific horizontal clearance requirements for these streets, they are based on clearances for normal operation and not based on maintaining a clear roadside for errant vehicles. It should be noted that curb has essentially no redirectional capability; therefore, curb should not be considered effective in shielding a hazard.

F REFERENCES FOR INFORMATIONAL PURPOSES

The following publications were either used in the preparation of this chapter, or may be helpful in designing TND Communities and understanding the flexibility in AASHTO design criteria:

- Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice, 2010
  https://www.ite.org/technical-resources/topics/complete-streets/

~~6. http://www.ite.org/css/~~

~~7.~~
- SmartCode 9.2
  http://www.smartcodecentral.org/

~~8.~~
- A Guide for Achieving Flexibility in Highway Design, AASHTO, May, 2004
  https://bookstore.transportation.org/

~~9.~~
- Accessing Transit, Design Handbook, ~~for Florida Bus Passenger Facilities~~, 2013~~08~~, and Accessing Transit Design Handbook Update, 2017, FDOT Public Transit Office
  https://www.fdot.gov/transit/Pages/NewTransitFacilitiesDesign.shtm ~~:~~
  ~~http://www.dot.state.fl.us/transit/NewTransitPlanning.shtm~~

~~10.~~
- Safe Routes to Schools Program, FDOT Safety Office
  https://www.fdot.gov/safety/2A-Programs/Safe-Routes.shtm~~:~~
  ~~http://www.dot.state.fl.us/safety/2A-Programs/Programs.shtm~~

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CHAPTER 1[KM1]

DRAINAGE[KM2][KM3]

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TABLES

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CHAPTER 20[KM8]

DRAINAGE[KM9]

A INTRODUCTION[KM10]

This chapter recognizes that Florida is regularly affected by adverse weather conditions. As such, the proper design of a roadway's drainage system is critical to its function and to the safety of the motoring public as well as pedestrians, bicyclists and other users of these facilities. Standing water on a roadway can not only create a hazard but could also impede the flow of traffic.

This chapter represents the minimum standards that should be used when designing roadway drainage. As is the case for all elements in a facility's design, the designer must consider site specific conditions and determine the proper level of service the facility's drainage system should provide. The design of drainage facilities should not only consider the system's ability to handle the design storm, but also consider the system's recovery time during an event which exceed the design storm.

B OBJECTIVES

The objective of this chapter is to establish the minimum standards to which a roadway's drainage system is to be designed. In order for the drainage system to function properly, the below guidelines should be used in the design, construction and maintenance of these systems.

- Design and maintain drainage systems to quickly move water out of the travel lanes in order provide a safer environment for users of a facility during adverse weather conditions.
- Design drainage systems by taking into consideration the future maintenance of said system in order to avoid creating hazardous conditions to drivers and maintenance staff during routine servicing.

C~~F~~ REGULATORY REQUIREMENTS~~STORMWATER MANAGEMENT~~[KM11][KM12]

~~F.1 Regulatory Requirements~~

F.1~~.a~~ Chapter 62-330~~25~~, Florida Administrative Code

Chapter 62-330~~25~~. F.A.C., rules of the Florida Department of Environmental ~~Protection~~ Protection, implements the comprehensive, statewide environmental resource permit (ERP) program under ***Section 373.4131, F.S.*** The ERP program governs the following: construction, alteration, operation, maintenance, repair, abandonment, and removal of stormwater management systems, dams, impoundments, reservoirs, appurtenant works, and works (including docks, piers, structures, dredging, and filling located in, on or over wetlands or other surface waters, as defined and delineated in ***Chapter 62-340, F.A.C.***)~~specifies minimum water quality treatment standards for new development.~~. ***Chapter 62-25 F.A.C.*** has been repealed.

F.1~~.b~~ Chapter 62-40, Florida Administrative Code

Chapter 62-40, F.A.C., rules of the Florida Department of Environmental Protection outlines basic goals and requirements for surface water protection and management to be implemented and enforced by the Florida Department of Environmental Protection and Water Management Districts.

F.1~~.c~~ National Pollutant Discharge Elimination System

The ***National Pollutant Discharge Elimination System*** (***NPDES***) permit program is administered by the U. S. Environmental Protection Agency and delegated to the Florida Department of Environmental Protection in Florida. This program requires permits for stormwater discharges into waters of the United States from industrial activities; and from large and medium municipal separate storm sewer systems (MS4s). Construction projects are within the definition of an industrial activity.

D. STORMWATER MANAGEMENT STRATEGIES

D.1 Watershed Approach to Evaluate Regional Stormwater Solutions (WATERSS)

WATERSS is a regional stormwater management process that promotes collaboration with state and local agencies, water resource managers and stakeholders to implement innovative stormwater management practices. The process is scalable depending on the type, size, complexity, context, and geographic location of the project. It enables the comparison of innovative solutions and partnerships with traditional solutions. The 12 steps detailing the WATERRS process is shown in Figure 20 – 1 WATERSS Process Flow Chart.

The WATERSS process identifies potential cost savings or additional environmental benefits for implementing feasible, non-traditional stormwater management solutions. Innovative practices include regional ponds, joint-use ponds, stormwater harvesting, land use modifications, upstream compensatory treatment, basin or resource improvements, well injection, and bio-sorption activated media (BAM). These practices along with examples of opportunities that can be leveraged by this process are found in Table 20 – 1 Matrix of Typical Innovative Stormwater Management Practices.

Collaboration with external partners is essential for the discovery of stormwater management partnership opportunities. This may involve more time and effort than traditional stormwater pond design, which focuses on isolated activities and design of individual ponds. However, collaborative stormwater management solutions have proven to result in substantial environmental and investment benefits across a watershed or region. ~~Following are steps detailing the WATERRS process~~.

Figure 20 – 1 WATERSS Process Flowchart

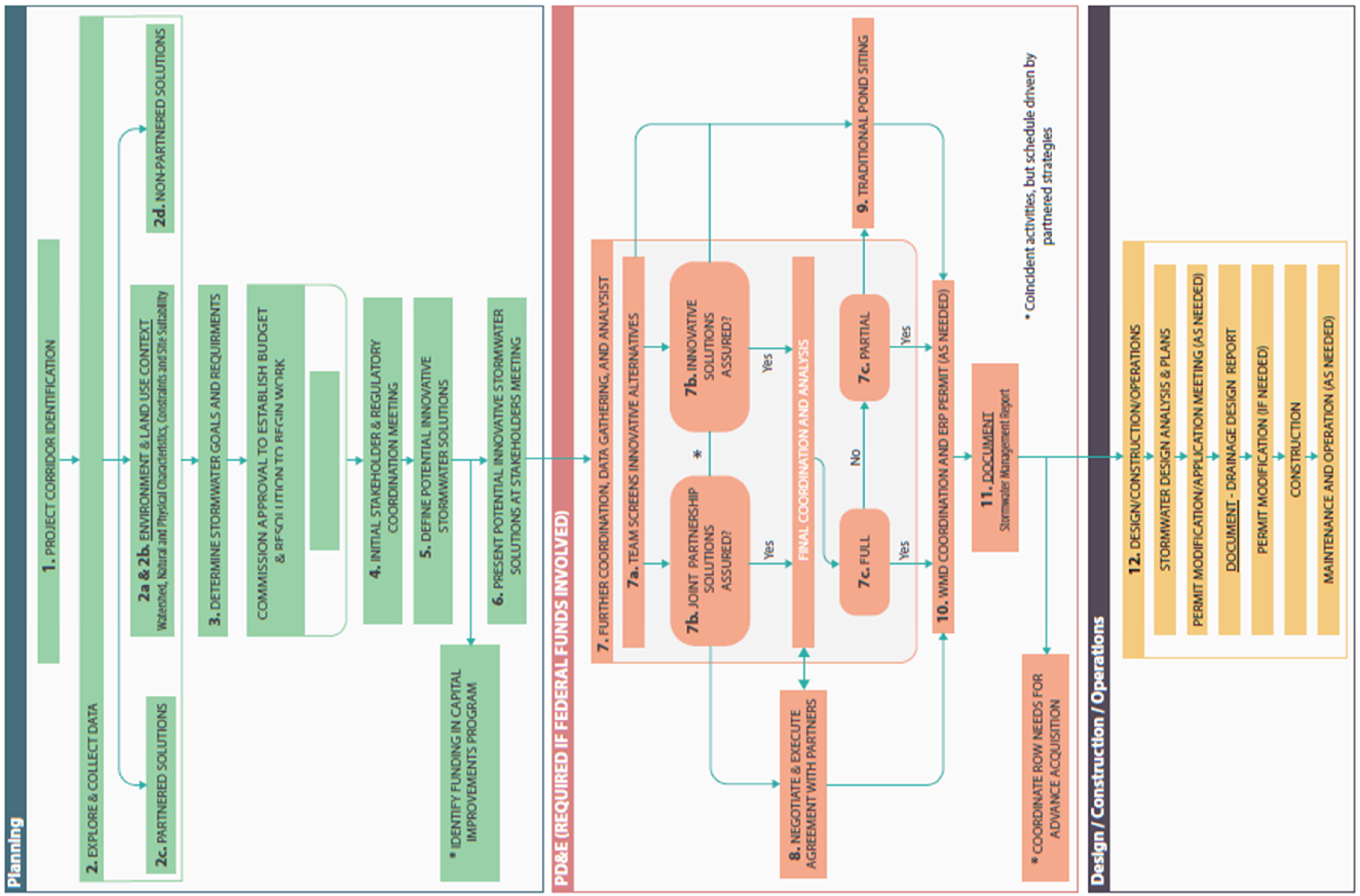


Table 20 – 1 Matrix of Typical Innovative Stormwater Management Practices

BMP	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
Surface Water BMPs									
Regional Pond	Downstream pond sized to accommodate runoff from the upstream basin rather than only onsite runoff from the development.	Desirable when pond ROW costs are high or land for ponds is unavailable.	Reduce long term pond costs and improve downstream water quality.	Highly effective in that land beyond the onsite project is treated and attenuated.	Pros: improved water quality and attenuation, reduced long term costs. Cons: (1) difficult to coordinate agreements and permit; and (2) possible long piped outfalls.	Minor increase in pollutants to waters of the state immediately downstream between the roadway and the regional pond.	Potential increased ROW costs are recouped by giving away maintenance to local municipalities.	Longer production schedule may be needed to accommodate negotiations with local municipalities and overcoming permitting hurdles.	Sometimes pre-treatment is required onsite, perhaps trapping sediments
Joint-Use Pond	Pond designed to accommodate runoff from two or more landowners. A formal agreement is crafted to outline terms of cooperation.	(1) Often occurs at the request of adjacent property owners to better integrate proposed pond locations into their properties; (2) sometimes initiated by FDOT to store runoff in downstream golf courses; and (3) sometimes adjacent developments are required to take FDOT runoff as a condition of county approvals.	Reduce pond ROW acquisition and long-term maintenance costs.	Standard ERP water quality rules are satisfied.	Pros: combining ponds into a single pond reduces costs due to economy of scale; typically, maintenance is assumed by the party other than FDOT. Cons: (1) co-mingling runoff can expose agency to NPDES responsibilities for offsite runoff; and (2) can be difficult to coordinate agreements	(1) Permits must be obtained/modified for all parties involved; (2) phased construction must be coordinated for future roadway or development expansion; and (3) legal agreement must address FDOT's right to maintain pond (or hold another public agency as surety) if the developer defaults on his responsibilities.	Combining ponds into a single pond reduces ROW costs due to economy of scale; maintenance is often assumed by the offsite party.	Longer production schedule may be needed to accommodate negotiations with the cooperating party.	The overflow from the combined pond must be able to adequately drain both upstream properties.

BMP	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
Stormwater Harvesting	Stormwater is collected and harvested for irrigation, raw water supply, wetland re-hydration, MFLs, or some other beneficial usage.	Useful when a high demand exists for non-potable water.	Reduce downstream pollutant loadings and provide an alternate water supply.	Highly effective in that land downstream discharge volume is reduced, lowering pollutant loading; usually has only minimal reduction in attenuating peak flow.	Pros: improved water quality and water supply. Cons: difficult to match with water consumers; partners can pull out late in the production schedule.	None, unless water consumer tries to negotiate CUP credits as part of the harvesting.	None, assuming that pumping and infrastructure costs are borne by the water consumer.	Longer production schedule may be needed to discover and negotiate with the water consumer.	(1) No privately-owned pumping/piping infrastructure within L/A ROW; (2) re-use with potential human contact must provide filtration; and (3) avoid the need for a CUP by avoiding the pumping of groundwater.
Land Use Modification	Changing existing land usage to a usage generating less of the pollutant of concern, usually nutrients.	Desirable when pond ROW costs are high or land for ponds is unavailable.	Cost savings.	Standard ERP water quality rules are satisfied due to a reduced pollutant loading.	Pros: cost savings. Cons: involves negotiating with external property owners.	(1) Potential adverse impacts to adjacent properties; and (2) will require additional coordination for the specific permit language and conditions.	Costs are reduced by avoiding expensive ROW adjacent to the highway.	Additional production time may be needed to negotiate with land owners – no ROW condemnation authority.	None.
Upstream Compensatory Treatment	Treating upstream offsite runoff in lieu of onsite runoff.	Desirable when pond ROW costs are high or land for ponds is unavailable.	Cost savings.	Standard ERP water quality rules are satisfied.	Pros: cost savings. Cons: permitting hurdles.	(1) Potential adverse impacts to adjacent properties; and (2) will require additional coordination for the specific permit language and conditions.	Costs are reduced by the selection of an alternate treatment site.	Additional production time may be needed to find and design a suitable upstream treatment alternative.	Requires design of offsite treatment BMP.

BMP	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
Basin/Resource Improvements	In lieu of onsite stormwater treatment, modifications to the basin or downstream resource (e.g., septic tank conversions, circulation enhancements, etc.) are constructed to improve the waterbody's health.	Desirable (1) when pond ROW costs are high or land for ponds is unavailable; and/or (2) when greater environmental benefit is sought.	Potential cost savings and improved downstream environmental benefit.	Highly effective due to significantly increased environmental benefit.	Pros: improved environmental benefit and reduced costs. Cons: significant amount of permitting coordination.	With no specific rules to address this approach, regulatory leadership must provide strong evidence of the improvement's effectiveness.	Significant cost savings can be realized in comparison with pond ROW acquisition.	Longer production schedule may be needed to accommodate discussions with the permitting agencies and/or municipality.	Specialty design services may be required depending on the mitigation strategy.
Groundwater BMPs									
Well Injection (not District 6 coastal zone)	Injecting runoff into the ground via a pipe rather than discharging it downstream.	Useful in springsheds and other areas where groundwater recharge is desirable; typically targets pond bleed down flows.	Increase groundwater recharge; decrease pollutant loadings to surface waters.	Effective in increasing groundwater recharge and reducing downstream surface water pollutant loadings by reducing discharge volume.	Pros: improved groundwater recharge; decreased surface water pollutant loadings. Cons: may need to include a special BAM design within the discharge well.	(1) FDEP working to secure flexibility in EPA's UIC rules to allow this option - untested at this point in time; and (2) will require additional coordination for the specific permit language and conditions.	Additional costs are incurred to construct the injection system; currently, the WMDs offer no incentives such as reduced treatment requirements.	Separate permitting process with independent timelines.	Requires well injection design downstream of overflow weir.

BMP	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
Bio-sorption Activated Media (BAM)	Media provides a carbon source to promote the cultivation of denitrifying bacteria; also removes phosphorus, though infrequently used for that nutrient.	Useful in springsheds and coastal areas to denitrify during infiltration; useful to treat phosphorus within impaired basins.	Remove nutrients from runoff; eliminate ROW for ponds by using BAM within roadside ditches.	Highly effective in removing nutrients.	Pros: improved groundwater quality; can eliminate the need for stormwater ponds in rural typical sections. Cons: design and specifications for BAM are not yet codified into Manuals and Specs.	Design practice is new to most WMDs, though included in the BMPTRAINS program; performance measures/expectations are not well established.	Additional costs for BAM material which is sometimes offset by reduced pond ROW; when used to remove phosphorus, the design life of the media is predicted to be about 20 years and may then need replacement.	Longer production schedule may be needed to coordinate design with UCF.	Required residence time within BAM layer may require additional storage in ditches or retention ponds.

Step 1 – Project Corridor Identification

Identify the overall project characteristics including project location, environment and land use context (urban vs. rural project), facility type, alternatives being considered, and potential stormwater needs.

Outcome: Watershed issues and concerns, conditions of the corridor(s), and potential stormwater needs.

Step 2 – Explore and Collect Data

A. Identify existing stormwater-related conditions on the project corridor and conduct an initial, desktop-level discovery of potential partnerships and innovative stormwater solutions available. Potential partnerships and initiatives are explored by using Geographic Information System (GIS) support tools, and by querying the National Pollutant Discharge Elimination System (NPDES) Coordinator regarding ongoing Total Maximum Daily Load (TMDL) and Basin Management Action Plan (BMAP) activities. The following information should be included:

- Previous planning studies.
- Existing roadway plans - as built.
- Soil types, depth, slope and infiltration rates from natural resources conservation service soil surveys and existing geotechnical data from previous projects.
- Proposed alternative alignments and conceptual typical sections.
- Available topographic data and aerial photography (include local data sources).
- Existing and future land use maps.
- Tax maps & land owner information (can be provided as part of public involvement research).
- Existing row maps.
- Copies of any previous stormwater studies or watershed masterplans.
- Available copies of permits for projects within the vicinity.

- Existing agreements (Joint Participation Agreements (JPAs), easements, maintenance agreements, etc.).
- Water supply planning regions.
- Identified springsheds (as appropriate).
- Springs Priority Focus Areas (PFA).
- Water Management District (WMD) mean flow limitations.
- Aquifer storage and recharge wells.
- Parks, golf courses, irrigation or water storage/recharge opportunities.
- BMAPs's.
- TMDLs with allocations.
- Identified public lands.
- Floodplain.
- Government-owned lands (schools, prisons, WMD lands, etc.).
- Developments of regional impacts (DRIs) and Sector Plans.

B. Investigate and document watershed information, environmental characteristics and constraints that may affect suitability of potential stormwater management solutions. The following list is provided as guidance:

- What are the characteristics of the watershed? Is the watershed fully developed? Mostly rural? A combination?
- Is the project area within a springshed/impaired basin? If so, is there a TMDL or BMAP for the area?
- What types of soils are in the project area?
- Is there an Outstanding Florida Water (OFW) located within the watershed?
- Is the project located in a floodplain?
- Are there wetlands in the area?
- Are there threated or endangered species or designated habitat which may cause certain types or locations of treatment to be not suitable for stormwater management?

- Are there contamination concerns which will cause a site to be not suitable for treatment?
- Is there land that is a Section 4(f) protected resource?
- Is there land that is protected by conservation easements?
- Is the project located near a designated Wild and Scenic River?
- Are there historic resources in the area?
- Is the project located within an area with a coastal management program?
- Is the project located near Essential Fish Habitat?
- Is the project located within the boundaries of a designated Sole Source Aquifer? There are two defined in Florida: Volusia-Floridan and Biscayne Aquifers.

C. Identify potential innovative stormwater solutions and partners. If the project is in an impaired basin, contact the NPDES Coordinator to obtain the BMAP stakeholder information and discuss a list of potential partners and available projects for funding. Pursue city, county, National Estuary Program, Water Management District, and developer partners. Examples are listed below:

- Regional Pond: If sub-basins are draining to the same outfall or future development is expected in the watershed.
- Additional offsite inflows: If new or additional offsite inflows of stormwater or wastewater are being proposed.
- Stormwater re-use: In urban or suburban areas, contact local governments or golf courses regarding their interest in stormwater as a raw water supply or for irrigation.
- Joint-use Ponds: Determine if there are large existing or proposed developments (residential or commercial) along the highway that might exchange storage on their property for an outfall.
- Springsheds: If the project is in a springshed PFA then additional scrutiny will be given from regulators on groundwater discharges (dry retention ponds) as opposed to surface water discharges where denitrification can occur. Is the groundwater beneath the project contaminated with nitrates or are there sources of nitrogen adjacent to the project? If so, the nitrogen-laden water may be pumped directly into the underground BAM layer to achieve large removals[KM13]

- Tidal or Lake Circulation Improvements: If a BMAP identifies tidal or lake flushing issues, consider improving a roadway crossing with a new or larger bridge or culvert to provide additional flushing.

D. Identify potential innovative stormwater solutions for which a partner is not typically needed. Examples are listed below:

- Regional Pond: If a substantial portion of the project drains to a single water body a regional pond would allow reduction of typical on-site pounds. Would a location downstream have equal or fewer community impacts or other benefits over on-site ponds? Consider if increased project runoff would create or worsen flooding or erosion issues between the project and the pond location? Could the runoff be piped or the conveyance improved, given the number of parcels and the length of piping required?
- Springsheds: For projects in springsheds, critical water needs area, water supply hardship areas, or areas of nutrient impairment consider the use of a nutrient removal product such as BAM for additional treatment.
- Onsite Irrigation: Consider re-use of the pond treatment volume for irrigation near the project rather than bleeding downstream.
- Wetland Re-hydration: Are nearby wetlands underhydrated?
- Compensatory Treatment: Are there upstream areas that retrofit treatment and attenuation could be done as compensation? Look especially for land already available and runoff with high nutrient loading such as agricultural lands.
- Minimum Flows and Levels: Does the project flow to waterbodies with Minimum Flows and Levels (MFL).

E. Conclude the Explore and Collect Data step with a narrative describing the existing project stormwater conditions, potential partnerships, and innovative stormwater solutions that may be applied on the project.

Outcome: Narrative describing existing project stormwater conditions, potential stormwater management projects, partnerships and innovative stormwater solutions.

Step 3 – Determine Stormwater Goals and Requirements

Identify and document the stormwater management goals and requirements for the project based on the information discovered in Step 2. Having a general knowledge about the scope of the proposed improvements and potential right of -way needs at the start of this step are essential to estimating the stormwater goals and requirements.

Outcome: A narrative describing identified stormwater management goals and requirements for the project.

Step 4 – Initial Stakeholders and Regulatory Coordination Meeting

Introduce the project to stakeholders and discuss cooperative or regional stormwater management opportunities and understand their priorities. During the initial stakeholders' coordination meeting, present the stormwater goals and opportunities being considered. The presentation should include the following project information:

- Project overview.
- Project baseline schedule including critical milestones.
- Stormwater goals and requirements.
- Potential innovative stormwater solutions that may be considered on the project.
- Preliminary Stormwater Costs (often based on the preliminary expected cost of traditional ponds) and Project Funding.

Outcome: List of potential partnership stormwater management solutions and innovative solutions to be further analysed.

Step 5 – Define Potential Stormwater Management Strategies

Discuss opportunities identified in Step 4 and screen out non-viable stormwater management solutions. Agree on the criteria for selection (includes constraints or limiting factors that may prevent implementation of solutions). These factors may include stormwater goals and requirements, cost, challenges in permitting, maintainability, constructability, schedule and environmental considerations. Table 20 – 2 Evaluation Factors for Screening of Solutions provides more information on the types of factors to consider in identifying feasible stormwater management strategies.

Additional evaluation factors could include reliability of partners, compatibility with production schedule, and benefit/cost. This step does not overtly compare solutions, but only eliminates solutions that are flawed or otherwise do not meet the stormwater management goals and requirements. The screening by the stormwater team includes both partnership and non-partnership innovative solutions.

Compile a matrix for the comparison of solutions using the information obtained from Steps 1 through 4. Factors used and the scoring method should be included with the matrix to demonstrate the factors and justify the scoring. An example matrix is provided in Exhibit 20 – 1 Evaluation Matrix Example.

Prepare a work plan for each partnership strategy that is recommended for detail evaluation. Use this plan to facilitate dialogue with the respective stakeholders and secure commitments for all participant's share of the stormwater management solution.

Outcome: A list of viable solutions are identified for further detailed evaluation and to be presented at follow up stakeholder meetings, documented in a memorandum.

Table 20 – 2 Evaluation Factors for Screening of Solutions[KM14]

Factor	Description/Issues to Consider
Project Needs for Water Quality	Will the solution provide all the water quality credits needed for the project?
Schedule Compatibility	Identify if negotiation and implementation of the solution to obtain water quality credits can be completed within the current project production schedule.
Cost / Benefit	The cost of solution vs. the benefit, i.e. reduction in maintenance costs, right-of-way costs, construction costs, mitigation costs, etc.
Partner Reliability	Identify if the partner of a solution can be relied upon to work with the agency for the duration of the solution.
Ease of Permitting	Identify if there have been preliminary discussions with the regulatory agencies, and document the feedback received. Is this solution permittable or will extensive negotiations be needed?
Water Quantity/Floodplain Benefit	Identify if the solution will provide water quantity or floodplain benefits and if so, quantify the benefits to be realized from the project.
Public Perception/Acceptance	Identify if the solution will be generally accepted by the public. Will extensive public involvement be required?
Threatened and Endangered Species and Associated Costs	Identify if there are threatened or endangered species which may be impacted by the solution. Identify any costs associated with avoiding or mitigating these impacts.
Wetland Credits	Identify if any wetland credits may be realized by the implementation of the solution and the associated benefit(s) that would be provided to the agency. Identify if the anticipated wetland credits would potentially satisfy mitigation requirements for the project and if there would be additional credits for future projects.
Seagrass Credits	Identify if any seagrass credits may be realized by the implementation of the solution and the associated benefit(s) that would be provided to the agency. Identify if the seagrass credits would satisfy mitigation requirements for the project and if there would be additional credits for future projects.

Table 20 – 2 Evaluation Factors for Screening of Solutions (continued)

Factor	Description/Issues to Consider
Section 4(f) Involvement	Identify the presence of potential Section 4(f) properties which may have a use under the definition of Section 4(f) or if there would be a benefit as a result of the solution.
Conservation Lands	Identify the presence of any conservation lands which may affect the suitability of a solution.
Cultural Resources Involvement	Identify the potential presence of cultural resources including archaeological and historical resources which could affect the suitability of a solution.
Public Wellfield Issues	Identify the proximity to any public wellfield locations and if the solution could potentially have a direct impact.
Contamination – Hazardous Materials	Identify if the area to be utilized for the solution is contaminated. Consider the costs associated with the clean-up of the area, and if the contamination will limit the area available for stormwater facilities.
Construction	Identify any construction related impacts of the solution and associated costs, such as additional drainage piping to transport stormwater and access for construction.
Maintenance	Identify the costs and frequencies of maintenance needed to maintain the solution.
Aesthetics	Identify if there are any associated costs or benefits for aesthetics of the solution, such as the cost to install and maintain plantings.
Priority of Regulatory Agencies	Identify if this solution is a priority of the regulatory agencies.
Multiple Benefits/Future Credits/Future Capacity for Other Projects	Identify if the solution will potentially provide for multiple types of credits such as water quality and seagrass. Identify if the project will potentially have credits available for future projects.

Exhibit 20 – 1 Evaluation Matrix Example

Weight of Factor	**Factor**	**Score**	**W Score**	**Score**	**W Score**	**Score**	**W Score**	**Score**	**W Score**
1-10		1-10		1-10		1-10		1-10	
	Alternative Number	A		B		C		D	
	Brief Description of Alternative	Vacant land near school		Home		Developed		Vacant land	
	Parcel Number	101		105		160		170	
	Parcel Size (Acres)	5		4		3.2		6.5	
2	Project Needs for Water Quality	5	10	6	12	5	10	6	12
7	Schedule Compatibility	3	21	8	56	3	21	1	7
10	Cost / Benefit	2	20	8	80	2	20	7	70
10	Partner Reliability	6	60	8	80	6	60	4	40
2	Ease of Permitting	1	2	3	6	1	2	5	10
10	Water Quantity/Floodplain Benefit	7	70	2	20	7	70	3	30
6	Public Perception/Acceptance	4	24	1	6	4	24	2	12
6	Threatened and Endangered Species	10	60	1	6	5	30	6	36
5	Wetland/Seagrass Credits	10	50	10	50	3	15	1	5
6	Section 4(f) Involvement	2	12	6	36	2	12	7	42
6	Conservation Lands	6	36	5	30	6	36	6	36
6	Cultural Resources Involvement	10	60	1	6	1	6	10	60
6	Public Wellfield Issues	10	60	1	6	7	42	10	60
8	Contamination – Hazardous Materials	6	48	3	24	4	32	6	48
9	Construction/Maintenance	5	45	2	18	10	90	5	45
2	Aesthetics	3	6	1	2	10	20	3	6
8	Priority of Regulatory Agencies	10	80	6	48	2	16	10	80
0	Multiple Benefits/Future Credits/Future Capacity for Other Projects	0	0	0	0	0	0	0	0
	Score	664		486		506		599	
	Ranking	4		1		2		3	

Note: "W Score" = Weighted Score

~~Prepare a work plan for each partnership strategy that is recommended for detail evaluation. Use this plan to facilitate dialogue with the respective stakeholders and secure commitments for all participant's share of the stormwater management solution.~~

~~**Outcome:** A list of viable solutions are identified for further detailed evaluation and to be presented at follow up stakeholder meetings, documented in a memorandum.~~

Step 6 – Present Potential Stormwater Strategies at Stakeholders Meeting

Present to the stakeholders viable partnership solutions and provide the stakeholders and regulators with an opportunity to provide input. Inform the group about any potential innovative stormwater solutions which are being pursued. This is also an opportunity to learn about any other projects that may be worth considering.

Outcome: Meeting notes and a memorandum that document the findings of the Planning phase.

Step 7 – Further Coordination, Data Gathering, and Analysis

Coordination with prospective partners continues during this step. In addition to technical investigations, i.e. preliminary soil borings or survey, specific to the solutions being proposed with potential partners, the topics listed under Partnership Solutions in Step 5 should be discussed with potential partners. Share the results of the investigations with water management districts (and other partners) to ascertain the ability to permit the alternative solutions and determine what additional information is needed to resolve the level of alternatives' certainty.

Where corridors cross several basins, a combination of solutions may be needed to address project stormwater requirements. When a single innovative approach does not fully satisfy stormwater regulatory requirements on the project, different solutions may be applied, including traditional stormwater retention or detention ponds.

Outcome: Documentation of satisfaction of stormwater regulatory requirements.

Step 8 – Negotiate and Execute Agreement with Partners

Formal agreements involving partnership solutions are developed by agency legal staff and executed between the agency and its partners. The type of legal agreement will depend on the partnering entity. For example, with state or federal regulatory agencies, a Memorandum of Agreement (MOA) or a Memorandum of Understanding (MOU) may be used, but local governments typically execute a Joint Project Agreement (JPA) or easements.

Outcome: MOU/MOA/JPA

Step 9 – Traditional Pond Siting

Once it has been determined by the Stormwater Team that ponds may be needed to meet regulatory requirements, and that the acquisition of right-of-way will be required to accommodate these proposed ponds, a Pond Siting Process may commence. FDOT's Pond Siting Process is in the Drainage Design Guide[KM15].

Outcome: Stormwater Management Report.

Step 10 – WMD Coordination and ERP Permit (as needed)

With innovative solutions selected and agreements in place, the stormwater component of the ERP may now be ready for at least a conceptual WMD permit. Different permitting scenarios can be employed, depending on the types of stormwater management solutions selected, as shown in Table 20 – 3 Project Permitting Scenarios Involving Full and Partial Solutions.

If the Design Phase is concurrent with the Preliminary Engineering Phase a Construction ERP permit can be obtained.

Table 20 – 3 Project Permitting Scenarios Involving Full and Partial Solutions

Innovative Solutions -Full	Innovative Solutions -Partial	Pond Siting Process Complete	Resource Requirements Satisfied and Roadway Plans Sufficiently Developed	Conceptual Permit	Construction Permit
✓	-	-	✓		✓
✓	-	-	X*	✓	
-	✓	✓	✓		✓
-	✓	✓	X*	✓	

* Conceptual plans will be needed for the Conceptual Permit application[KM16].

Outcome: Appropriate WMD permit.

Step 11 – Document: Stormwater Management Report

The Stormwater Management Report summarizes the memoranda prepared in planning; discusses the stormwater solutions ~~analysed~~analyzed, and solutions considered but eliminated; and documents the stormwater management solutions which will satisfy the water quality and attenuation needs of the project. This report will include all agreements with stakeholders and a summary of all meetings. If traditional pond siting was pursued the report will contain the preliminary drainage design of the project and, as needed, all traditional pond sites ~~analysed~~analyzed for design. The memoranda prepared in planning, any agreements with stakeholders, and meeting minutes should be included as attachments to this report.

Outcome: Stormwater Management Report.

Step 12 – Final Design, Final Permits, Construction, and Maintenance

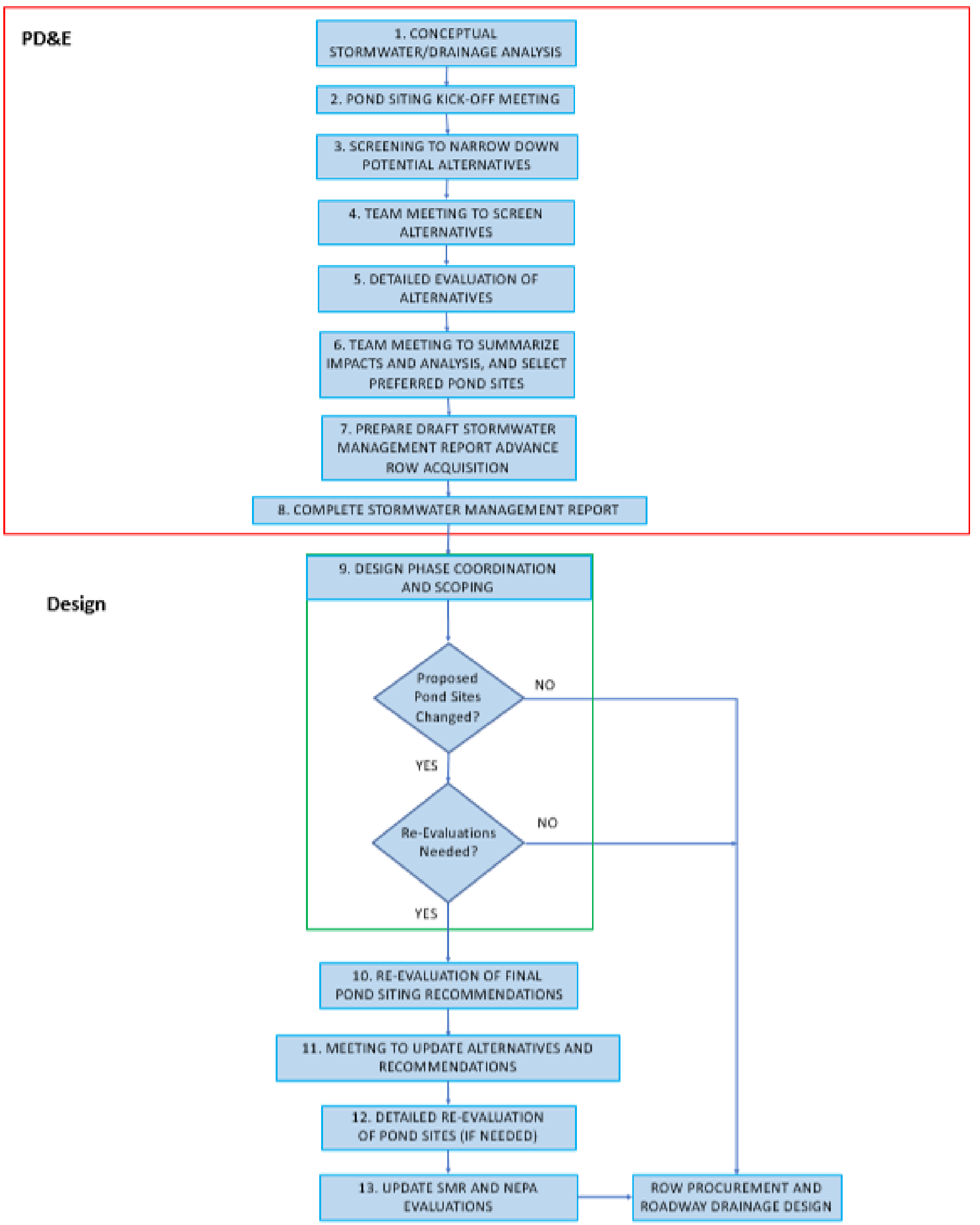
Design and stormwater plans production are finalized. Construction permits are obtained for the project as required. Stakeholder coordination and communication should be continued by the Champion during this time, including the transfer of maintenance responsibility to partners, if agreed upon as part of the partnership.

Outcome: Completed project including transfer of maintenance to partners, if applicable.

D.2 Pond Siting Process[KM17]

The following pond siting process provides guidance for identifying, evaluating, and selecting locations for stormwater management ponds when those ponds require right of way (ROW) acquisition. The need for ponds may be driven by regulatory water quality, attenuation, and/or floodplain mitigation requirements. An overview is provided in Figure 20 – 2 Pond Siting Process Flowchart.

Figure 20 – 2 Pond Siting Process Flowchart[KM18]



Step 1: Conceptual Stormwater/Drainage Analysis

Once it has been determined that traditional pond sites are needed to meet water quality or quantity requirements or dual evaluation will be needed, the following process can be used for conceptual analysis.

1. Establish drainage design criteria (may include a pre-permit application meeting with agencies). Criteria should include the following:

    - Permitting criteria (water quality and quantity as well as discharge limitations).
    - Rainfall intensity for critical duration events (identify design storm events).
    - Curve numbers or runoff coefficients.
    - Times of concentration.
    - Tailwater criteria (discharge condition and stages).

2. Conduct a review of drainage permit files for the corridor and adjacent developments.

3. Determine drainage basin boundaries using aerial contour maps, old construction plans, and available surveys to identify the primary basins and general outfall locations.

    - Identify high points on the profile to separate the primary basins.
    - Conduct field visits for this determination.

4. Determine major off-site contributing areas.

5. Establish floodplain elevations and potential for encroachment.

6. Identify outfall locations and verify if closed basin criteria apply.

7. Develop generic soils information (obtain from County Soil Conservation Survey or from earlier geotechnical studies conducted in the area).

8. Establish seasonal high ground water table (SHGWT) elevations.

9. Develop design estimates for water quality and water quantity requirements.

10. Develop an initial system model using a routing program.

11. Identify alternative pond design options based on project site conditions and available funding. A general rule of thumb for placement of ponds in relatively flat terrain is to target one pond per mile of corridor. In hilly areas, pond locations are typically much more frequent, as driven by the roadway profile.

12. Identify alternative stormwater management options (consider available funding):

    - Existing stormwater management facilities – are these adequate to handle the proposed improvements (with or without modifications)?
    - Potential exfiltration trench options.
    - Dry detention / retention systems.
    - Wet detention / retention systems.

13. Coordinate with the ROW Office on some initial sites to discuss at the kick-off meeting.

14. Discuss the area's stormwater management with the other agencies involved and estimate the impacts of the potential pond sites and feasibility of being incorporated into the area plan.

Outcome: Conceptual drainage design, including identified types of ponds and their approximate capacity.

Approximate Timeline: 2 months

Step 2: Pond Siting Kick-off Meeting

Before the meeting, coordinate with the right of way and legal staff to identify some initial pond sites to discuss at the kick-off meeting. During the meeting, the following issues should be addressed:

1. Verification of pond design guidelines and criteria (includes District preferences).
2. Identify potential detention / retention pond sites.
3. Assign property ID number to each property to be considered. The ROW Office will provide these numbers.
4. Identify potential joint-use pond sites (public / private).
5. Task team members with an assignment to conduct an impact analysis. Assign impact analysis to team members.

Outcome: A developed framework for future pond site evaluations.

Approximate Timeline: 2 weeks

Step 3: Screening to Narrow Down Potential Alternatives

This evaluation consists of a general review to narrow down potential alternatives. This effort may include site specific geotechnical testing, survey, constructability reviews, etc. Issues to consider when evaluating right-of-way include:

1. Use existing ROW whenever possible.
2. Minimize the number of parcels required for pond construction along the corridor.
3. Review aerials for potentially available vacant land. Use vacant land whenever possible and economical.
    - Establish why a property is vacant, and if the property owner has plans for development. Land may be vacant because the owner is having difficulty in permitting proposed improvements.

- Consider the development potential of a property.

4. Look at how each pond location is situated on the site. Consider the impacts to the remainder of the parcel and its viability for development. How will it function for its current or future use?

   - Weigh the impacts of a partial ROW acquisition versus a whole acquisition of the property.

5. Avoid the following types of properties if possible:

   - Residential and commercial relocations.
   - Public and historic facilities.
   - Pond sites directly located on major streets and highways.
   - Pond sites on or adjacent to contaminated sites.

6. Look at access management issues and how the remainder of the site will operate.

   - Avoid landlocking the remaining property.
   - Consider how maintenance will access the pond site.

7. Avoid or minimize impacts to existing wetland systems and wildlife habitat. When placing ponds near wetlands, check the potential drawdown effects on the wetlands.

8. Avoid floodplain impacts.

9. Minimize utility relocations and review requirements for utility access for maintenance purposes.

10. Identify if proposed pond sites are candidates for advanced acquisition. If so, the ROW staff must have an increased role and the advanced ROW process identified in the project schedule.

Outcome: Initial evaluation of potential pond sites.

Approximate Timeline: 4 weeks.

Step 4: Team Meeting to Screen Alternatives

For the evaluation of stormwater management ponds several standardized factors should be considered, as shown in Table 20 – 4 Evaluation Factors for Pond Siting Alternatives. The project's stormwater team has the option of customizing the factors within the matrix to satisfy the particularities of their project. An example of a matrix format is shown in Exhibit 20 – 1 Evaluation Matrix Example.

For consistency, the team should use a ranking for each factor that is agreed upon by the entire group.

Outcome: Pond site alternatives are reduced to 3 sites per basin, with (1) team member assignments allocated for further, more detailed evaluation; and (2) needed survey requested for the alternative sites still under consideration.

Approximate Timeline: 2 - 3 weeks.

Table 20 – 4 Evaluation Factors for Pond Siting Alternatives

Factor	Description/Issues to Consider	Cost $	Weighted Value
Brief Description of Alternative	Provide a detailed description of the pond site.	N/A	N/A
Parcel Number	Identify the Parcel Number with the Right-of-Way office.	N/A	N/A
Estimated Parcel Size (Acres)	Provide the total area for the required ROW acquisition. The total area is to include the area to meet the water quality / quantity storage requirements as well as maintenance berm width, slopes, perimeter drainage/conveyance ditch area and access to pond sites for maintenance.	N/A	N/A
Right-of-Way (Zoning)	Describe the status of the parcel in question. For example, the parcel could be currently under a proposed plan for improvement (Rezoning Request) or the site may currently be located on a commercial site with an active business. Consideration should also be given to existing and proposed zoning.	N/A	If there are no zoning issues with the site add 5 points per acre. If there are potential zoning issues, add zero points.
Land Use	Identify the current and/or proposed land use, which could affect the acquisition costs of the parcel. For example, a partial ROW acquisition of a property could have a significant impact on the use of the remaining parcel.	N/A	Costs will need to be added to the overall site costs and a weighted value applied accordingly.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Right-of-Way Costs	Identify Right-of-Way Costs associated with the acquisition of the parcel.	$	Costs will need to be added to the overall site costs and a weighted value applied accordingly.
Drainage Considerations	Include a description of the system and corresponding outfall location and parameters. Consider pond location such as in the center of the basin, in the low area within the basin, adjacent to the outfall location, and piping needs / costs, etc. Also consider site elevations and the corresponding need to elevate (build-up) the perimeter berm.	$	Meets FDOT's needs – points TBD by Team. Meets most needs – points TBD by Team. Other issues between sites will be depend on construction costs of a facility at each particular site.
FEMA Flood Zone	Identify the Flood Zone and associated impacts / benefits of a pond within the flood zone. The perimeter berm will affect flood zone storage, while the pond will enhance storage. When right-of-way is acquired within a low-lying area, the construction of the roadway template may affect adjacent properties' ability to use that area for storage.	N/A	Meets FDOT's needs – points TBD by Team. Meets most needs – points TBD by Team. Other issues will depend on the benefit to the floodplain at each particular site.
Contamination – Hazardous Materials	Identify if the parcel is contaminated; this will limit the ability to use the site. Consideration of this parcel must include the costs associated with the clean-up of the site.	N/A	Additional costs will need to be added to the overall site costs and a weighted value applied accordingly.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Utilities	Identify existing and proposed utilities within or adjacent to the parcel. The cost of relocating utilities must be included in the consideration of a parcel.	$	Additional costs will need to be added to the overall site costs, and weighted value applied accordingly.
Threatened & Endangered Species (TES) and associated Mitigation Costs	Identify species as Threatened, Endangered, or Significant. Identify the anticipated mitigation costs.	N/A	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.
Noise	Identify noise impacts and corresponding noise abatement, which may impact the location and placement of pond sites.	N/A	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.
Wetlands / Protected Uplands and associated Mitigation Costs	High values indicate known habitat or historic presence such as Rookery Area. Medium values may be indicative of relatively undisturbed, natural, or stable habitat types. Low values may indicate disturbed habitats. Identify the cost of mitigating for these impacts.	$	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.
Cultural Resources Involvement and associated Costs	Identify the presence of cultural resources including archaeological and historical resources which could affect the suitability of the site in question and associated costs.	N/A	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Section 4(f)	Identify the presence of Section 4(F) properties which could affect the suitability of the site in question and associated costs.	N/A	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.
Public Wellfield	The proximity to a wellfield site will have a direct impact on the type of drainage facility which can be placed on the corresponding parcel.	N/A	N/A
Construction	Identify access for construction and associated impacts which may affect construction costs, such as amount of drainage piping required to reach pond.	N/A	No set weighted value is applicable for this item; however, requirements for items identified may have a direct impact on the construction cost. Consider this and add to the overall costs associated with utilizing this site.
Maintenance	Identify the costs of maintaining a facility at this location and the potential for maintenance agreements with others. Consider access costs to the pond site.	$	Working with District Maintenance, staff needs to establish yearly maintenance costs per acre of pond area. This could be a yearly cost, say over a twenty-year period, and brought to present value for inclusion in the overall cost item below. Establish a cost for: • Wet Detention Maint. Cost per Acre $ _____

Factor	Description/Issues to Consider	Cost $	Weighted Value
			• Dry Pond Maint. Cost per Acre[KM19] • Dry Linear Swale Cost per Acre • Offsite Pond Maintenance by others At the beginning of the Preliminary Engineering Study, the Project Manager should consult with the Maintenance Office for current maintenance costs.
Aesthetics	Identify the need for landscape buffers, fencing, variable pond shapes, etc.	N/A	No set weighted value is applicable for this item; however, requirements for fencing, landscaping, littoral shelves, etc. which have a direct impact on the area required to physically set the pond needs to be considered. Costs associated with plants, fencing etc. will need to be added to the overall costs of using the site.
Public Opinion / Adjacent Residency Concerns	Identify possible impacts to current or proposed land use (i.e., schools may dictate a dry pond versus a wet pond).	N/A	N/A; however, this factor may affect the type of system selected for a site.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Other	Joint Use potential	N/A	If the ability to use joint use ponds is available, assume a weighted value of 10 per acre-ft of available storage. Otherwise use zero for this value.
Total Applicable Costs	Identify the total cost of the parcel including cost identified from all issues above.	$	Costs vary significantly between rural and urban locations. This value should be used when comparing final costs between alternative pond locations. Engineering judgment will need to be considered and an acceptable cost modifier applied as agreed to by the team members. Use 1 point per 5% differential in cost between alternative sites.
Comments, Advantages, Disadvantages, etc.	Include a detailed description of the Advantages and Disadvantages associated with the parcel in question.	N/A	N/A

Step 5: Detailed Evaluation of Alternatives

Conduct a field review(s) and obtain survey as deemed necessary. The extent of the field review should include the verification of impacts to assess the viability of a potential pond site.

Outcome: Alternatives are fully evaluated in preparation for selecting a preferred pond site in each basin.

Approximate Timeline: 4 weeks.

Step 6: Team Meeting to Summarize Impacts and Analysis, and Select Preferred Pond Sites

During the public involvement process, reasonable efforts must be made to inform the public/affected property owners of the potential impacts to the community/properties of the proposed improvements. As such, properties identified for potential acquisition for retention/detention ponds should be presented to the public in the same manner as acquisition for geometric requirements. Although the proposed right of way acquisition is displayed, the public should be clearly informed that all proposals are preliminary, and subject to change, as the project develops.

Outcome: Selection of preferred pond sites.

Approximate Timeline: 1 week.

Step 7: Prepare Draft Stormwater Management Report/Advanced ROW Acquisition

The Stormwater Management Report should have been incrementally prepared as the pond siting process was unfolding and reviewed by the team. The draft Stormwater Management Report will be presented at the Public Meeting.

Outcome: The Draft Stormwater Management Report should be made available for the Public Meeting.

Approximate Timeline: 1 month.

Step 8: Hold Public Meeting/Workshop

Advertise and host public meeting/workshop to inform the public about the project and pond locations being considered. Gather public input and document comments for further consideration in design. Conceptual project plans, aerial photos, geotechnical information can be provided to improve the public's understanding of project impacts. Ensure notice of meeting is provided in a timely manner.

Outcome: Obtain public input.

Approximate Timeline: 6 weeks.

Step 9: Complete Stormwater Management Report

Finalize Stormwater Management Report and recommendations based on team's evaluation. Exhibit~~Table~~ 20~~xx~~ – 2, below, is a sample Table of Contents for Stormwater Management Reports.

1. Discuss and address comments from the Public Meeting.

2. Re-rank recommended and alternative pond sites, if necessary.

Outcome: Final Stormwater Management Report is completed.

Approximate Timeline: 1 week

Exhibit 20 – 2 Sample Table of Contents for Stormwater Management Reports

TABLE OF CONTENTS FOR POND SITING REPORTS

Exhibit F- Pond H Site Plan
Exhibit G- Pond Siting Matrix

APPENDICES

Appendix A- Pond Siting Plan

Appendix B- Geotechnical Data

a. Excerpts from Draft Preliminary Report of Geotechnical Exploration; S.R. 50 from Hancock Road to Orange County Line, Lake County, Florida by Law Engineering and Environmental Services, Inc. October 2003.

b. Excerpts from Draft Preliminary Report of Geotechnical Exploration; S.R. 50 from Lake County Line to East Turnpike Ramps, Orange County, Florida by Law Engineering and Environmental Services, Inc. October 2003.

c. Excerpts from the PD&E Geotechnical Investigation

d. Excerpts from Soil Survey of Lake County, Florida

e. Excerpts from Soil Survey of Orange County, Florida

Appendix C- Rainfall

Appendix D- Floodplain Data

Appendix E- Pond Siting Calculations

a. Water Quality and Attenuation
b. Pond Area Requirements (Proposed Locations)
c. Pond Area Requirements (Alternative Locations)
d. Recovery Time (Preliminary Evaluation)
e. ICPR Pre-Development Model Input & Results
f. ICPR Post-Development Model Input & Results

Step 10: Reevaluation of Final Pond Siting Recommendations

If pond sites selected in the Stormwater Management Report have materially changed from their conditions at the time of the completion, the team should ~~revaluate~~reevaluate the pond siting recommendations.

Outcome: Team members have reviewed changed pond sites and additional engineering data is identified for pursuit. Pond site layouts are refined.

Approximate Timeline: 1 week.

Step 11: Detailed Re-Evaluation of Pond Sites (If Needed)

Re-evaluate remaining viable recommended sites and identified alternate sites and conduct field reviews as necessary. Finalize pond site layout with site geometrics for the viable recommended sites and identified alternatives.

Outcome: Changes to previous pond sites are evaluated in preparation for team discussion and updating of documents.

Approximate Timeline: 3 weeks.

Step 12: Update Stormwater Management Report

Review the findings from the previous step, update the matrix as necessary, recommend final pond sites for project, update the Stormwater Management Report based on team evaluations, and finalize the information. Send to right of way mapping the preferred pond sites as specified in the revised Stormwater Management Report. Send right of way requirements to the right of way staff for procurement.

Outcome: Stormwater Management Report is updated, ROW acquisition begins.

Approximate Timeline: 4 weeks.

E~~C~~ OPEN CHANNEL[KM20]

This section presents minimum standards for the design of natural or manmade open channels, including roadside ditches, swales, median ditches, interceptor ditches, outfalls, and canals.

E~~C~~.1 Design Frequency

Open channels shall be designed to convey and to confine storm water within the ditch. Standard design frequencies for stormwater flow are shown in Table 20 – 5~~1~~ Stormwater Flow Design Frequencies.

Table 20 – 5~~1~~ Stormwater Flow Design Frequencies

Facility Types	Frequency
Major roadway	10-year
All other road types	5-year

Site-specific factors may warrant the use of an atypical design frequency. Any increase over pre-development stages shall not significantly change land use values, unless flood rights are acquired.

E~~C~~.2 Hydrologic[AT21] Analysis

For the design of open channels, use one of the following methods as appropriate for the site: ~~Hydrologic data used for the design of open channels shall be based on one of the following methods as appropriate for the particular site:~~

1. A frequency analysis of observed (gage) data shall be used when available. If insufficient or no observed data is available, one of the procedures below shall be used as appropriate. However, the procedures below shall be calibrated to the extent practical with available observed data for the drainage basin, or nearby similar drainage basins.

~~1.~~a) Regional or local regression equation developed by the United States Geological Survey (USGS).

~~2.~~b) Rational Equation for drainage areas up to 600 acres.

~~3.~~c) For outfalls from stormwater management facilities, the method used for the design of the stormwater management facility may be used.

2. For regulated or controlled canals, hydrologic data shall be requested from the controlling entity. Prior to use for design, this data shall be verified to the extent practical.

~~2.~~3. Stormwater modeling software, approved by the maintaining agency or local government jurisdiction.

E~~C~~.3 Hydraulic Analysis

The Manning's Equation shall be used for the design of open channels.

E~~C~~.3.a Manning's "n" Values

Recommended Manning's n values for channels with bare soil, vegetative linings, and rigid linings are presented in the ~~Department's Drainage Manual (2008), Table 2.1 and 2.2.~~ ***Department's Drainage Manual (2018)***, Table 2.2~~1~~ Manning's "n" Values for Artificial Channels with Bare Soil and Vegetative Linings and Table 2.3 Manning's 'n" Values for Artificial Channels and Rigid Linings. The manual is incorporated by reference in ***Section 14-86.003, F.A.C., Permit, Assurance Requirements, and Exceptions***.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

The probable condition of the channel when the design event is anticipated shall be considered when a Manning's n value is selected.

E~~C~~.3.b Slope

Roadside channels should be designed to have self-cleaning velocities, where possible. Channels should also be designed to avoid standing water in the roadway right-of-way.

E~~C~~.3.c Channel Linings and Velocity

The design of open channels shall consider the need for channel linings. When design flow velocities do not exceed the maximum permissible for bare earth, the standard treatment of ditches may consist of grassing and mulching. For higher design velocities, sodding, ditch paving, or other form of lining shall be provided. Tables for maximum velocities for bare earth and the various forms of channel lining can be found in the Department's Drainage Manual (2018), Tables 2.4~~3~~ Maximum Shear Stress Values and Allowable Velocities for Different Soils and Table 2.5~~4~~ Maximum Velocities for Various Lining Types.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

E~~C~~.3.d Limitations on Use of Linings

Grassing or sodding should not be used under the following conditions:

1. Continuous standing or flowing water
2. Areas that do not receive the regular maintenance necessary to prevent overgrowth by taller vegetation
3. Lack of nutrients
4. Excessive soil drainage
5. Areas excessively shaded

To prevent cracking or failure, concrete lining must be placed on a firm, well-drained foundation. Concrete linings are not recommended where expansive clays are present.

When concrete linings are to be used where soils may become saturated, the potential for buoyancy shall be considered. Acceptable counter-measures may include:

1. Increasing the thickness of the lining to add additional weight.

2. For sub-critical flow conditions, specifying weep holes at appropriate intervals in the channel bottom to relieve the upward pressure on the channel.

3. For super-critical flow conditions, using subdrains in lieu of weep holes.

E~~C~~.4 Construction and Maintenance Considerations

The type and frequency of maintenance that may be required during the life of drainage channels should be considered during their design, and allowances should be made for the access of maintenance equipment.

E~~C~~.5 Safety

The design and location of open channels shall comply with roadside safety and clear zone requirements. See ***Chapter 3 – Geometric Design*** for clear zone requirements, including special clearance criteria for canals.

E~~C~~.6 Documentation

For new construction, design documentation for open channels shall include the hydrologic and the hydraulic analyses, including analysis of channel lining requirements

.

F~~D~~ STORM DRAIN HYDROLOGY AND HYDRAULICS

This section presents minimum standards for the design of storm drain systems.

F~~D~~.1 Pipe Materials

See Section H~~G~~ for pipe material requirements.

F~~D~~.2 Design Frequency

The minimum design storm frequency for the design of storm drain systems shall be 3 years.

Site-specific factors may warrant the use of an atypical design frequency. Any increase over pre-development stages shall not significantly change land use values, unless flood rights are acquired.

F~~D~~.3 Design Tailwater

For most design applications where the flow is subcritical, the tailwater will either be above the crown of the outlet or can be considered to be between the crown and critical depth. To determine the energy grade line (EGL), begin with either the tailwater elevation or $(d_c + D)/2$, whichever is higher, add the velocity head for full flow and proceed upstream, adding appropriate losses (e.g., exit, friction, junction, bend, entrance).

An exception to the above procedure is an outfall with low tailwater. In this case, a water surface profile calculation would be appropriate to determine the location where the water surface will either intersect the top or end of the barrel and full-flow calculations can begin. In this case, the downstream water surface elevation would be based on critical depth or the tailwater, whichever is higher.

F~~D~~.4 Hydrologic Analysis

The Rational Method is the preferred~~most common~~ method in use for the design of storm drains when the momentary peak-flow rate is desired[KM22][AT23]. Other methods may be used, with permission by the maintaining agency or local government jurisdiction[KM24].

F~~D~~.4.a Time of Concentration

Minimum time of concentration shall be 10 minutes.

F~~D~~.5 Hydraulic Analysis

Hydraulic calculations for determining storm drain conduit sizes shall be based on open channel and pressure flow as appropriate. The Manning's equation shall be used.

F~~D~~.5.a Pipe Slopes

The minimum physical slope should be that which will produce a velocity of 2.5 feet per second (fps) when the storm drain is flowing full. Where not practical or possible in flat terrain, include design features to limit soils from entering the pipes.

F~~D~~.5.b Hydraulic Gradient

If the hydraulic grade line (HGL) does not rise above the top of any manhole or above an inlet entrance, the storm drainage system is satisfactory. Standard practice is to ensure that the HGL is below the top of the inlet for the design discharge (some local agencies may add an additional safety factor which can be up to 12 inches). Manholes with bolted lids may be used in locations where the top is below the HGL.

F~~D~~.5.c Outlet Velocity

When discharge exceeds 4 fps, consider special channel lining or energy dissipation. For computation of outlet velocity the lowest anticipated tailwater condition for the given storm event shall be assumed.

F~~D~~.5.d Manning's Roughness Coefficients

Standards Manning's Roughness Coefficients can be found in the Department's ***Drainage Manual (2018) Section 3.6.4***.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

F~~D~~.6 Hydraulic Openings

If the hydraulic grade line does not rise above the top of any manhole or above an inlet entrance, the storm drainage system is satisfactory. Standard practice is to ensure that the HGL is below the top of the inlet for the design discharge.

F~~D~~.6.a Entrance Location and Spacing

Drainage inlets and other hydraulic openings are sized and located to satisfy hydraulic capacity, structural capacity, safety (pedestrians, cyclists and motor vehicles), and durability requirements.~~limit the spread of water on the roadway to allowable widths for the design storm.~~

Grate inlets and the depression of curb opening inlets should be located outside the through traffic lanes to minimize the shifting of vehicles attempting to avoid them. All grate inlets shall be bicycle safe where used on roadways that allow bicycle travel.

The Department's ***Drainage Manual (2018), Section 3.7*** ~~***Storm Drain Handbook***~~ provides guidance on hydraulic openings and protective treatments. Table 3.3 Curb and Inlet Application Guidelines, Table 3.4 Ditch Bottom Inlet Application Guidelines and Table 3-5 Drainage End Treatment – Lateral Offset Criteria in the ***Drainage Manual*** provide ~~s available as a~~ guidance for inlet selection.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

Inlet spacing shall consider the following:

- Regardless of the results of the hydraulic analysis, inlets on grade should be spaced at a maximum of 300 feet for 48 inches or smaller pipes.
- Inlets on grade should be spaced at a maximum of 600 feet for pipes larger than 48 inches.
- Inlets should be placed on the upstream side of bridge approaches.
- Inlets should be placed at all low points in the gutter grade.

- Inlets should be placed upstream of intersecting streets.
- Inlets should be placed on the upstream side of a driveway entrance, curb-cut ramp, or pedestrian crosswalk even if the hydraulic analysis places the inlet further down grade or within the feature.
- Inlets should be placed upstream of median breaks.
- Inlets should be placed to capture flow from intersecting streets before it reaches the major highway.
- Flanking inlets in sag vertical curves are standard practice.
- Inlets should be placed to prevent water from sheeting across the highway (i.e., place the inlet before the superelevation transition begins).
- Inlets should not be located in the path where pedestrians walk.

F~~D~~.6.b Grades

F~~D~~.6.b.1 Longitudinal Gutter Grade

The minimum longitudinal gutter grade shall be 0.3%. Minimum grades can be maintained in very flat terrain by use of a rolling profile.

F~~D~~.7 Spread Standards

The spread, in both temporary and permanent conditions, resulting from a rainfall intensity of 4.0 inches per hour shall be limited as shown in Table 20 – 6~~2~~ Spread Criteria.

Table 20 – 6~~2~~ Spread Criteria

Design Speed (mph)	**Spread Criteria***
Design ~~Speed ≤~~Speed ≤ 30	Crown of Road
30 < Design speed ≤ 45	Keep ½ of lane clear
45 < Design Speed ≤ 55	Keep 8’ of lane clear
Design Speed > 55	No encroachment

* The criteria in this column apply to travel, turn, or auxiliary lanes adjacent to barrier wall or curb, in normal or super elevated sections.

In addition to the above standards, for sections with a shoulder gutter, the spread resulting from a 10-year frequency storm shall not exceed 1' 3" outside the gutter in the direction toward the front slope. This distance limits the spread to the face of guardrail posts.

F~~D~~.8 Construction and Maintenance Considerations

Proper design shall also consider maintenance concerns of adequate physical access for cleaning and repair.

F~~D~~.8.a Pipe Size and Length

Consider using a minimum pipe size of 18" for trunk lines and laterals. 15" hubcaps commonly block smaller pipes resulting in roadway flooding. The minimum pipe diameter for all proposed exfiltration trench pipes (french drain systems) within a drainage system is 18".

The maximum pipe lengths without maintenance access structures are as follows:

Pipes without French Drains:

18" - 42" pipe	300 feet
48" and larger and all box culverts	600 feet

French Drains that have access through only one end:

18" to 30" pipe	150 feet
36" and larger pipe	200 feet

French Drains that have access through both ends:

24" to 30" pipe	300 feet
36" and larger pipe	400 feet

F~~D~~.8.b Minimum Clearances

A minimum cover of 1 ft should be provided between the top of pipe and the top of subgrade. A minimum clearance of 1 ft should be provided between storm drainage pipes and other underground facilities (e.g., sanitary sewers). Check with local utility companies, as their clearance requirements may vary from the 1' minimum.

F~~D~~.9 Protective Treatment

Drainage designs shall be reviewed to determine if some form of protective treatment will be required to prevent unauthorized entry to long or submerged storm drain systems, steep ditches, or water control facilities. If other modifications, such as landscaping or providing flat slopes, can eliminate the potential hazard and thus the need for protective treatment, they should be considered first. Areas provided for retention and detention, for example, can often be effectively integrated into parks or other green spaces.

Vehicular and pedestrian safety are attained by differing protective treatments, often requiring the designer to make a compromise in which one type of protection is more completely realized than the other. In such cases, an evaluation should be made of the relative risks and dangers involved to provide the design that gives the best balance. It must be remembered that the function of the drainage feature will be essentially in conflict with total safety, and that only a reduction rather than elimination of all risk is possible.

The three basic types of protective treatment are shown in Table 20 – 7~~3~~ Protective Treatments.

Table 20 – 7~~3~~ Protective Treatments

Feature	Typical Use
Grates	To prevent persons from being swept into long or submerged drainage systems.
Guards	To prevent entry into long sewer systems under no-storm ~~-~~conditions, to prevent persons from being trapped.
Fences	To prevent entry into areas of unexpected deep standing water or high velocity water flow, or in areas where grates or guards are warranted but are unsuitable for other reasons.

When determining the type and extent of protective treatment, the following considerations should be reviewed:

- The nature and frequency of the presence of children in the area, e.g., proximity to schools, school routes, and parks, should be established.
- Highway access status should be determined. Protective treatment is usually not warranted within a limited access highway; however, drainage facilities located outside the limited access area or adjacent to a limited access highway should be considered unlimited access facilities.
- Adequate debris and access control would be required on all inlet points if guards or grates are used at outlet ends.
- Hydraulic determinations such as depth and velocity should be based on a 25-year rainfall event.
- The hydraulic function of the drainage facility should be checked and adjusted so the protective treatment will not cause a reduction in its effectiveness.

- Use of a grate may cause debris or persons to be trapped against the hydraulic opening. Grates for major structures should be designed in a manner that allows items to be carried up by increasing flood stages.
- Use of a guard may result in a person being pinned against it. A guard is usually used on outlet ends.
- A fence may capture excessive amounts of debris, which could possibly result in its destruction and subsequent obstruction of the culvert. The location and construction of a fence shall reflect the effect of debris-induced force.

F~~D~~.10 Documentation

For new construction, supporting calculations for storm sewer system design shall be documented and provided to facility owner.

G~~E~~ CROSS DRAIN HYDRAULICS

This section presents standards and procedures for the hydraulic design of cross drains including culverts, bridge-culverts[1], and bridges.

G~~E~~.1 Design Frequency

The recommended minimum design flood frequency for culverts is shown in Table 20 – 8~~4~~ Recommended Minimum Design Flood Frequency. The minimum flood frequency used to design the culvert can be adjusted based on:

- An analysis to justify the flood frequencies greater or lesser than the minimum flood frequencies listed below; and
- The culvert being located in a National Flood Insurance Program mapped floodplain.

Table 20 – 8~~4~~ Recommended Minimum Design Flood Frequency

Roadway Classification	Exceedance Probability (%)	Return Period (Year)
Local Roads and Streets~~,~~ ADT >3,000 VPD	4%	25
Local Roads and Streets~~,~~ ADT ≤ 3,000 VPD*	20 - 10%	5 - 10

*At the discretion of the local agency

G~~E~~.2 Backwater

Allowable headwater is the depth of water that can be ponded at the upstream end of the culvert during the design flood. The allowable headwater for the design frequency should:

[1] A culvert qualifies as a bridge if it meets the requirements of Item 112 in the Department's FDOT "*Bridge Management System (BMS) Coding Guide.*"

- Have a level of inundation that is tolerable to upstream property and roadway for the design discharge;

- Consider a duration or inundation that is tolerable to the upstream vegetation to avoid crop damage; and

- Be lower than the upstream shoulder edge elevation at the lowest point of the roadway within the drainage basin.

If the allowable headwater depth to culvert height ratio (HW/D) is established to be greater than 1.5, the inlet of the culvert will be submerged. Under this condition, the hydraulics designer should provide an end treatment to mitigate buoyancy.

G~~E~~.3 Tailwater

For the sizing of cross drains and the determination of headwater and backwater elevations, the highest tailwater elevation which can be reasonably expected to occur coincident with the design storm event shall be used.

G~~E~~.4 Clearances

To permit the passage of debris, a minimum clearance of 2 ft should be provided between the design approach water surface elevation and the low chord of the bridge where practical. Where this is not practicable, the clearance should be established by the hydraulics engineer based on the type of stream and level of protection desired. Additional vertical clearance information can be found in ***Chapter 3 – Geometric Design***.

G~~E~~.5 Bridges and Other Structures

See ***Chapter 17, Section C.3.e*** for Drainage Criteria.

~~F STORMWATER MANAGEMENT~~[KM25][KM26]

~~F.1 Regulatory Requirements~~

~~F.1.a Chapter 62-25, Florida Administrative Code~~

~~***Chapter 62-25. F.A.C.,*** rules of the Florida Department of Environmental Protection specifies minimum water quality treatment standards for new development.~~

~~F.1.b Chapter 62-40, Florida Administrative Code~~

~~***Chapter 62-40, F.A.C.***, rules of the Florida Department of Environmental Protection outlines basic goals and requirements for surface water protection and management to be implemented and enforced by the Florida Department of Environmental Protection and Water Management Districts.~~

~~F.1.c National Pollutant Discharge Elimination System~~

~~The ***National Pollutant Discharge Elimination System*** (***NPDES***) permit program is administered by the U. S. Environmental Protection Agency and delegated to the Florida Department of Environmental Protection in Florida. This program requires permits for stormwater discharges into waters of the United States from industrial activities; and from large and medium municipal separate storm sewer systems (MS4s). Construction projects are within the definition of an industrial activity.~~

H~~G~~ CULVERT MATERIALS

The evaluation of culvert materials shall consider functionally equivalent performance in three areas: durability, structural capacity, and hydraulic capacity.

H~~G~~.1 Durability

Culverts shall be designed for a design service life (DSL) appropriate for the culvert function and highway type. The design service life should be based on factors such as:

- Projected service life of the facility
- Importance of the facility
- Economics
- Potential inconvenience and difficulties associated with repair or replacement, and projected future demands on the facility.

In estimating the projected service life of a material, consideration shall be given to actual performance of the material in nearby similar environmental conditions, its theoretical corrosion rate, potential for abrasion, and other appropriate site factors. Theoretical corrosion rates shall be based on the environmental conditions of both the soil and water. At a minimum, the following corrosion indicators shall be considered:

1. pH
2. Resistivity
3. Sulfates
4. Chlorides

The Department ~~of Transportation~~ provides a ~~free~~ program called ***Culvert Service Life Estimator***[AT27] for estimating the service life of culverts~~service life determination~~ based on the above criteria. ~~The program is available for download at:~~ The Culvert Service Life Estimator is based upon the soils the pipe is placed in, and not type of water the pipe carries.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

To avoid unnecessary site specific testing, generalized soil maps may be used to delete unsuitable materials from consideration. The potential for future land use changes which may change soil and water corrosion indicators shall also be considered to the extent practical.

H~~G~~.2 Structural Capacity

AASHTO design guidelines and industry recommendations should be considered in pipe material selection.

H~~G~~.3 Hydraulic Capacity

The hydraulic evaluation shall establish the hydraulic size for the particular culvert application. For storm drains and cross drains, the design shall use the Manning's roughness coefficient associated with the pipe material selected.

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