Design Manual Revision Summaries
Design Policy and Standards Revisions

May 2004 Revision

The revision starts after page 5 of this document

The Design Office is launching a new service of providing a summary of the most recent revisions to the *Design Manual*.

Design Manual

Reminder: Revision marks are used throughout to highlight content changes. This is primarily demonstrated through the use of sidebars and underlining. Manual users should periodically check the *Design Manual* Errata webpage located on the Design Policy page under "What's New". Manual users should report all undocumented errors to ensure all errors are documented.

General

- Review and update references, definitions, titles, & acronyms as appropriate.
- Clean up references to metric units of measure
- The "Documentation" subheadings are revised to direct the reader to the Documentation Check List on line.

***Design Manual* Supplements**

In alignment with the major *Design Manual* revision packages, an occasional *Design Manual* supplement may be issued. There have been three issued since May 2003. They are listed with the chapters that are affected.

Chapter 430 DM Supplements

(DM Supplement – March 25, 2004 – Urban Roadways {Revised})
Revised note to Figures 430-3 and 4 previously inserted by July 22, 2003 DM Supplement deleted as it is included in the companion DM Supplement (Design Speed) dated March 25, 2004.

(DM Supplement – March 2004 – Design Speed)
A complete rewrite of 430.02, Design Speed for modified design level projects. Correlation between design speed and posted speed. Figures 430-3 and 4 replaced.

(May 2004)

This minor revision revised one figure note to direct designer to Chapter 440 for urban area conditions when shoulders and curbs are involved

Chapter 440 Full Design Level

(DM Supplement – March 25, 2004 – Urban Roadways{Revised})
Incorporated text of Instructional Letter (IL) 4053.00 issued May 5, 2003 relating to jurisdiction over state highways within cities or towns. Remainder of Supplement restates July 2003 material but carries a March 25, 2004 date.

(DM Supplement – March 25, 2004 – Design Speed)
The definition of freeway added, and revised Figure 440-1 Desirable Design Speed.

Chapter 510 Investigation of Soils, Rock, and Surfacing Materials – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 530 Geosynthetics – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 620 Geometric Plan Elements – (May 2004)

Several significant changes were made in this chapter revision.

- The definition of outer separation was expanded to included relationship to a collector distributor road
- A slight refinement of where existing spiral curves fit in with the horizontal alignment.
- Added guidance to 620.03(3) Horizontal Curve Length and a new figure to address maximum deflection angles without curve (horizontal angle points).
- For distribution facilities, the user is now directed to Chapters 440 and 1430 for design values and right of way/access/turnback considerations. The user is no longer directly referred to the WAC 468-18, Local Agency Guidelines, or city/county standards from this chapter.
- For glare considerations the user is directed to Chapter 700
- A new paragraph and formula have been added to determine the minimum length of transition on roadways with a design speed less than 45 mph. **Note: unless we can get this page changed prior to printing the formula shown is incorrect. It should read: $L = TV^2/60$. For other technical *Design Manual* errata go to the following web site:**

  http://www.wsdot.wa.gov/eesc/design/policy/DMerrata3.htm

- For turning roadway widening widths the user is directed to Chapter 640
- Figures have been renumbered

Chapter 630 Geometric Profile Elements – (May 2004)

Several significant changes were made in this chapter revision.

- Minimum Length of Vertical Curves. Sag vertical curves may be reduced to a value less than required for stopping sight distance when three conditions are met:
  - An evaluate upgrade to justify the length reduction
  - Continuous illumination
  - Design for comfort of the vehicle occupants in accordance with the formula: $L = AV^2/46.5$. See chapter for variables
- Length of Grade. The basic speed reduction parameter has been change from 15 mph to 10 mph. New Figure 630-1 reflects the effects of this change and replaces former Figure 630-2
- Figures have been renumbered

Chapter 640 Geometric Cross Section
(DM Supplement – March 25, 2004 – Urban Roadways {Revised})

This supplement restates the guidance included in the July, 2003 supplement but carries the March 25, 2004 date.

(May 2004)

This chapter incorporated one minor revision.

- The "General" subheading was rewritten to incorporate applicable portions of IL 4053.00 Jurisdiction Over State Highways Within Cities

Chapter 710 – Traffic Barriers

(May 2004)

- Existing Type 7 bridge rail over a NHS highway is allowed to remain in place with a posted speed of 30 mph or less.
- Clarified that Case 4 in Figure 710-14 (Cable Barrier Locations on Slopes) – is for median applications

Chapter 720 Impact Attenuators – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 830 Delineation – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

(May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 850 Traffic Control Signals – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 915 Roundabouts – (May 2004)

This chapter was rewritten to:

- Update terminology for clarification
- Revise the presentation of subheading 915.01(2) to more clearly express the concerns of roundabouts over other intersection types
- Revise definition for central island diameter to include the truck apron
- Add guidance on pedestrian facilities and clarify that "truncated domes are the appropriate detectable warning surface
- Provide additional guidance on design of central islands
- Clarify design vehicle for individual movements and for the circulating roadway.
- Explain flexibility in design values based on specific site characteristics. Similar note was added to figure.
- Add guidance on entry speed, entry angle, spacing of entries, and entry capacity. Revised and added supporting figures.
- Add guidance on approach alignment. New figure added.
- Add guidance on operational influence of radius
- Clarification on evaluating stopping sight distance using the deflection speed.
- Add guidance on the effects of grades in excess of 4%
- Add reference to the MUTCD for signing and pavement marking
- Re-number and revise figures consistent with text changes

Chapter 960 Median Crossovers – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 1010 Auxilliary Lanes – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 1025 Pedestrian Design Considerations – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 1040 Weigh Sites – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 1060 Transit Benefit Facilities – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 1410 Right of Way Considerations – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 1425 Access Point Decision Report – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

Chapter 1450 Monumentation – (May 2004)

This chapter incorporated some minor revisions in terminology and references.

JANUARY 5, 2004
35 new or revised standard plans

Significant additions
- New NCHRP 350 crash-tested guardrail transitions
- New Precast concrete piles for ferry docks and local agencies
- Dept. of Labor and Industries acceptable overhead maintenance walkways
- Environmental Affairs approved temporary erosion control plans

Washington State Department of Transportation

Publications Transmittal

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Instructions:
Page numbers and corresponding sheet-counts are given in the table below to indicate portions of the *Design Manual* that are to be removed and inserted to accomplish this revision.

Chapter	Remove		Insert	
	Pages	Sheets	Pages	Sheets
Letter's List	N/A	1	N/A	1
Contents	1-23	12	1-23	12
430, "Modified Design Level"	3-4	1	3-4	1
510, "Investigation of Soils, Rock, and Surfacing Materials"	1-16	8	1-15	8
530, "Geosynthetics"	11-14	2	11-14	2
620, "Geometric Plan Elements"	1-8	4	1-8	4
630, "Geometric Profile Elements"	1-8	4	1-8	4
640, "Geometric Cross Section"	1-2	1	1-2	1
710, "Traffic Barriers"	3-4	1	3-4	1
710, "Traffic Barriers"	23-24	1	23-24	1
720, "Impact Attenuator Systems"	7-8	1	7-8	1
830, "Delineation"	5-6	1	5-6	1

840, “Illumination”	15-16	1	15-16	1
850, “Traffic Control Signals”	15-16	1	15-16	1
915, “Roundabouts”	1-29	15	1-29	15
960, “Median Crossovers”	1-2	1	1-2	1
1010, “Auxiliary Lanes“	5-6	1	5-6	1
1025, “Pedestrian Design Considerations”	7-12	3	7-12	3
1040, “Weigh Sites”	5-6	1	5-6	1
1060, “Transit Benefit Facilities”	19-20	1	19-20	1
1410, “Right of Way Considerations”	1-6	3	1-6	3
1425, “Access Point Decision Report”	9-10	1	9-10	1
1450, “Monumentation”	3-4	1	3-4	1
DM Supplement, “Urban Roadways” Revised 3/25/2004	N/A		1 – 17	9
DM Supplement, “Design Speed” dated 3/25/2004	N/A		1 – 6	3
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Washington State Department of Transportation

Design Manual Supplements and Instructional Letters

Spring 2004

In Effect	Chapter	Date	Type	Subject/Title
Yes No No	HOV* 940 1050	9/28/99	DM Supplement	Left-Side HOV Direct Access Connections (Chapter 940 revised September 2002) (Chapter 1050 revised May 2003)
Yes No	HOV* 1050	05/03/00	DM Supplement	Left-Side HOV Parallel On-Connection (Chapter 1050 revised May 2003)
Yes	650	10/09/02	DM Supplement	Stopping Sight Distance
No **No** **No** **No** **No**	**700** **325** **330** **440** **640**	**5/5/2003**	**Instructional Letter 4053.00**	**Jurisdiction Over State Highways Within Cities** (Chapter 700 revised May 2003) (Chapters 325 & 330 revised December 2003) (Chapters 440 & 640 revised May 2004)
Yes **Yes** **No**	**440** **640** **430**	**3/25/2004**	**DM Supplement** **DM Supplement**	**Urban Roadways (Revised)** **(Design Speed 3/25/2004)**
Yes **Yes**	**430** **440**	**3/25/2004**	**DM Supplement**	**Design Speed**

* The *HOV Direct Access Design Guide*, Draft M 22-98

Notes:

- Changes since the last revision to the *Design Manual* are shown in bold print.
- Items with **No** in the **In Effect** column were superseded by the latest revision and will be dropped from the next printing of this list.
- The listed items marked *yes* have been posted to the web at the following location: http://www.wsdot.wa.gov/fasc/engineeringpublications/DesignLettersMemInstruction.htm

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Division 7 Roadside Safety Elements

Division 8 Traffic Safety Elements

Division 9 Interchanges and Intersections

Division 10 Auxiliary Facilities

Division 11 Structures

Division 14 Right of Way and Access Control

Figures

430.08 Fill Slopes and Ditch Inslopes

Foreslopes (fill slopes and ditch inslopes) and cut slopes are designed as shown in Figure 430-9 for modified design level main line roadway sections. After the foreslope has been determined, use the guidance in Chapter 700 to determine the need for a traffic barrier.

When a crossroad or road approach has steep foreslopes, there is the possibility that an errant vehicle might become airborne. Therefore, flatten crossroad and road approach foreslopes to 6H:1V where practical and at least to 4H:1V. Provide smooth transitions between the main line foreslopes and the crossroad or road approach foreslopes. Where possible, move the crossroad or road approach drainage away from the main line. This can locate the pipe outside the design clear zone and reduce the length of pipe required.

430.09 Intersections

(1) General

Except as given below, design intersections to meet the requirements in Chapter 910.

(2) Design Vehicle

Figure 430-2 is a guide for determining the design vehicle. Perform a field review to determine intersection type, type of vehicle that use the intersection, and adequacy of the existing geometrics.

(3) Angle

The allowable angle between any two respective legs is between 60° and 120°. When realignment is required to meet this angle requirement, consider realigning to an angle between 75° and 105°.

430.10 Bridges

Design all new and replacement bridges to full design level (Chapter 440) unless a corridor or project analysis justifies the use of modified design level lane and shoulder widths. Evaluate bridges to remain in place using Figures 430-3 and 4. Whenever possible, continue the roadway lane widths across the bridge and adjust the shoulder widths.

Intersection Type	Design Vehicle
Junction of Major Truck Routes	WB-67
Junction of State Routes	WB-40
Ramp Terminals	WB-40
Other Rural	SU(1)
Urban Industrial	SU(1)
Urban Commercial	P(1)
Residential	P(1)

(1) When the intersection is on a transit or school bus route, use the BUS design vehicle. See Chapter 1060 for additional guidance for transit facilities and for the BUS turning path templates.

Design Vehicles
Modified Design Level
Figure 430-2

Consider joint use with other modes of transportation in lane and shoulder design. See Chapters 1020, 1050, and 1060.

430.11 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

	Multilane Divided				Multilane Undivided			
	Trucks Under 10%		Trucks 10% and Over		Trucks Under 10%		Trucks 10% and Over	
Design Class	MDL-1	MDL-2	MDL-3	MDL-4	MDL-5	MDL-6	MDL-7	MDL-8
Current ADT(1)	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000
Design Speed	The posted speed, the proposed posted speed, or the operating speed, whichever is higher.							
Traffic Lanes Number Width	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft
Parking Lanes Urban	None	None	None	None	8 ft	8 ft (2)	8 ft	8 ft (2)
Median Width Rural Urban	Existing Existing	Existing Existing	Existing Existing	Existing Existing	2 ft 2 ft	4 ft 2 ft	4 ft 2 ft	4 ft 2 ft
Shoulder Width Right (3) Left (4)	4 ft 2 ft	6 ft 2 ft	4 ft 2 ft	6 ft 2 ft	4 ft	6 ft (5)	4 ft	6 ft (5)
Minimum Width for Bridges to Remain in Place (6)(7)(8)	24 ft (9)	26 ft (9)	24 ft (9)	26 ft (10)	48 ft (9)	50 ft (9)(11)	50 ft (9)(11)	54 ft (10)(11)
Minimum Width for Rehabilitation of Bridges to Remain in Place (6)(12)(8)	28 ft (9)	30 ft (9)	28 ft (9)	32 ft (10)	54 ft (9)	60 ft (9)(11)(13)	56 ft (9)(11)	64 ft (10)(11)(13)
Minimum Width for Replacement	Full Design Level Applies (14)							
Access Control	See Chapter 1420 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Access Management Classification Report							

(1) If current ADT is approaching a borderline condition, consider designing for the higher classification.

(2) Parking restricted when ADT is over 15,000.

(3) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft. In urban areas, see Chapter 440. On designated bicycle routes, the minimum shoulder width is 4 ft. (See Chapter 1020.)

(4) For lanes 11 ft or more in width, the minimum shoulder width to the face of the curb is 1 ft on the left.

(5) May be reduced by 2 ft under urban conditions.

(6) Width is the clear distance between curbs or rails, whichever is less.

(7) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only.

(8) For median widths 25 ft or less, see Chapter 1120.

(9) Add 11 ft for each additional lane.

(10) Add 12 ft for each additional lane.

(11) Includes a 4 ft median which may be reduced by 2 ft under urban conditions.

(12) Use these widths when a bridge within the project limits requires any work beyond the treatment of the deck such as bridge rail replacement, deck replacement, or widening.

(13) Includes 6 ft shoulders — may be reduced by 2 ft on each side under urban conditions.

(14) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

Modified Design Level for Multilane Highways and Bridges
Figure 430-3

Chapter 510 Investigation of Soils, Rock, and Surfacing Materials

510.01 General

It is the responsibility of the Washington State Department of Transportation (WSDOT) to understand the characteristics of the soil and rock materials that support or are adjacent to the transportation facility to ensure that the facility, when designed, will be adequate to safely carry the estimated traffic. It is also the responsibility of WSDOT to ensure the quality and quantity of all borrow materials used in the construction of transportation facilities.

The following information serves as guidance in the above areas. Where a project consists of a surface overlay of an existing highway, requirements as set forth in *WSDOT Pavement Guide for Design, Evaluation and Rehabilitation* are used.

To identify the extent and estimated cost for a project, it is necessary to obtain and use an adequate base data. In recognition of this need, preliminary soils investigation work begins during project definition. This allows early investigative work and provides necessary data in a timely manner for use in project definition and design. More detailed subsurface investigation follows during the project design and plan, specification, and estimate (PS&E) phases.

It is essential to get the region's Materials Engineer (RME) and the Headquarters (HQ) Geotechnical Services Division involved in the project design as soon as possible once the need for geotechnical work is identified. See 510.04(3) for time-estimate information. Furthermore, if major changes occur as the project is developed, inform the RME and HQ Geotechnical Services Division as soon as possible so that the geotechnical design can be adapted to the changes without significant delay to the project.

510.02 References

Construction Manual, M 41-01, WSDOT

Hydraulics Manual, M 23-03, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT

WSDOT Pavement Guide Interactive

510.03 Materials Sources

(1) General

The region's Project Development Engineer (RPDE) determines when a materials source is needed. The region's Materials Engineer (RME) determines the best materials source for the project. (See Figure 510-1.) It is preferred that existing approved materials source sites be used when there are suitable sites available. When there are no approved sites available, the RME conducts a site investigation. The HQ Geotechnical Services Division provides assistance upon request.

The RME selects sources for gravel base, borrow excavation and gravel borrow, crushed surfacing materials, mineral and concrete aggregates, riprap, and filler only after careful investigation of:

- The site. (Consider the adequacy of the work area.)
- The quality of the material.
- The quantity of the material. (Consider the needs of the immediate project and the needs to support future maintenance and construction work in the area.)

- Reclamation requirements.
- Aesthetic considerations.
- Economic factors.
- Ability to preserve or enhance the visual quality of the highway and local surroundings.

Once the materials source investigation and laboratory testing have been completed the RME prepares a materials source report. The materials source report summarizes the site geology, site investigation (including boring and test pit logs), source description, quality and quantity of material available, and other aspects of the materials sources that are relevant.

(2) Materials Source Approval

The RME submits the materials source report to the HQ Geotechnical Services Division for review and approval.

The HQ Materials Office and the HQ Design Office must approve each pit or quarry site before it is purchased, leased, or acquired on a royalty basis. Until the approval process is complete, the project cannot be advertised for bids. Local and state permits are required for materials sources. To avoid delay in advertising the project, begin the site investigations and permitting process in the early stages of project definition.

510.04 Geotechnical Investigation, Design, and Reporting

(1) General

A geotechnical investigation is conducted on all projects that involve significant grading quantities, unstable ground, or foundations for structures in a manner that preserves the safety of the public who use the facility, as well as preserving the economic investment by the state of Washington. Geotechnical engineering must be conducted by engineers or engineering geologists who possess adequate geotechnical training and experience, and must be conducted in accordance with regionally or nationally accepted geotechnical practice. Where required by law, geotechnical engineering must be performed by, or under the direct supervision of, a person licensed to perform such work in the state of Washington.

(2) Key Contacts for Initiating Geotechnical Work

In general, the RME functions as the clearing house for all geotechnical work, with the exception of structural projects and Washington State Ferries (WSF) projects. The RME takes the lead in conducting the geotechnical work if the geotechnical work required is such that the ground is stable and relatively firm, bedrock is not involved, and the design of the project geotechnical elements does not require specialized geotechnical design expertise. If this is not the case, the RME asks for the involvement and services of the HQ Geotechnical Services Division. They respond to and provide recommendations directly to the region's project design office (or the HQ Facilities Office in the case of Facilities projects), but always keeping the RME "in the loop."

For structural projects (bridges and tunnels, for example), the HQ Bridge and Structures Office works directly with the HQ Geotechnical Services Division.

For WSF projects, the Terminal Engineering Office works directly with the RME or the HQ Geotechnical Services Division, depending on the nature of the project.

For walls and noise walls, see Chapters 1130 and 1140, respectively. For geosynthetic design, see Chapter 530.

(3) Scheduling Considerations for Geotechnical Work

The region's Design Office, HQ Bridge and Structures Office, WSF, and the HQ Facilities Office are responsible for identifying the potential need for geotechnical work, and requesting time and budget estimates from the RME or the HQ Geotechnical Services Division, as early as practical to prevent delays to the project.

Once the geotechnical design request and the site data are received by the RME or the HQ Geotechnical Services Division, it can take anywhere from two to six months, or more, to complete the geotechnical design, depending on the complexity of the project, whether or not test holes are needed, current workload, the need to give the work to consultants, and how long it takes to obtain environmental permits and rights of entry (ROE).

If a consultant must be used, the minimum time required to complete a design (for even a simple project) is typically 2.5 months.

In true emergency situations (a highway blocked by a landslide or a collapsed bridge, for example), it is possible to get geotechnical design work completed (in house or by consultants) more rapidly to at least provide a design for temporary mitigation.

Consider all of these factors when deciding how soon to initiate the geotechnical work for a project but, in general, the sooner, the better.

(4) Site Data and Permits Needed to Initiate Geotechnical Work

To initiate geotechnical work on a project during the design and PS&E phases, provide the following information:

(a) Project description.

(b) Plan sheets showing the following:

- Station and location of cuts, fills, walls, bridges, retention/detention ponds, or other geotechnical features to be designed.
- Existing utilities (as-built plans are acceptable).
- Right of way limits.
- Wetlands.
- Drainage features.
- Existing structures.
- Other features or constraints that could affect the geotechnical design or investigation.

(c) Electronic files, or cross sections every 50 ft to 65 ft or as appropriate, to define existing and new ground line above and below the wall, cut, fill, and other pertinent information.

- Show stationing.
- Show locations of existing utilities, right of way lines, wetlands, and other constraints.
- Show locations of existing structures that might contribute load to the cut or fill.

(d) Right of entry agreements and permits required for geotechnical investigation.

(e) Due date and work order number.

(f) Contact person.

When the alignment and any constraints as noted above are staked, the stationing on the plans and in the field must be in the same units. Physical surveys are preferred to photogrammetric surveys to ensure adequate accuracy of the site data.

Permits and agreements to be supplied by the region might include:

- HPA
- Shoreline permits
- Tribal lands and waters
- Railroad easement and right of way
- City, county, or local agency use permits
- Sensitive area ordinance permits

The region's project office is also responsible for providing the stations, offsets, and elevations of test holes to the nearest 1 ft once the test holes have been drilled. Provide test hole locations using state plane coordinates as well, if available.

(5) Overview of Geotechnical Design Objectives for the Various Project Stages

(a) **Project Definition.** The project design office uses the geotechnical investigation results obtained during the project definition phase to develop the project delivery cost and schedule. Geotechnical recommendations provided for this phase will be at the conceptual/feasibility level. The investigation for this phase usually consists of a visual project walk-through and a review of the existing records, geologic maps, and so forth.

For projects of significant geotechnical scope and complexity, and if soil borings are not available at critical locations within the project, some soil borings might be drilled at this time. Potential geotechnical hazards (earthquake faults, liquefaction, landslides, rockfall, soft ground, for example) are identified during project definition, and conceptual hazard avoidance or mitigation plans are developed. Future geotechnical design services needed in terms of time and cost, including the need for special permits to perform the geotechnical exploration (critical areas ordinances), are determined at this time.

(b) **Project Design.** Once the roadway geometry is established, detailed design of cut and fill slopes, adequate to establish the right of way needs, is accomplished. Once approximate wall locations and heights are known, preliminary design of walls is performed to establish feasibility, primarily to establish right of way needs (as is true for slopes) and likely wall types. A similar level of design is applied to hydraulic structures, and to determine overall construction staging and constructibility requirements to address the geotechnical issues at the site. Conceptual and/or more detailed preliminary bridge foundation design is conducted during this phase if it was not conducted during project definition. Before the end of this phase, the geotechnical data necessary to allow future completion of the PS&E level design work is gathered (final geometric data, test hole data, and so forth.).

(c) **PS&E Development.** Final design of all geotechnical project features is accomplished. Recommendations for these designs, as well as special provisions and plan details to incorporate the geotechnical design recommendations in the PS&E, are provided in the geotechnical report. Minor geotechnical features such as signal/sign foundations and small detention/retention ponds are likely to be addressed at this stage, as the project details become clearer. Detailed recommendations for the constructibility of the project geotechnical features are also provided.

(6) Earthwork

(a) **Project Definition.** The project designer contacts and meets with the RME, and the HQ Geotechnical Services Division as needed, at the project site to conduct a field review to help identify the geotechnical issues for the project.

In general, if soil/rock conditions are poor and/or large cuts or fills are anticipated, the RME requests that the HQ Geotechnical Services Division participate in the field review and reporting efforts.

The designer provides a description and location of the proposed earthwork to the RME.

- For widening of existing facilities, the anticipated width, length, and location of the widening, relative to the current facility, are provided.
- For realignments, the approximate new location proposed for the facility is provided.
- Locations in terms of length can be by mile post or stations.

A brief conceptual level report is provided to the designer that summarizes the results of the investigation.

(b) **Project Design.** Geotechnical data necessary to allow completion of the PS&E level design is compiled during the design phase. This includes soils borings, testing, and final geometric data. Detailed design of cut and fill slopes can be done once the roadway geometry is established and geotechnical data is available. The purpose of this design effort is to determine the maximum stable cut or fill slope and, for fills, potential for short and long term settlement. Also, the usability of the cut materials and the type of borrow needed for the project, if any, is evaluated. Evaluate the use of soil bioengineering as an option for building steeper slopes or to prevent surface erosion. See the Chapter 1350 "Soil Bioengineering," for more information.

The designer requests a geotechnical report from the RME. The site data indicated in 510.04(4), as applicable, is provided. It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. The time required to obtain permits and rights of entry must be considered when establishing schedule requirements.

The RME, in conjunction with the HQ Geotechnical Services Division, provides the following information as part of the geotechnical report (as applicable):

1. General description of the regional and site geology
2. Summary of the investigation

3. Boring logs
4. Laboratory tests and results
5. Soil/rock unit descriptions
6. Ground water conditions
7. Embankment design recommendations
   - The slope required for stability
   - Estimated amount and rate of settlement
   - Stability and settlement mitigation requirements
   - Construction staging requirements
   - Effects of site constraints
   - Monitoring needs
   - Material and compaction requirements
   - Subgrade preparation
8. Cut design recommendations
   - The slope required for stability
   - Stability mitigation requirements (deep seated stability and erosion)
   - Identification of seepage areas and how to mitigate them
   - Effects of site constraints
   - Monitoring requirements
   - Usability of excavated cut material, including gradation, moisture conditions and need for aeration, and shrink/swell characteristics

The recommendations include the background regarding analysis approach and any agreements with the region or other customers regarding the definition of acceptable level of risk.

The project office uses the report to finalize design decisions for the project. To meet slope stability requirements, additional right of way might be required or a wall might be needed. Wall design is covered in Chapter 1130. Construction timing might require importing material rather than using cut materials. The report is used to address this and other constructibility issues. The report is also used to proceed with completion of the project PS&E design.

(c) **PS&E Development.** Adequate geotechnical design information to complete the PS&E is typically received during project design. Additional geotechnical work might be needed when right of way cannot be acquired, restrictions are included in permits, or other requirements are added that result in changes in the design.

Special provisions and plan details, if not received as part of the report provided during project design, are developed with the assistance of the RME or the HQ Geotechnical Services Division. The project designer uses this information, as well as the design phase report, to complete the PS&E documents. Both the region's Materials Section and the HQ Geotechnical Services Division can review the contract plans before the PS&E review process begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(7) Hydraulic Structures and Environmental Mitigation

(a) **Project Definition.** The designer provides a description and location of the proposed hydraulic/environmental improvements and other pertinent site information, and discusses the extent of the hydraulics and environmental improvements, with both the RME and the HQ Hydraulics Branch, to identify the geotechnical issues to be investigated. At this stage, only the identification and feasibility of the proposed hydraulic structures or environmental mitigation are investigated. The cost and schedule requirements for the geotechnical investigation are also determined at this time.

Examples of hydraulic structures include, but are not limited to, large culverts, pipe arches, underground detention vaults, and fish passage structures. Examples of environmental mitigation include, but are not limited to, detention/retention ponds and wetland creation.

(b) **Project Design.** The designer requests a geotechnical report from the RME. The site data indicated in 510.04(4), as applicable, is provided along with the following information:

- Pertinent field observations (such as unstable slopes, existing soft soils or boulders, or erosion around and damage to existing culverts or other drainage structures).
- Jurisdictional requirements for geotechnical design of berms/dams.

It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. The time required to obtain permits and rights of entry must be considered when establishing schedule requirements.

The RME, with support from the HQ Geotechnical Services Division as needed, provides the following information, when requested and where applicable, as part of the project geotechnical report:

- Soil boring logs.
- Soil pH and resistivity.
- Water table elevation.
- Soil infiltration rates (highest rate for assessing spill containment/aquifer protection and long-term rate for determining pond capacity).
- Bearing capacity and settlement for hydraulic structure foundations.
- Slope stability for ponds.
- Retention berm/dam design.
- Potential for and amount of differential settlement along culverts and pipe arches and the estimated time required for settlement to occur.
- Soil pressures and properties (primarily for underground detention vaults).
- Erosion potential.
- Geosynthetic design per Chapter 530.
- Recommendations for mitigation of the effect of soft or unstable soil on the hydraulic structures.
- Recommendations for construction.

Note that retaining walls that are part of a pond, fish passage, and the like, are designed per Chapter 1130.

The project designer uses the geotechnical information to:

- Finalize design decisions.
- Evaluate and mitigate environmental issues.
- Proceed with completion of the PS&E design (includes determining the most cost effective hydraulic structure/pond to meet the desired objectives, locating and sizing ponds and foundations for hydraulic structures, structural design, mitigating the effects of settlement, satisfying local jurisdictional requirements for design, and so forth).

(c) **PS&E Development.** During PS&E development, the designer uses the information provided in the geotechnical report as follows:

- Select pipe materials in accordance with corrosion, resistivity, and abrasion guidelines in the *Hydraulics Manual*.
- Consider and include construction recommendations.

Additional design and specification guidance and support from the RME or the HQ Geotechnical Services Division are sought as needed. Both sections provide careful review of the contract plans before the PS&E review process begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(8) Signals, Sign Bridges, Cantilever Signs, and Luminaire Foundations

(a) **Project Definition and Design.** Geotechnical information is usually not required for signals, sign bridges, cantilever signs, and luminaires during project definition.

The region's Traffic Office contacts the RME for conceptual foundation recommendations. The conceptual recommendations are based on existing information in the area, and identify if Standard Plan foundations are feasible or if special design foundations are required. If good soils are anticipated or the foundations will be placed in fill, Standard Plan foundations can be assumed. If special design foundations are required, additional time and money can be included in the project to accommodate increased field exploration for foundation design, HQ Geotechnical Services Division involvement, and structural design by the HQ Bridge and Structures Office.

(b) **PS&E Development.** Foundation recommendations are made by either the RME or the HQ Geotechnical Services Division. The recommendations provide all necessary geotechnical information to complete the PS&E.

The region's Traffic Office (or region's Project Engineer in some cases) is responsible for delivering the following project information to the region's Materials Engineer:

- Plan sheet showing the location of the structures (station and offset) and the planned structure type.
- Applicable values for: XYZ, strain pole class, sign bridge span length, luminaire height, variable message sign weight, wind load, CCTV pole height, and known utility information in the area.

The RME provides the following information to the requester if Standard Plan foundation types can be used:

- Allowable lateral bearing capacity of the soil.
- Results of all field explorations.
- Groundwater elevation.
- Foundation constructibility.

The region uses this information to complete the plan sheets and prepare any special provisions. If utilities are identified during the field investigation that could conflict with the foundations, the region's project office pursues moving or accommodating the utility. Accommodation could require special foundation designs.

If special designs are required, the RME notifies the requester that special designs are required and forwards the information received from the region to the HQ Geotechnical Services Division. The HQ Geotechnical Services Division provides the HQ Bridge and Structures Office with the necessary geotechnical recommendations to complete the foundation designs. The region coordinates with the HQ Bridge and Structures Office to ensure that they have all the information necessary to complete the design. Depending on the structure type and complexity, the HQ Bridge and Structures Office might produce the plan sheets and special provisions for the foundations, or they might provide the region with information so that the region can complete the plan sheets and special provisions.

(9) Buildings, Park and Ride Lots, Rest Areas, and Communication Towers

In general, the RME functions as the clearing house for the geotechnical work to be conducted in each of the phases for technical review of the work if the work is performed by consultants, or for getting the work done in-house. For sites and designs that are more geotechnically complex, the RME contacts the HQ Geotechnical Services Division for assistance.

Detailed geotechnical investigation guidance is provided in Facilities Operating Procedure 9-18, "Site Development." In summary, this guidance addresses the following phases of design:

(a) **Site Selection.** Conceptual geotechnical investigation (based on historical data and minimal subsurface investigation) of several alternative sites is performed in which the geotechnical feasibility of each site for the intended use is evaluated, allowing the sites to be ranked. In this phase, geological hazards (landslides, rockfall, compressible soils, liquefaction, and so forth) are identified, and geotechnical data adequate to determine a preliminary cost to develop and build on the site is gathered.

(b) **Schematic Design.** For the selected site, the best locations for structures, utilities, and other elements of the project are determined based on site constraints and ground conditions. In this phase, the site is characterized more thoroughly than in the site selection phase, but subsurface exploration is not structure specific.

(c) **Design Development.** The final locations of each of the project structures, utilities, and other project elements determined from the schematic design phase are identified. Once these final locations are available, a geotechnical investigation adequate to complete the final design of each of the project elements (structure foundations, detention/retention facilities, utilities, parking lots, roadways, site grading, and so forth) is conducted. From this investigation and design, the final PS&E is developed.

(10) Retaining Walls, Reinforced Slopes, and Noise Walls

(a) **Project Definition.** The designer provides a description and location of the proposed walls or reinforced slopes, including the potential size of the proposed structures and other pertinent site information, to the RME. At this stage, only the identification and feasibility of the proposed walls or reinforced slopes are investigated. A field review may also be conducted at this time as part of the investigation effort. In general, if soil/rock conditions are poor and/or large walls or reinforced slopes are anticipated, the RME requests that the HQ Geotechnical Services Division participate in the field review and reporting efforts. The cost and schedule requirements for the geotechnical investigation are also determined at this time.

A brief conceptual level report that summarizes the results of the investigation may be provided to the designer at this time, depending on the complexity of the geotechnical issues.

(b) **Project Design and PS&E Development**. Geotechnical data necessary to allow completion of the PS&E level design for walls and reinforced slopes are compiled during the design and PS&E development phases. This includes soils borings, testing, and final geometric data. Detailed design of walls and reinforced slopes can be done once the roadway geometry is established and geotechnical data are available. The purpose of this design effort is to determine the wall and slope geometry needed for stability, noise wall and retaining wall foundation requirements, and the potential for short- and long-term settlement.

The designer requests a geotechnical report from the RME for retaining walls, noise walls, and reinforced slopes that are not part of the bridge preliminary plan. For walls that are part of the bridge preliminary plan, the HQ Bridge and Structures Office requests the geotechnical report for the walls from the HQ Geotechnical Services Division. For both cases, see Chapter 1130 for the detailed design process for retaining walls and reinforced slopes and Chapter 1140 for the detailed design process for noise walls. It is important that requests for a geotechnical report be made as early in the design phase as practical. The time required to obtain permits and rights of entry must be considered when establishing schedule requirements.

For retaining walls and reinforced slopes, the site data to be provided with the request for a geotechnical report are as indicated in Chapter 1130. Also supply right of entry agreements and permits required for the geotechnical investigation. The site data indicated in 510.04(4), as applicable, are provided for noise walls.

The RME or the HQ Geotechnical Services Division (see Chapter 1130 or 1140 for specific responsibilities for design), provides the following information as part of the geotechnical report (as applicable):

1. General description of the regional and site geology
2. Summary of the investigation
3. Boring logs
4. Laboratory tests and results
5. Soil/rock unit descriptions
6. Ground water conditions
7. Retaining wall/reinforced slope and noise wall recommendations
    - Recommended geometry for stability
    - Stability and settlement mitigation requirements, if needed
    - Foundation type and capacity
    - Estimated amount and rate of settlement

- Design soil parameters
- Construction staging requirements
- Effects of site constraints
- Monitoring needs
- Material and compaction requirements
- Subgrade preparation

The recommendations may also include the background regarding analysis approach and any agreements with the region or other customers regarding the definition of acceptable level of risk. Additional details and design issues to be considered in the geotechnical report are as provided in Chapter 1130 for retaining walls and reinforced slopes and in Chapter 1140 for noise walls. The project designer uses this information for final wall/reinforced slope selection and to complete the PS&E.

For final PS&E preparation, special provisions and plan details (if not received as part of the report provided during project design) are developed with the assistance of the region Materials Section or the HQ Geotechnical Services Division. Both the region Materials Section and the HQ Geotechnical Services Division can review the contract plans before the PS&E review process begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(11) Unstable Slopes

Unstable slope mitigation includes the stabilization of known landslides and rockfall that occur on slopes adjacent to the WSDOT transportation system, and that have been programmed under the P3 unstable slope program.

(a) **Project Definition.** The region's project office provides a description and location of the proposed unstable slope mitigation work to the RME. Location of the proposed work can be mile post limits or stationing. The region's project designer meets at the project site with the RME and HQ Geotechnical Services Division to conduct a field review, discuss project requirements, and identify geotechnical issues associated with the unstable slope project. The RME requests that the HQ Geotechnical Services Division participate in the field review and project definition reporting.

The level of work in the project definition phase for unstable slopes is conceptual in nature, not final design. The geotechnical investigation generally consists of a field review, a more detailed assessment of the unstable slope, review of the conceptual mitigation developed during the programming phase of the project, and proposed modification (if any) to the original conceptual level unstable slope mitigation. The design phase geotechnical services cost and schedule, including any required permits, are determined at this time. A brief conceptual level report is provided to the project designer that summarizes the results of the project definition investigation.

(b) **Project Design.** Geotechnical information and field data necessary to complete the unstable slope mitigation design is compiled during this design phase. This work includes, depending on the nature of the unstable slope problem, test borings, rock structure mapping, geotechnical field instrumentation, laboratory testing, and slope stability analysis. The purpose of this design effort is to determine the most appropriate method(s) to stabilize the known unstable slope.

The designer requests a geotechnical report from the HQ Geotechnical Services Division through the RME. The site data indicated in 510.04(4), as applicable, is provided along with the following information:

- Plan sheet showing the station and location of the proposed unstable slope mitigation project.
- If requested, Digital Terrain Model (DTM) files necessary to define the on-ground topography of the project site. The limits of the DTM will have been defined during the project definition phase.

It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. Unstable slope design investigations might require geotechnical monitoring of ground movement and ground water over an extended period of time to develop the required field information for the unstable slope mitigation design. The time required to obtain rights of entry and other permits, as well as the long-term monitoring data, must be considered when establishing schedule requirements for the geotechnical report.

The HQ Geotechnical Services Division provides the following information as part of the project geotechnical report (as applicable):

- General site description and summary of site geology.
- Summary of the field investigation.
- Boring logs.
- Laboratory tests and results.
- Geotechnical field instrumentation results.
- Summary of the engineering geology of the site including geologic units encountered.
- Unstable slope design analysis and mitigation recommendations.
- Constructibility issues associated with the unstable slope mitigation.
- Appropriate special provisions for inclusion in the contact plans.

The region's project design office uses the geotechnical report to finalize the design decisions for the project and the completion of the PS&E design.

(c) **PS&E Development.** Adequate geotechnical design information to complete the PS&E is typically obtained during the project design phase. Additional geotechnical work might be needed when right of way cannot be acquired, restrictions are included in permits, or other requirements are added that result in changes to the design.

Special provisions, special project elements, and design details (if not received as part of the design phase geotechnical report) are developed with the assistance of the RME and the HQ Geotechnical Services Division. The region's project designer uses this information in conjunction with the design phase geotechnical report to complete the PS&E document. The RME and the HQ Geotechnical Services Division can review the contract plans before the PS&E review begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(12) Rockslope Design

(a) **Project Definition.** The region's project office provides a description and location of the proposed rock excavation work to the RME. For widening of existing rock cuts, the anticipated width and length of the proposed cut in relationship to the existing cut are provided. For new alignments, the approximate location and depth of the cut are provided. Location of the proposed cut(s) can be mile post limits or stationing. The project designer meets at the project site with the RME and the HQ Geotechnical Services Division to conduct a field review, discusses project requirements, and identify any geotechnical issues associated with the proposed rock cuts. The RME requests that the HQ Geotechnical Services Division participate in the field review and project definition reporting.

The level of rock slope design work for the project definition phase is conceptual in nature. The geotechnical investigation generally consists of the field review, review of existing records, an assessment of existing rockslope stability, and preliminary geologic structure mapping. The focus of this investigation is to assess the feasibility of the rock cuts for the proposed widening or realignment, not final design. A brief conceptual level report that summarizes the result of the project definition investigation is provided to the project designer.

(b) **Project Design.** Detailed rockslope design is done once the roadway geometrics have been established. The rockslope design cannot be finalized until the roadway geometrics have been finalized. Geotechnical information and field data necessary to complete the rockslope design are compiled during this design phase. This work includes rock structure mapping, test borings, laboratory testing, and slope stability analysis. The purpose of this design effort is to determine the maximum stable cut slope angle, and any additional rockslope stabilization measures that could be required.

The designer requests a geotechnical report from the HQ Geotechnical Services Division through the RME. The site data indicated in 510.04(4), as applicable, is provided.

It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. The time required to obtain permits and rights of entry must be considered when establishing schedule requirements.

The HQ Geotechnical Services Division provides the following information as part of the project geotechnical report (as applicable):

1. General site description and summary of site geology.

2. Summary of the field investigation.

3. Boring logs.

4. Laboratory tests and results.

5. Rock units encountered within the project limits.

6. Rock slope design analysis and recommendations.

- Type of rockslope design analysis conducted and limitation of the analysis. Also included will be any agreements with the region and other customers regarding the definition of acceptable risk
- The slope(s) required for stability
- Additional slope stabilization requirements (rock bolts, rock dowels, and so forth.)
- Rockslope ditch criteria (See Chapter 640)
- Assessment of rippability
- Blasting requirements including limitations on peak ground vibrations and air blast over-pressure, if required
- Usability of the excavated material including estimates of shrink and swell
- Constructibility issues associated with the rock excavation

The project office uses the geotechnical report to finalize the design decisions for the project, and the completion of the PS&E design for the rockslope elements of the project.

(c) **PS&E Development.** Adequate geotechnical design information to complete the PS&E is typically obtained during the project design phase. Additional geotechnical work might be needed when right of way cannot be acquired, restrictions are included in permits, or other requirements are added that result in change to the design.

Special provisions, special blasting requirements, and plans details, if not received as part of the design phase geotechnical report, are developed with the assistance of the RME or the HQ Geotechnical Services Division. The project designer uses this information in conjunction with the design phase geotechnical report to complete the PS&E documents. The RME and the HQ Geotechnical Services Division review the contract plans before the PS&E review begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(13) Bridge Foundations

(a) **Project Definition.** The HQ Geotechnical Services Division supports the project definition process to develop reasonably accurate estimates of bridge substructure costs. For major projects and for projects that are located in areas with little or no existing geotechnical information, a field review is recommended. The region's office responsible for project definition coordinates field reviews. Subsurface exploration (drilling) is usually not required at this time, but might be needed if cost estimates cannot be prepared within an acceptable range of certainty.

The HQ Bridge and Structures Office, once they have received the necessary site data from the region's project office, is responsible for delivering the following project information to the HQ Geotechnical Services Division:

- Alternative alignments and/or locations of bridge structures.
- A preliminary estimate of channelization (structure width).

- Known environmental constraints.

The Bridge and Structures and region offices can expect to receive the following from the HQ Geotechnical Services Division:

- Summary or copies of existing geotechnical information.
- Identification of geotechnical hazards (slides, liquefiable soils, soft soil deposits, and so forth.).
- Identification of permits that might be required for subsurface exploration (drilling).
- Conceptual foundation types and depths.
- If requested, an estimated cost and time to complete a geotechnical foundation report.

The HQ Bridge and Structures Office uses this information to refine preliminary bridge costs. The region's project office uses the estimated cost and time to complete a geotechnical foundation report to develop the project delivery cost and schedule.

(b) **Project Design.** The HQ Geotechnical Services Division assists the HQ Bridge and Structures Office with preparation of the bridge Preliminary Plan. Geotechnical information gathered for project definition will normally be adequate for this phase, as test holes for the final bridge design cannot be drilled until accurate pier location information is available. For selected major projects, a type, size, and location (TS&L) report might be prepared which usually requires some subsurface exploration to provide a more detailed, though not final, estimate of foundation requirements.

The HQ Bridge and Structures Office is responsible for delivering the following project information, based on bridge site data received from the region's project office, to the HQ Geotechnical Services Division:

- Anticipated pier locations
- Approach fill heights
- For TS&L, alternate locations/alignments/ structure types

The HQ Bridge and Structures Office can expect to receive:

- Conceptual foundation types, depths and capacities
- Permissible slopes for bridge approaches
- For TS&L, a summary of site geology and subsurface conditions, and more detailed preliminary foundation design parameters and needs
- If applicable or requested, erosion or scour potential

The HQ Bridge and Structures Office uses this information to complete the bridge preliminary plan. The region's project office confirms right of way needs for approach embankments. For TS&L, the geotechnical information provided is used for cost estimating and preferred alternate selection. The preliminary plans are used by the HQ Geotechnical Services Division to develop the site subsurface exploration plan.

(c) **PS&E Development.** During this phase, or as soon as a 95 percent preliminary plan is available, subsurface exploration (drilling) is performed and a geotechnical foundation report is prepared to provide all necessary geotechnical recommendations needed to complete the bridge PS&E.

The HQ Bridge and Structures Office is responsible for delivering the following project information to the HQ Geotechnical Services Division:

- 95 percent preliminary plans (concurrent with distribution for region approval)
- Estimated foundation loads and allowable settlement criteria for the structure, when requested

The HQ Bridge and Structures Office can expect to receive:

- Bridge geotechnical foundation report

The HQ Bridge and Structures Office uses this information to complete the bridge PS&E. The region's project office reviews the geotechnical foundation report for construction considerations and recommendations that might affect region items, estimates, staging, construction schedule, or other items.

Upon receipt of the structure PS&E review set, the HQ Geotechnical Services Division provides the HQ Bridge and Structures Office with a Summary of Geotechnical Conditions for inclusion in Appendix B of the contract.

(14) Geosynthetics

See Chapter 530 for geosynthetic design guidance.

(15) Washington State Ferries Projects

(a) **Project Design.** The HQ Geotechnical Services Division assists the Washington State Ferries (WSF) division with determining the geotechnical feasibility of all offshore facilities, terminal facility foundations, and bulkhead walls. For upland retaining walls and grading, utility trenches, and pavement design, the RME assists WSF with determining geotechnical feasibility.

In addition to the site data identified in Section 510.04(4), as applicable, the following information is supplied by WSF to the HQ Geotechnical Services Division or the RME, as appropriate, with the request for the project geotechnical report::

- A plan showing anticipated structure locations as well as existing structures.
- Relevant historical data for the site.
- A plan showing utility trench locations.
- Anticipated utility trench depths.
- Proposed roadway profiles.

WSF can expect to receive:

- Results of any borings or laboratory tests conducted.
- A description of geotechnical site conditions.
- Conceptual foundation types, depths and capacities.
- Conceptual wall types.
- Assessment of constructibility issues that affect feasibility.
- Surfacing depths and/or pavement repair and drainage schemes.
- If applicable or requested, erosion or scour potential.

WSF uses this information to complete the project design report, design decisions, and estimated project budget and schedule.

WSF is responsible for obtaining any necessary permits or right of entry agreements needed to access structure locations for the purpose of subsurface exploration (for example, test hole drilling). The time required for obtaining permits and rights of entry must be considered when developing project schedules. Possible permits and agreements might include but are not limited to:

- City, county, or local agency use permits.
- Sensitive area ordinance permits.

(b) **PS&E Development**

Subsurface exploration (drilling) is performed and a geotechnical foundation report is prepared to provide all necessary geotechnical recommendations needed to complete the PS&E.

The designer requests a geotechnical report from the HQ Geotechnical Services Division or the RME, as appropriate. The site data indicated in 510.04(4), as applicable, is provided along with the following information:

- A plan showing final structure locations as well as existing structures.
- Proposed structure loadings.

WSF can expect to receive:

- Results of any borings or laboratory tests conducted.
- A description of geotechnical site conditions.
- Final foundation types, depths, and capacities.
- Final wall types and geotechnical designs/parameters for each wall.
- Assessment of constructibility issues to be considered in foundation selection and when assembling the PS&E.
- Pile driving information - driving resistance and estimated overdrive.

- Surfacing depths and/or pavement repair and drainage schemes.

WSF uses this information to complete the PS&E.

Upon receipt of the WSF PS&E review set, the HQ Geotechnical Services Division provides WSF with a Summary of Geotechnical Conditions for inclusion in Appendix B of the Contract. A Final Geotechnical Project Documentation package is assembled by the HQ Geotechnical Services Division and sent to WSF or the Plans Branch, as appropriate, for reproduction and sale to prospective bidders.

510.05 Use of Geotechnical Consultants

The HQ Geotechnical Services Division or the RME assists in developing the geotechnical scope and estimate for the project, so that the consultant contract is appropriate. (Consultant Services assists in this process.) A team meeting between the consultant team, the region or Washington State Ferries (depending on whose project it is), and the HQ Geotechnical Services Division/RME is conducted early in the project to develop technical communication lines and relationships. Good proactive communication between all members of the project team is crucial to the success of the project due to the complex supplier-client relationships.

510.06 Geotechnical Work by Others

Geotechnical design work conducted for the design of structures or other engineering works by other agencies or private developers within the right of way is subject to the same geotechnical engineering requirements as for engineering works performed by WSDOT. Therefore, the provisions contained within this chapter also apply in principle to such work. All geotechnical work conducted for engineering works within the WSDOT right of way or that otherwise directly impacts WSDOT facilities must be reviewed and approved by the HQ Geotechnical Services Division or the RME.

510.07 Surfacing Report

Detailed criteria and methods that govern pavement rehabilitation can be found in WSDOT Pavement Guide Interactive. The RME provides the surfacing report to the region's project office. This report provides recommended pavement types, surfacing depths, pavement drainage recommendations, and pavement repair recommendations.

510.08 Documentation

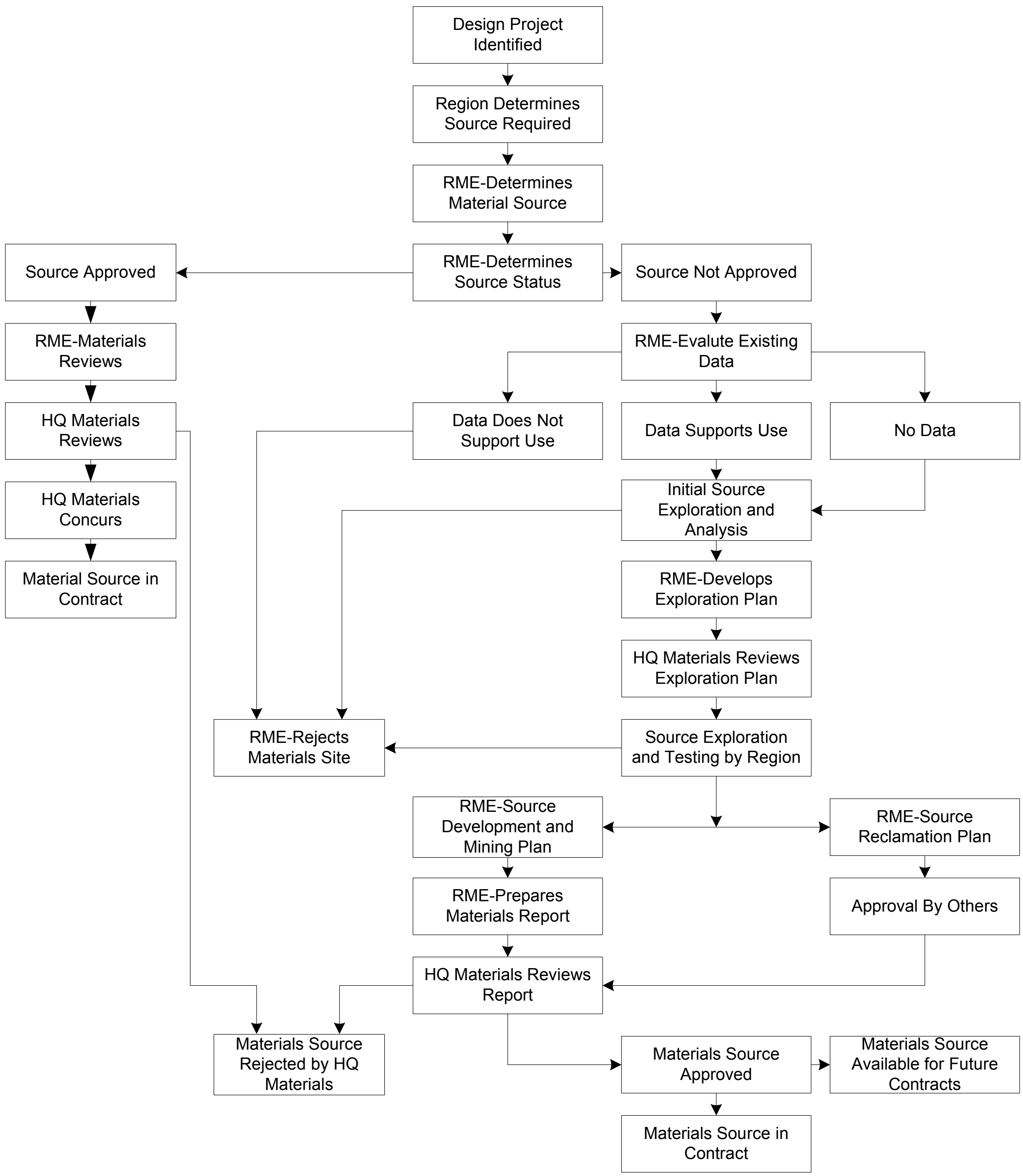
(1) Design Documentation

A list of documents that are required to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

(2) Final Geotechnical Project Documentation and Geotechnical Information Included as Part of the Construction Contract

Once a project PS&E is near completion, all of the geotechnical design memorandums and reports are compiled together to form the Final Geotechnical Project Documentation, to be published for the use of prospective bidders. The detailed process for this is located in the *Plans Preparation Manual*.

Geotechnical information included as part of the contract generally consists of the final project boring logs, and, as appropriate for the project, a Summary of Geotechnical Conditions. Both of these items are provided by the HQ Geotechnical Services Division.



Material Source Development Plan
Figure 510-1

For all site-specific designs of applications not covered by the Standard Specifications, complete plans and special provisions are needed. In general, for site-specific designs of Standard Specification applications, only a minor modification of the appropriate geotextile property table will be needed.

530.06 Design Responsibility

The design responsibility and process for geotextile design are illustrated in Figures 530-4 and 5. The Regional Project Development Office, in particular the Regional Project Manager, is responsible to initiate and develop all Standard Specification geotextile designs, except for roadway separation and soil stabilization applications, which are initiated and developed by the Regional Materials Laboratory.

The Regional Materials Laboratory assists the Regional Project Manager with Standard Specifications underground drainage and permanent erosion control designs.

The Regional Environmental Design Section assists with Standard Specifications, permanent erosion control, and temporary silt fence designs.

Once the Regional Project Manager or Materials Laboratory has determined that a geotextile is appropriate, development of a Standard Specification geotextile design includes the development of plan details showing the plan location and cross-section of the geotextile installation. Standard details for geotextiles as provided in the *Plans Preparation Manual* may be used or modified to adapt to the specific project situation. Note that only minimum dimensions for drains are provided in these standard details.

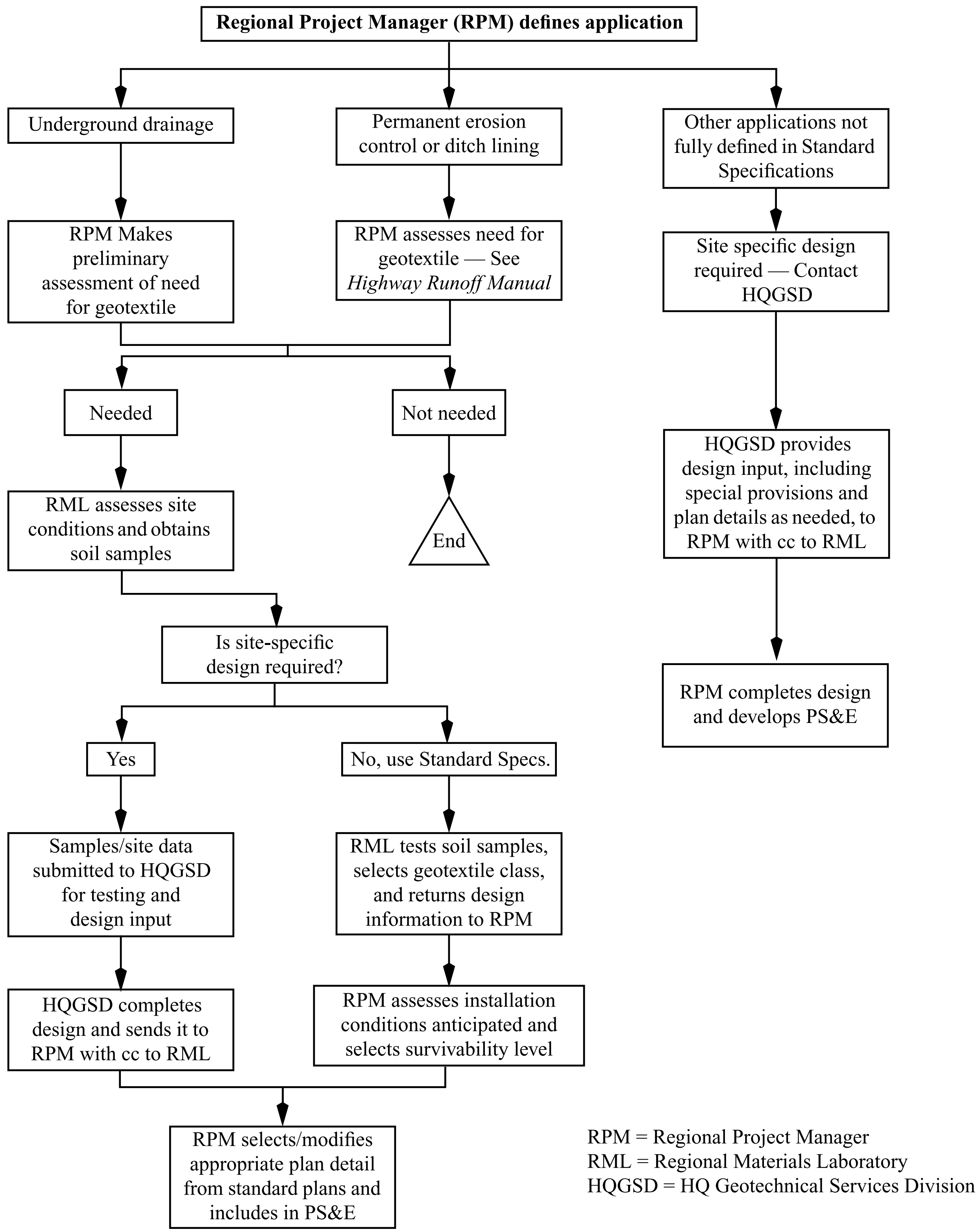
Site-specific geosynthetic designs and applications not addressed by the Standard Specifications are designed by the region with the assistance of the HQ Materials Laboratory Geotechnical Services Division or the HQ Hydraulics Branch as described in 530.05.

Design assistance by the HQ Geotechnical Services Division or HQ Hydraulics Branch for site-specific design of Standard Specifications applications includes determination of geosynthetic properties and other advice as needed to complete the geosynthetic plans and any special provisions required.

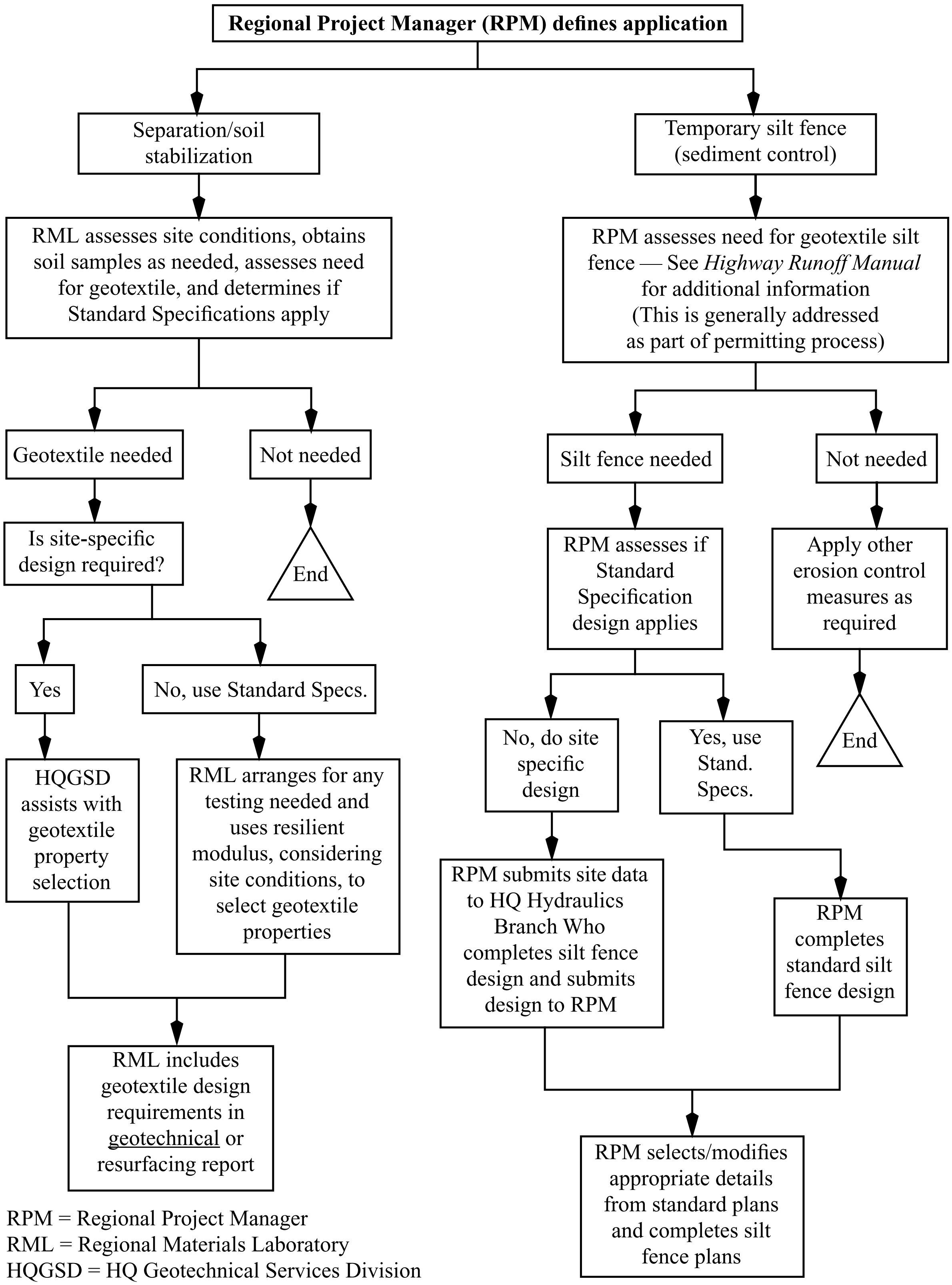
The HQ Geotechnical Services Division is fully responsible to develop and complete the geosynthetic design, plan details that can be used to develop the contract plan sheets, and special provisions for geosynthetic reinforced walls, slopes, and embankments; deep trench drains for landslide stabilization; and other applications that are an integral part of an HQ geotechnical design. The Regional Project Manager incorporates the plan details and special provisions into the PS&E.

530.07 Documentation

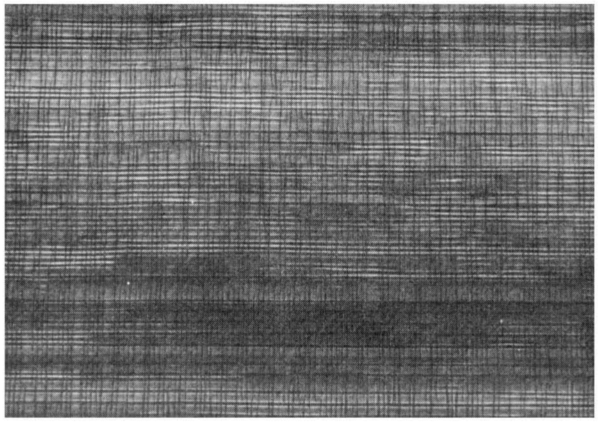
A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/



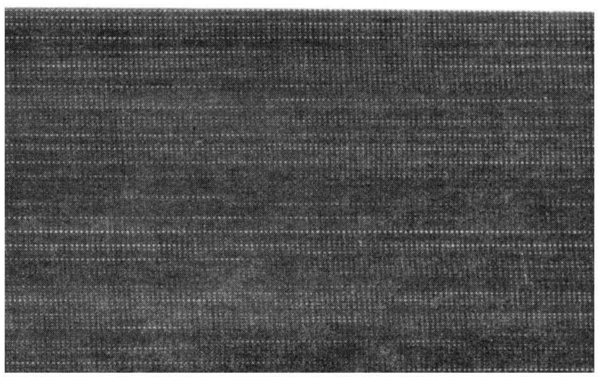
Design Process for Drainage and Erosion Control Geotextiles and Nonstandard Applications
Figure 530-4



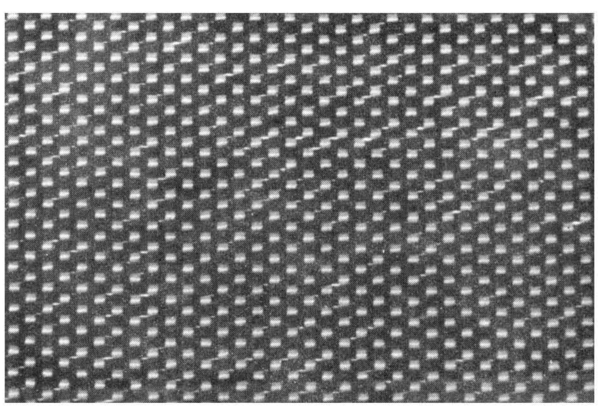
Design Process for Separation, Soil Stabilization, and Silt Fence
Figure 530-5



Slit Film Woven Geotextile



Monofilament Woven Geotextile



Multifilament Woven Geotextile

Examples of Various Geosynthetics
Figure 530-6a

620.01 General

This chapter provides guidance on the design of horizontal alignment, frontage roads, number of lanes, the arrangement of the lanes, and pavement transitions. See the following chapters for additional information:

Chapter	Subject
430	All roadway width requirements for modified design level
440	Lane and shoulder width requirements for full design level
440	Shoulder width requirements at curbs
640	Open highway and ramp lane widths on turning roadways for full design level
640	Superelevation rate and transitions
650	Sight distance
910	Requirements for islands
940	Ramp lane and shoulder requirements

620.02 References

Washington Administrative Code (WAC) 468-18-040, "Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings"

Utilities Manual M 22-87, WSDOT

Plans Preparation Manual M 22-31, WSDOT

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, WSDOT (MUTCD) http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm

Right of Way Manual M 26-01, WSDOT

Local Agency Guidelines (LAG), M 36-63, WSDOT

A Policy on Geometric Design of Highways and Streets (Green Book), 2001, AASHTO

620.03 Definitions

auxiliary lane The portion of the roadway adjoining the traveled way for parking, speed change, turning, storage for turning, weaving, truck climbing, passing, and other purposes supplementary to through-traffic movement.

basic number of lanes The minimum number of general purpose lanes designated and maintained over a significant length of highway.

frontage road An auxiliary road that is a local road or street located on the side of a highway for service to abutting property and adjacent areas and for control of access.

outer separation The area between the outside edge of traveled way for through traffic and the nearest edge of traveled way of a frontage road or collector/distributor road.

turning roadway A curve on an open highway, a curve on a ramp, or a connecting roadway between two intersecting legs of an intersection.

620.04 Horizontal Alignment

(1) General

Horizontal and vertical alignments (Chapter 630) are the primary controlling elements for highway design. It is important to coordinate these two elements with design speed, drainage, intersection design, and aesthetic principles in the early stages of design.

Figures 620-2a through 2c show desirable and undesirable alignment examples for use with the following considerations:

(a) Make the highway alignment as direct as practical and still blend with the topography while considering developed and undeveloped properties, community boundaries, and environmental concerns.

(b) Make highway alignment consistent by:

- Using gentle curves at the end of long tangents.
- Using a transition area of moderate curvature between the large radius curves of rural areas and the small radius curves of populated areas.
- Making horizontal curves visible to approaching traffic.

(c) Avoid minimum radii and short curves unless:

- Restrictive conditions are present and are not readily or economically avoidable.
- On two-lane highways, minimum radii will result in tangent sections long enough for needed passing.

(d) Avoid any abrupt change in alignment. Design reverse curves with an intervening tangent long enough for complete superelevation transition for both curves. See Chapter 640 for more information on superelevation transitions.

(e) Avoid the use of curves in the same direction connected by short tangents (broken back curves); substitute a single larger curve.

(f) Avoid compound curves on open highway alignment if a simple curve can be obtained. When compound curves are used, make the shorter radius at least two-thirds the longer radius. Make the total arc length of a compound curve not less than 500 ft.

(g) On divided multilane highways, take advantage of independent alignment to produce a flowing alignment along natural terrain.

(h) The preferred locations for bridges, interchanges, intersections, and temporary connections are on tangent sections in clear view of drivers.

(i) On two-lane, two-way highways, strive for as much passing sight distance as possible. (See Chapter 650.)

(2) Horizontal Curve Radii

Design speed is the governing element of horizontal curves. For guidance regarding design speed selection see Chapter 440 for full design level, Chapter 430 for modified design level, and Chapter 940 for ramps.

Use the following factors to determine the radius for a curve:

- Stopping sight distance where sight obstructions are on the inside of a curve. Median barriers, bridges, walls, cut slopes, wooded areas, buildings, and guardrails are examples of sight obstructions. See Chapter 650 to check for adequate stopping sight distance for the selected design speed.
- Superelevation is the rotation or banking of the roadway cross section to overcome part of the centrifugal force that acts on a vehicle traversing a curve. Design information on the relationship between design speed, radius of curve, and superelevation is in Chapter 640.
- Coordinate vertical and horizontal alignment. (see Chapter 630.)

Spiral curves, although no longer used on new highway construction or major realignment, still exist on Washington highways. Spirals were used to transition between tangents and circular curves with the horizontal curvature rate increasing from tangent to the central curve and decreasing from curve to tangent. Spirals do not pose an operational concern and may remain in place. See the "Green Book" for information on spirals.

(3) Horizontal Curve Length

A curve is not required for small deflection angles. Figure 620-1 gives the maximum allowable angle without a curve. See Chapter 910 for guidance on angle points or short radii curves in the vicinity of intersections at grade.

Design Speed (mph)	Maximum Angle Without Curve
25	2º17’
30	1º55’
35	1º38’
40	1º26’
45	1º16’
50	1º09’
55	1º03’
60	0º57’
65	0º53’
70	0º49’
75	0º46’
80	0º43’

Maximum Angle Without Curve
Figure 620-1

To avoid the appearance of a kink in the road, the desirable length of curve for deflection angles larger than given in Figure 620-1 is at least 500 ft long.

620.05 Distribution Facilities

(1) General

In addition to the main highway under consideration, other facilities can be provided to distribute traffic to and from the highway and to fulfill access requirements. Highway flexibility can be augmented by:

- Frontage roads
- Collector distributor roads
- On and off connections
- Parallel arterial routes with connections between them and the main highway
- Loop highways around large metropolitan areas

A city or county may be asked to accept a proposed distribution facility as a city street or county road. Plan and design these facilities according to the applicable design values as city streets or county roads. (See Chapter 440.)

(2) Frontage Roads

Frontage roads constructed as part of highway development may serve any of the following purposes:

- To reestablish continuity of an existing road severed by the highway.
- To provide service connections to adjacent property that would otherwise be isolated as a result of construction of the highway.
- To control access to the highway.
- To maintain circulation of traffic on each side of the highway.
- To segregate local traffic from the higher speed through traffic and intercept driveways of residences and commercial establishments along the highway.
- To relieve congestion on the arterial highway during periods of high use or in emergency situations.

Frontage roads are generally not permanent state facilities. They are usually turned back to the local jurisdiction. Plan and design frontage roads as city streets or county roads. (See Chapter 440.) Initiate coordination with the local agency that will be the recipient of the facility early in the planning process, and carry through design and construction. See Chapter 1430 for additional guidance on frontage roads and turnbacks.

Outer separations function as buffers between the through traffic on the highway and the local traffic on the frontage road. The width is governed by requirements for grading, signing, barriers, aesthetics, headlight glare, and ramps. Where possible, make the separation wide enough to allow for development on both sides of the frontage road. Wider separations also move the intersection with the frontage road and a cross road farther from the intersection with the through roadway. It also can reduce the amount of limited access control rights to be acquired. (See Chapter 1430.)

Where two-way frontage roads are provided, a driver on the highway must contend with approaching traffic on the right (opposing frontage road traffic) as well as opposing traffic on the left. Make the outer separation wide enough to minimize the effects of approaching traffic, particularly the headlight glare. See Chapter 700 for information on headlight glare considerations. With one-way same-direction frontage roads, the outer separation need not be as wide as with two-way frontage roads.

Wide separations lend themselves to landscape treatment and can enhance the appearance of both the highway and the adjoining property.

A substantial width of outer separation is particularly advantageous at intersections with cross streets. The wider separation reduces conflicts with pedestrians and bicycles.

Where ramp connections are provided between the through roadway and the frontage road, the minimum outer separation width will depend on design requirements for the ramp termini.

620.06 Number of Lanes and Arrangement

(1) General

The basic number of lanes is designated and maintained over a length of highway. The total number of lanes is the basic number of lanes plus any auxiliary lanes required to meet:

- Level of service (volume-capacity).
- Lane balance.
- Flexibility of operation.

(2) Basic Number of Lanes

Keep the basic number of lanes constant over a highway route, or a significant portion thereof, regardless of changes in traffic volume. See Chapter 440 for the minimum number of lanes for each functional class of highway.

Change the basic number of lanes only for general changes in traffic volume over a substantial length of the route. The recommended location for a reduction in the basic number of lanes is on a tangent section between interchanges or intersections.

To accommodate high traffic volumes for short distances, such as between adjacent interchanges, use auxiliary lanes. When consecutive sections between interchanges require auxiliary lanes, consider increasing the basic number of lanes through the entire length.

(3) Auxiliary Lanes

Auxiliary lanes are added to the basic number of lanes to allow additional traffic movements on short segments. These added lanes are based primarily on volume-to-capacity relationships (Chapter 610).

To ensure efficient operation of auxiliary lanes see the following:

910	Left and right turn lanes and storage for turning
940	Weaving and auxiliary lanes associated with interchanges
1010	Truck climbing and passing lanes

620.07 Pavement Transitions

(1) Lane Transitions

(a) **For lane width changes** that create an angle point in an adjacent lane, the maximum angle is given in Figure 620-1. When a lane width change does not create an angle point in an adjacent lane, A 25:1 taper is sufficient.

(b) To **reduce the number of lanes**, a transition is required. The following guidelines apply:

- Locate transitions where decision sight distance exists, preferably on a tangent section and on the approach side of any crest vertical curve (except the end of climbing lanes which are transitioned in accordance with Chapter 1010).
- Supplement the transition with traffic control devices.
- Reduce the number of lanes by dropping only one at a time from the right side in the direction of travel. (When dropping a lane on the left side, an approved deviation is required.) See the MUTCD when more than one lane in a single direction must be dropped.

- Use the following formula to determine the minimum length of the lane transition for high speed conditions (45 mph or more):

  $L = VT$

  Where:

  L = length of transition (ft)
  V = design speed (mph)
  T = tangential offset width (ft)

- Use the following formula to determine the minimum length of the lane transition for low speed conditions (less than 45 mph):

  $$L = \frac{TV^2}{60}$$

  Where:

  L = length of transition (ft)
  V = design speed (mph)
  T = tangential offset width (ft)

- Use a tangential rate of change of 1:25 or flatter for low speed conditions (less than 45 mph).

(c) **To increase the number of lanes**, a tangential rate of change in the range of 1:4 to 1:15 is sufficient. Aesthetics are the main consideration.

(d) **For turning roadway** widening width transitions, see Chapter 640

(2) Median Width Transitions

Whenever two abutting sections have different median widths, use long, smooth transitions (L = VT or flatter). When horizontal curves are present, this can be accomplished by providing the transition throughout the length of the curve. When required on a tangent section, the transition may be applied about the center line or on either side of the median based on whether or not the abutting existing section is programmed for the wider median in the future. To satisfy aesthetic requirements, make the transition length as long as feasible.

620.08 Procedures

When the project will realign the roadway, develop horizontal alignment plans for inclusion in the PS&E. Show the following as needed to maintain clarity and provide necessary information:

- Horizontal alignment details (tangent bearing, curve radius, and superelevation rate)
- Stationing
- Number of lanes
- Intersections, road approaches, railroad crossings, and interchanges (Chapters 910, 920, 930, and 940)
- Existing roadways and features affecting or affected by the project

See the *Plans Preparation Manual* for additional plan requirements.

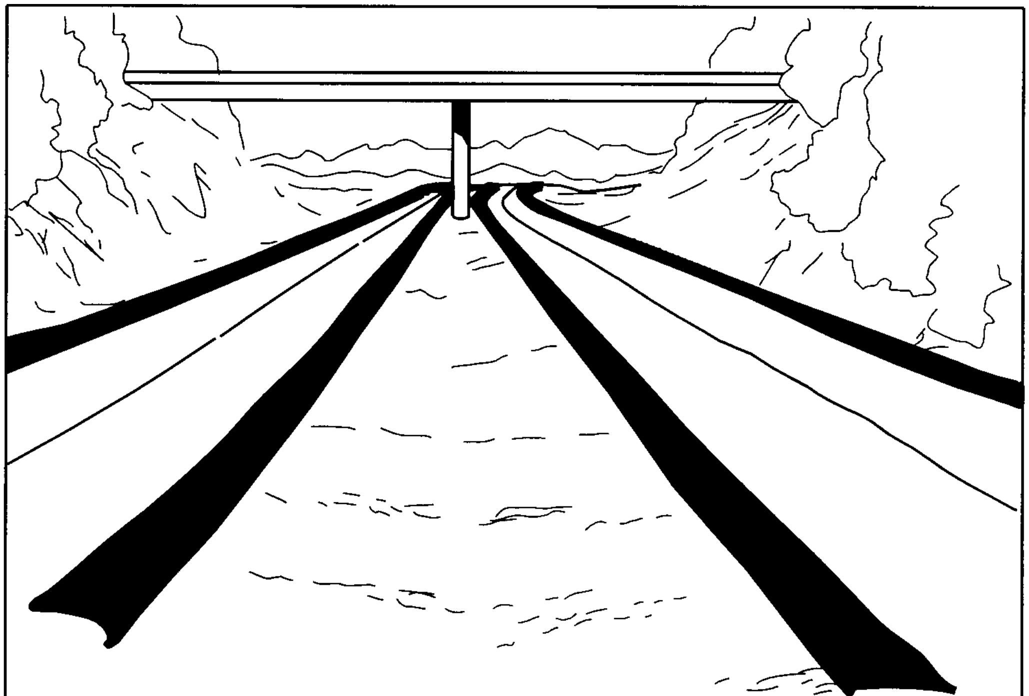
Justify any realignment of the roadway. Include the reasons for the realignment, profile considerations, alternatives considered, and the reasons the selected alignment was chosen.

When the project will change the number of lanes, include a capacity analysis supporting the number selected (Chapter 610) with the justification for the number of lanes.

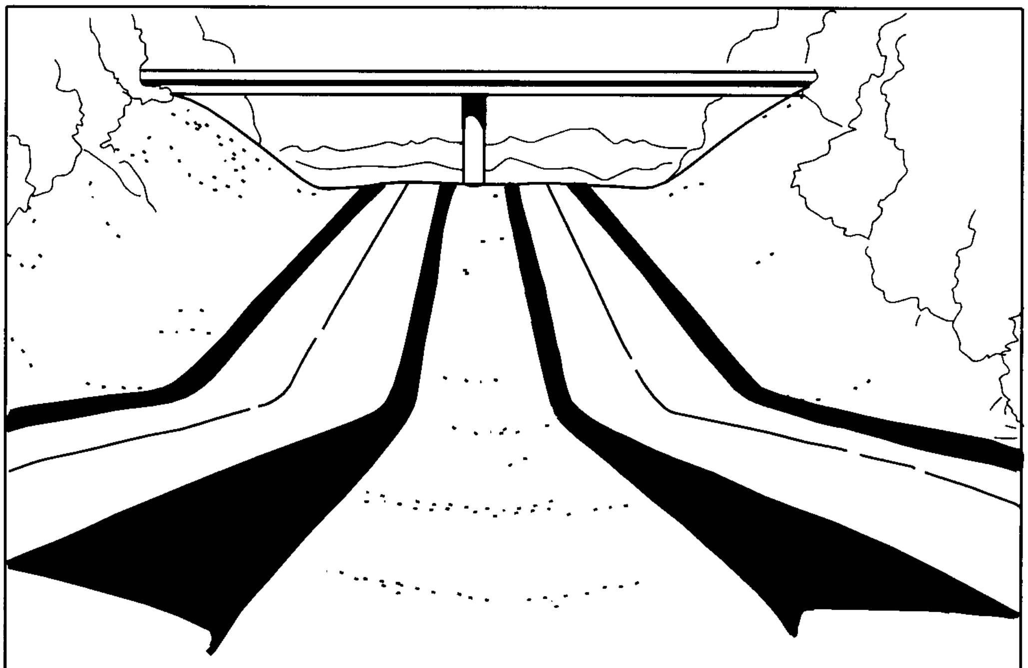
Include with the justification for a frontage road any traffic analyses performed, the social, environmental, and economic considerations, the options considered, and the reasons for the final decision.

620.09 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site: http//www.wsdot.wa.gov/eesc/design/projectdev/

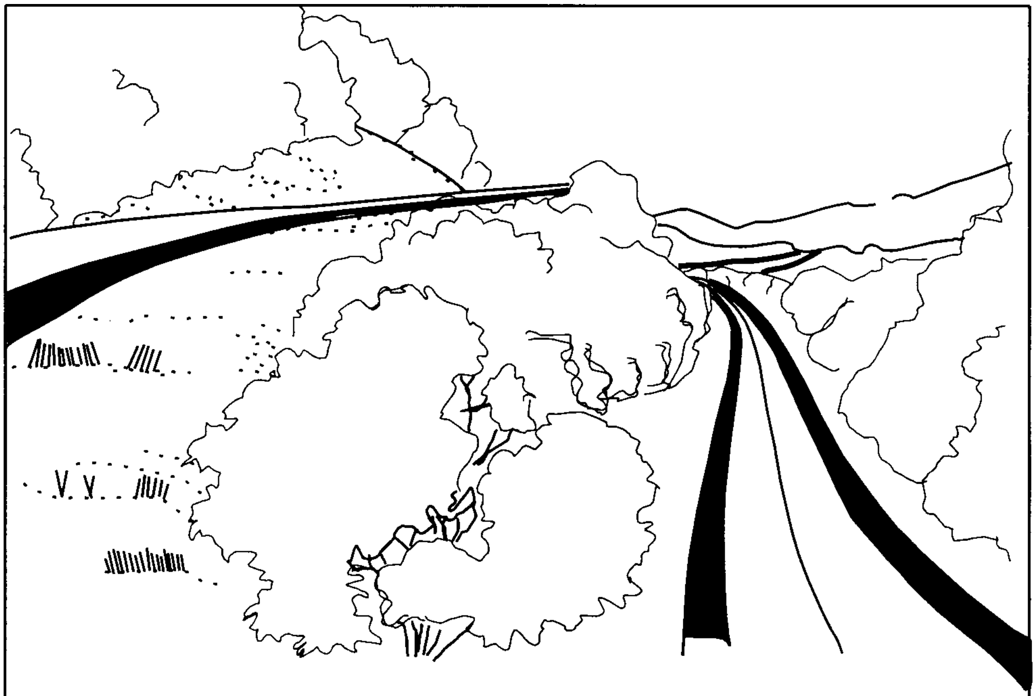


Desirable - Vertical Curves Lengthened

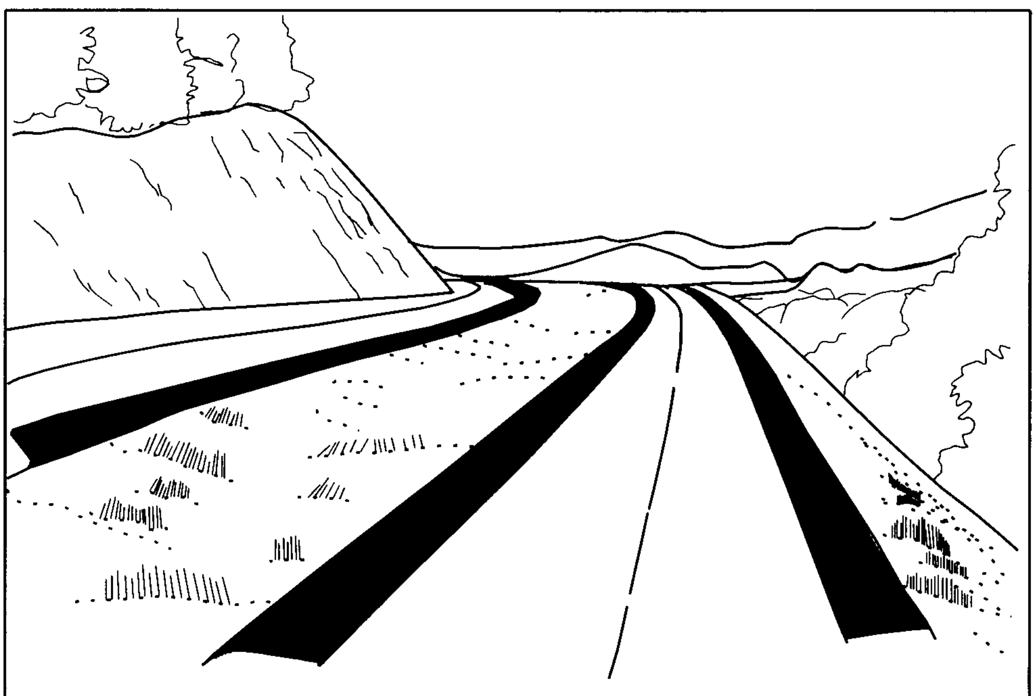


Undesirable - Minimum Vertical Curves Used

Alignment Examples
Figure 620-2a

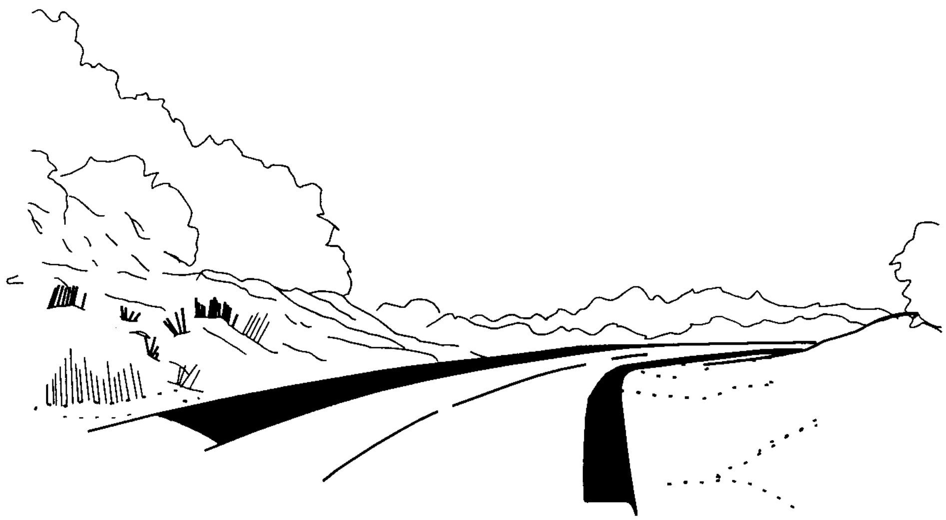


Desirable - Consistency with Topography

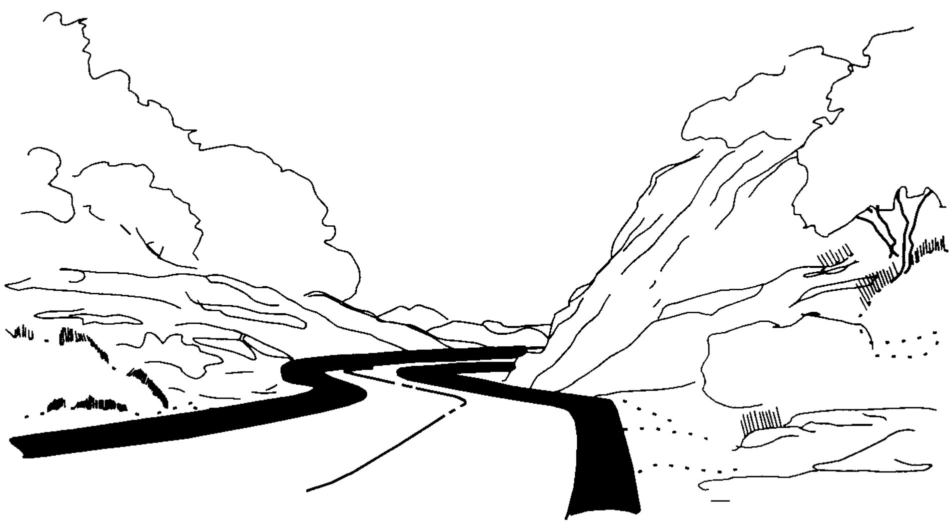


Undersirable - Heavy Cuts and Fills

Alignment Examples
Figure 620-2b



Desirable - Daylighting and a Simple Curve



Undesirable - Short Curve Reversals

Alignment Examples

Figure 620-2c

630.01 General

Vertical alignment (roadway profile) consists of a series of gradients connected by vertical curves. It is mainly controlled by:

- Topography
- Class of highway
- Horizontal alignment
- Safety
- Sight distance
- Construction costs
- Drainage
- Adjacent land use
- Vehicular characteristics
- Aesthetics

This chapter provides guidance for the design of vertical alignment. See the following chapters for additional information:

Chapter	Subject
440	Maximum grade for each functional class
620	Horizontal alignment
650	Sight distance
910	Grades at intersections
940	Maximum grade for ramps

630.02 References

Washington Administrative Code (WAC) 468-18-040, "Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings"

Plans Preparation Manual, M 22-31, WSDOT

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, WSDOT (MUTCD) http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm

Local Agency Guidelines (LAG), M 36-63, WSDOT

A Policy on Geometric Design of Highways and Streets, (Green Book), 2001, AASHTO

630.03 Vertical Alignment

(1) Design Controls

The following are general controls for developing vertical alignment (also see Figures 630-2a through 2c):

- Use a smooth grade line with gradual changes, consistent with the class of highway and character of terrain. Avoid numerous breaks and short grades.
- Avoid "roller coaster" or "hidden dip" profiles by use of gradual grades made possible by heavier cuts and fills or by introducing some horizontal curvature in conjunction with the vertical curvature.
- Avoid grades that will affect truck speeds and, therefore, traffic operations.
- Avoid broken back grade lines with short tangents between two vertical curves.
- Use long vertical curves to flatten grades near the top of long steep grades.
- Where at-grade intersections occur on roadways with moderate to steep grades, it is desirable to flatten or reduce the grade through the intersection.

- Establish the subgrade at least 1 ft above the high water table (real or potential) or as recommended by the region Materials Engineer. Consider the low side of superelevated roadways.
- When a vertical curve takes place partly or wholly in a horizontal curve, coordinate the two as discussed in 630.04.

(2) Minimum Length of Vertical Curves

The minimum length of a vertical curve is controlled by design speed, the requirements for stopping sight distance, and the change in grade. Make the length of a vertical curve, in feet, not less than three times the design speed, in miles per hour. See Chapter 650 to design vertical curves to meet stopping sight distance requirements. For aesthetics, the desirable length of a vertical curve is two to three times the length required for stopping sight distance.

Sag vertical curves may have a length less than required for stopping sight distance when all three of the following are provided:

- An evaluate upgrade to justify the length reduction.
- Continuous illumination.
- Design for the comfort of the vehicle occupants. For comfort use:

$$L = \frac{AV^2}{46.5}$$

where: L = Curve length ft
A = Change in grade %
V = Design speed mph

The sag vertical curve lengths designed for comfort are about 50% of those required for sight distance.

(3) Maximum Grades

Analyze grades for their effect on traffic operation because they may result in undesirable truck speeds. Maximum grades are controlled by functional class of the highway, terrain type, and design speed (Chapters 440 and 940).

(4) Minimum Grades

Minimum grades are used to meet drainage requirements. Avoid selecting a "roller coaster" or "hidden dip" profile merely to accommodate drainage.

Minimum ditch gradients of 0.3% on paved materials and 0.5% on earth can be obtained independently of roadway grade. Medians, long sag vertical curves, and relatively flat terrain are examples of areas where independent ditch design may be justified. A closed drainage system may be needed as part of an independent ditch design.

(5) Length of Grade

The desirable maximum length of grade is the maximum length on an upgrade at which a loaded truck will operate without a 10 mph reduction. Figure 630-1 gives the desirable maximum length for a given percent of grade. When grades longer than the desirable maximum are unavoidable, consider an auxiliary climbing lane (Chapter 1010). For grades that are not at a constant percent, use the average.

When long steep downgrades are unavoidable, consider an emergency escape ramp (Chapter 1010).

(6) Alignment on Structures

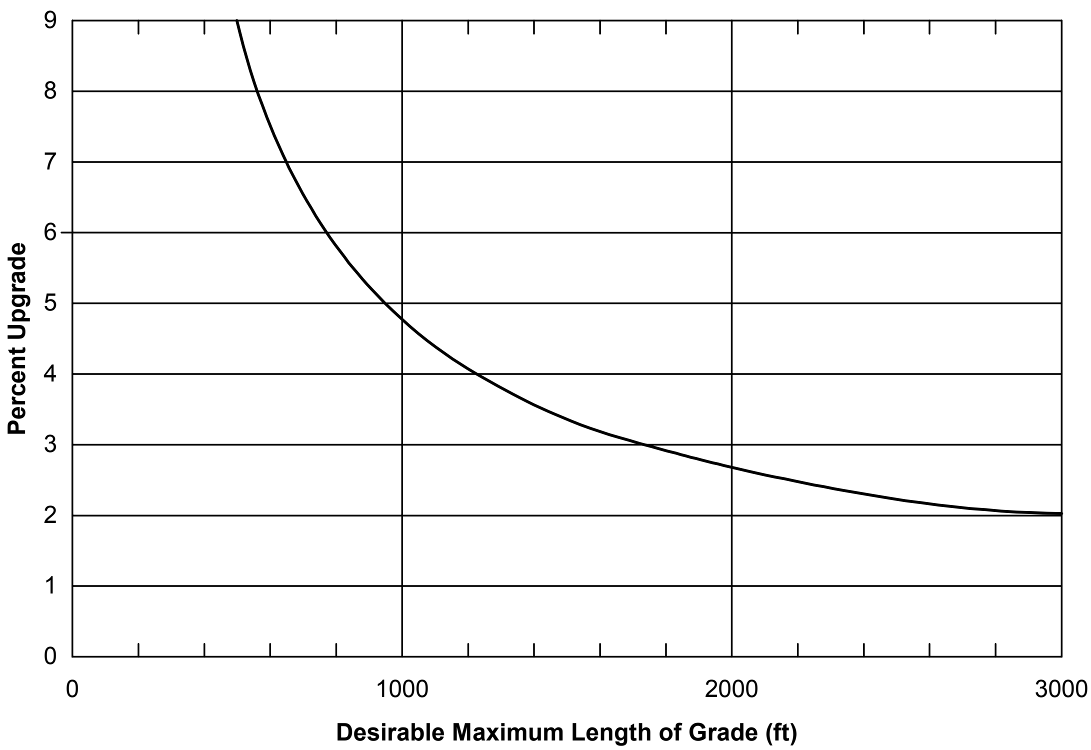
Where practical, avoid high skew, vertical curvature, horizontal curvature, and superelevation on structures, but do not sacrifice safe roadway alignment to achieve this.

630.04 Coordination of Vertical and Horizontal Alignments

Do not design horizontal and vertical alignment independently. Coordinate them to obtain safety, uniform speed, pleasing appearance, and efficient traffic operation. Coordination can be achieved by plotting the location of the horizontal curves on the working profile to help visualize the highway in three dimensions. Perspective plots will also give a view of the proposed alignment. Figures 630-2a and 2b show sketches of desirable and undesirable coordination of horizontal and vertical alignment.

Guides for the coordination of the vertical and horizontal alignment are as follows:

- Balance curvature and grades. Using steep grades to achieve long tangents and flat curves, or excessive curvature to achieve flat grades, are both poor designs.
- Vertical curvature superimposed on horizontal curvature generally results in a more pleasing facility. Successive changes in profile not in combination with horizontal curvature may result in a series of dips not visible to the driver.
- Do not begin or end a horizontal curve at or near the top of a crest vertical curve. This condition can be unsafe, especially at night, if the driver does not recognize the beginning or ending of the horizontal curve. Safety is improved if the horizontal curve leads the vertical curve, that is, the horizontal curve is made longer than the vertical curve in both directions.
- To maintain drainage, design vertical and horizontal curves so that the flat profile of a vertical curve will not be located near the flat cross slope of the superelevation transition.
- Do not introduce a sharp horizontal curve at or near the low point of a pronounced sag vertical curve. The road ahead is foreshortened and any horizontal curve that is not flat assumes an undesirably distorted appearance. Further, vehicular speeds, particularly of trucks, often are high at the bottom of grades and erratic operation may result, especially at night.
- On two-lane roads, the need for safe passing sections (at frequent intervals and for an appreciable percentage of the length of the roadway) often supersedes the general desirability for combination of horizontal and vertical alignment. Work toward long tangent sections to secure sufficient passing sight distance.



For grades longer than indicated, consider an auxiliary climbing lane (Chapter 1010).

Grade Length
Figure 630-1

- On divided highways, consider variation in width of median and the use of independent alignments to derive the design and operational advantages of one-way roadways.
- Make horizontal curvature and profile as flat as feasible at intersections where sight distance along both roads is important and vehicles may have to slow or stop.
- In residential areas, design the alignment to minimize nuisance factors to the neighborhood. Generally, a depressed facility makes a highway less visible and less noisy to adjacent residents. Minor horizontal adjustments can sometimes be made to increase the buffer zone between the highway and clusters of homes.
- Design the alignment to enhance attractive scenic views of the natural and manmade environment, such as rivers, rock formations, parks, and outstanding buildings.

When superelevation transition within the limits of a vertical curve is necessary, plot profiles of the edges of pavement to ensure smooth transitions.

630.05 Airport Clearance

For proposed highway construction or alteration in the vicinity of a public or military airport, early contact by the region with the airport authorities is required so that advance planning and design work can proceed within the required FAA regulations (Chapter 240).

630.06 Railroad Crossings

When a highway crosses a railroad at grade, design the highway grade so that a low-hung vehicle will not damage the rails or get hung up on the tracks. Figure 630-3 gives guidance on designing highway grades at railroad crossings. For more information on railroad-highway crossings, see Chapter 930.

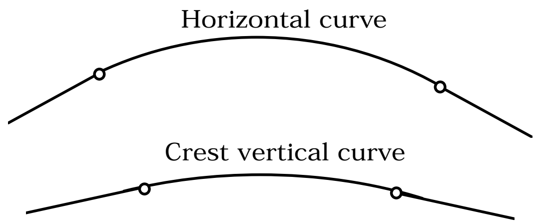
630.07 Procedures

When the project will modify the vertical alignment, develop vertical alignment plans for inclusion in the PS&E to a scale suitable for showing vertical alignment for all proposed roadways including ground line, grades, vertical curves, and superelevation. See the *Plans Preparation Manual* for additional requirements.

When justifying any modification to the vertical alignment, include the reasons for the change, alternatives considered (if any) and why the selected alternative was chosen. When the profile is a result of new horizontal alignment, consider vertical and horizontal alignments together and document the profile with the horizontal alignment justification.

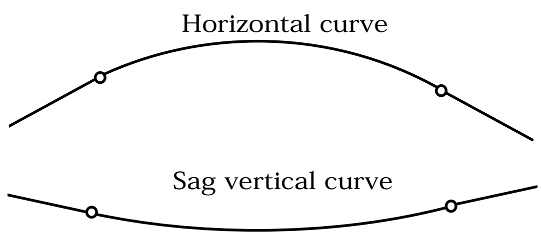
630.08 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site: http//www.wsdot.wa.gov/eesc/design/projectdev/



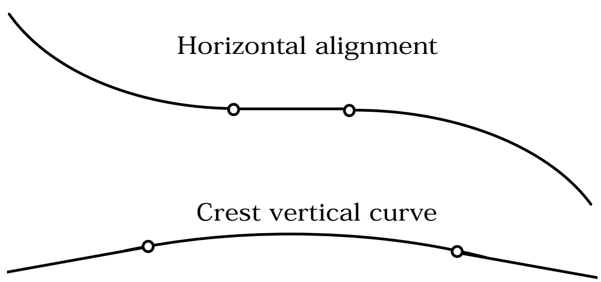
Coinciding Horizontal and Crest Vertical Curves.

When horizontal and crest vertical curves coincide, a satisfactory appearance results.



Coinciding Horizontal and Sag Vertical Curves

When horizontal and sag vertical curves coincide, a satisfactory appearance results.



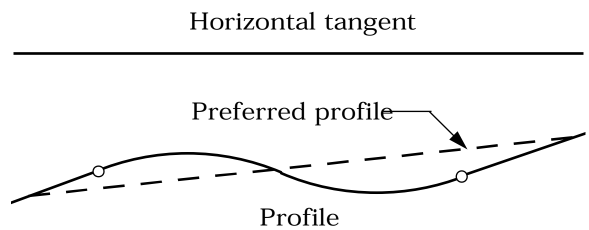
Short Tangent on a Crest Between Two Horizontal Curves

This combination is deficient for several reasons:

- The curve reversal is on a crest making the second curve less visible.
- The tangent is too short for the superelevation transition.
- The flat area of the superelevation transition will be near the flat grade in the crest.

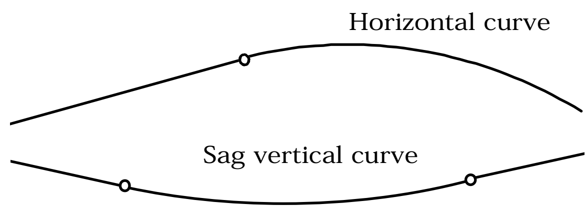
Coordination of Horizontal and Vertical Alignments

Figure 630-2a



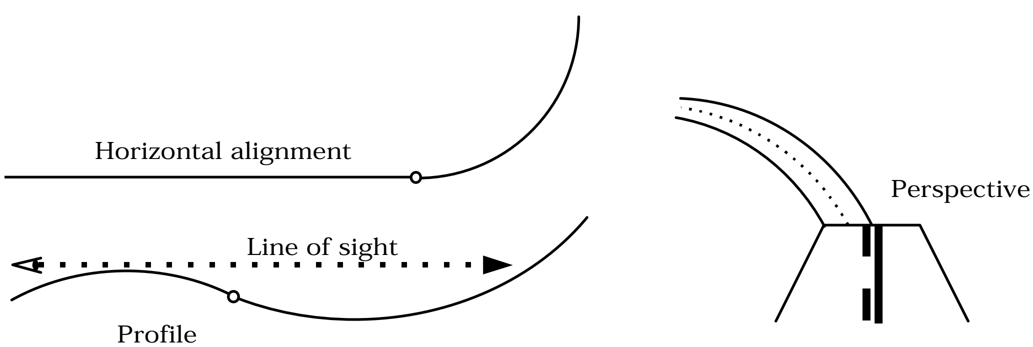
Profile with Tangent Alignment

Avoid designing dips on an otherwise long uniform grade.



Sharp Angle Appearance

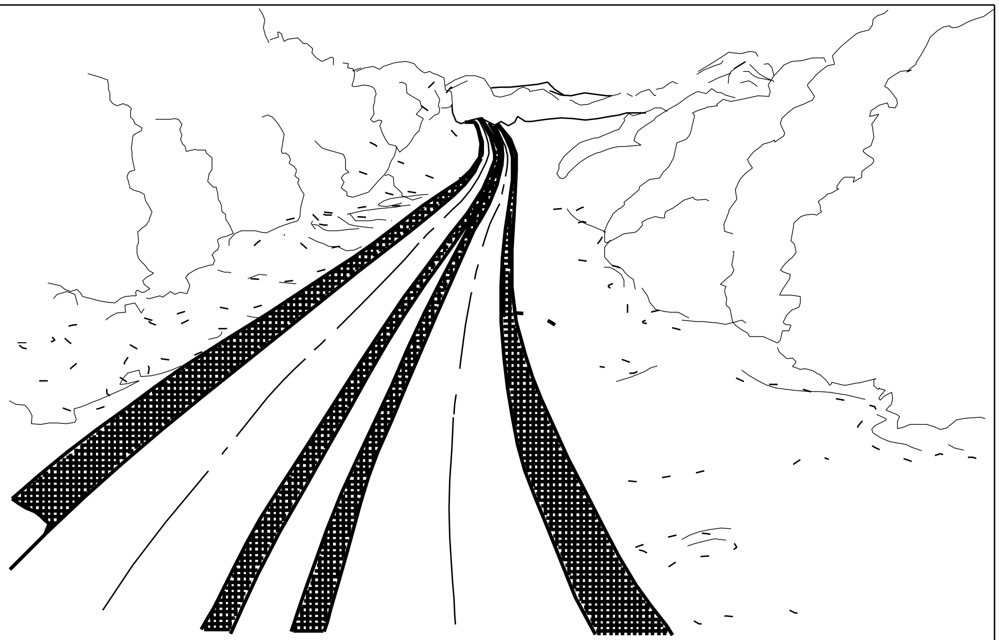
This combination presents a poor appearance. The horizontal curve looks like a sharp angle.



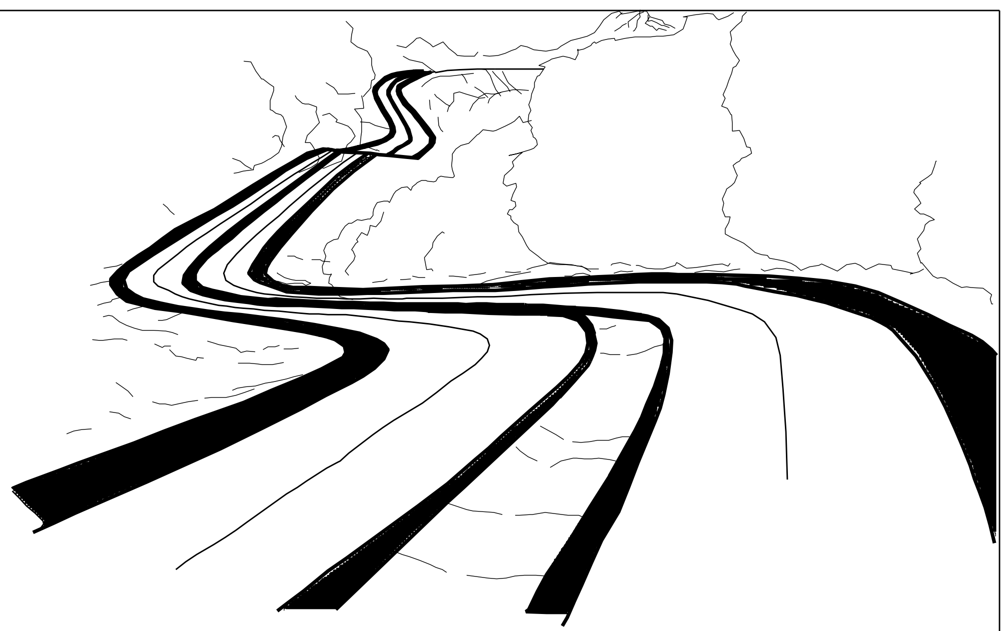
Disjointed Effect

A disjointed effect occurs when the beginning of a horizontal curve is hidden by an intervening crest while the continuation of the curve is visible in the distance beyond the intervening crest.

Coordination of Horizontal and Vertical Alignments
Figure 630-2b

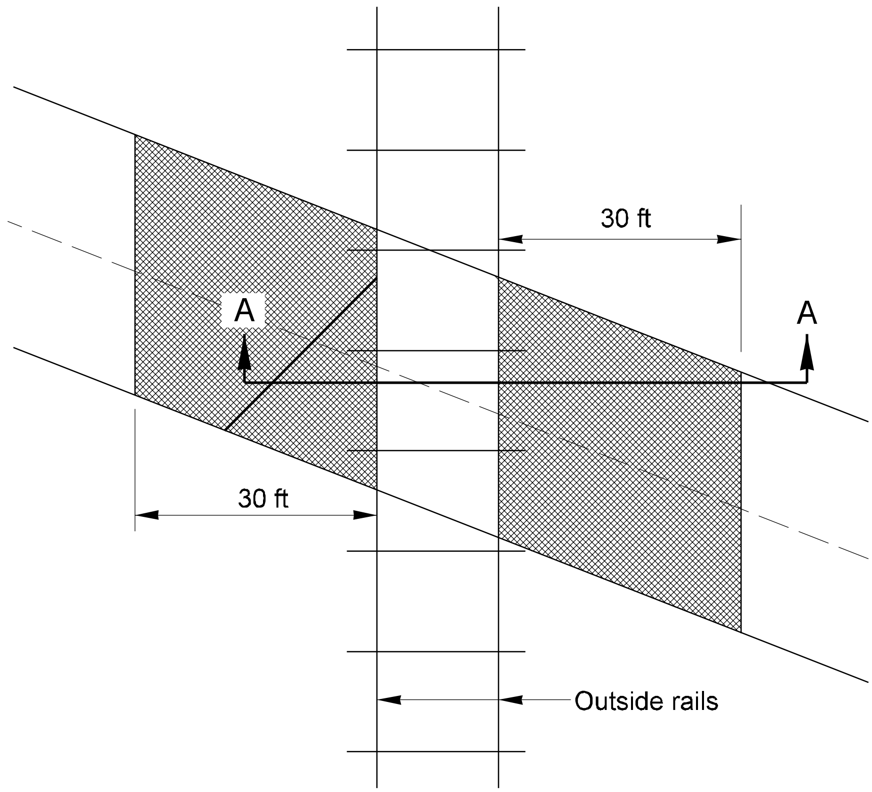


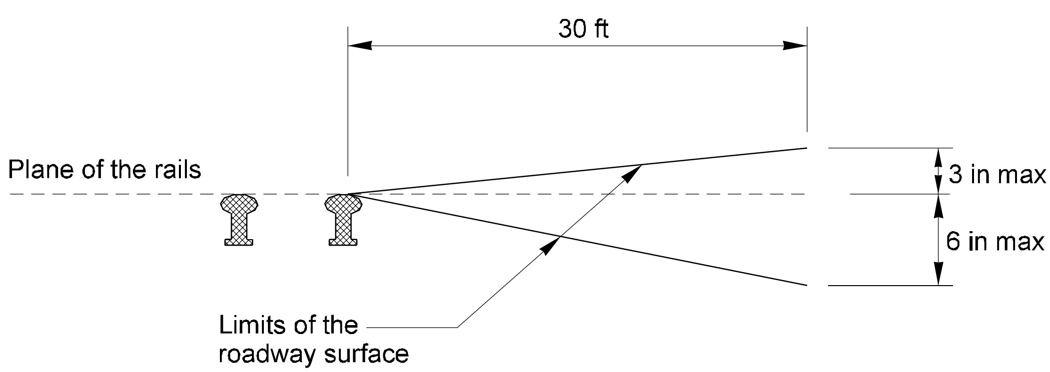
Desirable Coordination of Vertical and Horizontal
Curves and the Use of Flowing Alignment



Undesirable - Vertical and Horizontal Curves
Not Coordinated and Using Minimums

Coordination of Horizontal and Vertical Alignments
Figure 630-2c





Detail A-A

Grading at Railroad Crossings
Figure 630-3

640.01 General

Geometric cross sections for state highways are governed by functional classification criteria, traffic volume, and whether the highway is in a rural or urban area. See Chapter 440 for guidance on selecting a design class.

High Occupancy Vehicle (HOV) lanes must be considered when continuous through lanes are to be added within the limits of an urban area over 200,000 population (Chapter 1050).

When a state highway within an incorporated city or town is a portion of a city street, the design features must be developed in cooperation with the local agency. On managed access highways within the limits of incorporated cities and towns, the cities or towns have full responsibility for design elements outside of curb, or outside the paved shoulder where no curb exists, using the *Local Agency Guidelines*, M 36-63. Medians are considered to be within the curb. For city streets and county roads that are not part of the state highway system, use Chapter 468-18 WAC City/County Project Coordination and the *Local Agency Guidelines*, M 36-63

See the following chapters for additional information:

Chapter	Subject
430	all roadway widths for modified design level
440	lane and shoulder widths for full design level
440	shoulder widths at curbs
910	requirements for islands
940	lane and shoulder widths for ramps

640.02 References

Washington Administrative Code (WAC 468-18-040), "Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings"

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

Plans Preparation Manual, WSDOT, M 22-31

Highway Runoff Manual, M 31-16, WSDOT

Local Agency Guidelines (LAG), M 36-63, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10,WSDOT

WSDOT Pavement Guide for Interactive

A Policy on Geometric Design of Highways and Streets (Green Book), 1994, AASHTO

640.03 Definitions

auxiliary lane The portion of the roadway adjoining the through lanes for parking, speed change, turning, storage for turning, weaving, truck climbing, and other purposes supplementary to through-traffic movement.

high pavement type Portland cement concrete pavement or asphalt cement concrete on a treated base.

intermediate pavement type Asphalt cement concrete pavement on an untreated base.

lane A strip of roadway used for a single line of vehicles.

lane width The lateral design width for a single lane, striped as shown in the Standard Plans and the Standard Specifications. The width of an existing lane is measured from the edge of traveled way to the center of the lane line or between the centers of successive lane lines.

low pavement type Bituminous surface treatment.

median The portion of a divided highway separating the traveled ways for traffic in opposite directions.

outer separation The area between the outside edge of traveled way for through traffic and the nearest edge of traveled way of a frontage road.

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

shoulder The portion of the roadway contiguous with the traveled way, primarily for accommodation of stopped vehicles, emergency use, lateral support of the traveled way, and use by pedestrians.

shoulder width The lateral width of the shoulder, measured from the outside edge of the outside lane to the edge of the roadway.

superelevation The rotation of the roadway cross section in such a manner as to overcome part of the centrifugal force that acts on a vehicle traversing a curve.

superelevation runoff The length of highway needed to accomplish the change in cross slope from a level section to a fully superelevated section, or vice versa.

superelevation transition length The length of highway needed to change the cross slope from normal crown or normal pavement slope to full superelevation.

tangent runout The length of highway needed to change the cross slope from normal crown to a section with adverse crown removed (level).

traveled way The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

turning roadway A curve on an open highway, a ramp, or the connecting portion of roadway between two intersecting legs of an intersection.

640.04 Roadways

The cross sections shown in Figures 640-3, 4, 5, 6a, and 6b represent minimum standards for full design level.

For the specific type of roadway section see Chapter 440. For pavement type details see the Pavement Guide.

(1) Traveled Way Cross Slope

The cross slope on tangents and curves is a main element in cross section design. The cross slope or crown on tangent sections and large radius curves is complicated by two contradicting controls. Reasonably steep cross slopes are desirable to aid in water runoff and to minimize ponding as a result of pavement imperfections and unequal settlement. However, steep cross slopes are undesirable on tangents because of the tendency for vehicles to drift to the low side of the roadway. Cross slopes greater than 2% are noticeable in steering and increase susceptibility to sliding to the side on icy or wet pavements.

A 2% cross slope is normally used for tangents and large radius curves on high and intermediate pavement types.

In some areas, a somewhat steeper cross slope may be desirable to improve roadway runoff, although it is undesirable operationally. For these areas, with justification, a 2.5% cross slope may be used.

On low pavement types, such as bituminous surface treatment, the cross slope may be increased to 3% to allow for reduced construction control and greater settlement.

Superelevation on curves is determined by the design speed and the radius of the curve. See 640.05 for guidance on superelevation design.

(2) Turning Roadway Widths

The roadway on a curve may need to be widened to make the operating conditions comparable to those on tangents. There are two main reasons to do this. One is the offtracking of vehicles, such as trucks and buses. The other is the increased difficulty drivers have in keeping their vehicles in the center of the lane.

Overlays in front of safety shaped concrete barriers can extend to the top of the lower, near-vertical face of the barrier before adjustment is required. Allow no more than 13 in from the pavement to beginning of the top near-vertical face on either the F or NJ shape barriers. Allow no less than 32 inches from the pavement to the top of the single slope barrier. Allow no less than 27 in from the ground to the top cable of the Type 1 cable barrier and no less than 30 in for the Type 2 and Type 3 cable barrier.

(b) **Full Design Level (F).** When the full design level (F) is indicated, in addition to the requirements for the basic design level, the barrier must meet the requirements found in the following:

700.06	Median Barrier Guidelines
710.05(1)	Shy Distance
710.05(2)	Barrier Deflections
710.05(3)	Flare Rate
710.05(4)	Length of Need
710.05(5)	Median Barrier Selection
710.06	Beam Guardrail
710.07	Cable Barrier
710.08	Concrete Barrier

Examples of barriers that are not acceptable as a "standard run" are:

- W-beam guardrail with 12 ft-6 in post spacing and no blockouts.
- W-beam guardrail on concrete posts.
- Cable barrier on wood or concrete posts.
- Half-moon or C shape rail elements.

(3) Bridge Rail

When the Bridge Rail column of a matrix applies to the project, the bridge rails must meet the following requirements:

Use an approved, crash tested concrete bridge rail on new bridges or bridges to be widened. The *Bridge Design Manual* provides examples of typical bridge rails. Consult the Bridge and Structures Office regarding bridge rail selection and design and for design of the connection to an existing bridge.

An existing bridge rail on a highway with a posted speed of 30 mph or less may remain in place if it is not located on a bridge over a National Highway System (NHS) highway. When Type 7 bridge rail is present on a bridge over a NHS highway with a posted speed of 30 mph or less it may remain place, regardless of the type of metal rail installed. All other bridge rails must be evaluated for strength and geometrics. See 710.11 for guidance on retrofit techniques. The funding source for retrofit of existing bridge rail is dependent on the length of the structure. Bridge rail retrofit, for bridges less than 250 ft in length (or a total bridge rail length of 500 ft), is funded by the project (Preservation or Improvement). For longer bridges, the retrofit can be funded by the I2 subprogram. Contact programming personnel to determine if funding is available.

The Type 7 bridge rail is common. Type 7 bridge rails have a curb, a vertical-face parapet, and an aluminum top rail. The curb width and the type of aluminum top rail dictate the adequacy of the Type 7 bridge rail as shown on Figure 710-1. Consult the Bridge and Structures Office for assistance in evaluating other bridge rails.

710.05 Barrier Design

When selecting a barrier, consider the flexibility, cost, and maintainability of the system. It is generally desirable to use the most flexible system possible to minimize damage to the impacting vehicle and injury to the vehicle's occupant(s). However, since nonrigid systems sustain more damage during an impact, the exposure of maintenance crews to traffic might be increased.

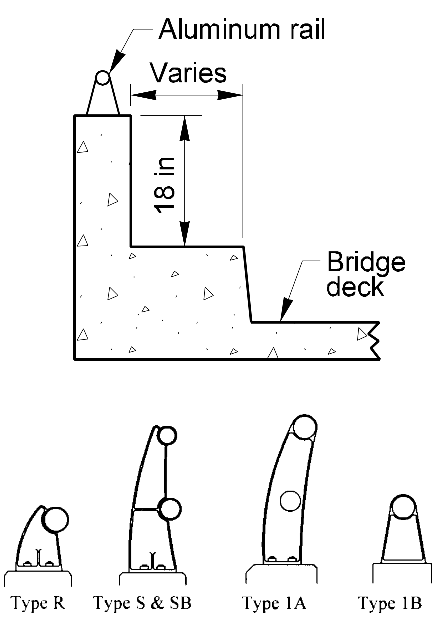
Concrete barrier maintenance costs are lower than for other barrier types. Deterioration due to weather and vehicle impacts is limited. Unanchored precast concrete barrier can usually be realigned or repaired when moved from its alignment. However, heavy equipment may be required to reposition or replace barrier segments. Therefore, in medians, consider the shoulder width and the traffic volume when determining the acceptability of unanchored precast concrete barrier versus a rigid concrete barrier.

Drainage, alignment, and drifting snow or sand are considerations that can influence the selection of barrier type. Beam guardrail and concrete barrier can contribute to snow drifts. Consider long-term maintenance costs associated with snow removal at locations prone to snow drifting. Slope flattening is highly recommended, even at additional cost, to eliminate the need for the barrier. Cable barrier is not an obstruction to drifting snow and can be used if slope flattening is not practical.

When designing a barrier for use on a Scenic Byway or Heritage Tour Route (formerly Scenic and Recreational Highway), consider barriers that are consistent with the recommendations in the associated Corridor Management Plan (if one is available). Contact the region's Landscape Architect or the Headquarters' Heritage Corridors Program manager to determine if the project is on such a designated route. Low cost options, such as using weathering steel beam guardrail (710.06) or cable barrier (710.07) might be feasible on many projects. Higher cost options, such as steel backed timber rail and stone guardwalls (710.09) might require a partnering effort to fund the additional costs. Grants might be available for this purpose if the need is identified early in the project definition phase. (See Chapter 120.)

(1) Shy Distance

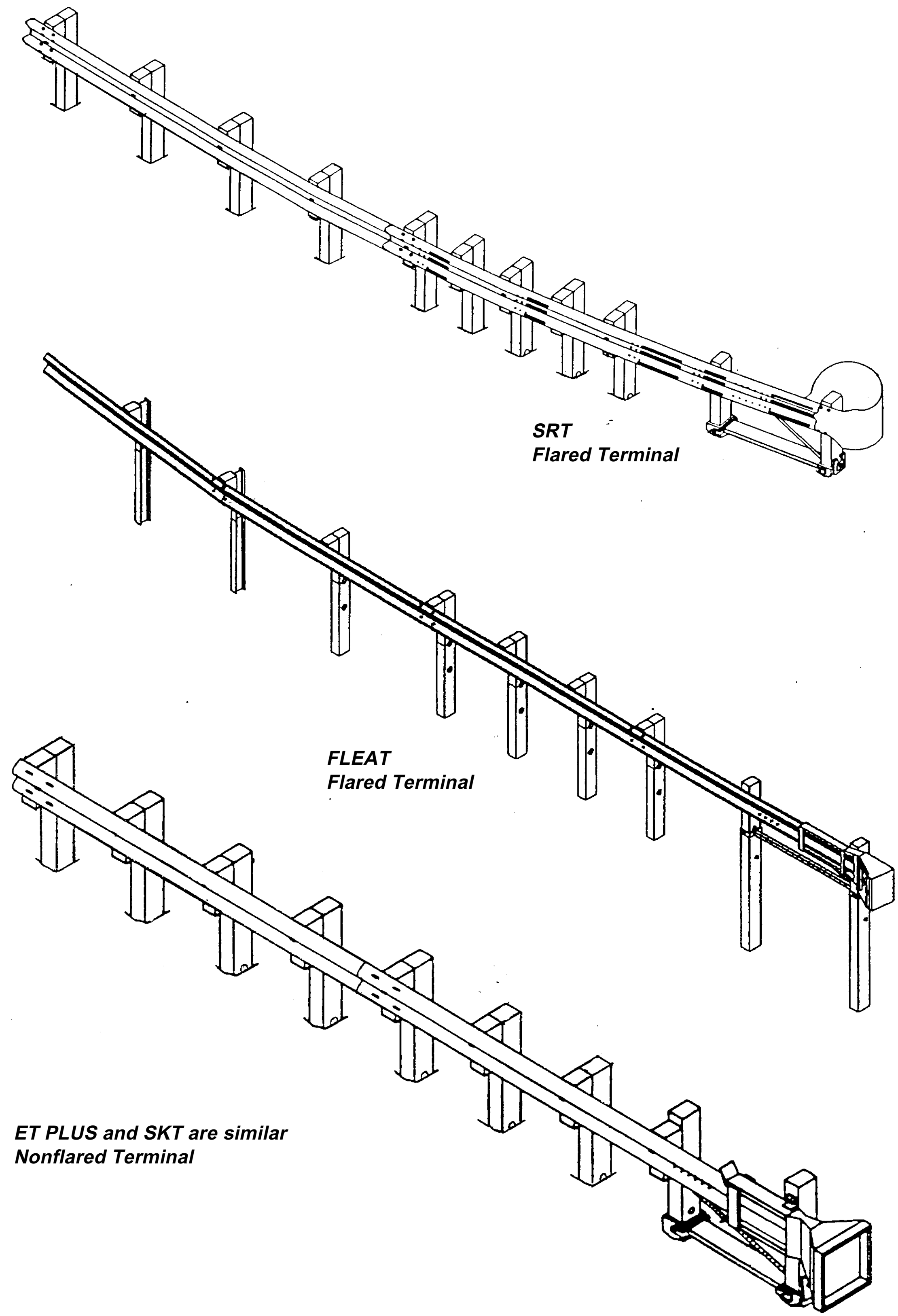
Provide 2 ft of additional widening for shy distance when a barrier is to be installed in areas where the roadway is to be widened and the shoulder width will be less than 8 ft. This shy distance is not required when the section of roadway is not being widened or the shoulders are at least 8 ft wide.



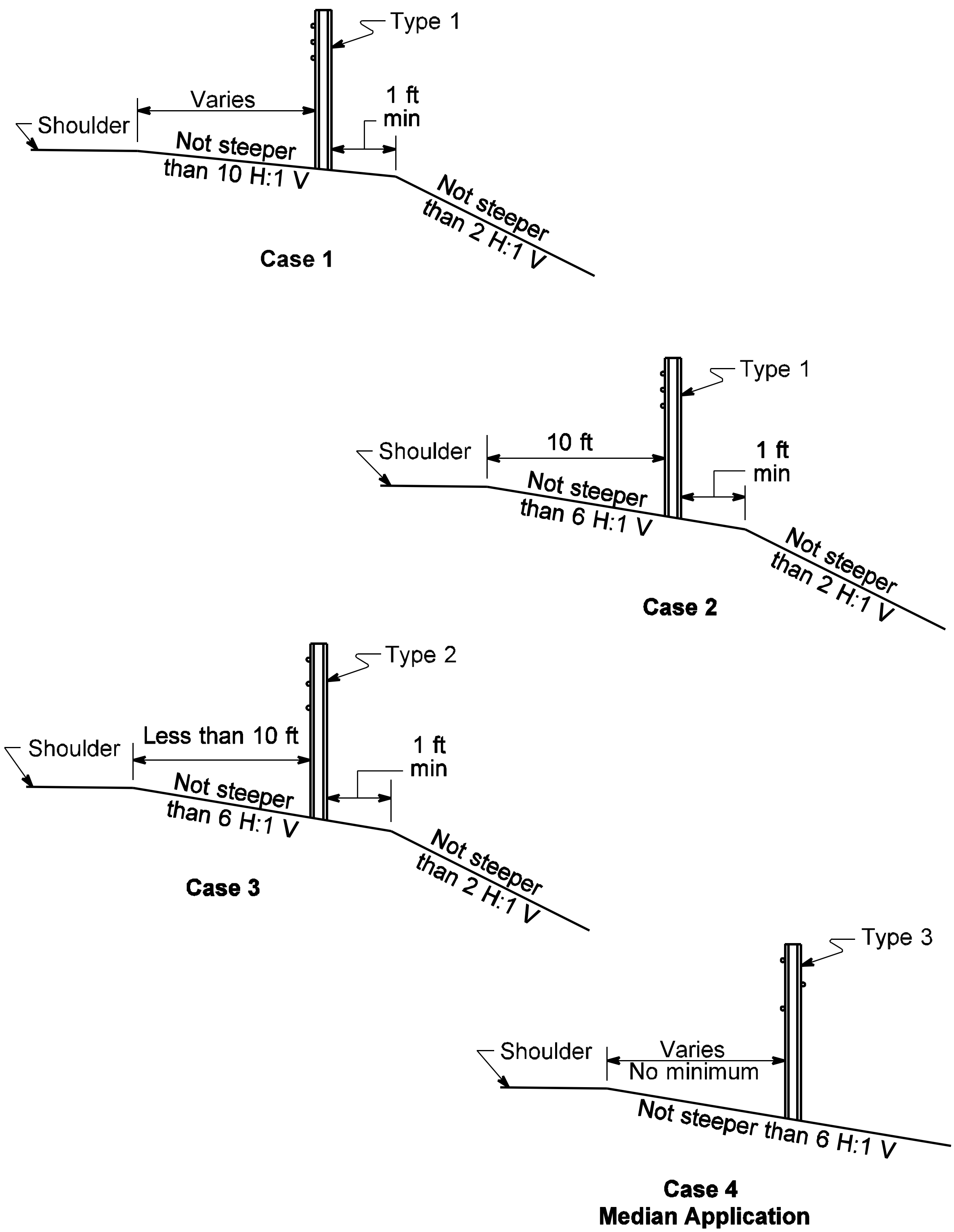
	Curb Width	
Aluminum Rail Type	9 in or less	Greater than 9 in*
Type R, S, or SB	Bridge rail adequate	Bridge rail adequate
Type 1B or 1A	Bridge rail adequate	Upgrade bridge rail
Other	Consult the Bridge and Structures Office	

* When the curb width is greater than 9 in, the aluminum rail must be able to withstand a 5 kip load.

Type 7 Bridge Rail Upgrade Criteria
Figure 710-1



Beam Guardrail Terminals
Figure 710-13



Cable Barrier Locations on Slopes
Figure 710-14

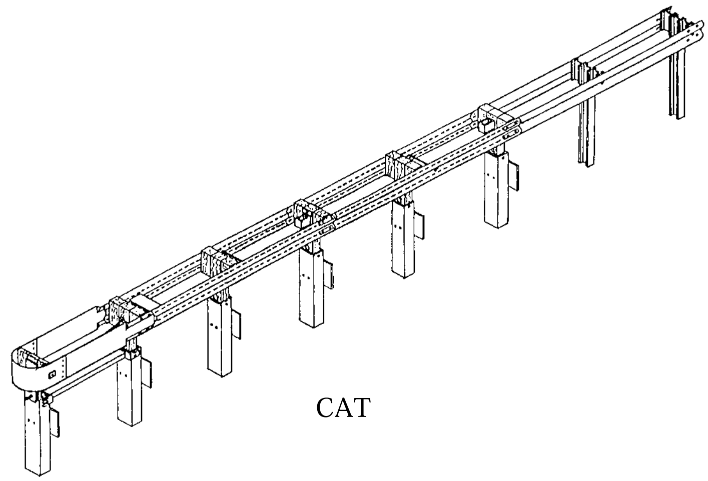
When specifying the system or systems that can be used at a specific location, the list shown in Figure 720-5 is to be used as a starting point. As the considerations discussed previously are analyzed, inappropriate systems may be identified and eliminated from further consideration. Systems that are not eliminated may be appropriate for the project. When the site conditions vary, it might be necessary to have more than one list of acceptable systems within a contract. Systems are not to be eliminated without documented reasons. Also, wording such as *or equivalent* is not to be used when specifying these systems. If only one system is found to be appropriate, then approval from the Assistant State Design Engineer of a public interest finding for the use of a sole source proprietary item is required.

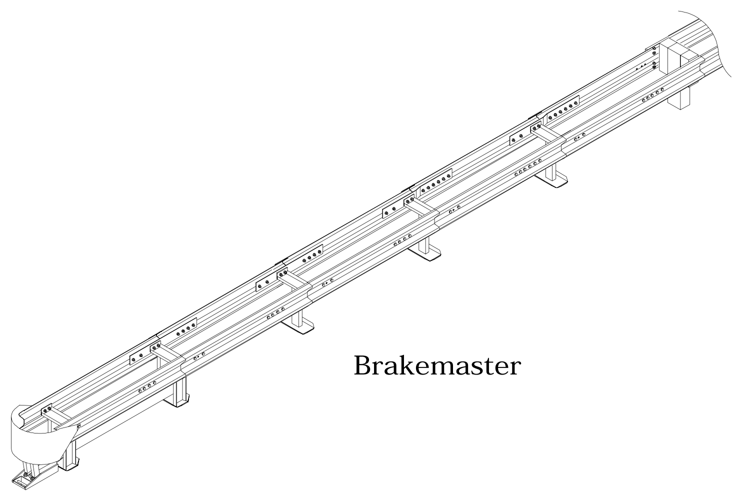
When a transition to connect with a concrete barrier (see Figure 720-5) is required, the transition type and connection must be specified and are included in the cost of the impact attenuator. See Chapter 710 for information on the transitions and connections to be used.

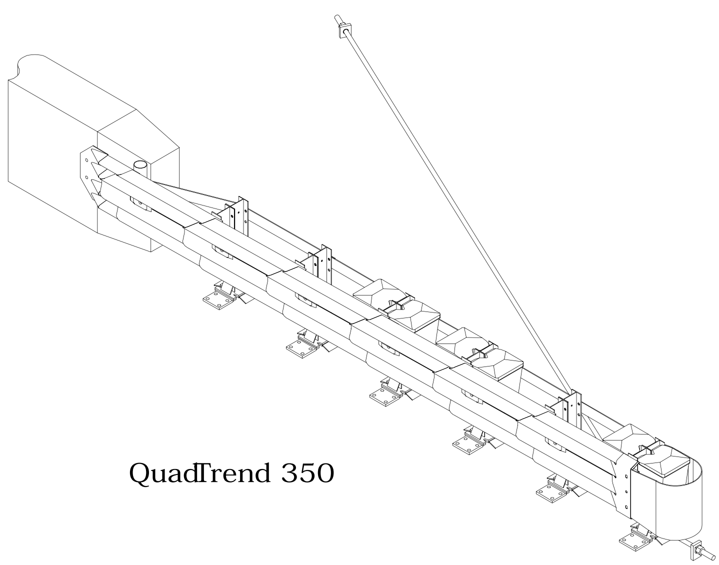
Contractors can be given more flexibility in the selection of work zone (temporary) systems, since long-term maintenance and repair are not a consideration.

720.04 Documentation

A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/







Impact Attenuator Systems — Permanent Installations

Figure 720-2a

830.05 Barrier Delineation

Traffic barriers are delineated where guide posts are required, such as bridge approaches, ramps, and other locations on unilluminated roadways. See Figure 830-2. At these locations, the barrier delineation has the same spacing as that of guide posts. Barrier delineation is also required when the traffic barrier is 4 ft or less from the traveled way. Use a delineator spacing of no more than 40 ft at these locations.

Beam guardrail is delineated by either mounting flexible guide posts behind the rail or by attaching shorter flexible guide posts to the wood guardrail posts.

Concrete barrier is delineated by placing retroreflective devices on the face of the barrier about 6″ down from the top. Consider mounting these devices on the top of the barrier at locations where mud or snow accumulates against the face of the barrier.

The terminal ends of impact attenuators are delineated with modified Type 3 Object Markers. These are the impact attenuator markers in the *Sign Fabrication Manual*. When the impact attenuator is used in a roadside condition, the marker with diagonal stripes pointing downward toward the roadway is used. When the attenuator is used in a gore where traffic will pass on either side, the marker with chevron stripes is used.

830.06 Wildlife Warning Reflectors

(1) Reflector System

Collisions between automobiles and wildlife (predominately deer) produce a substantial economic cost through damage to vehicles, human injuries, fatalities, and loss of the wildlife resources.

A wildlife warning reflector system has been developed to reduce this accident potential. This system consists of a series of reflectors mounted adjacent to the roadway. During the hours of low natural light (dusk, dawn, and night), light from the headlights of an approaching vehicle is reflected to the adjacent roadside by the reflectors. This reflected light creates an "optical fence" causing deer to remain motionless until the vehicle has passed.

The Headquarters (HQ) Environmental Services biologist maintains a history of vehicle-deer collisions on state highways and can furnish the region with prospective "optical fence" locations. The biologist is available to assist with a benefit/cost analysis of proposed reflector installations. Consider wildlife reflectors where the deerkill for any one mile section exceeds five kills per year. Also, consider wildlife reflectors for special circumstances such as at a high use deer crossing where a short section of this reflector system might be appropriate. After-installation maintenance costs can be a prohibitive factor when considering a wildlife reflector system. To remain effective, dirty reflectors must be cleaned periodically and reflector posts damaged by snow plowing or errant vehicles must be replaced.

(2) Reflector Placement

Spacing of the wildlife reflectors along the shoulder edges is dependent upon the geometric configuration of the highway and upon the roadside conditions. Reflectors are placed along both sides of the roadway in a staggered arrangement with the longitudinal spacing roughly equal to the combined transverse width of the roadway and reflector offset. See Figures 830-3 and 830-4 for examples of wildlife reflector placements. More detailed information for reflector placement in different locations is available from the manufacturer. Contact the HQ Environmental Services biologist or the HQ Traffic Office.

830.07 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

Ice Chisel Snow Removal Areas					
Roadway Classification	Marking Type				
	Center Lines	Lane Lines	Edge Lines	Wide Lines	Special Markings
Interstate	N.A.	Plastic Insets	Paint	Paint	Paint
Major Arterial	Paint and RRPMs	Paint	Paint	Paint	Paint
Minor Arterial	Paint	Paint	Paint	Paint	Paint
Collector	Paint	Paint	Paint	Paint	Paint

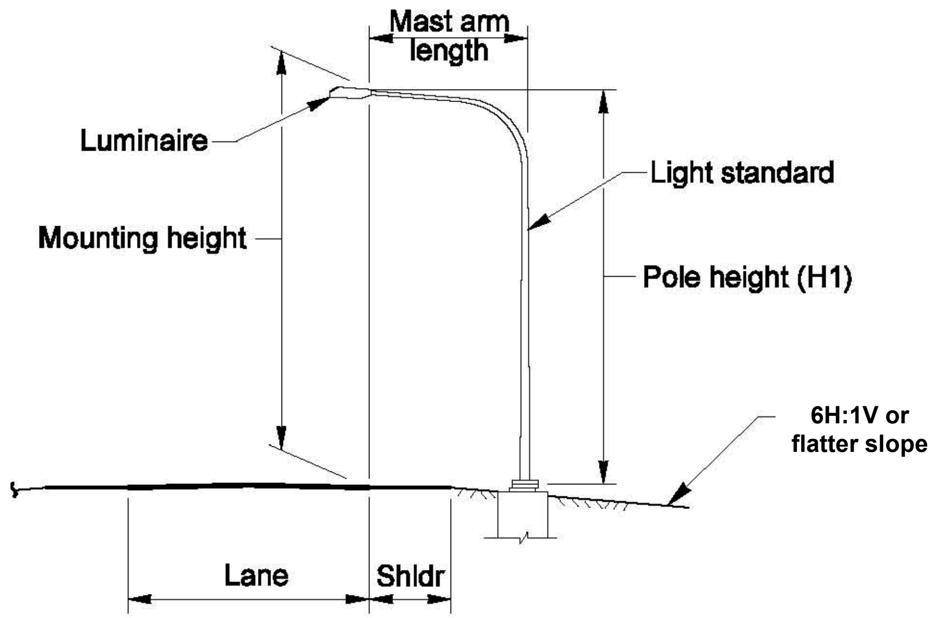
Steel Blade Snow Removal Areas					
Roadway Classification	Marking Type				
	Center Lines	Lane Lines	Edge Lines	Wide Lines	Special Markings
Interstate-Urban	N.A.	Plastic	Paint or Plastic	Paint or Plastic	Paint or Plastic
Interstate-Rural	N.A.	Paint	Paint or Plastic	Paint or Plastic	Paint or Plastic
Major Arterial	Paint and RRPMs or Plastic	Paint	Paint or Plastic	Paint or Plastic	Paint or Plastic
Minor Arterial	Paint	Paint	Paint	Paint or Plastic	Paint or Plastic
Collector	Paint	Paint	Paint	Paint or Plastic	Paint or Plastic

Rubber Blade Snow Removal Areas					
Roadway Classification	Marking Type				
	Center Lines	Lane Lines	Edge Lines	Wide Lines	Special Markings
Interstate-Urban	N.A.	RPMs only or Plastic and RPMs	Paint or Plastic	Plastic	Plastic
Interstate-Rural	N.A.	RPMs only or Plastic and RPMs	Paint	Plastic	Plastic
Major Arterial	Paint and RPMs or Plastic and RPMs	Paint and RPMs	Paint	Plastic	Plastic
Minor Arterial	Paint and RPMs	Paint and RPMs	Paint	Plastic	Plastic
Collector	Paint and RPMs	Paint	Paint	Plastic	Plastic

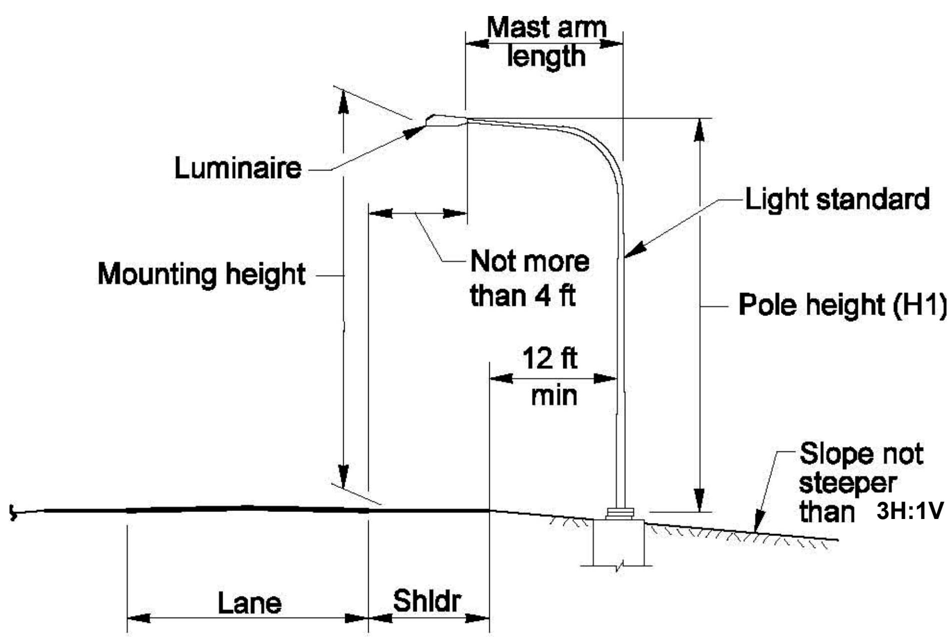
Notes

1. Insets are grooves ground into the pavement and filled with material, usually methyl methacrylate.
2. Plastic refers to methyl methacrylate, thermoplastic, or preformed tape.
3. See Standard Plan H-5d for RPM substitute applications.
4. See Standard Plan H-3 and H-3a for RPM applications with paint or plastic.
5. Special Markings include arrows, symbols, letters, channelizing lines, and transverse markings.
6. RRPMs refers to RPMs installed in a groove ground into the pavement.
7. Type 2 RPMs are not required with painted or plastic center or lane line in continuously illuminated sections. See Section 830.03(2).

Pavement Marking Material Guide
Figure 830-1



Preferred Location
Embankment slope



Alternate Location

Light Standard Locations
Figure 840-7

Luminaire Wattage	Initial Lumens*	H1	Recommended Mounting Height	
			Maximum	Minimum
200	22,000	30 ft	32 ft	28 ft
250	28,000	35 ft	38 ft	32 ft
310	37,000	40 ft	44 ft	36 ft
400	50,000	40 ft	44 ft	36 ft
400	50,000	50 ft	54 ft	46 ft
1,000	140,000	100 ft	110 ft	90 ft

Note:
*Lumens are for high pressure sodium vapor luminaires

Luminaire Wattage, Lumens, and Mounting Heights
Figure 840-8

- Pedestrian detector locations
- Signal standard types and locations
- Vehicle signal displays
- Pedestrian signal displays
- Phase diagram including pedestrian movements
- Emergency vehicle preemption requirements
- Illumination treatment

Submit a copy of the preliminary signal plan to the State Traffic Engineer for review and comment. When the proposed traffic signal is on an NHS highway, also submit a copy of the preliminary signal plan to the Assistant State Design Engineer for review and concurrence. After addressing review comments, finalize the plan and preserve as noted in the documentation section of this chapter. Prepare the contract plans in accordance with the *Plans Preparation Manual*.

If HQ is preparing the contract plans, specifications, and estimates for the project, submit the above preliminary signal plan with the following additional items:

- Contact person.
- Charge numbers.
- Critical project schedule dates.
- Existing utilities, both underground and overhead.
- Existing intersection layout, if different from the proposed intersection.
- Turning movement traffic counts; peak hour for isolated intersections; and AM, Midday, and PM peak hour counts if there is another intersection within 500 ft.
- Speed study indicating 90th and 10th percentile speeds for all approaches.
- Electrical service location, source of power, and utility company connection requirements.

After the plans, specifications, and estimate are prepared, the entire package is transmitted to the region for incorporation into their contract documents.

(11) Electrical Design

(a) **Circuitry Layout.** Consider cost, flexibility, construction requirements, and ease of maintenance when laying out the electrical circuits for the traffic signal system. Minimize roadway crossings whenever possible.

(b) **Junction Boxes.** Provide junction boxes at each end of a roadway crossing, where the conduit changes size, where detection circuit splices are required, and at locations where the sum of the bends for the conduit run equals or exceeds 360°. Signal standard or strain pole bases are not used as junction boxes. In general, locate junction boxes out of paved areas and sidewalks. Placing the junction boxes within the traveled way is rarely an effective solution and will present long-term maintenance problems. If there is no way to avoid locating the junction box in the traveled way, use traffic-bearing boxes. Avoid placing junction boxes in areas of poor drainage. In areas where vandalism can be a problem, consider junction boxes with locking lids. The maximum conduit capacities for various types of junction boxes are shown in the Standard Plans.

(c) **Conduit.** Use galvanized steel conduit for all underground raceways for the traffic signal installation on state highways. Thick-walled polyvinyl chloride (Schedule 80 PVC) conduit is used by many local agencies for ease of installation. At existing intersections, where roadway reconstruction is not proposed, place these conduits beyond the paved shoulder or behind existing sidewalks to reduce installation costs. With the exception of the 1/2 inch conduit for the service grounding electrode conductor, the minimum size conduit is 1 inch. The minimum size conduit for installations under a roadway is $1^1/4$ inch. Size all conduits to provide 26% maximum conductor fill for new signal installations. A 40% fill area can be used when installing conductors in existing conduits. See Figure 850-16 for conduit and signal conductor sizes.

(d) **Electrical Service and other components.** Electrical service types, overcurrent protection, and other components are covered in Chapter 840.

850.07 Documentation

A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

915.01 General

Modern roundabouts are circular intersections at grade. They can be an effective intersection type with fewer conflict points, lower speeds, and provide for easier decision making than conventional intersections. They require less maintenance than traffic signals. When well designed, they have been found to reduce fatal and severe injury accidents, traffic delays, fuel consumption, and air pollution. They also can have a traffic calming effect. For additional information and details on roundabouts, see *Roundabouts: An Informational Guide*.

Selection of a roundabout as the preferred intersection type is based on several factors including traffic volume, pedestrian and bicycle volume, space requirements, right of way availability, and traffic speeds. The safety benefits of a roundabout decrease with higher traffic volumes, particularly when pedestrians and bicycles are considered. Select a roundabout only when it is clearly the best intersection type.

Modern roundabouts differ from the old rotaries and traffic circles in three important respects: they have a smaller diameter that constrains circulating speeds; they have raised splitter islands that provide entry deflection, slowing down the entering vehicles; and they have yield at entry, which requires entering vehicles to yield, thus allowing circulating traffic free flow.

Old rotaries and traffic circles are characterized by a large diameter, often in excess of 300 ft. This large diameter typically results in travel speeds within the circulating roadway that exceed 30 mph. They typically provide little or no horizontal deflection of the paths of through traffic. These large diameters also create weaving areas that increase accidents in the circulating roadway. At times, traffic control was imposed on the circulating traffic, such as yield or stop signs that required circulating traffic to yield to entering traffic. In some cases, each entry was controlled with a traffic signal. Circular intersections with any of these features are not an approved intersection type.

(1) Locations Recommended for Roundabouts

Consider roundabouts at intersections:

- Where stop signs result in unacceptable delays for the crossroad traffic.
- With a high left-turn percentage on one or more legs.
- Where a disproportionately high number of accidents involve crossing or turning traffic.
- Where the major traffic movement makes a turn, for example where a state route or city arterial makes a turn.
- Where traffic growth is expected to be high and future traffic patterns are uncertain.
- Where it is not desirable to give priority to either roadway.
- Where major roads intersect at a wye (Y) or tee (T) intersection or with unusual geometry.

(2) Locations Where Roundabouts Need Additional Evaluation

The following conditions raise concerns that might make a roundabout less than desirable over other intersection types. With an evaluation that gives equal consideration to other intersection types, roundabouts may be considered:

- On a facility with a functional class of collector or above where any leg has a posted speed of 45 mph or higher.
- Where the grade for any leg exceeds 4%.
- Where traffic flows are unbalanced with higher volumes on one or more approaches.
- Where a major road intersects a minor road and a roundabout would result in unacceptable delays to the major road traffic.
- Where there is considerable pedestrian activity and, due to high traffic volumes, it would be difficult for pedestrians to cross either road. This includes special-need pedestrians such as large numbers of children or elderly.
- Where there is inadequate sight distance.
- Where there is considerable bicycle traffic.
- Where a downstream traffic control device could cause a queue that extends into the roundabout. Examples include traffic signals, signalized pedestrian crossings, railroad crossings, and drawbridges.
- Where a railroad will cross through the roundabout.
- With more than six approach legs.

(3) Locations Not Recommended for Roundabouts

Roundabouts are not recommended at intersections:

- Where a satisfactory geometric design (deflection, diameter, roadway width, or grade for example) cannot be provided.
- Where peak period reversible lanes are required.
- At a single intersection in a network of coordinated traffic signals and spacing prevents progression of the traffic signals.
- Where a signal interconnect system would provide a better level of service.
- Where it is desirable to be able to modify traffic movements via signal timings.
- Where volumes on the major roadway does not provide sufficient gaps for the minor roadway drivers, based on gap acceptance analysis model.

915.02 References

Americans with Disabilities Act of 1990 (ADA).

ADA Accessibility Guidelines (ADAAG), US Access Board, http://www.access-board.gov/adaag/html/adaag.htm

Revised Code of Washington (RCW) 47.05.021, Functional classification of highways.

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT.

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT.

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, M 24-01, WSDOT (MUTCD), http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm

Local Agency Guidelines (LAG), M 36-63, WSDOT.

Roundabouts: An Informational Guide, FHWA-RD-00-067, USDOT, FHWA.

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO.

Use of Roundabouts, ITE Technical Council Committee 5B-17, Feb. 1992.

Highway Capacity Manual (HCM), Special Report 209, Transportation Research Board, National Research Council.

NCHRP Synthesis 264, Modern Roundabout Practice in the United States, Transportation Research Board, 1998.

Guide to Traffic Engineering Practice, Part 6-Roundabouts (Austroad Guide), Sydney, Australia: Austroad, 1993.

The Traffic Capacity of Roundabouts, TRRL Laboratory Report 942, Kimber, R.M.

Crowthorne, England: Transport and Road Research Laboratory, 1980.

Roundabout Design Guidelines; Ourston & Doctors, Santa Barbara, California, 1995.

The Design of Roundabouts. State of the Art Review; Brown, Mike; Transportation Research Laboratory, Department of Transport. London, HMSO, 1995.

Crash Reductions Following Installation of Roundabouts in the United States, Insurance Institute for Highway Safety, March 2000.

ARCADY (Assessment of Roundabout CApacity and DelaY) program, developed by MVA Systematica under contract to Transport Road Research Laboratory (TRRL).

RODEL (ROundabout DELay) program, developed by the Highway Department of Staffordshire County Council in the UK.

aaSIDRA (Signalized Intersection Design and Research Aid) program, developed by The Australian Road Research Board (ARRB).

915.03 Definitions

approach roadway The lane or set of lanes for traffic approaching the roundabout. (See Figure 915-1.)

central island The area of the roundabout surrounded by the circulating roadway.

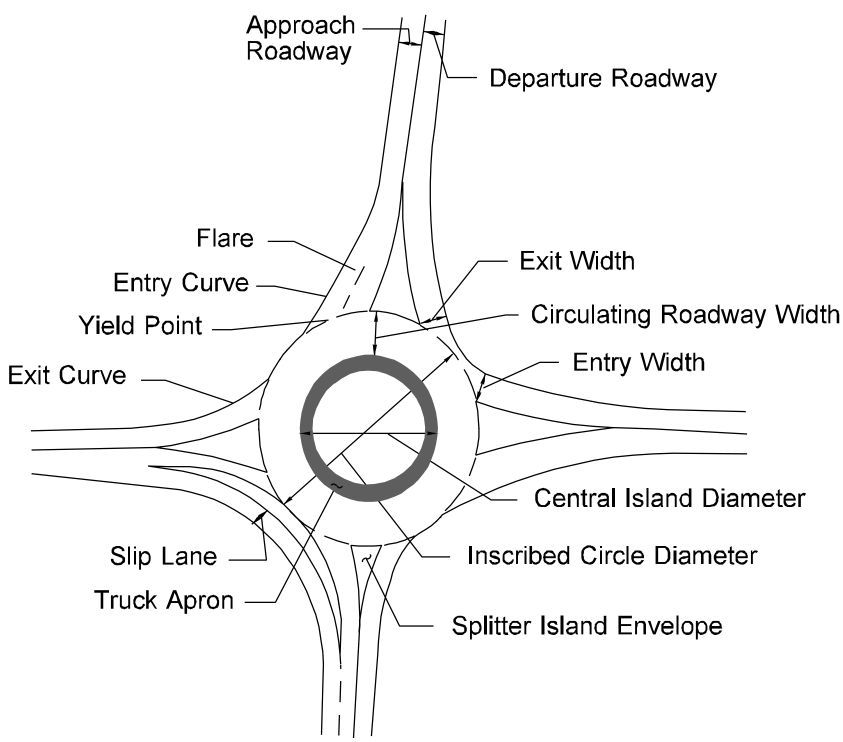
central island diameter The diameter of the central island, including the truck apron. (See Figure 915-1.)

circulating lane A lane used by vehicles circulating in the roundabout.

circulating roadway width The width of the area within the inscribed circle for vehicular movement measured from inscribed circle to the central island. (See Figure 915-1.)

conflict An event involving two or more road users in which the action of one user causes the other user to make an evasive maneuver to avoid a collision.

curb bulb A bulge in a curb line that reduces the width of the roadway.



Roundabout Elements
Figure 915-1

deflection The change in the path of a vehicle imposed by geometric features of a roundabout resulting in a slowing of vehicles. (See Figures 915-9a and 9b.)

departure roadway The lane or set of lanes for traffic leaving the roundabout. (See Figure 915-1.)

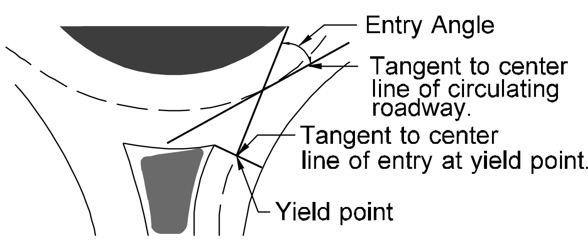
design speed The speed used to determine the various geometric design features of the roadway.

design vehicle A vehicle, the dimensions and operating characteristics of which are used to establish the layout geometry.

detectable warning surface A feature of a walking surface to warn visually impaired pedestrians of a hazard. Truncated domes are specified by The ADAAG.

double-lane roundabout A roundabout with the circulating roadway and one or more entry or exit legs designed as two lanes.

entry angle The angle between the entry roadway and the circulating roadway measured at the yield point. (See Figure 915-2.)



Entry Angle
Figure 915-2

entry curve The curve of the right curb that leads vehicles into the circulating roadway. (See Figure 915-1.)

entry width The width of an entrance leg at the inscribed circle. (See Figure 915-1.)

exit curve The curve of the right curb that leads vehicles out of the circulating roadway. (See Figure 915-1.)

exit width The width of an exit leg at the inscribed circle. (See Figure 915-1.)

flare The widening of the approach to the roundabout to increase capacity. (See Figure 915-1.)

functional classification The grouping of streets and highways according to the character of the service they are intended to provide as provided in RCW 47.05.021.

inscribed circle The entire area within a roundabout between all of the approaches and exits.

inscribed circle diameter The diameter of the inscribed circle. (See Figure 915-1.)

intersection angle The angle between any two intersection legs at the point that the center lines intersect.

intersection at grade The general area where a roadway or ramp terminal is met or crossed at a common grade or elevation by another roadway.

intersection leg Any one of the roadways radiating from and forming part of an intersection.

intersection sight distance The sight distance for the driver of a vehicle on the crossroad along the main roadway, as compared to the distance required for safe operation.

island A defined area within an intersection, between traffic lanes, for the separation of vehicle movements or for pedestrian refuge.

lane A strip of roadway used by a single line of vehicles.

lane width The lateral design width for a single lane, striped as shown in the Standard Plans and the Standard Specifications. The width of an existing lane is measured from the edge of traveled way to the center of the lane line or between the centers of successive lane lines.

roadway The portion of a state highway; a federal, county, or private road; or a city street, including shoulders, for vehicular use.

roundabout A circular intersection with yield control of all entering traffic, channelized approaches with raised splitter islands, counter-clockwise circulation, and appropriate geometric curvature to ensure that travel speeds on the circulating roadway are typically less than 30 mph.

sight distance The length of roadway visible to the driver.

single-lane roundabout A roundabout with the circulating roadway and all entry and exit legs designed as one lane.

shoulder The portion of the roadway contiguous with the traveled way, primarily for accommodation of stopped vehicles, emergency use, lateral support of the traveled way, and use by pedestrians and bicycles.

slip lane A lane that separates heavy right turn movements from the roundabout circulating traffic. (See Figure 915-1.)

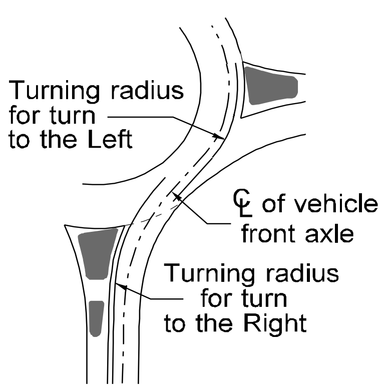
splitter island The raised island at each two-way leg between entering vehicles and exiting vehicles, designed primarily to deflect entering traffic.

splitter island envelope The raised splitter island and the painted channelization surrounding it. (See Figure 915-1.)

stopping sight distance The sight distance, as compared to the distance required to detect a hazard and safely stop a vehicle traveling at design speed.

superelevation The rotation of the roadway cross section in such a manner as to overcome part of the centrifugal force that acts on a vehicle traversing a curve.

rural area A nonurban area.



Turning Radius (R)
Figure 915-3

truck apron The optional, outer, mountable portion of the central island of a roundabout between the raised, nontraversable area of the central island and the circulating roadway. (See Figure 915-1.)

turning radius The radius that the front wheel of the design vehicle on the outside of the curve travels while making a turn. (See Figure 915-3.)

urban area One of the following areas:

- Within the federal urban area boundary as designated by FHWA.
- Characterized by intensive use of the land for the location of structures and receiving such urban services as sewers, water, and other public utilities and services normally associated with urbanized areas.
- With not more than twenty-five percent undeveloped land.

yield-at-entry The requirement that vehicles on all approaches yield to vehicles within the circulating roadway.

yield point The point of entry from an approach into the circulating roadway. If necessary, entering traffic must yield to circulating traffic at this point before entering the circulating roadway. (See Figure 915-1.)

915.04 Roundabout Categories

Roundabouts have been categorized according to size and environment to facilitate discussion of specific performance or design issues. There are six basic categories based on environment, number of lanes, and size:

- Mini roundabouts
- Urban compact roundabouts
- Urban single-lane roundabouts
- Urban double-lane roundabouts
- Rural single-lane roundabouts
- Rural double-lane roundabouts

Characteristics of the different roundabout categories are summarized on Figure 915-7. These categories and Figure 915-7 represent general characteristics of roundabouts, not design limits. Final design values may vary.

Separate categories have not been identified for suburban environments. Suburban settings combine higher approach speeds common in rural areas with multimodal activity that is more similar to urban settings. Therefore, generally, design suburban roundabouts as urban roundabouts but with the high-speed approach treatments recommended for rural roundabouts.

(1) Mini Roundabouts

Mini roundabouts are small roundabouts used in low-speed urban environments and are not suitable for use on a state route. They can be useful in low-speed urban environments, with average operating speeds of 35 mph or less, where a conventional roundabout is precluded by right of way constraints. In retrofit applications, mini roundabouts are relatively inexpensive because they typically require minimal additional pavement at the intersecting roads. They are mostly recommended when there is insufficient right of way for an urban compact roundabout. Because they are small, mini roundabouts are perceived as pedestrian friendly with short crossing distances and very low vehicle speeds on approaches and exits. The mini roundabout is designed to accommodate passenger cars without requiring them to drive over the central island. A mountable central island is recommended because larger vehicles might be required to cross over it. Provide speed control around the mountable central island in the design by requiring horizontal deflection. Capacity for this type of roundabout is expected to be similar to that of the urban compact roundabout. Permeable pavement might be appropriate in the mountable center island to offset any storm water impacts.

(2) Urban Compact Roundabouts

Urban compact roundabouts are also intended to be pedestrian and bicyclist friendly. Because of the smaller design vehicle, they are normally not suitable for use on a state route. Their perpendicular approach legs require very low vehicle speeds. All legs have single-lane entries. However, the urban compact treatment meets all the design requirements of effective roundabouts. The principal objective of this design is to enable pedestrians to have safe and effective use of the intersection. Consider urban compact roundabouts only where capacity is not a critical issue. The geometric design includes raised splitter islands that incorporate at-grade pedestrian storage areas, and a nonmountable central island. There is usually a truck apron surrounding the compact central island to accommodate large vehicles.

(3) Urban Single-Lane Roundabouts

Urban single-lane roundabouts are characterized as having single-lane entries at all legs and one circulating lane. They are distinguished from urban compact roundabouts by their larger inscribed circle diameters and more tangential entries and exits, resulting in higher capacities. Their design allows slightly higher speeds at the entry, on the circulating roadway, and at the exit. This roundabout design is focused on achieving consistent entering and circulating vehicle speeds. The geometric design includes raised splitter islands, a nonmountable central island, and (preferably) no apron. However, a truck apron might be necessary to allow large trucks to make left turns. When a truck apron is used, design the roundabout so that a bus will not need to use it.

(4) Urban Double-Lane Roundabouts

Urban double-lane roundabouts include all roundabouts in urban areas that have at least one entry with two lanes. They include roundabouts with entries on one or more approaches that flare from one to two lanes. These require wider circulating roadways to accommodate two vehicles traveling side by side. The speeds at the entry, on the circulating roadway, and at the exit are similar to those for the urban single-lane roundabouts. It is important that the vehicular speeds be consistent throughout the roundabout. Geometric design includes raised splitter islands, a nonmountable central island, and appropriate horizontal deflection.

Alternate routes may be provided for bicyclists who choose to bypass the roundabout. Delineate bicycle and pedestrian pathways clearly. Use sidewalks and landscaping to direct users to the appropriate crossing locations and alignment. Urban double-lane roundabouts located in areas with high pedestrian or bicycle volumes might have special design requirements.

When a double-lane roundabout is required for the design year but traffic projections indicate that one lane will be sufficient for 10 years or more, consider restricting it to one lane until traffic volumes require a double-lane roundabout.

(5) Rural Single-Lane Roundabouts

Rural single-lane roundabouts generally have high approach speeds. They require supplementary geometric and traffic control device treatments on approaches to encourage drivers to slow to an appropriate speed before entering the roundabout. Rural roundabouts may have larger diameters than urban roundabouts to allow slightly higher speeds at the entries, on the circulating roadway, and at the exits. This is possible if current and anticipated future pedestrian volumes are low.

Design rural roundabouts that might become part of an urban area with slower speeds and pedestrian treatments. However, in the interim, provide supplementary approach and entry features to achieve safe speed reduction. Supplemental geometric design elements include extended and raised splitter islands, a nonmountable central island, and adequate horizontal deflection.

The central island needs to have “target value” to give cues to approaching drivers that there is something that they must drive around. Designers will need to mound the planting area and plant native materials that are out of clear zone and provide “target value”.

The geometric design includes a truck apron where necessary for WB-50 and larger trucks to use the roundabout. Design the roundabout so that a WB-40 will not be required to use the truck apron.

(6) Rural Double-Lane Roundabouts

Rural double-lane roundabouts have speed characteristics similar to rural single-lane roundabouts. They differ in having two entry lanes, or entries flared from one to two lanes, on one or more approaches. Consequently, many of the characteristics and design features of rural double-lane roundabouts mirror those of their urban counterparts. The main design differences are higher entry speeds and larger diameters, and recommended supplementary approach treatments. Design rural roundabouts that might become part of an urban area for slower speeds, with design details that fully accommodate pedestrians and bicyclists. However, in the interim, design approach and entry features to achieve safe speed reduction.

The central island needs to have “target value” to give cues to approaching drivers that there is something that they must drive around. Designers will need to mound the planting area and plant native materials that are out of clear zone and provide “target value”.

When a double-lane roundabout is required for the design year but traffic projections indicate that one lane will be sufficient for at least 5 to 10 years, consider restricting it to one lane until traffic volumes require a double-lane roundabout.

915.05 Capacity Analysis

A capacity analysis is required for each proposed roundabout to compare it to other types of intersection control.

Design roundabouts so that the demand volume to capacity ratio is 0.85 or less and the anticipated delays are comparable to other types of intersection control.

There are two methods of performing the capacity analysis:

- An analysis based on gap acceptance (the Australian method). Use the method given in the *Austroad Guide* or the *Highway Capacity Manual*.
- An empirical formula based on measurements at a saturated roundabout (the British method). Use the method given in TRRL Report 942.

While each method has advantages, it is felt there is currently not enough United States performance data on which to base the empirical method analysis. Therefore, the gap acceptance method is preferred.

Figure 915-8 may be used to estimate the entry capacity of each roundabout entry leg; however, perform a capacity analysis using other methods to verify roundabout capacity.

915.06 Geometric Design

(1) Design Vehicle

The physical characteristics of the design vehicle are one of the elements that control the geometric design of a roundabout. See Chapter 910 for guidance on the selection of a design vehicle. As with other intersections, the design vehicle may differ for each movement. Use the largest vehicle selected for any movement as the design vehicle for the circulating roadway. For a roundabout on a state highway, this is the WB-50 vehicle. Design a roundabout so that the design vehicle can use it with 2 ft clearance from the turning radius to any curb face. The rear wheel of a semitrailer may encroach on the truck apron.

It is desirable to design the circulating roadway so that a BUS design vehicle in urban areas and a WB-40 in rural areas can use the roundabout without encroaching on the truck apron.

Design roundabouts on state routes so the WB-67 can use it without leaving the truck apron or encroaching on a curb. Use vehicle turning path templates to verify that this vehicle can make all state highway to state highway movements.

The vehicle path through a roundabout will normally contain reverse or compound curves. To check the roundabout for the design vehicles, a computer generated template for each path is recommended.

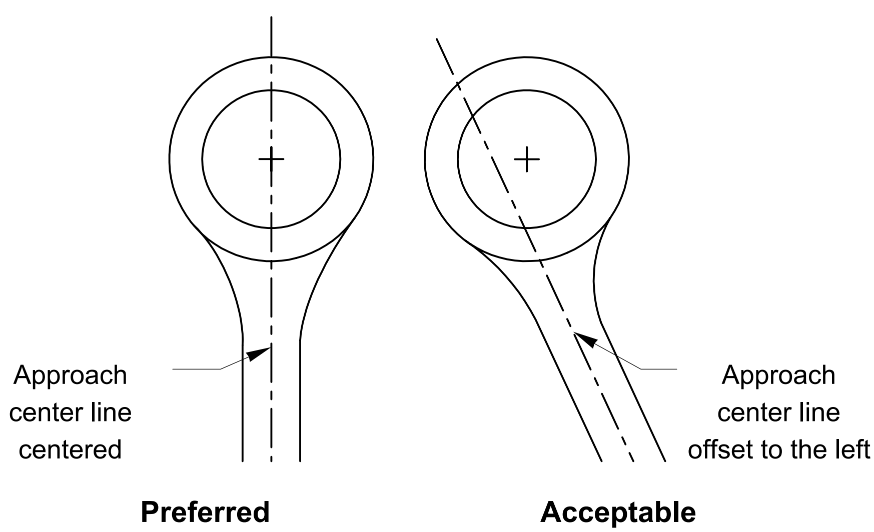
(2) Approach Alignment

The preferred alignment of an approach leg to a roundabout is with the centerline passing through the center of the inscribed circle. (See Figure 915-4.) This allows the roundabout to be designed so that vehicles will maintain slow speeds at both the entries and the exits. This alignment makes the central island more conspicuous to approaching drivers.

Where it is not possible to align an approach leg through the center of the inscribed circle, a slight offset to the left is acceptable. (See Figure 915-4.) This will allow adequate curvature at the entry, which is of greatest importance. In some cases, it may be beneficial to offset the approach slightly to the left to enhance the entry curvature. However, this will create a more tangential exit with increased exit speed and might increase the risk for pedestrians.

Approach alignment offset to the right of the roundabout's center point is unacceptable. This alignment

It is desirable to equally space the angles between entries. This will optimize the separation between successive entries and exits. When site conditions make equal spacing impractical, spacing may be varied to a minimum of 40°. When reducing the angle between approaches, ensure that speed consistency [915.06(4)] is maintained.



Approach Leg Alignment
Figure 915-4

(3) Deflection and Design Speed

For a roundabout to work properly, it must be designed to reduce the relative speeds between conflicting traffic streams. The most significant feature that will control the speed is adequate deflection. The deflection is expressed as the radius of the center line of a vehicle path through the roundabout. Figures 915-9a and 9b illustrate the vehicle paths for determining deflection.

The vehicle path can be adjusted by:

- Changing the alignment and width of the entry and the shape, size, and position of the approach splitter island.
- Changing the central island size.
- Staggering alignment between entrance and exit.

The deflection design speed is controlled by the path radius and cross slope of the roadway. Figure 915-5 gives the deflection radii for design speeds for roadways that slope down to the outside of the curve (-2%), that are level (0%), and that slope down to the inside of the curve (2%). Use the following equation to make the final adjustments for speeds between those given:

$$V = \sqrt{\frac{R(c+f)}{6.69}}$$

Where:

V	=	Design speed in mph
R	=	The deflection radius in feet.
c	=	Slope of the roadway in percent
f	=	Side friction factor from Figure 915-4

Design roundabouts so that deflection limits the entry speed to 30 mph or less and achieves speed consistency. In areas with a large number of pedestrians or bicyclists, design roundabouts for a maximum speed of 15 to 20 mph.

Design Speed (mph)	Deflection Radius (ft) Cross Slope			Side Friction actor f
	-2%	0%	2%	
10	20	20	20	38
15	50	50	45	32
20	110	100	95	27
25	200	185	170	23
30	335	300	275	20
35	515	455	410	18

Deflection
Figure 915-5

(4) Speed Consistency

Speed consistency for all movements is an important element of roundabout design. Speed consistency is achieved when the differences between speeds of paths that merge, cross, or parallel each other do not exceed 12 mph.

Figure 915-10 shows five critical path radii to be checked for each leg. The entry path (R_1) is the minimum radius for through traffic approaching the yield point. The circulating path (R_2) is the minimum radius for through traffic around the central island. The exit path (R_3) is the minimum radius for through traffic into the exit. The left-turn path (R_4) is the minimum radius for the conflicting left-turn movement. The right-turn path (R_5) is the minimum radius for a right-turning vehicle. These vehicular path radii are determined as shown on Figures 915-9a and 9b.

Make R_1 smaller than or equal to R_2, and R_2 smaller than or equal to R_3 ($R_1 \leq R_2 \leq R_3$). This ensures that speeds will be reduced to their lowest at the roundabout entry reducing the likelihood of problems in the roundabout.

(5) Inscribed Diameter

The inscribed diameter is controlled by the space available, the design speed, design vehicle and the number of legs. The size of the inscribed diameter is a balance between designing for large vehicles and providing adequate deflection for the design speed. Select a diameter that will result in a speed at or below the desired design speed.

To meet the need to provide an adequate turning radius, the right-turn movement might require that the inscribed diameter be increased for roundabouts with more than four legs or with high skew angles. On state routes, make the turning radius 50 ft minimum with 2 ft clearance to the face of a curb.

The inscribed circle is not always circular, with a constant-radius circulating roadway; ovals and tear drops have been used. Noncircular shapes are allowed when the smaller turning radius is at least 50 ft. When a noncircular roundabout is used, where possible align it so that the heavier traffic uses the larger radius.

(6) Entry

Design the entry width to accommodate the design vehicles and required entry lanes while providing adequate deflection. Design the entry so that the entry angle is between 20° and 60°, preferably between 30° and 40°. Figure 915-11 provides additional guidance for entry design.

When the approach width, including shoulders and parking lanes, is wider than needed for the entry width, consider curb bulbs to reduce the width. For information on parking limitation at roundabouts, see 915.11.

When the roundabout is on a state route, the minimum turning radius is 50 ft to provide for large trucks. It is desirable for the entry radius to be smaller than both the circulating radius and the exit radius. This makes the speeds the lowest at the roundabout entry. It also helps to reduce the speed differential between entering and circulating traffic.

Design the entry radius, R_1 on Figure 915-10, to limit entry speeds to not more than 25 mph in urban areas and 30 mph in rural area.

At single-lane roundabouts, it is not difficult to reduce the value of the entry radius. The curb radius at the entry can be reduced or the alignment of the approach can be shifted to the left to achieve a slower entry speed. This is more difficult at double-lane roundabouts. When entry and exit curve radii are too small, the natural path of adjacent traffic can overlap. Path overlap occurs when the geometry leads a vehicle in the left lane to cross into the right lane to avoid the central island. (See Figure 915-12.) Path overlap can reduce capacity and increase accidents. Take care when designing double-lane roundabouts to avoid path overlap. For more information on path overlap, see *Roundabouts: An Informational Guide*.

Flaring is an effective means of introducing a double-lane roundabout without requiring as much right of way as a full lane addition. 130 ft is the optimum flare length to add a second lane at a double-lane roundabout. However, if right of way is constrained, shorter flare lengths may be used with decreased capacity.

At rural locations, consider the speed differential between the approaches and entries. If the posted speed of the approach is greater than 15 mph above the design speed of the entry curve, consider introducing speed reduction measures before the entry curve.

(7) Circulating Roadway

Keep the circulating width constant throughout the roundabout with the minimum width equal to or slightly wider (120%) than the maximum entry width.

At single-lane roundabouts, provide a circulating roadway width plus truck apron to just accommodate the design vehicle. Use appropriate vehicle-turning templates or a computer program to determine the swept path of the design vehicle through each turning movement. Provide a minimum clearance of 2 ft between the vehicle's tire track and all vertical curbs with a height of 6 in or more.

Design the circulating radius, R_2 on Figure 915-10, to be larger than the entry radius. In some cases where capacity is not a concern, it might not be possible for the circulating radius to be greater than the entry radius. In such cases, the entry radius may be greater than the circulating radius, provided the difference in speeds is less than 12 mph and preferably less than 6 mph.

(8) Exit

Design the exit width to accommodate the design vehicles while providing adequate deflection. Figure 915-11 provides additional guidance for exit design.

Generally, design the exit radius, R_3 on Figure 915-10, larger than both the entry radius (R_1) and the circulating radius (R_2). The larger exit curve radii improve the ease of exit and minimize the likelihood of congestion at the exits. This, however, is balanced by the need to maintain low speeds at the pedestrian crossing on exit. If the exit path radius is smaller than the circulating path radius, vehicles might be traveling too fast to negotiate the exit and crash into the splitter island or into oncoming traffic.

At single-lane roundabouts with pedestrian activity, design exit radii the same as or slightly larger than the circulating radius to minimize exit speeds. However, at double-lane roundabouts, additional care must be taken to minimize the likelihood of exit path overlap. Exit path overlap can occur when a vehicle on the left side of the circulating roadway exits into the right exit lane. Where no pedestrians are expected, make the exit radii large enough to minimize the likelihood of exiting path overlap. Where pedestrians are present, tighter exit curvature might be necessary to ensure low speeds at the pedestrian crossing.

When the departure roadway width, including shoulders and parking lanes, is wider than needed for the exit width, consider curb bulbs to reduce the width.

(9) Turning movements

Evaluate the left- and right-turn radii, R_4 and R_5 on Figure 915-10, to ensure that the maximum speed differential between entering and circulating traffic is no more than 12 mph. The left-turn movement is the lowest circulating speed. The left-turn radius can be determined by adding 5 ft to the central island radius.

(10) Sight Distance

The operator of a vehicle approaching a roundabout needs to have an unobstructed view of the splitter island, central island, yield point, and sufficient lengths of the intersecting roadways to permit recognition of the roundabout and to initiate the required maneuvers to maintain control of the vehicle and to avoid collisions. To do this, two aspects of the sight distance are necessary:

- **Stopping Sight Distance.** Provide the stopping sight distance given on Figure 915-6 at all points on the approach roadways, the circulating roadway, and the departure roadways. Check each vehicle path using the deflection speed. See Chapter 650 for additional information on stopping sight distance.

Speed (mph)	Stopping Sight Distance (ft)
10	47
15	77
20	113
25	153
30	198
35	248

Stopping Sight Distance for Roundabouts
Figure 915-6

- **Intersection Sight Distance.** For intersection sight distance at roundabouts, provide a clear view of traffic on the circulating roadway and approaching the roundabout on the leg to the left for a distance equal to that traveled in 4.5 seconds. The required gap is also a function of capacity and, at lower volumes, a larger gap may be required. However, do not use an intersection sight distance (Figure 915-13) less than the stopping sight distance (Figure 915-6).

  Because traffic is approaching a yield condition and might not be required to stop before entering a roundabout, provide the sight distance along the approach for 50 ft. Momentary sight obstructions that do not hide a vehicle, such as poles, sign posts, and narrow trees, are acceptable in the sight triangles including the central island. Guidance for intersection sight distance at a roundabout is shown on Figure 915-13.

Providing adequate sight distance will also provide clear zone for the central island.

(11) Islands

Raised islands are important for effective operation of a roundabout. Their primary purpose is to control deflection.

(a) **Central Island**. The central island is a raised, nontraversable area and may include a truck apron (Figure 915-14). The truck apron is the outer part of the central island, designed to allow for encroachment by the rear wheels of large trucks.

The primary control of the central island size is the inscribed diameter, the required circulating width, and the required deflection. When the required circulating width for the large vehicles results in a deflection radius larger than the maximum for the design speed, increase the central island diameter to achieve the desired deflection radius and provide a truck apron. Make the surfacing of the truck apron different from the circulating roadway. However, make the surfacing of the apron different from the sidewalks so that pedestrians are not encouraged to cross the circulating roadway. Use a 3 in mountable curb between the circulating roadway and the truck apron.

Use a 6 in or higher vertical curb between the truck apron and the nontraversable area. Landscape or mound the raised, nontraversable area to improve the visual impact of the roundabout to approaching drivers. When designing landscaping, consider sight distance and roadside safety. Also, consider maintenance needs for access to the landscaping in the central island.

When designing the landscaping for the central island, do not use items that might tempt people to take a closer look. Do not place street furniture or other objects that may attract pedestrian traffic to the central island, such as benches or monuments with small text. Design fountains or monuments in the central island in a way that will enable proper viewing from the perimeter of the roundabout. In addition, design and locate all objects in the center island to maintain sight distance, minimize driver distraction, and minimize the possibility of impact from an errant vehicle.

(b) **Splitter Island**. Splitter islands are built at each two-way leg. They serve to:

- Control the entry and exit speeds by providing deflection.
- Prevent wrong way movements.
- Provide pedestrian refuge.
- Provide a place to mount signs.

The desirable length of a splitter island envelope is equal to the stopping sight distance for the design speed of the roadway approaching the roundabout. (See Chapter 650.) Make the extensions of the curves that form the splitter islands tangent to the outside edge of the central island. The minimum width of the island at any crosswalk is 6.5 ft. Figure 915-15 gives guidance on the design of splitter islands.

For information on shoulders at islands, island nose radii, nose offsets, and other details, see Chapter 910.

(12) Grades and Superelevation

It is preferred that the grade on all of the intersecting roadways at a roundabout is 4% or flatter and that the grades be constant through the roundabout or that the roundabout be in a sag vertical curve. Grade in excess of 4% can result in reduces sight distance, increased difficulty slowing or stopping, and higher possibility of vehicle rollover.

When a roundabout must be built at or near the crest of a vertical curve on one of the roadways, pay special attention to the sight distances. For additional information on grades at roundabouts, see *Roundabouts: An Informational Guide*.

Do not use superelevation for the circulating roadway. It is desirable to maintain the normal 2% cross slope from the central island to the outside of the circle. (See Figure 915-5) This will improve drainage and help reduce the speed of circulating traffic.

(13) Right-Turn Slip Lane

Right-turn slip lanes may be used, with justification, when a right-turn movement is heavy enough to lead to a breakdown in roundabout operation and the radius produces a speed comparable to the speed through the roundabout.

For additional information on channelization for right-turn slip lanes, see right turn lanes at islands in Chapter 910 and *Roundabouts: An Informational Guide*.

(14) Design Clear Zone

For the right side of the circulating roadway, see Chapter 700 using the R_2 speed for the required design clear zone. Do not place light standards or other poles without breakaway features in splitter islands or on the right side just downstream of an exit point. When any approach leg has a posted speed of 45 mph or higher, place no fixed object, water features with a depth of 2 ft or more, or other hazards in the central island. At roundabouts with all approach legs posted at 40 mph or less, avoid water features with a depth of 2 ft or more in the central island. Avoid fixed objects in central islands when the island diameter is less than 65 ft. Within the central island, clear zone is desirable to provide both a recovery area for errant vehicles and sight distance. When necessary to protect features in the central island, provide a central island low profile barrier 18 in high or higher.

915.07 Pedestrians

Pedestrian crossings are unique at roundabouts in that the pedestrian is required to cross at a point behind the vehicles entering the roundabout. The normal crossing point at intersections is in front of these vehicles. For this reason, mark all pedestrian crosswalks at urban roundabouts and at rural roundabouts when pedestrian activity is anticipated. Position the crosswalk one car length, approximately 20 ft, from the yield point and use the raised splitter island as a pedestrian refuge. (See Figures 915-15 and 16.) Consider landscaping strips to discourage pedestrians crossing at undesirable locations.

Provide a barrier-free passageway at least 6 ft wide, 10 ft desirable, through this island for persons with disabilities. Whenever a raised splitter island is provided, also provide pedestrian refuge. This facilitates the pedestrian crossing in two separate movements.

Give special attention to assisting pedestrians who are visually impaired through design elements such as providing tactile cues through the installation of truncated domes at curb ramps, splitter islands, and any other pedestrian facility that might lead to conflicts with pedestrians and vehicular traffic. These pedestrians typically attempt to maintain their approach alignment to continue across a street in the crosswalk. A roundabout requires deviation from that alignment. Provide appropriate informational cues to pedestrians regarding the location of the sidewalk and the crosswalk.

See Chapter 1025 for sidewalk ramps and additional information on pedestrian needs.

915.08 Bicycles

The operating speed of vehicles within smaller low speed roundabouts is, in most cases, the same speed as that of bicyclists and both can use the same roadway without conflict or special treatment. Larger roundabouts with higher operating speeds can present problems for the bike rider and an alternate bike path, a shared use sidewalk, or warning signs might be necessary. If the bike riders are children, as in the case of a nearby elementary school, consider signing and pavement markings directing them to use the adjacent sidewalk. End all bicycle lanes before they enter a roundabout, with the bicycles either entering traffic to use the circulating roadway or leaving the roadway on a separate path or a shared use sidewalk. See Figure 915-16 for the recommended design for ending a bicycle lane with a shared use sidewalk at a roundabout.

915.09 Signing and Pavement Marking

Roundabouts, being a new concept in Washington State, require consistent signing and pavement markings to familiarize motorists with their intended operation.

Roundabout signing is shown on Figure 915-17. Locate signs where they have maximum visibility for road users but a minimal likelihood of obscuring other signs, pedestrians, or bicyclists. Use only signs contained in the MUTCD. A diagrammatic guide sign, as shown in the figure, can be used to provide the driver with destination information. Provide a route confirmation sign on all state routes shortly after exiting the roundabout.

Pavement markings are shown in the MUTCD. Optional lane lines between lanes within the circulating roadway may be used on multilane roundabouts. When evaluating whether or not to provide lane lines within the circulating roadway, consider the following potential impacts:

- Reduce confusion
- Reduce flexibility
- Improve lane alignment
- Reduce capacity
- Provide a more normal situation
- Might require advanced signing for proper lane usage at the entry

When lane lines are to be used, include the striping plan with the roundabout approval request.

915.10 Illumination

For a roundabout to operate satisfactorily, a driver must be able to enter, move through, and exit the roundabout in a safe and efficient manner. To accomplish this, a driver must be able to see the layout and operation in time to make the appropriate maneuvers. Adequate lighting is needed for this at night.

Provide illumination for roundabouts with any one of the following:

- At least one leg is a state route or ramp terminal.
- It is necessary to improve the visibilityof pedestrians and bicyclists.
- One or more of the legs are illuminated.
- An illuminated area in the vicinity can distract the driver's view.
- Heavy nighttime traffic is anticipated.

Provide illumination for each of the conflict points between circulating and entering traffic in the roundabout and at the beginning of the raised splitter islands. Figure 915-18 depicts the light standard placement for a four-legged roundabout. See Chapter 840 for additional information and requirements on illumination. A single light source located in the central island is not acceptable. When one or more of the legs are illuminated, provide a light level within the roundabout approximately 50% higher than the highest level on any leg. Use a high pressure sodium vapor luminaire with a medium or short cut-off light distribution for the light source. Position the luminaire over the outside edge of the roundabout to use the "house side" lighting to illuminate the pedestrian crosswalks.

915.11 Access, Parking, and Transit Facilities

No road approach connections to the circulating roadway are allowed at roundabouts, unless it is designed as a leg to the roundabout appropriate for the traffic volume using the approach. Road approach connections to the circulating roadway are allowed only when no other reasonable access is available. It is preferred that road approaches not be located on the approach or departure legs within the length of the splitter island. The minimum distance from the circulating roadway to a road approach is controlled by the corner clearance using the circulating roadway as the crossroad. (See Chapter 1435.)

Parking is not allowed in the circulating roadway or on the approach roadway past the crosswalk. It is also desirable that no parking be allowed on the approach or departure legs for the length of the splitter island. See Chapter 1025 for additional information on parking limitations near a crosswalk.

Transit stops are not allowed in the circulating roadway or on the approach roadway past the crosswalk. Locate transit stops on departure legs in a pullout or where the pavement is wide enough that a stopped bus will not block the through movement of traffic. Locate transit stops on approach or departure legs where they will not obstruct sight distance.

915.12 Procedures

(1) Selection

Use the following steps when selecting a roundabout for intersection control:

(a) Consider the context. Are there constraints that must be addressed? Are there site-specific and community impact reasons why a roundabout of a particular size would not be a good choice?
(b) Determine the roundabout category (Figure 915-7) and a preliminary lane configuration (Figure 915-8) based on capacity requirements.
(c) Identify the justification category. See 915.12(2). This establishes why a roundabout might be the preferred choice and determines the need for specific information.
(d) Perform the analysis appropriate to the selection category. If the selection is to be based on operational performance, use the appropriate comparisons with alternative intersections
(e) Determine the right of way requirements and feasibility.
(f) If additional right of way must be acquired or alternative intersection forms are viable, an economic evaluation will be useful.
(g) Contact all approving authorities to obtain concurrence that a roundabout is an acceptable concept at the proposed location. On state routes this includes the HQ Design Office.

(2) Justification

Consider roundabouts only when fulfilling one or more of the following justification categories:

(a) **Safety Improvement.** At high accident location intersections, a roundabout might be a method of reducing accidents by reducing the number of conflict points. At conventional intersections, many accidents involve left-turning or crossing vehicles; with roundabouts these movements are eliminated. With the low operating speeds and low entry angles, accidents at roundabouts are generally less severe.

Roundabouts in this category require an accident analysis that shows high accidents of a type that a roundabout can reduce in number or severity. In the analysis, consider any potential shift of accidents to another accident type.

(b) **Improve Intersection Capacity.** A roundabout may be analyzed as an alternative to traditional traffic control options to increase the capacity of an intersection. With traffic signals, alternating traffic streams through the intersection can cause a loss of capacity when the intersection clears between phases. In a roundabout, vehicles may enter available gaps simultaneously from multiple approaches. This can result in an advantage in capacity. This advantage becomes greater when the volume of left turning vehicles is high.

Justify roundabouts in this category with a capacity analysis showing that it can provide the required capacity comparable to the optimum design for a conventional intersection. Discuss the effects on “off-peak” traffic.

(c) **Queue Reduction.** Roundabouts can improve operations at locations where the space for queuing is limited. Roadways are often widened for queuing at traffic signals, but the reduced delays and continuous flows at roundabouts allow the use of fewer lanes. Possible applications are at interchanges where left turn volumes are high. Roundabouts at ramp terminals can improve capacity without widening a structure.

Roundabouts in this category require an analysis showing that the roundabout will eliminate the need to build additional lanes or widen a structure without additional impacts to the main line operations.

(d) **Special Conditions.** The special conditions where a roundabout might be preferred over a conventional intersection include locations with unusual geometrics; right of way limitations; closely spaced intersections; wye (Y) intersections; and, on nonstate routes, for traffic calming. Roundabouts might be better suited for intersections with unusual geometrics; such as high skew angle and offset legs. Roundabouts can provide adequate levels of operation without significant realignment or complicated signing or signal phasing.

Roundabouts can avoid the need to obtain additional right of way along the intersection legs. Roundabouts can shift any required right of way from the roadway between the intersections to the area of the intersection.

Roundabouts can eliminate closely spaced intersections, and any associated operational problems, by combining them into one intersection. The ability of roundabouts to serve high turning volumes make them a practical design at wye (Y) or tee (T) intersections.

Roundabouts proposed for a special condition require documentation indicating what the condition is and how the roundabout will address it.

(3) Approval

A proposal to install a roundabout on any route, either NHS or non-NHS, with a posted speed limit of 45 mph or higher requires an analysis of alternatives. See Chapter 910 for requirements.

HQ Design Office approval of the design is required when a roundabout is to be used on a state highway. Submit to the HQ Design Office:

- Supporting engineering data.
- Concurrence that a roundabout is an acceptable concept 915.12(1)(g).
- An intersection plan.
- Roundabout justification from 915.12 (2).
- A comparison of the roundabout to alternative intersection types with an explanation as to why the roundabout is the preferred alternative.
- A traffic analysis of the roundabout and alternative intersection types, including a discussion of any loss in level of service or increase in delay. Include the effects on "off-peak" traffic and discuss any adverse impacts of the roundabout.
- An analysis of pedestrian and bicycle activities.
- An approved analysis of alternatives for roundabouts on any state route with a posted speed of 45 mph or higher.
- The approval of the State Design Engineer or designee for roundabouts within the limits of limited access control.
- The calculated design speeds for the entry path, the circulating path, the exit path, the left-turn path, and the right-turn path for each leg of the roundabout.
- A corridor and network analysis.
- Current or projected traffic control or safety problems at the roundabout.
- Demonstration that the proposed configuration can be implemented and that it will provide adequate capacity on all approaches.
- All potential complicating factors, their relevance to the location, and any mitigation efforts that might be required.
- An economic analysis, indicating that a roundabout compares favorably with lternative control modes from a benefit-cost perspective.

915.13 Documentation

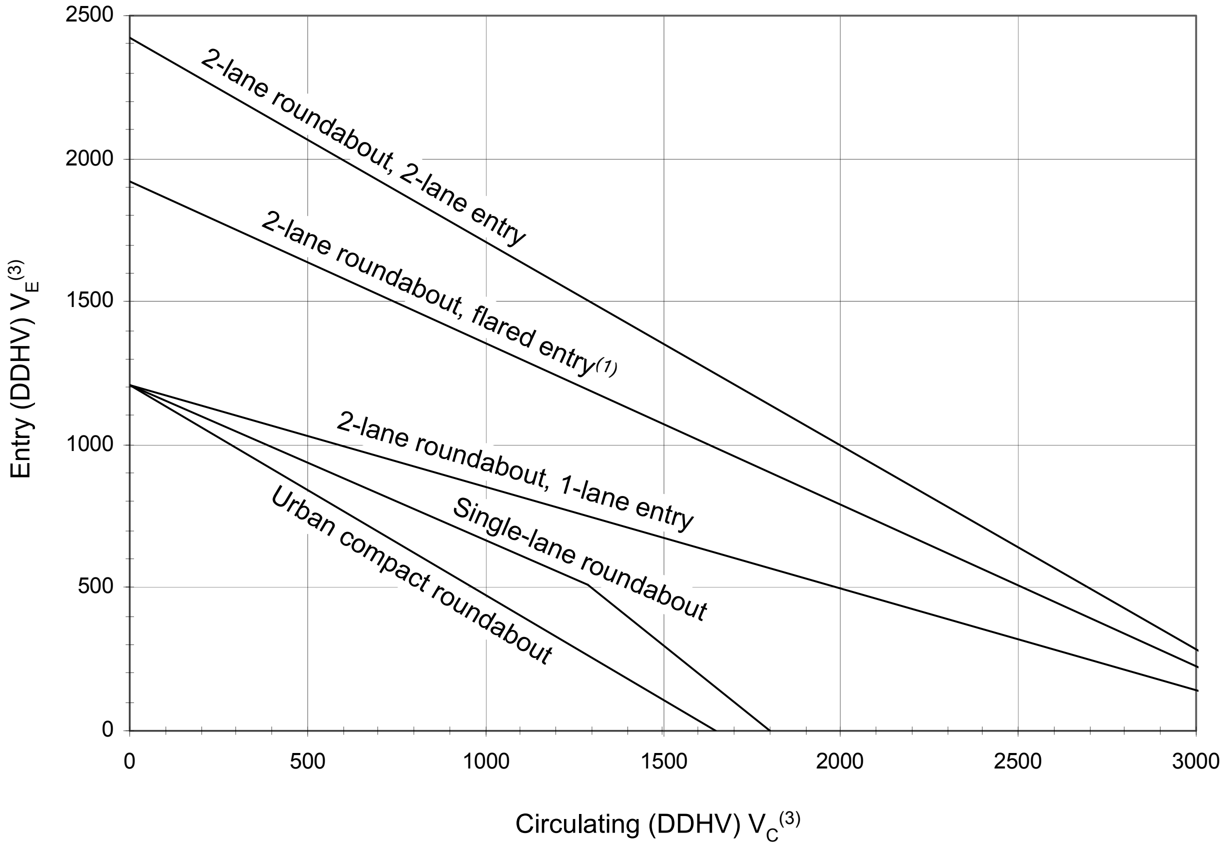
A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site: http//www.wsdot.wa.gov/eesc/design/projectdev/

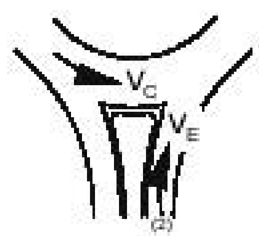
	Design Element	Mini (1)	Urban (2) Compact	Urban Single-Lane	Urban Double-Lane	Rural Single-Lane	Rural Double-Lane
General	Number of Lanes	1	1	1	2	1	2
	Typical max. (3) ADT	12,000	15,000	20,000	40,000	20,000	40,000
	Splitter Island Treatment	Painted, raised if possible	Raised	Raised	Raised	Raised extended	Raised extended
	Max. Design(4) Vehicle	SU	SU/BUS	WB-50	WB-50	WB-67	WB-67
Circulating	Inscribed Circle Diameter	45'-80'	80'-100'(5)	100'-130'(6)	150'-180'	115'-130'(6)	180'-200'
	Circulatin Roadway Design Speed	15-18 mph	16-20 mph	20-25 mph	22-28 mph	22-27 mph	25-30 mph
	Circulating Roadway Width	14'-19'	14'-19'	14'-19'	29'-32'	14'-19'	29'-32'
Entry	Max. Entry Design Speed	15 mph	15 mph	20 mph	25 mph	25 mph	30 mph
	Entry Radius	25'-45'	25'(7)-100'	35'(7)-100'	100'-200'	40'(7)-120'	130'-260'
	Entry Lane Widths	14'-16'	14'-16'	14'-16'	25'-28'	14'-16'	25'-28'

(1) Mini roundabouts are not suitable for use on a state route.
(2) Urban compact roundabouts are normally not suitable for use on a state route.
(3) Total ADT entering a 4-leg roundabout with 33% of the volume on the minor roadway. Multiply by 1.2 for 4-leg roundabouts with equal volume on both roadways. Multiply by 0.9 for 3-leg roundabouts.
(4) See Chapter 910 for selecting a design vehicle on a state route.
(5) Use 100 ft minimum on state routes.
(6) When roundabout might be expanded to a double-lane roundabout, consider using a double-lane roundabout diameter.
(7) Use 50 ft minimum on state routes.

Note:
The values given in this figure are approximate. They are intended for planning and preliminary design. Final design values may vary.

Roundabout Categories Design Characteristics
Figure 915-7





Note:

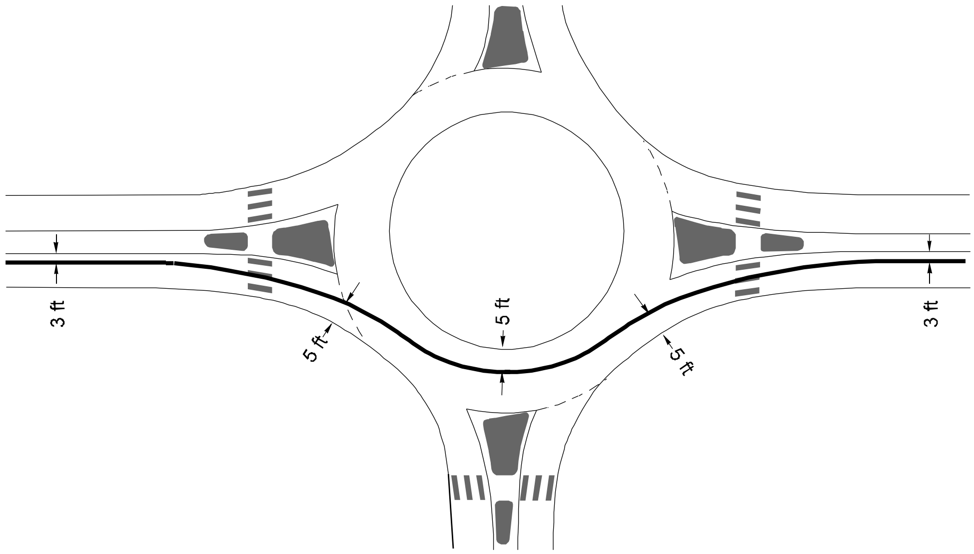
(1) Entry flared with 2 vehicle storage lane.

(2) Check for each entry.

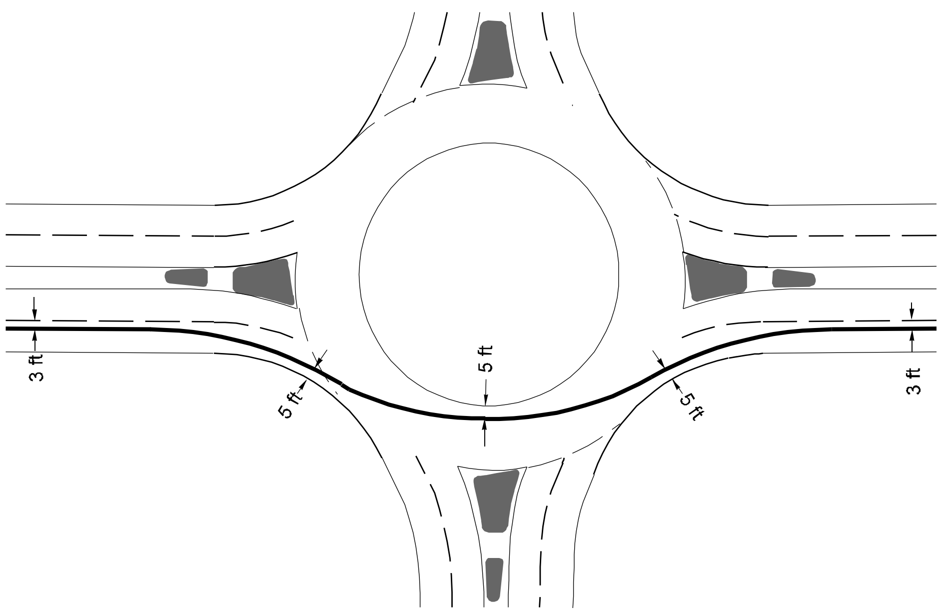
(3) DDHV in passenger car equivalents.

Vehicle Type	Passenger Car Equivalent
Car	1.0
SU or BUS	1.5
Other truck	2.0
Bicycle or Motorcycle	0.5

Approximate Entry Capacity
Figure 915-8

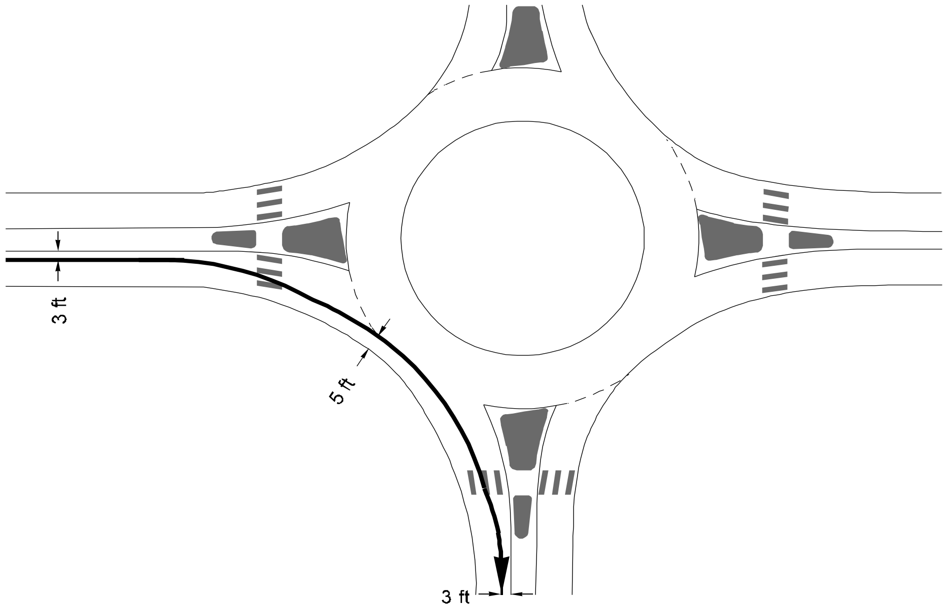


Single-Lane Roundabout

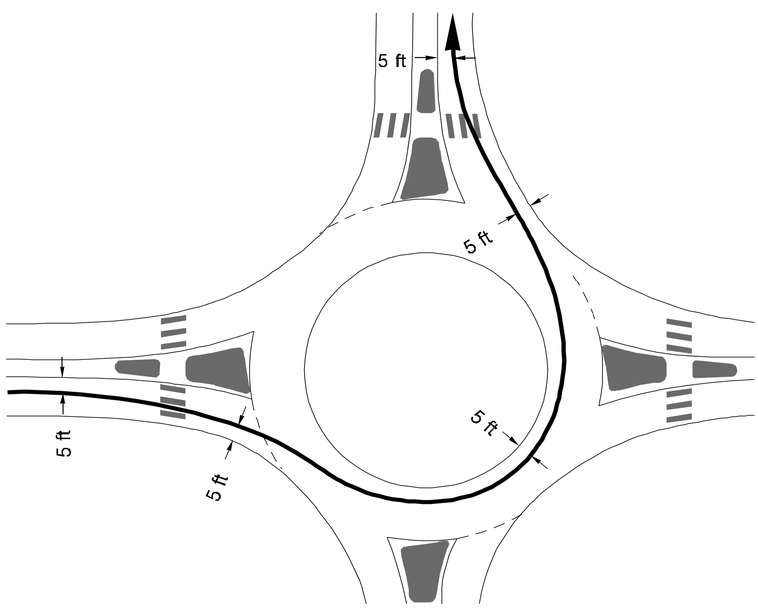


Double-Lane Roundabout

Deflection Path
Figure 915-9a

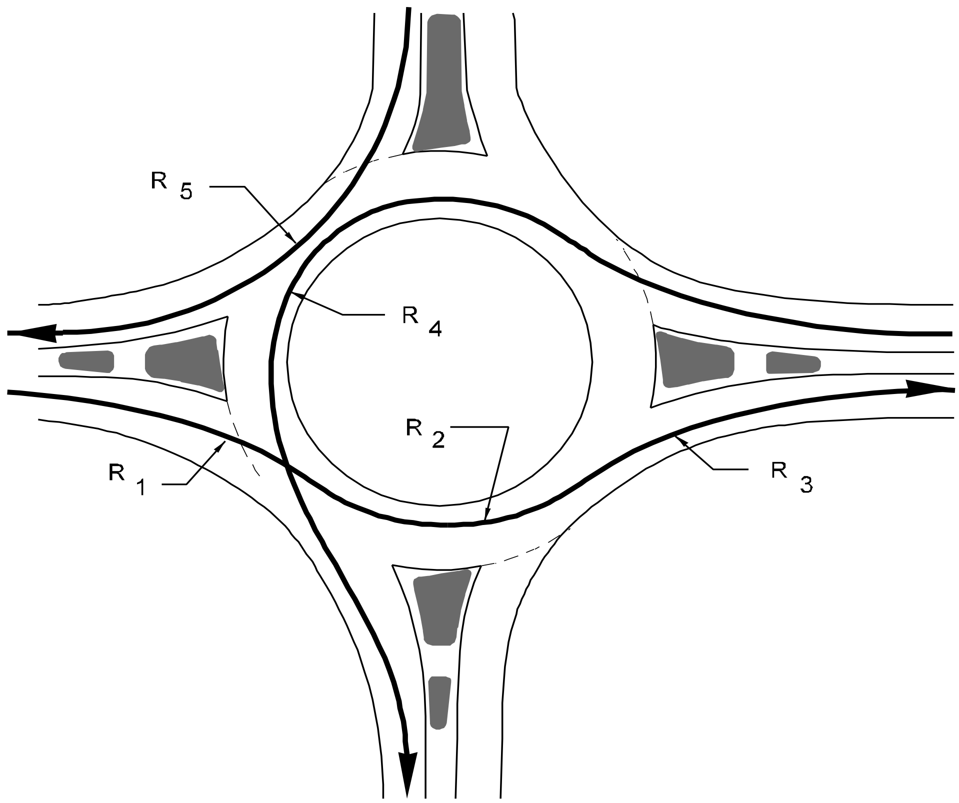


Right-Turn Movement



Left-Turn Movement

Deflection Path
Figure 915-9b

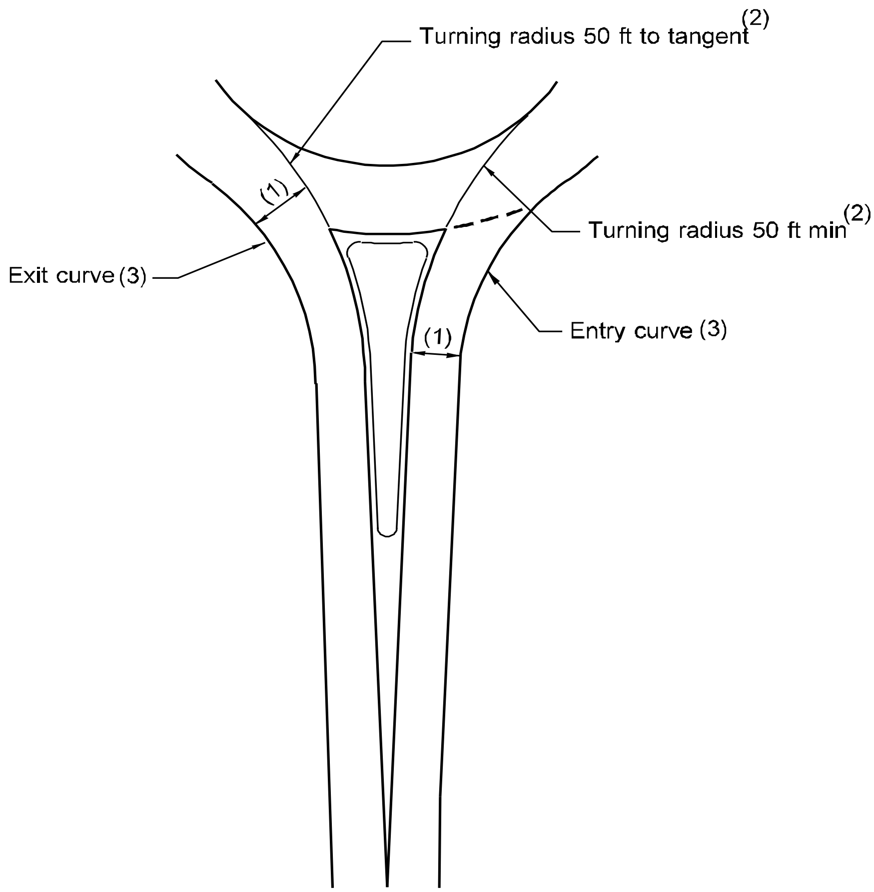


Where:

- R_1 = entry path radius.
- R_2 = circulating path radius.
- R_3 = exit path radius.
- R_4 = left-turn path radius.
- R_5= right-turn path radius.

Deflection Path Radius

Figure 915-10



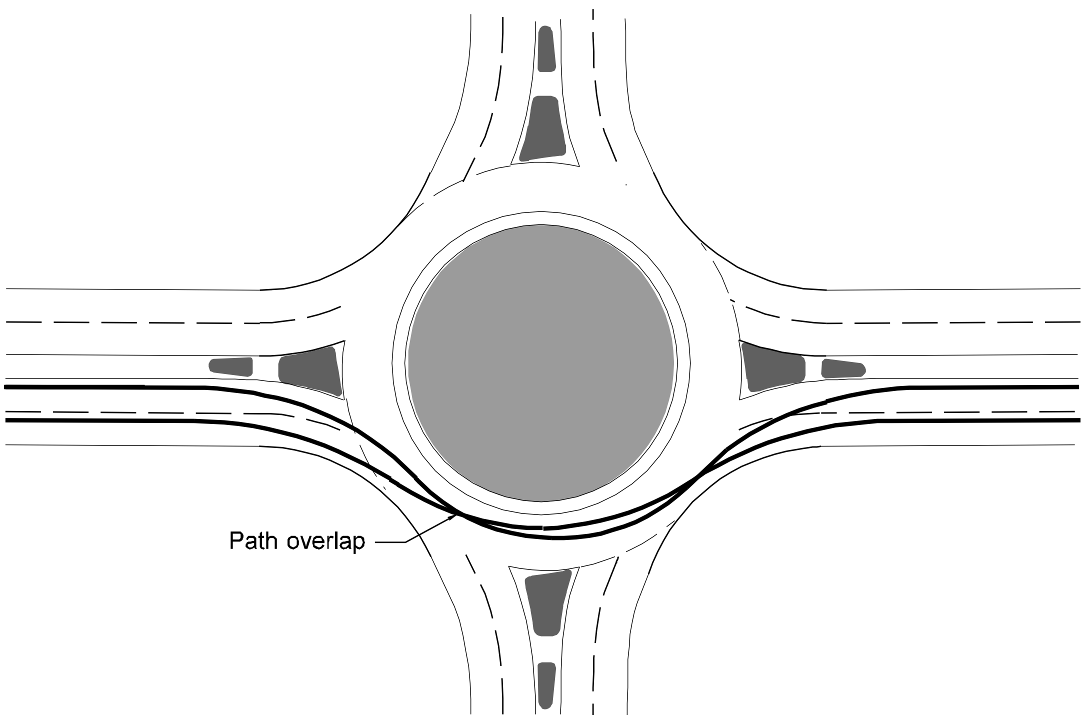
Notes:

(1) Minimum width is 15 ft for 1-lane and 25 ft for 2-lane. Entry and exit widths based on capacity needs (see Figure 915-8) and design vehicle requirements (see Chapter 640 or use templates).

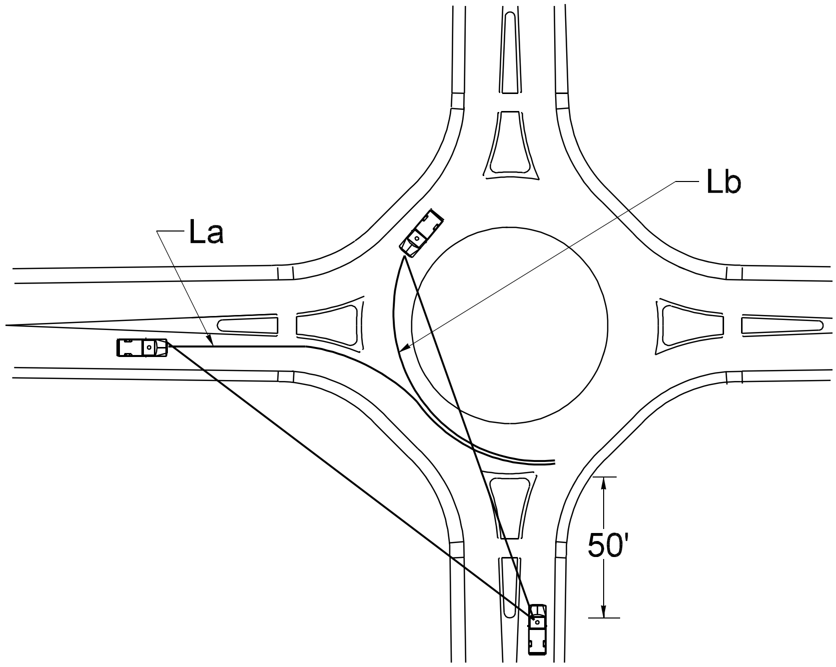
(2) Continuation of splitter island envelope curve tangential to central island.

(3) Entry and exit curves tangential to outside edge of circulating roadway.

Entry and Exit
Figure 915-11



Path Overlap
Figure 915-<u>12</u>



Speed (mph)	Gap Acceptance Length (min), L (ft)
15	115
20	150
25	185
30	225
35	260

Where:

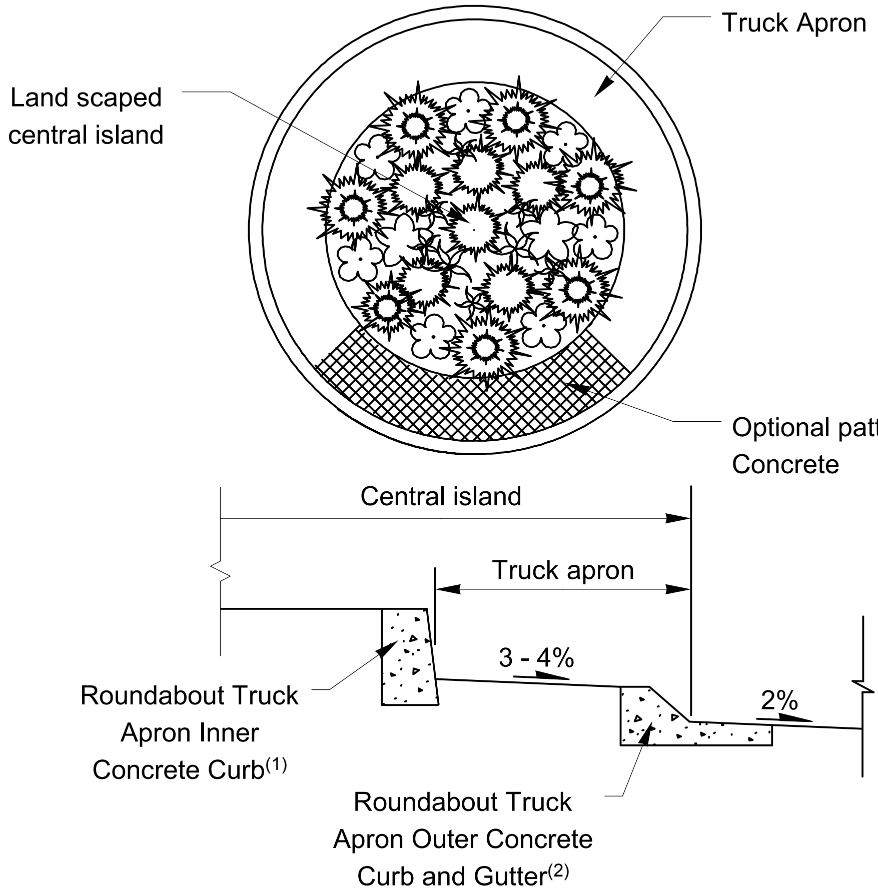
La = Sight distance, measured from the yield point, along approach roadway to the left, the minimum gap acceptance length (L) using the average of the entry speed (R_1) and the circulating speed (R_2).

Lb = Sight distance, from the yield point, along the circulating roadway, the minimum gap acceptance Length (L) using the left-turning vehicle speed (R_4).

Note:

See 915.06(2) and Figures 915-9a and 9b for information on determining R_1, R_2, and R_4 speeds.

Roundabout Intersection Sight Distance
Figure 915-13

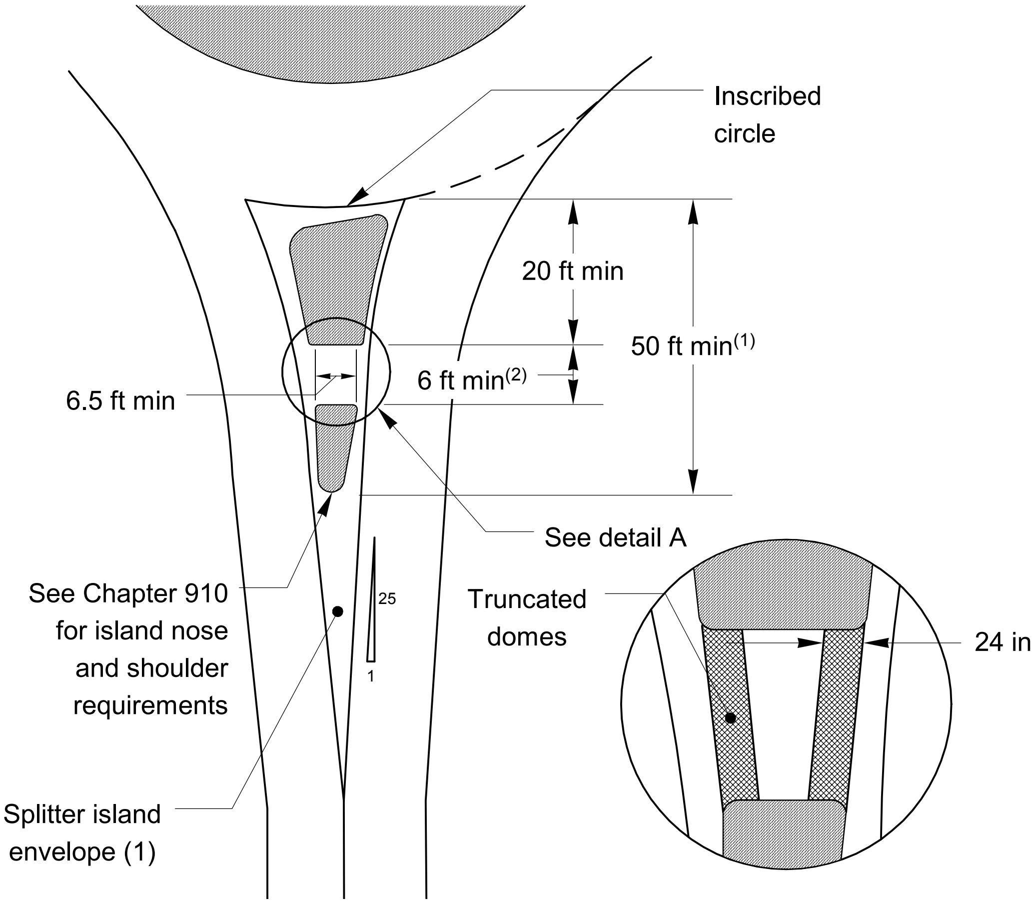


Notes:

(1) See Standard Plans for Roundabout Truck Apron Inner Concrete Curb details.

(2) See Standard Plans for Roundabout Truck Apron Outer Concrete Curb details. Other mountable curbs, with a maximum height of 3 in, may be used.

Central Island
Figure 915-14

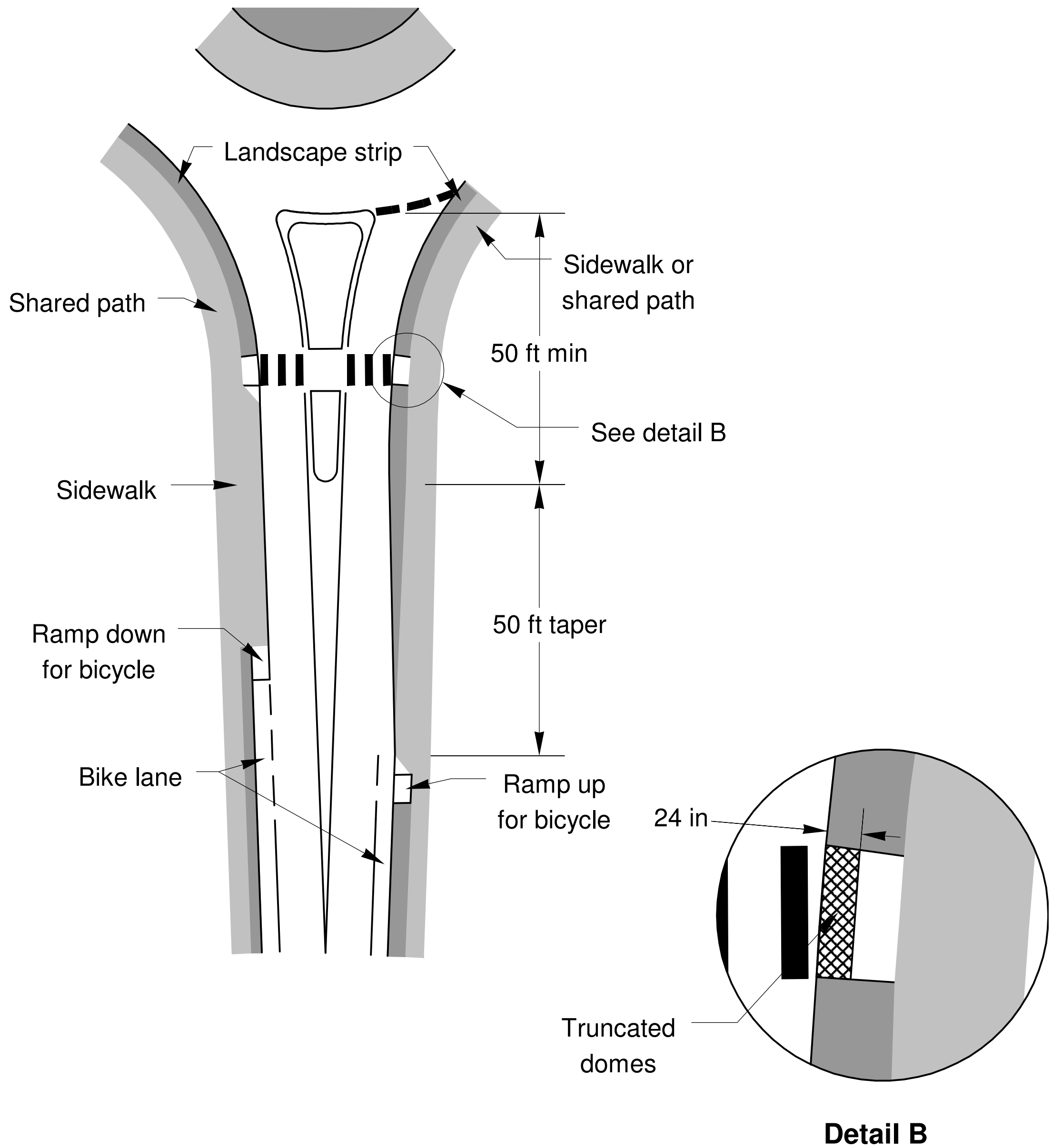


Notes:

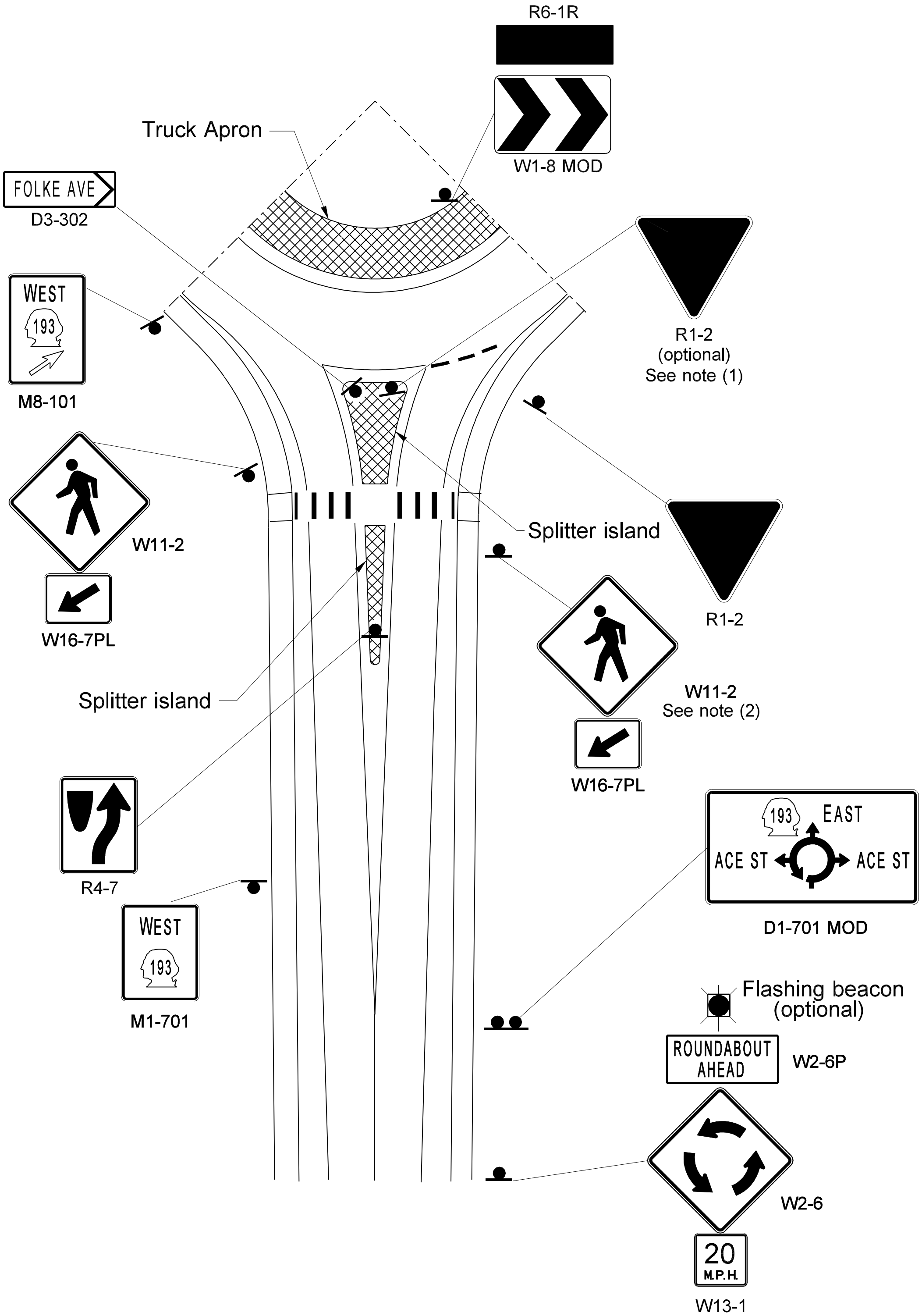
(1) Stopping sight distance desirable for length of splitter island envelop.

(2) A 10 ft width to accommodate full crosswalk width is desirable.

Splitter Island
Figure 915-15



Shared Use Sidewalk
Figure 915-16



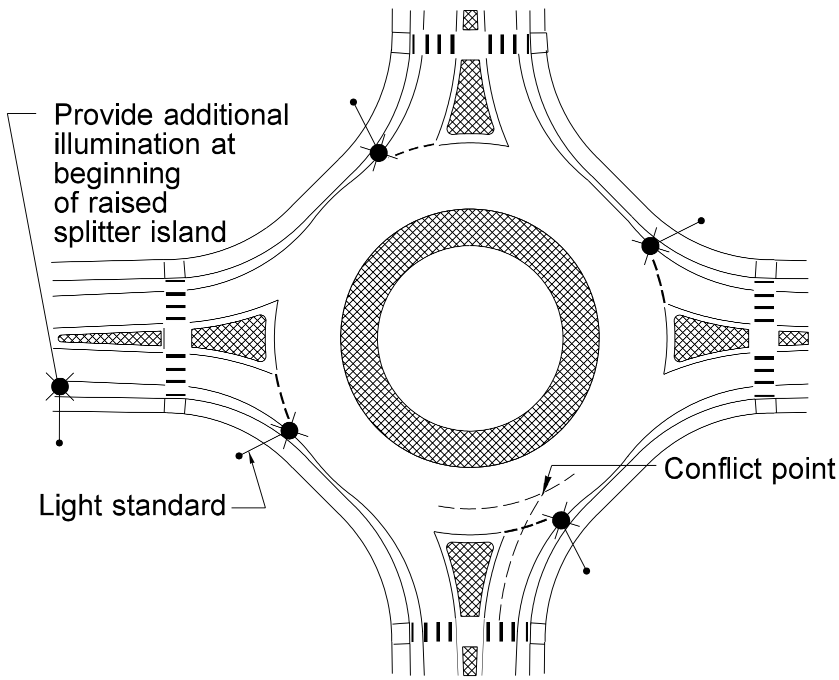
Notes:

(1) Required on two-lane entries, consider when view of right side sign might become obstructed.

(2) Locate in such a way as to not obstruct view of yield sign.

(3) See Chapter 820 for additional information on sign installation.

Roundabout Signing
Figure 915-17



Note:

Consider additional lighting for walkways and crosswalks to provide visibility for pedestrians.

Roundabout Illumination
Figure 915-18

960.01 General

Median crossovers are provided at selected locations on divided highways for crossing by maintenance, traffic service, emergency, and law enforcement vehicles. Crossovers may be provided:

- Where they appear on the master plan of crossovers for the corridor
- Where analysis demonstrates that access through interchanges or intersections is not practical
- As part of a law-enforcement plan

This chapter provides guidance for locating and designing median openings not located at an intersection and for which use is restricted to maintenance, traffic service, emergency, and law enforcement vehicles. For median openings to provide unrestricted U-turns to allow public access to both sides of the roadway, see Chapter 910, Intersections At Grade.

960.02 Analysis

A list of existing and preapproved median crossovers is available from the HQ Transportation Data Office of Strategic Planning and Programming.

Two general categories of vehicles are recognized as legitimate users of median crossovers. One category is law enforcement vehicles and the other is governmental services vehicles (emergency, traffic service, and maintenance vehicles).

In an urban area with a high occupancy vehicle lane adjacent to the median, crossovers may be used in conjunction with law enforcement observation points, and downstream enforcement (widened shoulder) areas, as part of the law enforcement plan.

In other urban areas and in rural areas, crossovers may be necessary to a law enforcement plan.

A crossover that is primarily for governmental service vehicles may be justified on the basis that access through interchanges or intersections is not practical. In urban areas where there are 3 or more miles between access points, providing an unobtrusive crossover may improve emergency service or improve efficiency for traffic service and maintenance forces.

Locate rural crossovers 3 or more miles from an interchange.

Where crossovers are justified and used for winter maintenance operations such as snow and ice removal, the interchange or intersection spacing rule does not apply and the distance from the ramp merge or diverge points may be decreased to a 500-ft minimum with 1,000 ft the desirable minimum.

Minimize visibility of the crossover to the traveling public.

960.03 Design

Consider the following design criteria for all median crossovers. However, taking into consideration the intended vehicle usage, some of the criteria may not apply to crossovers intended primarily for enforcement.

- Adequate median width at the crossover location is required to allow the design vehicle to complete a U-turn maneuver without encroaching within 8 ft of the traffic lanes, and without backing. The common design vehicles for this determination are a passenger car and a single unit truck depending upon the intended use of the crossover. Generally the minimum recommended median width is 40 ft.
- Use grades and radii that are suitable for all authorized user vehicles.

- Provide adequate inside shoulders to allow vehicle deceleration and acceleration to occur off the traffic lanes. Ten-foot inside shoulders are adequate for most cases. Provide full 10-foot shoulders for a distance of 450 ft upstream of the crossover area to accommodate deceleration, and extend downstream of the crossover area for a distance of 600 ft to allow acceleration prior to entering the traffic lane.
- Provide adequate stopping sight distance for vehicles approaching the crossover area. Because of the unexpected maneuvers associated with these inside access points and higher operating speeds commonly experienced in the inside traffic lanes, use conservative values for stopping sight distance. (See the Roadside Classification Plan.)
- Use side slopes of the crossing no steeper than 10H:1V. Grade for a relatively flat and gently contoured appearance that is inconspicuous to the public.
- Do not use curbs or pavement markings.
- Flexible guide posts may be provided for night reference. (See the Standard Plans.)
- Consider the terrain and locate the crossover to minimize visibility to the public.
- Vegetation may be used to minimize visibility. Low vegetation, with a 3-ft year-round maximum height is recommended for this purpose. (See Chapter 1300).
- In locations where vegetation cannot be used to minimize visibility and there is a high incidence of unauthorized use, appropriate signing (No U-Turns) may be used to discourage unauthorized use.

A stabilized all-weather surface is required. Urban crossovers for a high occupancy vehicle enforcement plan are usually paved. Other urban crossovers may be paved if unauthorized use is minimized. Rural crossovers are not usually paved in order to be inconspicuous.

960.04 Approval

All existing and planned crossover locations will be designated on a corridor or regional Master Plan for Median Crossovers. A committee consisting of the Assistant Regional Administrator for Operations or Project Development, the Washington State Patrol Assistant District Commander, the Headquarters (HQ) Access Engineer and the FHWA Safety and Operations Engineer or equivalents will be responsible for establishing and updating this plan yearly with proposed new crossings and removal of crossings that are no longer necessary.

Regional Administrators are responsible for the design and construction of median crossovers. Prior to construction of the opening, submit the documentation of crossover and the design data (together with a right of way print showing the opening in red) to the State Design Engineer for right of way or limited access plan approval. Construction should not proceed until approval is received.

After notification of approval, the Headquarters (HQ) Right of Way Plans Section sends the region a revised reproducible right of way or limited access plan which includes the approved crossover location.

960.05 Documentation

A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

- Provide drainage adequate to prevent the bed from freezing or compacting.
- Consider including an impact attenuator at the end of the ramp if space is limited.
- A surfaced service road adjacent to the arrester bed is needed for wreckers and maintenance vehicles to remove vehicles and make repairs to the arrester bed. Anchors are desirable at 300 ft intervals to secure the wrecker when removing vehicles from the bed.

A typical example of an arrester bed is shown in Figure 1010-8.

Include justification, all calculations, and any other design considerations in the documentation of an emergency escape ramp documentation.

1010.09 Chain-Up Area

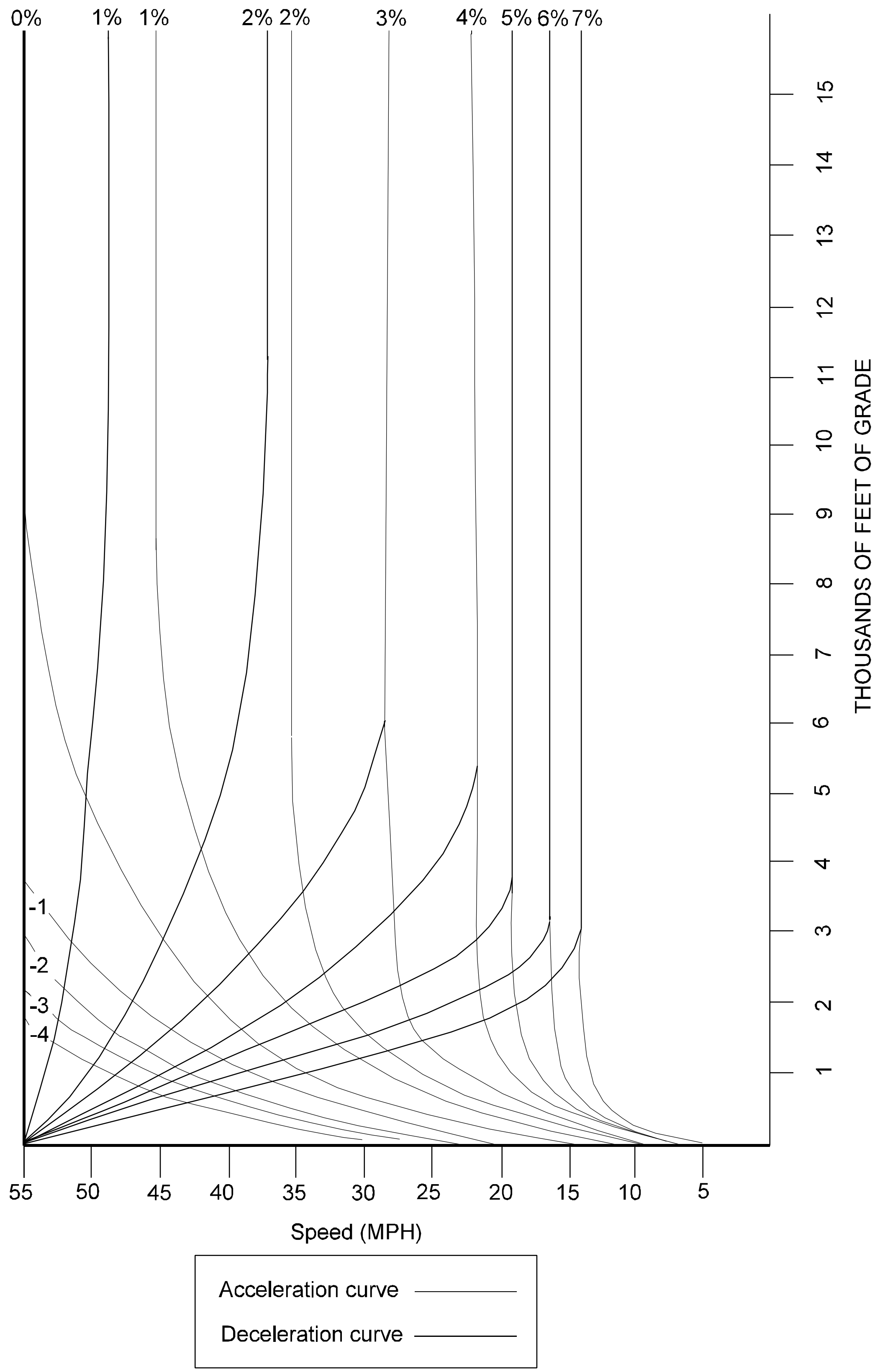
Provide chain-up areas to allow chains to be put on vehicles out of the through lanes at locations where traffic enters chain enforcement areas. Provide chain-off areas to remove chains out of the through lanes for traffic leaving chain enforcement areas.

Chain-up or chain-off areas are widened shoulders, designed as shown in Figure 1010-9. Locate chain-up and chain-off areas where the grade is 6% or less and preferably on a tangent section.

Consider illumination for chain-up and chain-off areas on multilane highways. When deciding whether or not to install illumination, consider traffic volumes during the hours of darkness and the availability of power.

1010.10 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site: http//www.wsdot.wa.gov/eesc/design/projectdev/



Performance For Heavy Truck<u>s</u>
Figure 1010-2a

When locating crosswalks at intersections, consider the visibility of the pedestrian from the motorist's point of view. Shrubbery, signs, parked cars, and other roadside appurtenances can block the motorist's view of the pedestrian. Figures 1025-6a and 6b illustrate these sight distance problems.

In urban areas where vehicle speeds are in the range of 25 to 35 mph, a sidewalk bulb out is sometimes used to place the pedestrian at a more visible location. The bulb out also shortens the length of the pedestrian crossing and reduces the pedestrian's exposure time. At intersections with traffic signals, the bulb out can be used to reduce both pedestrian signal timing and the mast arm lengths of the signal supports. Examples of sidewalk bulb outs are shown in the Figure 1025-7. The right turn path of the design vehicle or the vehicle most likely to make this turn is a critical element in determining the size and shape of the bulb out. Sidewalk bulb outs tend to restrict the width of the roadway and can make right turns difficult for extremely long trucks. Any proposal to install bulb outs on state highways is a deviation that requires approval and documentation.

On roadways with two-way left-turn lanes with pedestrian crossing traffic caused by nearby pedestrian generators, consider removing a portion of the turn lane and installing a raised median refuge and a midblock pedestrian crossing. The installation of a midblock pedestrian crossing on a state highway, however, is a design deviation that requires approval and documentation. An example of a midblock crossing is shown in Figure 1025-8.

An engineering study is required when considering a midblock pedestrian crossing on a state highway. Conditions that might favor a midblock crossing are:

- Significant pedestrian crossings and substantial pedestrian and vehicle conflicts occur.
- The proposed crossing can concentrate or channel multiple pedestrian crossings to a single location.
- The crossing is at an approved school crossing on a school walk route.
- The adjacent land use creates high concentrations of pedestrians needing to cross the highway.
- The pedestrians fail to recognize the best or safest place to cross along a highway and there is a need to delineate the optimal location.
- There is adequate sight distance for motorists and pedestrians.

Midblock pedestrian crossings on state highways are not desirable at the following locations:

- Immediately downstream (less than 300 ft) from a traffic signal or bus stop where motorists do not expect a pedestrian to cross.
- Within 600 ft of another pedestrian crossing.
- On high speed roadways as noted in Figure 1025-4.
- Where pedestrians must cross three or more lanes of traffic in the same direction.

The minimum width of a raised median refuge area is 6 ft to accommodate people in wheelchairs. Raised medians are usually too narrow to allow the installation of ramps and a level landing. When the median is 16 ft or less in width, provide a passageway through the median. This passageway connects with the two separate roadways and cannot exceed a grade of 5%.

(4) Sidewalk Ramps

Sidewalk ramps are required at all legal crossing. These ramps provide an easily accessible connection from a raised sidewalk down to the roadway surface. To comply with ADA requirements, these ramps are at least three feet wide and have slopes <u>12H:1V</u> or flatter. Examples of sidewalk ramps are shown in the Standard Plans and the *Sidewalk Details* guide.

The lower terminus of the sidewalk ramp is always located at the beginning of a marked or unmarked crosswalk when separate ramps are used for each direction. Diagonal ramps are used at the junction of two crosswalks. A separate sidewalk ramp is preferred for each crossing because the crossing distance is shorter and people with vision impairments have fewer difficulties with this arrangement. Diagonal ramps are sometimes necessary when altering an existing roadway because of right of way constraints.

Surface water runoff from the roadway can flood the lower end of a sidewalk ramp. Determine the grades along the curb line and provide catch basins or inlets to prevent the flooding of the ramps. Figure 1025-9 shows examples of how drainage structures are located. Verify that the drainage structure will not be in the path of a wheelchair user.

A level landing is necessary at the top of a sidewalk ramp. This landing is provided to allow a person in a wheelchair room to maneuver into a position to use the ramp or to bypass it. In alterations of existing roadways, the landings must be at least three feet square. In new construction, a four-foot square landing is required. When right of way constraints are not an issue, provide a larger five-foot square landing. If the landing is next to a vertical wall, a five-foot wide clear area is desirable to allow a person in a wheelchair more room to maneuver. Examples of these wheelchair maneuvers are shown in the *Sidewalk Details* guide. When the upper area of a sidewalk ramp is adjacent to a vertical wall, a 5 ft clearance from the edge of the ramp to the wall is desirable.

At signalized intersections, the pedestrian push buttons are located near the sidewalk ramps for ADA accessibility. See Chapter 850, “Traffic Control Signals,” for information on pedestrian requirements at traffic signal locations.

(5) Pedestrian Grade Separations

In areas where heavy pedestrian traffic is present and opportunities to cross the roadway are infrequent, consider providing a pedestrian grade separation. When considering a pedestrian structure, determine if the conditions that require the crossing are permanent. If there is a likelihood that the pedestrian activity generator might not exist in the near future, consider less costly solutions. Locate the grade separated crossing where pedestrians are most likely to cross the roadway. A crossing might not be used if the pedestrian is required to deviate significantly from a more direct route. A structure might be under-utilized if the additional average walking distance for 85 percent of the pedestrians exceeds 1/4 mile. It is sometimes necessary to install fencing or other physical barriers to channel the pedestrians to the structure and reduce the possibility of undesired at-grade crossings. Pedestrian grade separations are more effective when the roadway is below the natural ground line as in a “cut” section. Elevated grade separations, where the pedestrian is required to climb stairs or use long approach ramps, tend to be under-utilized.

Grade separated structures are proposed during the planning stage of a project because of the high costs associated with their design and construction. Consider grade-separated crossings under the following conditions:

- Where there is moderate to high pedestrian demand to cross a freeway or expressway
- Where there is a large number of young children, particularly on schools routes, who regularly cross a high speed or high volume roadway
- On streets with high vehicular volumes and high pedestrian crossing volumes, and crossings are extremely hazardous for pedestrians

The Headquarters (HQ) Bridge and Structures Office designs pedestrian grade separation bridges and tunnels on a project-by-project basis. Railings 3 ft 6 in high are provided on pedestrian bridges. The bridge rail is designed so that a 6-inch sphere cannot pass through any part of the railing. In addition, a 2 ft 6 in to 2 ft 10 in high handrail is provided for grades greater than 5%. The minimum width between the railings of an overhead structure or the vertical walls of a tunnel is 8 ft. The minimum overhead clearance for a tunnel is 10 ft. Protective screening to prevent objects from being thrown from an overhead pedestrian structure is sometimes necessary. See Chapter 1120, “Bridges.”

The minimum vertical clearance from the bottom of the pedestrian structure to the roadway beneath is 17 ft 6 in. This minimum height requirement can affect the length of the pedestrian ramps to the structure. To comply with ADA requirements, a ramp cannot have a grade exceeding 8.33% and the maximum rise of the ramp cannot exceed 2 ft 6 in without landings. Landings are a minimum of 5 ft wide and 5 ft long except the landing at the bottom of the ramp, which is 6 ft in length. When ramps are not feasible, provide both elevators and stairways. Stairways are designed in accordance with the Standard Plans.

Pedestrian tunnels are an effective method for providing crossings for roadways located in embankment sections. When possible, design the tunnel with a nearly level profile to provide complete vision from portal to portal. Pedestrians are reluctant to enter a tunnel with a depressed profile because they are unable to see if the tunnel is occupied. Police officers also have difficulty patrolling depressed profile tunnels. Provide day and nighttime illumination within the pedestrian tunnel. Installing gloss-finished tile walls and ceilings can also enhance light levels within the tunnel.

(6) Transit and School Bus Stops

The location of transit stops is an important consideration in providing appropriate pedestrian facilities. See Chapter 1060, "Transit Benefit Facilities." A transit stop on one side of a street usually has a counterpart on the opposite side because transit routes normally function in both directions on the same roadway. When passengers use this type of route, they will either cross the street at the beginning of a trip or the end of the return trip. Pedestrian collisions are more frequent at these locations. When analyzing high pedestrian accident locations, consider the presence of nearby transit stops and the opportunities for a pedestrian to safely cross the street. At-grade midblock pedestrian crossings are effective at transit stop locations on roadways with lower vehicular volumes. Pedestrian grade separations are appropriate at midblock locations when vehicular traffic volumes prohibit pedestrian crossings at grade.

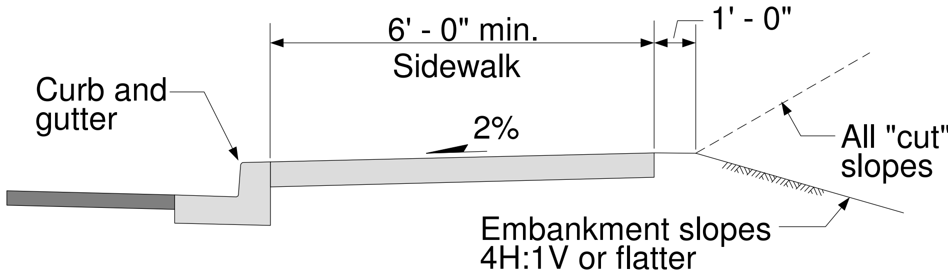
School bus stops are typically adjacent to sidewalks in urban areas and along shoulders in rural areas. Determine the number of children using the stop and provide an appropriate waiting area. Children, because of their smaller size, might be difficult for motorists to see at crossings or stops. Determine if utility poles, vegetation, and other roadside features interfere with the motorist's ability to see the children. When necessary, relocate the obstructions or move the bus stop. Parked vehicles can also block visibility and parking prohibitions might be necessary near the bus stop.

(7) Illumination and Signing

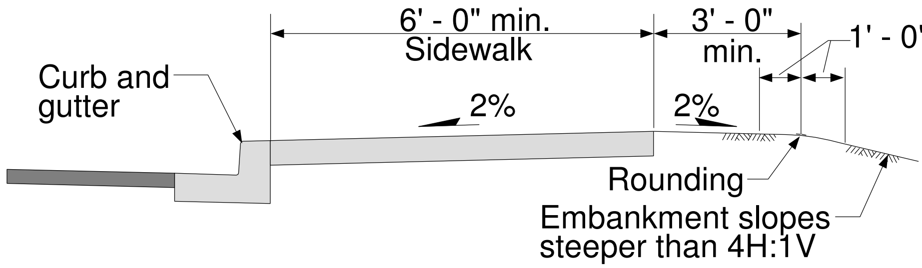
In Washington State, the highest number of collisions between vehicles and pedestrians occur in the months November through February when there is poor visibility and fewer daylight hours. At high pedestrian accident locations, illumination of pedestrian crossings and other walkways is an important design consideration. Illumination provided solely for vehicular traffic is not always effective in lighting parallel walkways for pedestrians. Consider additional lighting, mounted at a lower level, for walkways with considerable nighttime pedestrian activity. Design guidance for illumination is in Chapter 840. See Chapter 820 and the MUTCD for pedestrian related signing.

1025.08 Documentation

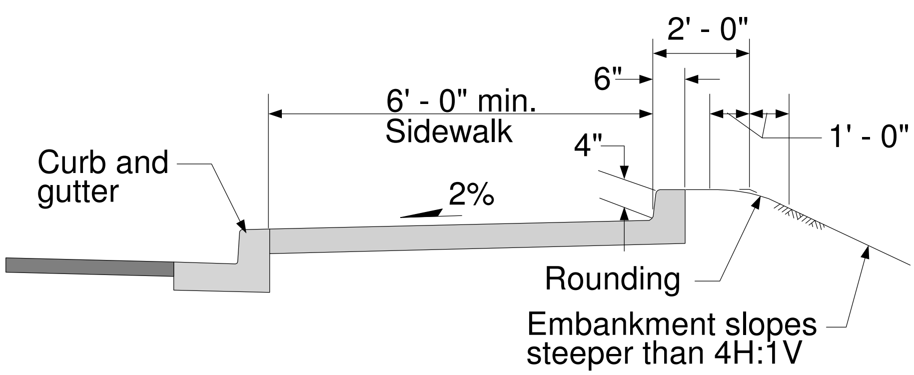
A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/



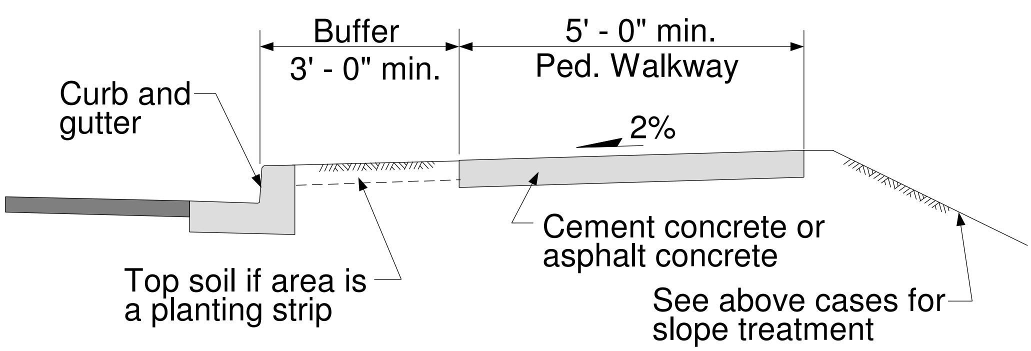
Case A



Case B

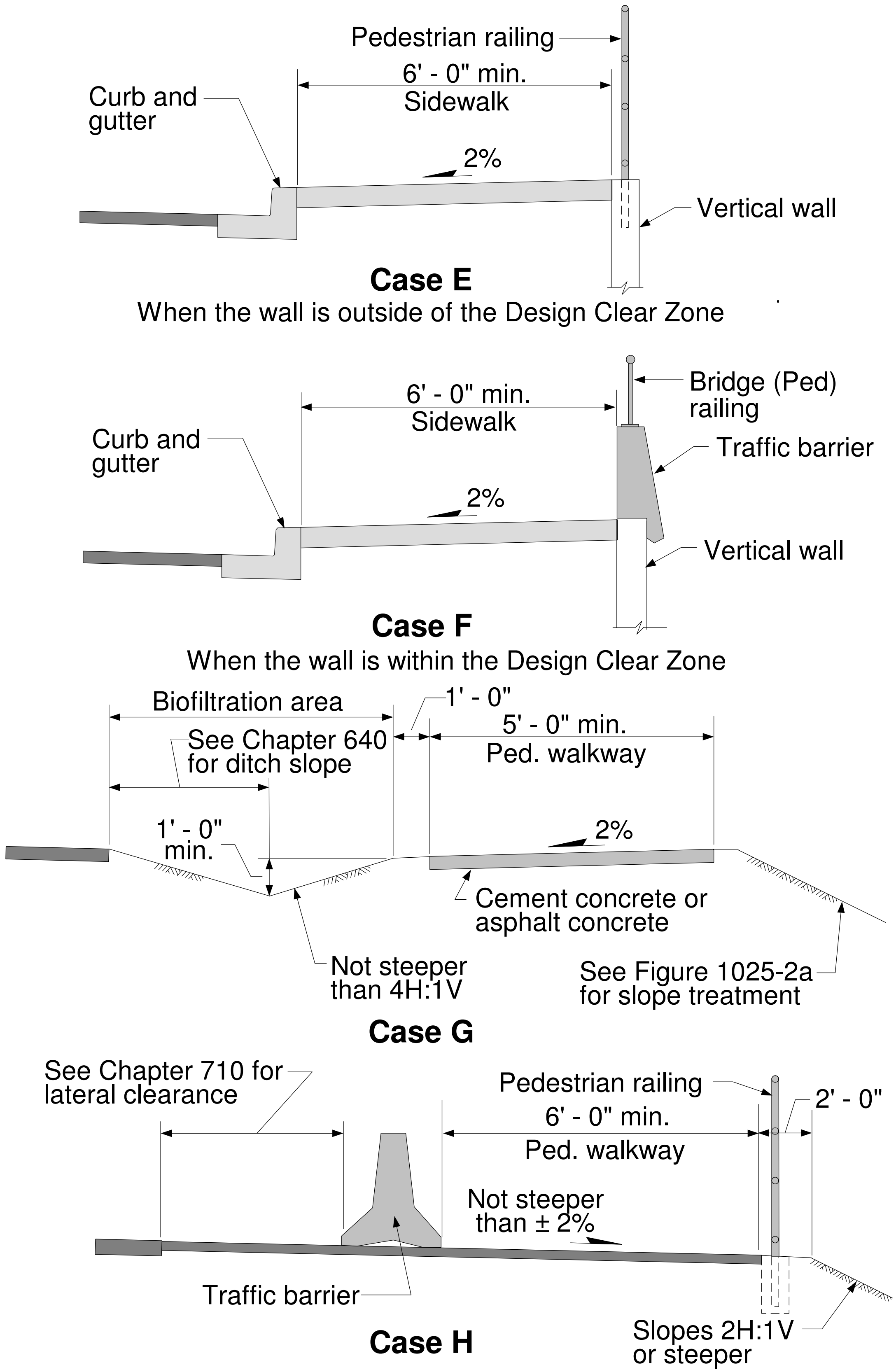


Case C



Case D

Pedestrian Walkways
Figure 1025-2a



Pedestrian Walkways
Figure 1025-2b

Roadway classification & land use	Sidewalk recommendations
Rural highways (less than one dwelling unit per acre)	No sidewalk recommended. Shoulder (four feet minimum width) adequate.
Suburban highways (one or less dwelling units per acre)	Sidewalk on one side desirable. Four feet wide shoulders adequate.
Suburban highway (2 to 4 dwelling units per acre)	Sidewalks on both sides of roadway desirable. Sidewalk on one side recommended.
Major arterial in residential area	Sidewalks on both sides of roadway recommended.
Collector or minor arterial in residential area	Sidewalks on both sides of roadway recommended.
Local street in residential area with less than 1 dwelling unit per acre	Sidewalk on one side desirable. Four feet wide shoulders adequate.
Local street in residential area with 1 to 4 dwelling units per acre	Sidewalks on both sides of roadway desirable. Sidewalk on one side recommended.
Local street in residential area with more than 4 dwelling units per acre	Sidewalks on both sides of roadway recommended.
Streets in commercial area	Sidewalks on both sides of roadway recommended
Streets in industrial area	Sidewalks on both sides of roadway desirable. Sidewalk on one side recommended.

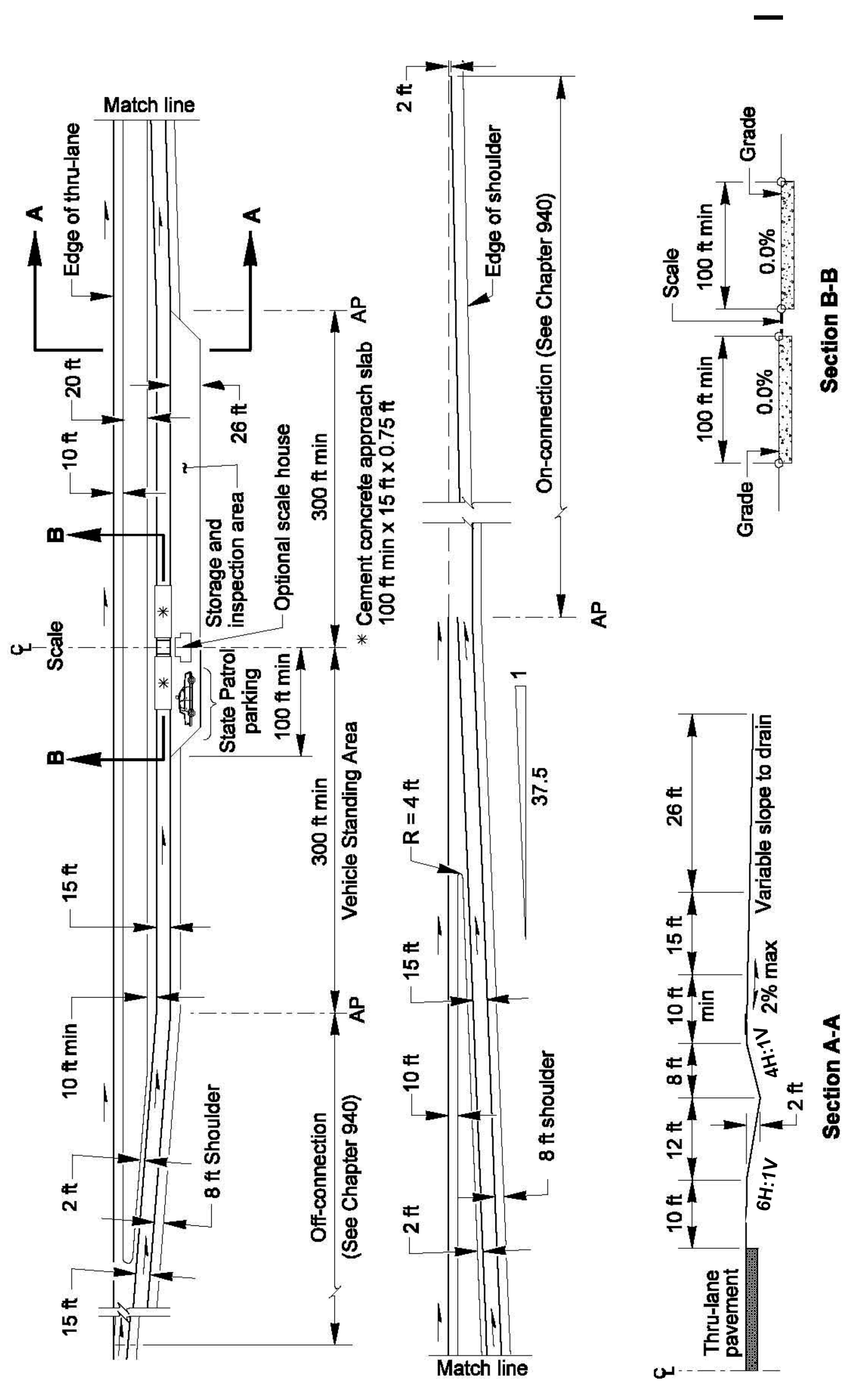
Sidewalk Recommendations
Figure 1025-3

- Illumination.
- Signing.
- Water supply and sewage treatment.
- Roadside development.

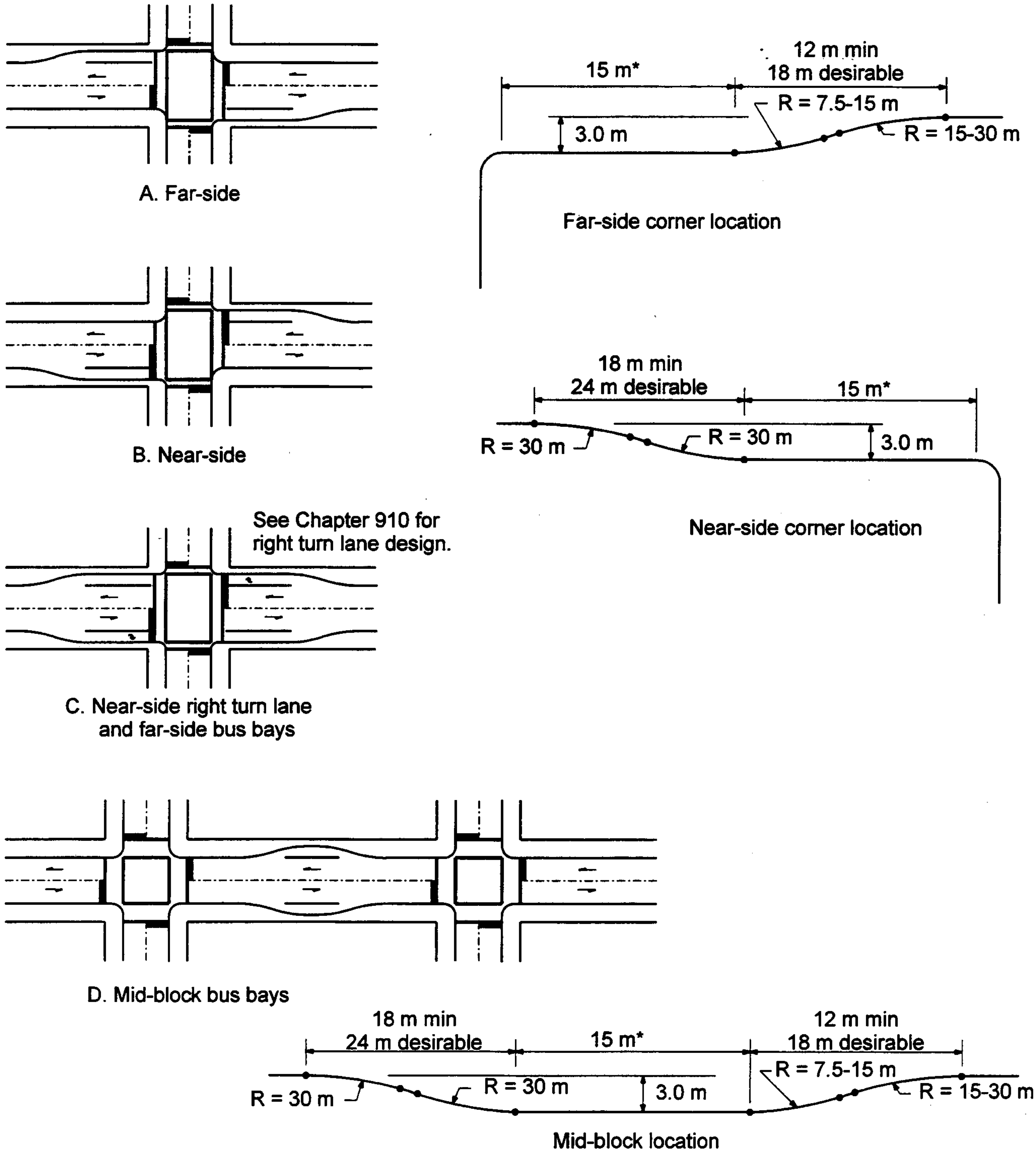
Get WSP approval of the site plans before the final plan approval.

1040.09 Documentation

A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

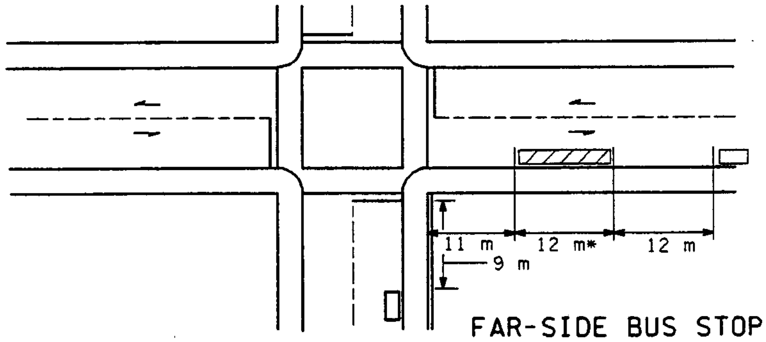


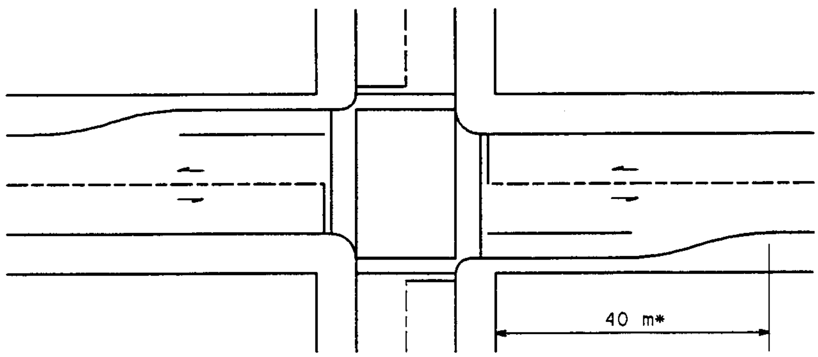
Truck Weigh Site (Multilane Highways)
Figure 1040-1

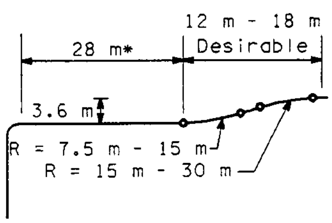


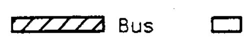
* 15 m Bay is for one standard 12 m bus.
Add 13.5 m for each additional standard bus.
Articulated buses require 21 m bays, with
19.5 m for each additional.

Bus Stop Pullouts, Arterial Streets
Figure 1060-6
(Metric)









* Based on a standard 12 m bus. Add 6 m for articulated buses.

MINIMUM BUS ZONE AND PULLOUT AFTER RIGHT TURN DIMENSIONS

Figure 1060-7
(Metric)

1410.01 General

Real Estate Services personnel participate in the project definition phase of a project to assist in minimizing right of way costs, defining route locations and acquisition areas, and determining potential problems and possible solutions.

Due to the variables in land acquisition, the following categories of right of way costs are considered in the project definition phase.

- Purchase costs (acquisition compensation).
- Relocation assistance benefits payments.
- Other Real Estate Services staff expenses (acquisition services, relocation services, interim property management services).

Right of way cost estimates are made by Real Estate Services specialists. When the parcels from which additional right of way will be acquired are known, title reports (including assessors' land areas) can be requested.

Real Estate Services personnel also "make project field inspections at appropriate times throughout the development of a project to ensure adequate consideration is given to significant right of way elements involved (including possible social, economic, and environmental effects)" in accordance with 23CFR Chapter 1 part 712 subpart B and the *Right of Way Manual*.

During plan development:

- Title reports are examined for easements or other encumbrances that would reveal the existence and location of water lines, conduits, drainage or irrigation lines, etc., that must be provided for in construction.
- Easements that indicate other affected ownerships are added to the right of way/access plan.
- Arrangements are made to obtain utility, railroad, haul road, detour routes, or other essential agreements, as instructed in the *Utilities Manual* and the *Agreements Manual*.
- Right of way acquisition, disposal, and maintenance is planned.
- Easements and permits are planned (to accommodate activities outside of the right of way).

See Chapter 440 concerning design right of way widths. The widths may be modified based on Real Estate Services input but cannot be moved to coincide with property boundaries in anticipation of a total take. Jogs in the final widths of the right of way are held to a minimum. See *Right of Way Manual* Chapter 6 for discussion of remainders.

All acquisition documents are processed through the Headquarters (HQ) Real Estate Services Office except temporary permits that are not shown on the Right of Way Plans and are not needed for the project (such as driveway connections).

1410.02 References

Code of Federal Regulations 23 CFR Chapter 1 part 712 subpart B, General Provisions and Project Procedures

49 CFR Part 24 Uniform Relocation Assistance and Real Property Acquisition Act of 1970

Revised Code of Washington (RCW) RCW 8.26, Relocation Assistance - Real Property Acquisition Policy

Washington Administrative Code (WAC) WAC 468-100. Uniform Relocation Assistance and Real Property Acquisition

Agreements Manual, M 22-99, Washington State Department of Transportation (WSDOT)

Plans Preparation Manual, M 22-31, WSDOT

Right of Way Manual, M 26-01, WSDOT

Utilities Manual, M 22-87, WSDOT

1410.03 Special Features

(1) Road Approaches

On access managed highways, the department will reconstruct legally existing road approaches that are removed or destroyed as part of the highway construction. New approaches required by new highway construction are negotiated by the region with the approval of the Regional Administrator. The negotiator coordinates with the region's design section to ensure that new approaches conform to the requirements of Chapter 920 for road approaches. All new approaches will be by permit through the appropriate regional office.

On limited access highways, road approaches of any type must be approved by the State Design Engineer before there is legal basis for negotiation by the Headquarters (HQ) Real Estate Services Office. When approved, approaches will be specifically reserved in the right of way transaction and will contain the identical limitations set by the State Design Engineer and as shown on the approved Limited Access Plan.

(2) Cattle Passes

The desirability of, or need for a cattle pass will be considered during the appraisal or negotiation process. A cattle pass will be approved only after complete studies of location, utilization, cost, and safety elements have proved its necessity. Upon approval, such an improvement and appurtenant rights will be established. Future right of access for maintenance is negotiated during acquisition.

On limited access highways, approval of the State Design Engineer and the addition of a traffic movement note on the right of way and limited access plan (*Plans Preparation Manual*) are required.

(3) Pit, Stockpile, and Waste Sites

These sites are investigated and planned as outlined in the *Plans Preparation Manual*. Detour and haul road agreements, approved by the Regional Administrator, are necessary when the state proposes to use city streets or county roads for the purpose of detouring traffic or hauling certain materials. See the *Utilities Manual* for detour and haul road agreement guidelines.

(4) International Boundaries

Construction proposed "within a 20-foot strip, 10 feet on each side of the international boundary," must be coordinated between the department and the British Columbia Ministry of Highways and Public Works.

Permission of the International Boundary Commission is required to work "within 10 feet of an international boundary." Their primary concern is monumentation of the boundary line and the line of sight between monuments. They require a written request stating what will be done, when, and why; sent to 1250 23rd Street NW, Washington DC 20037.

1410.04 Easements and Permits

(1) General

If others request rights within existing WSDOT ownership, they are to contact the region's Real Estate Services Office.

Easements and permits to accommodate WSDOT activities outside the right of way usually fall into one of the categories defined below.

Easements and permits are processed in accordance with the requirements of the *Right of Way Manual*. The region's Real Estate Services Office drafts the legal descriptions for all easements and permits for acquisition or disposition of rights. These requests are to be directed through the region's Real Estate Services Manager.

The region's Real Estate Services Office either obtains or assists in obtaining easements and permits. The region is responsible for compliance with and appropriate retention of the final documents. Easements and permits are to be shown on the contract plans in accordance with the *Plans Preparation Manual*.

(2) Perpetual Easements

Perpetual easements are shown on the right of way plans in accordance with the *Plans Preparation Manual*.

(a) **State Maintenance Easement.** Used when the state is to construct a facility and provide all maintenance. Examples are slope and drainage easements.

(b) **Dual Maintenance Easement.** Used when the state is to construct and maintain a facility and the owner is to maintain the remainder. Examples are; the surface area above a tunnel and the area behind a retaining wall or noise wall.

(c) **Transfer Easement.** Used when an easement must be acquired to replace an existing easement for a facility that is to be relocated. The region's Real Estate Services Office obtains or prepares instruments that contain all necessary rights and provide for maintenance by the party to whom the easement will ultimately be conveyed. Easements are conveyed when they remain within state rights of way and are replacing existing property rights. Easements are transferred only when the easement is outside the state right of way and not needed for highway purposes. The right of way/limited access plan is modified to identify the party to whom the easement will be transferred. The department cannot obtain easements for transfer across lands under the jurisdiction of the Department of Natural Resources (DNR). WSDOT cannot condemn for a transfer easement to a private party.

(3) Temporary Easements

Temporary easements are used when the state requires a property right of a temporary nature that involves either more than minor work or construction activities on privately owned property. In the cases where the rights required or the work to be performed is not beneficial to the property owner, just compensation may be paid.

Temporary easements are usually shown on the right of way plans in accordance with the *Plans Preparation Manual* when the encroachment is significant; more than about 5 ft. Consult the region's Plans and Real Estate Services personnel for exceptions. If the easement is not mapped, mark and submit plans as described for construction permits.

(4) Construction Permits

Construction permits are used for temporary rights during construction and not used when WSDOT needs a perpetual right. A construction permit is recommended for rights of entry to publicly owned property. Local agencies might require the use of specific Forms when applying for these rights of entry. Regardless of the Form or its name, the region is responsible for appropriate central storage.

A construction permit is only valid with the current owner and must be renegotiated if property ownership changes before construction begins. For private ownerships, a temporary construction easement is recommended.

The construction permit is usually obtained without the payment of compensation (donation or mutual benefits, for example). Consult the region's Plans and Real Estate Services personnel for exceptions.

Permits are allowed where minor right of way acquisitions are obtained for intersections.

Mapping requirements for a construction permit are as follows:

1. Construction permits are not shown on the right of way plan.

2. The region's Project Coordinator's Office is provided two sets of right of way plans with all required construction permits delineated in red. The region sends one copy of the marked plans and copies of the permits to the HQ Real Estate Services Office. These plan sheets provide the following information:

- Ownership boundaries. (Confirmation of ownership and parcel boundaries may be completed by a search of county records and mapping. A formal title report is not required for construction permits.)
- Parcel number assigned to each ownership.
- Sufficient engineering detail to write legal descriptions.
- Statement of the intended use of each construction permit area.

1410.05 Programming for Funds

The phases in Figure 1410-1, in relation to plan development, apply to the authorization of stage programming.

When federal funds are involved, special attention must be given to Federal Highway Administration (FHWA) requirements. When federal participation in right of way costs is anticipated, specific authorization must be obtained from the FHWA. The rules and procedures provided in RCW 8.26, WAC 468-100, and the *Right of Way Manual* must be followed to ensure federal and state participation. In many cases, for example, federal funds are contingent upon the department setting up a relocation advisory procedure for any owner or tenant who is displaced by an improvement and desires such assistance. Relocation advisory assistance is a function of the HQ Real Estate Services Office.

1410.06 Appraisal and Acquisition

(1) All Highways

The phases in Figure 1410-1, in relation to plan development, apply to the authorization of right of way acquisition for all access highways.

(3) Exceptions

Exceptions can be made to the requirements in Figure 1410-1 if unusual hardships result for the individual or the state. The approval of right of way hardship action will be based on the individual parcel merit and is processed in accordance with hardship acquisition policy (*Right of Way Manual*).

1410.07 Transactions

(1) Private Ownerships

Right of way is ordinarily acquired from private property owners by region-level negotiation between the owner and the right of way agent.

(2) Utilities

The region ascertains ownership of all utilities and makes arrangements for necessary adjustment, including relocation of portions of the utility, if necessary. Provisions for relocation or adjustment are included in the PS&E plans when:

- The items are normal construction items and the department is obligated for the moving expense.
- The utility requests that relocation be performed by the department and the department has approved the request.

Readjustment may require the department to purchase substitute rights of way or easements for eventual transfer to the utility. Such rights of way or easements must be shown on the right of way plans with the same engineering detail as highway right of way.

Because of the considerable time required to obtain approvals, processing of utility relocation agreements must begin as soon as possible.

(3) Railways

Right of way is generally not acquired in fee from a railroad company. Instead, the state acquires a perpetual easement for encroachment or crossing. A construction and maintenance agreement may also be required. The easement must be shown on the right of way plan and identified by both highway and railroad stationing.

The HQ Design Office coordinates with the railroad design staff to determine a mutually agreeable location before the proposed easement is sent to Real Estate Services. The negotiations with the railroads are done by HQ Real Estate Services. Because of the considerable time required to obtain approvals, processing of railroad agreements must begin as soon as possible.

The perpetual easement document is executed by the Director, Real Estate Services.

(4) Federal Agencies

Acquisition of right of way from most federal agencies must be negotiated and processed through several federal offices. Allow at least one year's time for efficient and economical right of way acquisition. Depending upon the particular federal agency involved, special exhibit maps and other documentation may be required, and the right of way may be acquired as an easement rather than in fee.

(5) Other State Agencies

Acquisition from other state agencies must be negotiated and processed through the individual agencies or designees. Negotiations with other state agencies are generally handled by HQ Real Estate Services. As in the case of federal agencies, substantial time must be allowed for compliance with applicable statutes and regulations peculiar to the agency before right of way will be granted.

(6) Condemnations

Condemnation may result from a disagreement between the department and the owner as to a fair settlement or from a faulty title. Since several months might elapse between the filing of a condemnation case and a court decision, the HQ Real Estate Services Office can be requested to investigate the possibility of obtaining a negotiated possession and use agreement as in the case of an emergency project, or when a sundry site is required at once.

1410.08 Documentation

A list of the documents that are required to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site:
http//www.wsdot.wa.gov/eesc/design/projectdev/

Plan Approval	Plan Approval	Programming of Funds for Appraisal and Acquisition
	Limited Access Highways	
PHASE 1 Acces Report Plan	State Design Engineer* approves Access Report Plan for prehearing discussion with county and/or city officials. The access report plan may be used for preparation of federal-aid program data for appraisals if federal funds are to be used for right of way acquisition. It may be used for requesting advance appraisal funds through the Planning and Capital Program Management for all projects with either state or federal funds.	Program appraisals of total takes. (No acquisition.)
PHASE 2 Acces Hearing Plan	State Design Engineer* approves Access Hearing Plan for use at a public access hearing. R/W information is complete. The access hearing plan may be used for the preparation of federal-aid program data for negotiations on federally funded projects, and for the preparation of true cost estimates and fund requests.	Program all appraisals and acquisitions. Note: Do not appraise or purchase partial takes in areas subject to controversy. Appraise or purchase total takes only if federal design hearing requirements are met.
PHASE 3 Findings and Order Plan	No signature required. Results of Findings and Order Access Hearing are marked in red and green on Access Hearing plan and sent to HQ R/W Plans Branch.	Program appraisals of partial takes where data is available to appraisers. Acquisition of total takes.
PHASE 4 Final R/W and L/A Plan	State Design Engineer* Approves final R/W and L/A plans or approves revisions to established R/W and L/A plans	Program all remaining appraisals and all remaining acquisitions. Note: If appeal period is not complete, delay action in areas subject to controversy and possible appeal.
	Managed Access Highways	
PHASE 5 Final R/W Plan	R/W plan submitted to HQ R/W Plans Branch for approval.	Program appraisals
	State Design Engineer* approves new R/W plans or approves revisions to established R/W plans.	Program all appraisals and acquisitions.

*Or a designee.

Appraisal and Acquisition
Figure 1410-1

introducing a weave, or significantly reducing the level of service on the main line due to additional travel demand) as well as what will be done to mitigate this adverse impact.

- Any location where a congestion point will be improved or eliminated by the proposal (such as proposed auxiliary lanes or collector-distributor roads for weave sections).
- Any surface system conditions that will affect traffic entering or exiting the freeway. If entering traffic is to be metered, explain the effect on the connecting surface system (for example, vehicle storage).
- When the existing facility does not meet the desired level of service, show how the proposal will improve the level of service or keep it from becoming worse than the future level with no change in access.

(b) **Accident analyses.** Demonstrate that the proposal does not have a significant adverse impact on the safety of the freeway or the adjacent affected surface system or that the impacts will be mitigated.

The required minimum limits of study are the same as for the operational analyses.

Identify all safety program (I2) locations. Where appropriate, identify accident histories, rates, and types for the freeway section and the adjacent affected surface system. Project the rates that will result from traffic flow and geometric conditions imposed by the proposed access point revision. Document the basis for all assumptions.

(7) Coordination

Are all coordinating projects and actions programmed and funded?

When the request for an access point revision is generated by new or expanded development (such as private developer or new park and ride lot), demonstrate appropriate coordination between the development and the changes to the transportation system.

Show that the proposal includes a commitment to complete the other noninterchange/nonintersection improvements that are necessary for the interchange/intersection to function as proposed. For example, the local circulation system must be in place before new ramps are opened to traffic and there must be commitment to the travel demand management and transportation system management concepts included in the proposal. If future reconstruction is part of the mitigation for design year level of service, the reconstruction projects must be in the State Highway System Plan.

All elements for improvements must be shown to include a fiscal commitment and a definite time for completion.

If the access point is to be designed as a left-side connection for HOV use only, include a commitment to close the access, rather than to open it to general use, if the HOV demand is moved to another access point or it declines to a level that no longer justifies the access.

(8) Planning and Environmental Processes

What is the status of the proposal's planning and environmental processes?

All requests for access point revisions on Interstate freeways must contain information on the status of the planning process. Show that the following federal objectives have been considered and report the proposed project's relationship to meeting them.

Federal law (23 USC 111) requires that *"each state carry out a transportation planning process that provides for consideration of projects and strategies that will:*

(a) Support the economic vitality of the United States, the states, and metropolitan areas, especially by enabling global competitiveness, productivity, and efficiency.

(b) Increase the safety and security of the transportation system for motorized and nonmotorized users.

(c) Increase the accessibility and mobility options available to people and for freight.

(d) Protect and enhance the environment, promote energy conservation, and improve quality of life.

(e) Enhance the integration and connectivity of the transportation system, across and between modes throughout the state, for people and freight.

(f) Promote efficient system management and operation.

(g) Emphasize the preservation of the existing transportation system."

All requests for access point revisions on freeways must contain information on the status of the environmental process. The following are just a few examples of status information that might apply.

- Are the environmental documents presently or soon-to-be submitted for approval?
- What applicable permits and approvals have been obtained and are pending?
- Are there hearings still to be held?
- Is the environmental process waiting for an engineering and operational acceptability decision?

1425.06 Documentation

A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

1450.06 Property Corners

A new property corner monument will be provided where an existing recorded monument has been invalidated as a direct result of a right of way purchase by the department. The new property corner monument shall be set by or under the direct supervision of a licensed professional land surveyor. The licensed professional land surveyor must record the survey with the county auditor and send copies to DNR and the Headquarters (HQ) Right of Way Plans Branch.

1450.07 Other Monuments

A DNR permit is required before any monument may be removed or destroyed.

Existing section corners and BLM or GLO monuments impacted by a project shall be reset to perpetuate their existence. After completing the work, a Land Corner Record is required.

Other permanent monuments established by any other governmental agency must not be disturbed until the agency has been contacted to determine specific requirements for the monument. If assistance is needed to identify a monument, contact the Headquarters (HQ) Geographic Services Office.

Resetting monuments must be done by or under the direct supervision of a licensed professional engineer or a licensed professional land surveyor. A copy of a Monumentation Map is filed with the county engineer of the county in which the monument is located and the original is sent to the HQ Right of Way Plans Branch. The HQ Right of Way Plans Branch will forward a copy to DNR for their records.

1450.08 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/

1450.09 Filing Requirements

(1) DNR Permit

When a DNR permit is required, use the application form shown in Figure 1450-2a. The completed application must be signed by a licensed professional engineer or a licensed professional land surveyor and submitted to DNR.

Monumentation work cannot be done until DNR has approved the permit. Verbal permission may be granted by DNR pending the issuance of a written permit.

After resetting the monument, the survey method used must be filed with DNR using the completion report form shown in Figure 1450-2b. The form must be signed by a licensed professional engineer or a licensed professional land surveyor.

(2) Monumentation Map

When a Monumentation Map is required, a plan sheet is prepared. Generally, the plan sheet is based on a right of way plan obtained from the HQ Right of Way Plans Branch. A Monumentation Map contains a description of all new and existing monuments indicating their kind, size, and location. In addition, it must contain the seal and signature of a licensed professional engineer or a licensed professional land surveyor. See the *Plans Preparation Manual*.

A copy of a Monumentation Map is filed with the county engineer of the county in which the monument is located and the original is sent to the HQ Right of Way Plans Branch. Headquarters will forward a copy to DNR for their records.

(3) Land Corner Record

When a Land Corner Record is required, use the forms shown in Figures 1450-3a and 3b. The completed forms must be signed and stamped by a licensed professional engineer or a licensed professional land surveyor and submitted to the county auditor for the county in which the monument is located. Copies are sent to DNR and the HQ Right of Way Plans Branch.

SET NEW

WSDOT Control Monument

Before: No permit required.

After: File a copy of a Monumentation Map with the county engineer. Send the original to the HQ R/W Plans Branch.

Alignment Monument

Before: No permits required.

After: File a copy of a Monumentation Map with the county engineer. Send the original to the HQ R/W Plans Branch.

Property Corner Monument*

Before: Engage a licensed professional land surveyor.

After: Licensed professional land surveyor files Record of Survey with county auditor and DNR and send a copy to the HQ R/W Plans Branch.

DISTURB EXISTING*

Control Monument

Before: Obtain DNR permit.

After: File a copy of a Monumentation Map with the county engineer. Send the original to the HQ R/W Plans Branch.

Alignment Monument

Before: Obtain DNR permit.

After: File a copy of a Monumentation Map with the county engineer. Send the original to the OSC R/W Plans Branch.

Section Corner, BLM, or GLO Monument

Before: Obtain DNR permit.

After: File Land Corner Record with the county auditor and DNR and send a copy to the HQ R/W Plans Branch.

All Other Monuments

Before:

- Obtain DNR permit.
- Contact governmental agency.

After: File a copy of a Monumentation Map with the county engineer. Send the original to the HQ R/W Plans Branch.

*Property corner monuments must be filed within 90 days of establishment, reestablishment, or restoration.

Monument Documentation Summary
Figure 1450-1

Washington State Department of Transportation

Design Manual Supplement

State Design Engineer

Effective Date: 3/25/2004
Supercedes: July 22, 2003

Urban Roadways (Revised)

I. Introduction

A. Purpose

To modify the Washington State Department of Transportation (WSDOT) design criteria for roadways in urban areas.

B. References

RCW 47.50, Highway Access Management

RCW 46.51.575, Additional parking regulations

RCW 46.61.150, Driving on divided highways.

WAC 468-51, Highway Access Management — Access Permits — Administrative Process

WAC 468-52, Highway Access Management — Access Control Classification System and Standards

Design Manual, M 22-01, WSDOT

Instructional Letter 4053.00, Jurisdiction Over State Highways Within Cities

C. Background

In the urban environment, development has limited the space available for all of the competing roadway needs such as lanes for capacity, shoulders, medians, sidewalks, and parking. Because of this, providing roadways that meet full design level in developed areas is often difficult.

Roadway design guidance developed for rural and limited access highways is not always appropriate for urban roadways. The existing guidance provides for higher design speeds; with wider lanes, shoulders, and medians than necessary for the developed urban environment. This has resulted in a higher level of design at a higher project cost.

D. Discussion

1. Design Speed

The design speed is the speed used to determine the various geometric design features of the roadway. Sight distance, superelevation, and maximum grade are the main design elements that depend on the design speed. A uniform design speed throughout a corridor provides consistent features that produce acceptable operating speeds.

The existing full design level design speed guidance does not fully account for roadside development. Before May 2001, the design speed could be selected from a range of speeds. The May 2001 *Design Manual* revision to Chapter 440 removed the lower end of the range leaving the required design speed as the high end of the range. This removed the designer's ability to select a design speed appropriate for the development in the area. The required design speeds are frequently higher than necessary for the conditions in urban areas.

Design speed is revised to restore the minimum design speeds values removed May 2001. A corridor analysis may be used to select an appropriate design speed for the roadway setting, with the posted speed as the minimum.

2. Lane Width

Lane width has an influence on safety, comfort, and capacity. Lanes 12 ft wide provide desirable clearance between large vehicles for safety and comfort. They also provide full capacity. Narrower lanes will have an adverse impact on the traffic flow. However, 11 ft lanes provide minimum clearance and the added benefit to traffic for wider lanes in developed urban areas is often less than the additional cost.

For roadways on the NHS, 12 ft lanes are preferred. For non NHS managed access highways, the minimum lane width is reduced to 11 ft, except when truck volumes and speeds are high.

3. Shoulder

There are many functions of a shoulder along the traveled way. In an urban environment the benefits that shoulders provide include:

- Separation from curbs to reduce driver shifting (shy distance)
- Improved capacity
- Areas for bike and pedestrian use
- Room for large vehicle tracking for turning movements

Before May 2001, when curb section was used the WSDOT *Design Manual* said, "… a 6 ft shoulder outside the face of curb is acceptable. See Chapter 910 for shy distances at curbs." Chapter 910, "Intersections at Grade" called for a 1 ft shy on the left with 11 ft or wider lanes and 2 ft on the right. Except, on the right, "For noncontinuous curbs or where bicycles are anticipated, the minimum shy distance to the face of the curb is 3 ft." This often resulted in confusion and the 6 ft requirement not being met.

With the May 2001 revision to the *Design Manual*, the terminology for this area was changed from "shy distance" to "shoulder" and the guidance was moved to Chapter 440, "Full Design Level". At the same time, the right shoulder width requirement increased to 4 ft to provide more room for bicyclists. The left shoulder width requirement was revised to provide a lane/shoulder width of 13 ft when the Design Speed is less than 50 mph. These criteria have been shown to be impractical for many of the projects being developed in urban areas.

For turn lanes, because traffic speeds and volumes are low, the need for shoulders is reduced to providing structural support and room for bike and pedestrian use. Where adjacent curb and sidewalk are provided, the need for shoulders adjacent to the turn-lane is eliminated.

The shoulder width for urban managed access highways is changed to be more practical in developed areas.

4. Median

A median is the portion of a highway separating the traveled ways for traffic in opposite directions. Medians separate opposing traffic streams, provide space for left turn lanes, control left turns, minimize headlight glare, and provide space for landscaping and storm water treatment.

Medians used on urban managed access highways have not been fully addressed in the *Design Manual*. The manual has covered medians commonly used in rural areas (depressed) and limited access highways in urban areas (barrier separated), but raised medians, which are common in urban areas, have not been included.

Guidance is added for medians on managed access highways in urban areas.

5. Superelevation

In urban areas, roadside development often makes superelevation impractical. To allow for this, AASHTO provides a different method for calculating superelevation with higher allowable side friction for low-speed urban roadways. The result is a reduction in the minimum radius for normal crown and a reduction in minimum radius at full superelevation. The low-speed urban roadway superelevation has not previously been included in the *Design Manual*. To allow more flexibility on low-speed urban managed access highways, the AASHTO low-speed urban roadway superelevation is adopted for urban managed access highways.

E. Revision

Design Manual Supplement; Urban Roadways, dated July 22, 2003, is revised. The changes are:

- Instruction II.A. deleted, changes to note 3, Figure 430-3 and note 4, Figure 430-4 included in *Design Manual* Supplement, Design Speed.
- Revised 440.06(2), *State Highways as City Street*s to include change from IL 4053.00, Jurisdiction Over State Highways Within Cities
- A definition for urbanized area (urban area with a population of 50,000 or more) is added.
- Note 2 in Figure 440-3a is revised for clarity.
- Urban considerations for design speed on the Interstate changed to urbanized.
- Note 7 in Figure 440-4 revised.
- Design speed criteria for the P-1 design class adjusted to agree with the Design Speed *Design Manual* Supplement.
- The design speed breaks for the urban managed access design classes adjusted for uniformity.
- References to the access chapters updated.

F. Implementation

This change is effective on the date of this supplement and will expire when the changes are incorporated in the *Design Manual*.

II. Instructions

~~A. Replace note 3, Figure 430-3 and note 4, Figure 430-4 with the following:~~

> ~~When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.~~ In urban areas, see Chapter 440. ~~On designated bicycle routes, the minimum shoulder width is 4 ft (See Chapter 1020).~~

B. Replace paragraph 440.06(2), *State Highways as City Streets*, with the following:

When a state highway within an incorporated city or town is a portion of a city street, the design features must be developed in cooperation with the local agency. For facilities on the NHS, use the design criteria in this manual as the minimum for the functional class of the route. For facilities not on the NHS, the *Local Agency Guidelines,* M 36-63 may be used as the minimum design criteria; however, the use of WSDOT design criteria is encouraged where feasible. On managed access highways within the limits of incorporated cities and towns, the cities or towns have full responsibility for design elements outside of curb, or outside the paved shoulder where no curb exists, using the *City and County Design Standards*.

C. Replace the last paragraph of 440.07 with the following:

> Select a design speed for urban arterial streets and highways with some access control and fairly long distances between intersections as discussed above. For highways in urban areas, see 440.16(3) for design speed determination.

D. Add the attached new 440.16 "Urban Roadways" to the end of Chapter 440. (Pages 6-8.)

E. Replace existing Figures 440-4 through 440-7b with the attached revised Figures. 440-4 through 440-8. (Pages 9-16)

F. Add the following to 640.05 "Superelevation".

> **(6) Low-Speed Urban Managed Access Highway Superelevation**
>
> Curves on low-speed Urban Managed Access Highways may be superelevated using a higher side friction. Figure 640-12b may be used to determine superelevation for Urban Managed Access Highways with a design speed of 40 mph or less.

G. Add new Figure 640-12b to Chapter 640. (Page 17)

440.16 Urban Roadways

(1) Definitions

divided multilane A roadway with 4 or more lanes and a median that physically or legally prohibits left-turns, except at designated locations.

limited access highway All highways where the rights of direct access to or from abutting lands have been acquired from the abutting landowners.

managed access highway All highways where the rights of direct access to or from abutting lands have not been acquired from the abutting landowners.

median The portion of a highway separating the traveled ways for traffic in opposite directions.

rural area An area that meets none of the conditions to be an urban area.

suburban area A term for the area at the boundary of an urban area. Suburban settings may combine higher speeds common in rural areas with activities that are more similar to urban settings. Separate design values are not given for suburban areas, classify suburban areas as either urban or rural as best fits the existing or design year conditions.

two-way left-turn lanes (TWLTL) A lane, located between opposing lanes of traffic, to be used by vehicles making left turns from either direction, either from or onto the roadway.

undivided multilane A roadway with 4 or more lanes on which left-turns are not controlled.

urban area An area defined by one or more of the following:

- Within a federal urban area boundary as designated by FHWA.
- Within the limits of an incorporated city
- Characterized by intensive use of the land for the location of structures and receiving such urban services as sewer, water, and other public utilities and services normally associated with incorporated cities.
- With not more than twenty-five percent undeveloped land.

urbanized area An urban area with a population of 50,000 or more.

(2) Design Class

The design class of limited access highways on the state system in urban areas is controlled by the functional class (See Figures 440-4 through 7b.)

The urban managed access highway design class (Figure 440-8) may be used on all managed access highways in urban areas, regardless of the functional class.

(3) Design Speed

For limited access facilities, the design speed is given for each design class in Figures 440-4 through 7b.

For managed access facilities in urban areas, select a design speed based on figure 440-1. In cases where the 440-1 design speed does not fit the conditions, a corridor analysis may be used to select a design speed. Select a design speed not less than the posted speed and logical with respect to topography, operating speed (or anticipated operating speed for new alignment), adjacent land use, design traffic volume, accident history, access control, and the functional classification. Consider both year of construction and design year. Maintain continuity throughout the corridor, with changes at logical points, such as a change in roadside development.

(4) Lanes

Figure 440-8 gives the minimum lane widths for urban managed access highways. See Chapter 640 for guidance on width requirements on turning roadways. The width for two-way two-lane turning roadways and two-lane one-way turning roadways given in the figures in Chapter 640 are based on 12 ft minimum lane widths. When 11 ft minimum lane widths are used, the widths from the figures may be reduced by 2 ft.

(5) Shoulders

Figure 440-8 gives the minimum shoulder widths for urban managed access highways without curb. When a curb section with a height of 8 in or less is used, the minimum shoulder width is given in Figure 440-3a. When a curb or barrier with a height between 8 in and 2 ft is used adjacent to the roadway, the minimum shoulder width is 2 ft. When traffic barrier with a height of 2 ft or greater is used adjacent to the roadway, the minimum shoulder width from the edge of traveled way to the face of the traffic barrier is 4 ft. Additional shy distance for traffic barrier is not normally required on urban managed access highways.

Lane Width	Posted Speed			
	>45 mph	≤45 mph	>45 mph	≤45 mph
	On Left		On Right (2)	
12 ft or wider	4 ft	1 ft (1)	4 ft	2 ft
11 ft	4 ft	1 ft (1)	4 ft	3 ft (3)

Notes:

(1) When mountable curb is used on routes with a posted speed of 35 mph or less, shoulder width is desirable but, with justification, curb may be placed at the edge of traveled way.

(2) When the route has been identified as a local, state, or regional significant bike route, the minimum shoulder width is 4 ft or as indicated in Chapter 1020 for signed bike lanes.

(3) When bikes are not a consideration, may be reduced to 2 ft with justification.

(4) Measured from the edge of traveled way to the face of the curb.

Shoulder Width for Curbed Sections (4) **- Urban**
Figure 440-3a

Where there are no sidewalks the minimum shoulder width is 4 ft. Shoulder widths less than 4 ft will require wheelchairs using the roadway to encroach on the through lane.

The need for shoulders adjacent to turn lanes, on urban managed access highways, is reduced. For roadways without curb sections, the shoulder adjacent to turn lanes may be reduced to 2 ft on the left and 4 ft on the right. When a curb and sidewalk section is used with a turn lane 400 ft or less in length, the shoulders adjacent to turn lanes may be eliminated. The design of the intersection may need to be adjusted to allow for vehicle tracking. On routes where bicycles are provided for, continue the bicycle facility between the turn lane and the through lane. (See Chapter 910 for information on turn lanes and Chapter 1020 for information on bicycle facilities.)

For routes identified as local, state, or regional significant bicycle routes, provide a minimum 4 ft shoulder. Maintain system consistence for the bicycle route, regardless of jurisdiction and functional class. See Chapter 1020 for additional information on bicycle facilities.

(6) Medians

Medians are either restrictive or nonrestrictive. Restrictive medians limit left-turns, physically or legally, to defined locations. Nonrestrictive medians allow left-turns at any point along the route. Consider restrictive medians when the DHV is over 2000.

A common form of restrictive median in urban areas is the raised median. When the median is to be landscaped or where rigid objects are to be placed in the median, see *Design Manual* Chapter 700 for clear zone requirements. The width of a raised median may be minimized by using a dual-faced cement concrete traffic curb, a precast traffic curb, or an extruded curb.

A two-way left-turn lane (TWLTL) may be used as a nonrestrictive median for an undivided roadway with a DHV of 2500 or less. The desirable width of a TWLTL is 13 ft with a minimum width of 11 ft. (See Chapter 910 for additional information.)

The traffic volume limits for restrictive medians and TWLTLs are based on WAC 468-52. For more exact values, see the WAC.

(7) Parking

Parallel parking may be permitted on urban managed access highways as shown on Figure 440-8. The widths given are minimum. Provide wider widths when practical.

Angle parking is not permitted on any state route without approval by WSDOT (RCW 46.61.575). For state routes, this approval is delegated to the State Traffic Engineer. Process Angle parking approval is to be requested through the HQ Design Office. Provide an engineering study, approved by the region's Traffic Engineer, with the deviation that shows the parking will not unduly reduce safety and that the roadway is of sufficient width that the parking will not interfere with the normal movement of traffic.

Design Class	**Divided Multilane** I-1	
Design Year	(1)	
Access Control (2)	Full	
Separate Cross Traffic		
Highways	All	
Railroads	All	
Design Speed (mph)		
Rural	80 (3)	
Urbanized	70 (4)	
Traffic Lanes		
Number	4 or more divided	
Width (ft)	12	
Median Width (ft)	4 lane	6 lanes or more
Rural —Minimum (5)	40	50
Urban —Minimum	16	22
Shoulder Width (ft)		
Right of Traffic	10 (6)	10 (6)
Left of Traffic	4	10 (6)(7)
Pavement Type (8)	High	
Right of Way (9)		
Rural — Minimum Width (ft)	63 from edge of traveled way	
Urban — Minimum Width (ft)	As required (10)	
Structures Width (ft) (11)	Full roadway width each direction (12)	

Type of Terrain	**Design Speed (mph)** 50	60	70	80
Level	4	3	3	3
Rolling	5	4	4	4
Mountainous	6	6	5	5

Grades (%) (13)

Interstate Notes:

(1) The design year is 20 years after the year the construction is scheduled to begin.

(2) See Chapter 1430 for access control requirements.

(3) 80 mph is the desirable design speed; with a corridor analysis, the design speed may be reduced to 60 mph in mountainous terrain and 70 mph in rolling terrain. Do not select a design speed that is less than the posted speed.

(4) 70 mph is the desirable design speed; in urbanized areas, with a corridor analysis the design speed may be reduced to 50 mph. Do not select a design speed that is less than the posted speed.

(5) Independent alignment and grade is desirable in all rural areas and where terrain and development permits in urban areas.

(6) 12 ft shoulders are desirable when the truck DDHV is 250 or greater.

(7) For existing 6-lane roadways, with design exception documentation, existing 6 ft left shoulders that are not being reconstructed may remain when no other widening is required.

(8) Submit Form 223-528, Pavement Type Determination.

(9) Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.

(10) In urban areas, make right of way widths not less than those required for necessary cross section elements.

(11) See Chapter 1120 for minimum vertical clearance.

(12) For median widths 26 ft or less, address bridge(s) in accordance with Chapter 1120.

(13) Grades 1% steeper may be used in urban areas where development precludes the use of flatter grades and for one-way down grades except in mountainous terrain.

Geometric Design Data, Interstate
Figure 440-4

Design Class	Divided Multilane				Two-Lane						Undivided Multilane	
	P-1		P-2		P-3		P-4		P-5		P-6 (1)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year (2) NHS Non NHS	Over 1,500		Over 700		Over 201 (3) Over 301		61-200 (4) 101-300		60 and under 100 and Under		Over 700	
Access Control	Full (5)		Partial (5)		(5)		(5)		(5)		(5)	
Separate Cross Traffic Highways Railroads (6)	 All All		 Where Justified All		 Where Justified All (7)		 Where Justified Where Justified (8)		 Where Justified Where Justified (8)		 Where Justified Where Justified (8)	
Design Speed (mph) (9) Minimum (10)	80 60 (11)		70 50(12)		70 50	60 40(12)	70 50	60 40(12)	60 40	60 30(12)	70 40	60 30(12)
Traffic Lanes Number Width (ft)	 4 or more divided 12		 4 or 6 divided 12		 2 12		 2 12		 2 12		 4 12	 4 or 6 11 (13)
Shoulder Width (ft) Right of Traffic Left of Traffic	 10 (14) Variable (16)		 10 Variable (16)		8		6		4		8	8(15)
Median Width (ft) 4 lane 6 or more lanes	 40 (17) 48 (17)	 16 22	 60 60	 16 22							 4 4	 2 (18) 2 (18)
Parking Lanes Width (ft) — Minimum	None		None		None		None	10	None	10	None	10 (19)
Pavement Type (20)	High				High or intermediate							
Right of Way (21) — Min Width (ft)	(22)	(23)	(22)	(23)	120	80	120	80	100	80	150	80
Structures Width (ft) (24)	Full roadway width (25)				40		36		32		Full roadway width	
Other Design Considerations-Urban					(26)		(26)		(26)		(26)	

	Rural — Design Speed (mph)					Urban — Design Speed (mph)			
Type of Terrain	40	50	60	70	80	30	40	50	60 (27)
Level	5	4	3	3	3	8	7	6	5
Rolling	6	5	4	4	4	9	8	7	6
Mountainous	8	7	6	5	5	11	10	9	8

Grades (%) (28)

Geometric Design Data, Principal Arterial

Figure 440-5a

Principal Arterial Notes:

(1) Justify the selection of a P-6 design class on limited access highways.
(2) The design year is 20 years after the year the construction is scheduled to begin.
(3) Where DHV exceeds 700, consider four lanes. When the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future four-lane facility. When considering truck climbing lanes on a P-3 design class highway, perform an investigation to determine if a P-2 design class highway is justified.
(4) When considering a multilane highway, perform an investigation to determine if a truck climbing lane or passing lane will satisfy the need. See Chapter 1010.
(5) See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways for access control requirements. Contact the HQ Design Office Access & Hearings Unit for additional information.
(6) Contact the Rail Office of the Public Transportation and Rail Division for input on the needs for the railroad.
(7) All main line and major-spur railroad tracks will be separated. Consider allowing at-grade crossings at minor-spur railroad tracks.
(8) Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
(9) These are the design speeds for level and rolling terrain in rural areas. They are the preferred design speeds for mountainous terrain and urban areas. Higher design speeds may be selected, with justification.
(10) These design speeds may be selected in mountainous terrain, with a corridor analysis. Do not select a design speed that is less than the posted speed.
(11) In urbanized areas, with a corridor analysis, 50 mph may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.
(12) In urban areas, with a corridor analysis these values may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.
(13) 12 ft lanes are required when the truck DDHV is 150 or greater.
(14) 12 ft shoulders are desirable when the truck DDHV is 250 or greater.
(15) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.
(16) Minimum left shoulder width is to be as follows: four lanes — 4 ft: six or more lanes — 10 ft. For 6-lane roadways, existing 6 ft left shoulders may remain when no other widening is required.
(17) On freeways or expressways requiring less than eight lanes within the 20-year design period, provide sufficient median or lateral clearance and right of way to permit addition of a lane in each direction if required by traffic increase after the 20-year period.
(18) When signing is required in the median of a six-lane section, the minimum width is 6 ft. If barrier is to be installed at a future date, an 8 ft minimum median is required.
(19) Restrict parking when DHV is over 1500.
(20) Submit Form 223-528, Pavement Type Determination.
(21) Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
(22) 63 ft from edge of traveled way.
(23) Make right of way widths not less than those required for necessary cross section elements.
(24) See Chapter 1120 for the minimum vertical clearance.
(25) For median widths 26 ft or less, address bridges in accordance with Chapter 1120.
(26) For bicycle requirements, see Chapter 1020. For pedestrian and sidewalk requirements, see Chapter 1025. Curb requirements are in 440.11. Lateral clearances from the face of curb to obstruction are in Chapter 700.
(27) For grades at design speeds grater than 60 mph in urban areas, use rural criteria.
(28) Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

Geometric Design Data, Principal Arterial
Figure 440-5b

Design Class	**Divided Multilane**		**Two-Lane**						**Undivided Multilane**	
	M-1		M-2		M-3		M-4		M-5 (1)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year (2) NHS Non NHS	Over 700		Over 201 (3) Over 401		61-200 (4) 201-400		60 and Under 200 and Under		Over 700	
Access Control	Partial (5)		(5)		(5)		(5)		(5)	
Separate Cross Traffic Highways Railroads (6)	Where Justified All		Where Justified All (7)		Where Justified Where Justified (8)		Where Justified Where Justified (8)		Where Justified Where Justified (8)	
Design Speed (mph) (9) **Minimum** (10)(11)	70 50		70 50	60 40	70 50	60 40	60 40	60 30	70 40	60 30
Traffic Lanes Number Width (ft)	4 or 6 divided 12		2 12		2 12		2 12		4 12	4 or 6 11 (12)
Shoulder Width (ft) Right of Traffic Left of Traffic	10 Variable (14)		8		6		4		8	8 (13)
Median Width (ft) 4 lane 6 lane	60 60	16 22							4	2 (15)
Parking Lanes Width (ft) — Minimum	None		None		None	10	None	10	None	10 (16)
Pavement Type (17)	High		As required						High or Intermediate	
Right of Way (18) — Min Width (ft)	(19)	(20)	120	80	120	80	100	80	150	80
Structures (ft) (21)	Full Roadway Width (22)		40		36		32		Full Roadway Width	
Other Design Considerations-Urban			(23)		(23)		(23)		(23)	

Type of Terrain	**Rural — Design Speed (mph)**					**Urban — Design Speed (mph)**			
	40	50	60	70	80	30	40	50	60 (24)
Level	5	4	3	3	3	8	7	6	5
Rolling	6	5	4	4	4	9	8	7	6
Mountainous	8	7	6	5	5	11	10	9	8

Grades (%) (25)

Geometric Design Data, Minor Arterial

Figure 440-6a

Minor Arterial Notes:

(1) Justify the selection of an M-5 design class on limited access highways.
(2) The design year is 20 years after the year the construction is scheduled to begin.
(3) Where DHV exceeds 700, consider four lanes. When the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future four-lane facility. When considering truck climbing lanes on an M-2 design class highway, perform an investigation to determine if an M-1 design class highway is justified.
(4) When considering a multilane highway, perform an investigation to determine if a truck climbing lane or passing lane will satisfy the need. See Chapter 1010.
(5) See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways for access control requirements. Contact the HQ Design Office Access & Hearings Unit for additional information.
(6) Contact the Rail Office of the Public Transportation and Rail Division for input on the needs for the railroad.
(7) All main line and major-spur railroad tracks will be separated. Consider allowing at-grade crossings at minor-spur railroad tracks.
(8) Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
(9) These are the design speeds for level and rolling terrain in rural areas. They are the preferred design speeds for mountainous terrain and urban areas. Higher design speeds may be selected, with justification.
(10) In urban areas, with a corridor analysis these values may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.
(11) These design speeds may be selected in mountainous terrain, with a corridor analysis. Do not select a design speed that is less than the posted speed.
(12) When the truck DDHV is 150 or greater, consider 12 ft lanes.
(13) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.
(14) The minimum left shoulder width is 4 ft for four lanes and 10 ft for six or more lanes. For 6-lane roadways, existing 6 ft left shoulders may remain when no other widening is required.
(15) When signing is required in the median of a six-lane section, the minimum width is 6 ft. If barrier is to be installed at a future date, an 8 ft minimum median is required.
(16) Restrict parking when DHV is over 1500.
(17) Submit Form 223-528, Pavement Type Determination.
(18) Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
(19) 63 ft from edge of traveled way
(20) Make right of way widths not less than those required for necessary cross section elements.
(21) See Chapter 1120 for the minimum vertical clearance.
(22) For median widths 26 ft or less, address bridges in accordance with Chapter 1120.
(23) For bicycle requirements, see Chapter 1020. For pedestrian and sidewalk requirements see Chapter 1025. Curb requirements are in 440.11. Lateral clearances from the face of curb to obstruction are in Chapter 700.
(24) For grades at design speeds grater than 60 mph in urban areas, use rural criteria.
(25) Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

Geometric Design Data, Minor Arterial
Figure 440-6b

Design Class	**Undivided Multilane**		**Two-Lane**					
	C-1		C-2		C-3		C-4	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year (1) NHS Non NHS	Over 900		Over 301 (2) Over 501		201-300 (3) 301-500		200 and under 300 and Under	
Access Control	(4)		(4)		(4)		(4)	
Separate Cross Traffic Highways Railroads (5)	 Where Justified Where Justified (6)		 Where Justified All (6)		 Where Justified Where Justified (6)		 Where Justified Where Justified (6)	
Design Speed (mph) (7) **Minimum** (8)(9)	70 40	60 30	70 50	60 40	70 50	60 40	60 40	60 30
Traffic Lanes Number Width (ft)	 4 12	 4 or 6 11 (10)	 2 12		 2 12		 2 12	
Shoulder Width (ft)	8	8 (11)	8		6		4	
Median Width — Minimum (ft)	4	2 (12)						
Parking Lanes Width (ft) — Minimum	None	10	None		None	10	None	10
Pavement Type (13)	High or Intermediate		As required					
Right of Way (ft) (14)	150	80	120	80	120	80	100	80
Structures Width (ft) (15)	Full Roadway Width		40		36		32	
Other Design Considerations-Urban	(16)		(16)		(16)		(16)	

	Rural — Design Speed (mph)					**Urban — Design Speed (mph)**			
Type of Terrain	30	40	50	60	70	30	40	50	60 (17)
Level	7	7	6	5	4	9	9	7	6
Rolling	9	8	7	6	5	11	10	8	7
Mountainous	10	10	9	8	6	12	12	10	9

Grades (%) (18)

Geometric Design Data, Collector

Figure 440-7a

Collector Notes:

(1) The design year is 20 years after the year the construction is scheduled to begin.

(2) Where DHV exceeds 900, consider four lanes. When the volume/capacity ratio is equal to or exceeds 0.85, consider the needs for a future four-lane facility. When considering truck climbing lanes on a C-2 design class highway, perform an investigation to determine if a C-1 design class highway is justified.

(3) When considering a multilane highway, perform an investigation to determine if a truck climbing lane or passing lane will satisfy the need. See Chapter 1010.

(4) See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways for access control requirements. Contact the HQ Design Office Access & Hearings Unit for additional information.

(5) Contact the Rail Office of the Public Transportation and Rail Division for input on the needs for the railroad.

(6) Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.

(7) These are the design speeds for level and rolling terrain in rural areas. They are the preferred design speeds for mountainous terrain and urban areas. Higher design speeds may be selected, with justification. Do not select a design speed that is less than the posted speed.

(8) In urban areas, with a corridor analysis these values may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.

(9) These design speeds may be selected in mountainous terrain, with a corridor analysis. Do not select a design speed that is less than the posted speed.

(10) Consider 12 ft lanes when the truck DHV is 200 or greater.

(11) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.

(12) When signing is required in the median of a six-lane section, the minimum width is 6 ft median. If barrier is to be installed at a future date, an 8 ft minimum median is required.

(13) Submit Form 223-528, Pavement Type Determination.

(14) Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.

(15) See Chapter 1120 for the minimum vertical clearance.

(16) For bicycle requirements, see Chapter 1020. For pedestrian and sidewalk requirements see Chapter 1025. Curb requirements are in 440.11. Lateral clearances from the face of curb to obstruction are in with Chapter 700.

(17) For grades at design speeds grater than 60 mph in urban areas, use rural criteria.

(18) Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

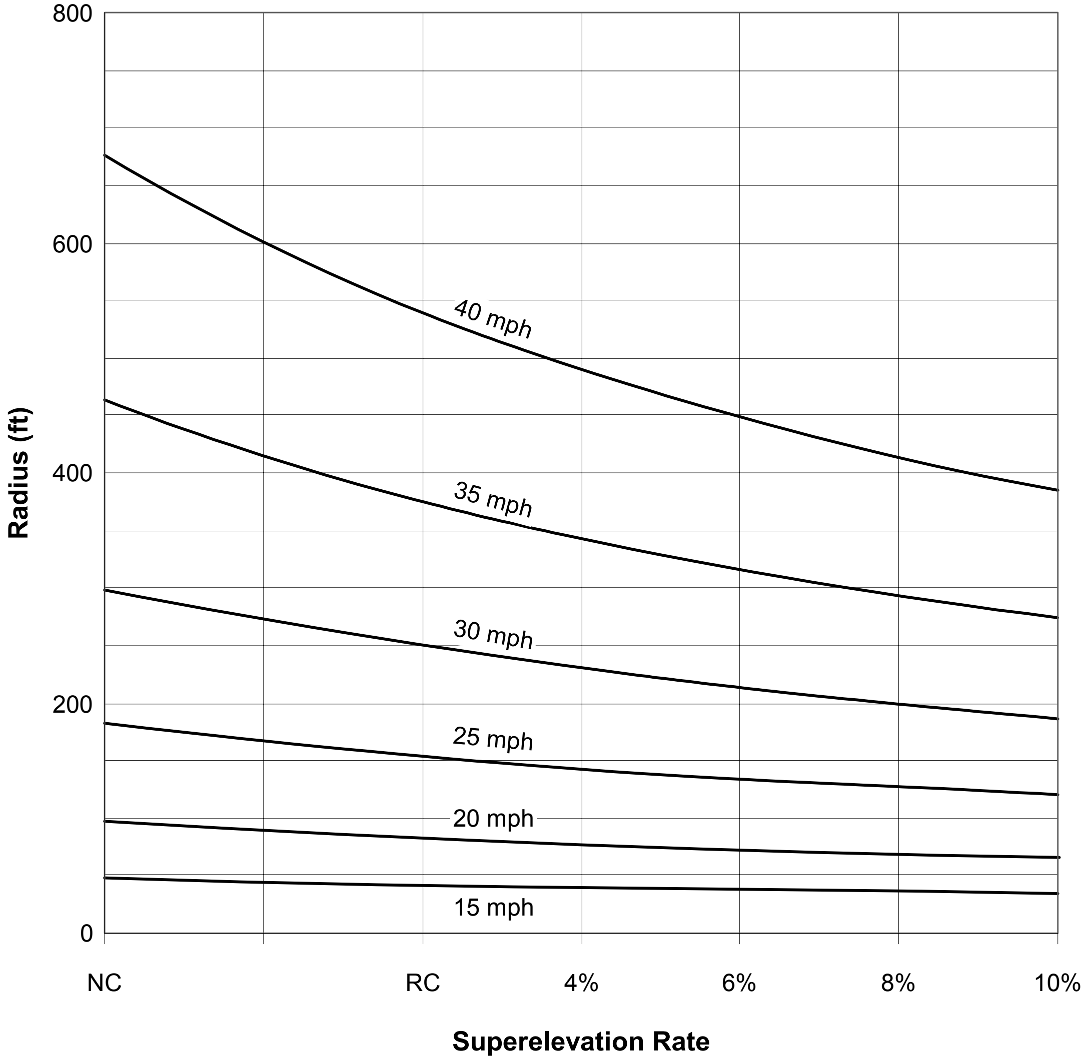
Geometric Design Data, Collector
Figure 440-7b

Design Class	Divided Multilane		Undivided Multilane		Two-Lane	
	UM/A1	UM/A2	UM/A3	UM/A4	UM/A5	UM/A6
DHV in Design Year (1)	Over 700	Over 700	700 – 2,500	Over 700	All	All
Design Speed (mph)	Greater than 45	45 or less	35 to 45	30 or less	Greater than 45	45 or less
Access	(2)	(2)	(2)	(2)	(2)	(2)
Traffic Lanes						
Number	4 or more	4 or more	4 or more	4 or more	2	2
Width (ft) NHS	12 (3)(4)	12 (3)	12 (3)	12 (3)	12 (3)(6)	12 (3)
Non NHS	11 (4)	11 (5)	11 (5)	11 (5)	11 (6)	11 (7)
Shoulder Width (ft)						
Right of Traffic	10	10 (8)	8 (8)	8 (8)	8 (9) (8)	4 (8)
Left of Traffic	4	4 (8)				
Median Width (ft)	10 (10)	3 (10)(11)	(12)	(12)		
Parking Lane Width (ft)	None	10 (13)	10 (13)	8 (14)	10 (15)	8 (14)
Structures Width (ft) (16)	Full roadway width (17)		Full roadway width		32	30
Other Design Considerations	(18)	(18)	(18)	(18)	(18)	(18)

Urban Managed Access Highways Notes:

(1) The design year is 20 years after the year the construction is scheduled to begin.
(2) The urban managed access highway design is only used on managed access highways. See Chapter 1435.
(3) May be reduced to 11 ft with justification.
(4) Provide 12 ft lanes when truck DDHV is 200 or greater.
(5) Consider 12 ft lanes when truck DDHV is 200 or greater.
(6) Provide 12 ft lanes when truck DHV is 100 or greater.
(7) Consider 12 ft lanes when truck DHV is 100 or greater.
(8) See Figure 440-3a when curb section is used.
(9) When DHV is 300 or less, may be reduced to 6 ft. When DHV is 200 or less, may be reduced to 4 ft.
(10) 12 ft desirable. At left-turn lanes, the minimum median width is 12 ft to accommodate the turn lane.
(11) The minimum median width is 10 ft when median barrier is used.
(12) 2 ft is desirable. When a TWLTL is present 13 ft is desirable, 11 ft is minimum.
(13) Prohibit parking when DHV is over 1500.
(14) 10 ft desirable.
(15) Prohibit parking when DHV is over 500.
(16) See Chapter 1120 for minimum vertical clearance.
(17) See Chapter 1120 for median requirements.
(18) For bicycle requirements, see Chapter 1020. For pedestrian and sidewalk requirements, see Chapter 1025. Lateral clearances from the face of curb to obstruction are in with Chapter 700. For railroad and other roadway grade separation, maximum grade, right of way requirements, and pavement type for the functional class, see Figures 440-5a through 7b

Geometric Design Data, Urban Managed Access Highways
Figure 440-8



Note:

1. NC = Normal crown. All or part of the roadway has 2% adverse crown.
2. RC = Reverse crown. 2% super.

Superelevation Rates for Low-Speed Urban Managed Access Highways
Figure 640-12b

Washington State Department of Transportation

State Design Engineer

Design Manual Supplement

Effective Date: 3/25/2004

Design Speed

I. Introduction

A. Purpose

To revise Washington State Department of Transportation (WSDOT) policies to: 1) remove the implication of the need for an operating speed study for preservation & improvement projects on existing alignments. 2) treat modified and full design levels similarly with respect to design speed. 3) minimize reference to posted speed to all extent possible when discussing design speed. 4) clarify how design speed is considered on WSDOT projects and align the process with the Urban Roadways *Design Manual* Supplement guidance.

B. References

Design Manual, M 22-01, WSDOT

Design Manual Supplement, Urban Roadways, dated July 22, 2003

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the Washington State Modifications to the *MUTCD*, M 24-01, WSDOT (MUTCD), http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm.

C. Background

Before 1996 using the posted speed as the design speed on modified design level projects often resulted in a design speed less than the operating speed. The maximum posted speed on non-Interstate roadways was set, by law, at 55 mph regardless of the operating speed. On many rural highways, the operating speed was higher than the posted speed. On these highways, selecting the posted speed as the design speed resulted in the operating speed higher than the design speed. Safety concerns with this led to design guidance requiring the operating speed to be considered when establishing the design speed.

Since 1996 this problem was reduced. The State law governing posted speed on highways was revised allowing the posted speeds to be increased to a maximum of 70 mph. It states "…in accordance with the design speed thereof (taking into account all safety elements included therein), or whenever the secretary determines upon the basis of an engineering and traffic investigation that such greater speed is reasonable and safe under the circumstances existing on such part of the highway."[1]

The continued consideration of the operating speed is causing more work than is appropriate on some modified design level projects. Speed studies often result in increasing the posted speed. The higher posted speed raises the design speed, requiring work that may not be appropriate.

D. Discussion

The design speed is used to determine the various geometric design features of the roadway. Sight distance, superelevation, acceleration and deceleration lane length, and maximum grade are the main design elements that depend on the design speed. A uniform design speed throughout a corridor provides greater consistency in the roadway elements, which is consistent with driver's expectations.

The existing *Design Manual* guidance for design speed on modified design level projects recommends designers consider operating speed, which usually results in a speed study. When the speed study indicates that a higher posted speed is justified, and the speed limit is increased, additional expense and effort is required to bring the design elements in line with the new design speed. Removing the modified design level requirement to establish a design speed no lower than the operating speed, will reduce expense and provide more uniformity in meeting driver's expectations.

To encourage a more uniform application of design speed for all projects, the relationship between the posted speed and the design speed for full design level, Chapter 440, is used for the desirable design speed on modified design level projects. Also, this relationship is adjusted to more reasonable values.

Some projects retain geometric design elements that are designed for a speed that is lower than the posted speed. Investigate the need, per the MUTCD, to install warning signs in advance of the deficiency, to maintain safety. Warning signs must be in accordance with the MUTCD to insure that the traveling public will understand the sign. Some signs, such as limited sight distance signs, have been found to have no effect in slowing vehicles and are not well understood by drivers[2]. The preferred option with deficient sight distance at a vertical curve is to sign any secondary hazard that is hidden by the sight distance deficiency.

Geometric design data figures for Interstate and principal arterial are changed to agree with the relationship between the posted speed and the design speed and to correct some concerns with the figures presented in the Urban Roadways *Design Manual* Supplement.

E. Implementation

This change is effective on the date of this supplement and will expire when the changes are incorporated in the *Design Manual*.

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[1] RCW 46.61.410, Increases by secretary of transportation -- Maximum speed limit for trucks -- Auto stages -- Signs and notices.

[2] See John C. Glennon, "Effects of Sight Distance on Highway Safety", State of the Art Report 6, TRB 1987

II. Instructions

A. Replace 430.02, Design Speed, with the following:

When applying modified design level to a project, select a design speed for use in the design process that reflects the character of the terrain and the type of highway. The desirable design speed for modified design level is given in Figure 430-A. The minimum design speed is not less than the posted speed, or the proposed posted speed. (See Chapter 440 for additional information on design speed.) Document which speed was used, include any supporting studies and data.

Route Type	Posted Speed	Desirable Design Speed
Freeways	All	10 mph over the posted speed
non-Freeways	45 mph or less	Not less than the posted speed
	Over 45 mph	5 mph over posted speed

Desirable Design Speed
Figure 430-A

When the posted speed exceeds the design speed for existing geometric features that are to remain in place (curve radius, superelevation, sight distance, or other elements that the design speed controls) one of two choices must be made:

1. Work with the region Traffic Office to lower the posted speed to be consistent with the existing design speeds for the geometric features on the facility, which would entail the removal and replacement of the existing speed limit signs.
2. A corridor analysis can be completed in order to leave the posted speed unchanged and identify all design elements that do not meet the criteria for the existing posted speed. Identify each appropriate location for cautionary signing (including road approach sight distance) and work with the region Traffic Office to install the cautionary signing as provided for in the MUTCD (either by contract or region sign personnel). Consult with and obtain guidance from Region Project Development leadership prior to progressing with the corridor analysis and the design. An approved deviation is required for any design element that does not meet the design speed.

B. Replace Figures 430-3 and 430-4 with the attached (pages 5 & 6)

C. Add the following to 440.03, Definitions

freeway A divided highway that has a minimum of two lanes in each direction, for the exclusive use of traffic, and with full control of access.

D. Replace Figure 440-1 with the following:

Route Type	Posted speed	Desirable Design Speed
Freeways	All	10 mph over the posted speed
non-Freeways	45 mph or less	Not less than the posted speed.
	Over 45 mph	5 mph over the posted speed

Desirable Design Speed
Figure 440-1

	Multilane Divided				Multilane Undivided			
	Trucks Under 10%		Trucks 10% and Over		Trucks Under 10%		Trucks 10% and Over	
Design Class	MDL-1	MDL-2	MDL-3	MDL-4	MDL-5	MDL-6	MDL-7	MDL-8
Current ADT (1)	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000
Design Speed	See Figure 430-A							
Traffic Lanes Number Width	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft
Parking Lanes Urban	None	None	None	None	8 ft	8 ft (2)	8 ft	8 ft (2)
Median Width Rural Urban	Existing Existing	Existing Existing	Existing Existing	Existing Existing	2 ft 2 ft	4 ft 2 ft	4 ft 2 ft	4 ft 2 ft
Shoulder Width Right (3) Left (4)	4 ft 2 ft	6 ft 2 ft	4 ft 2 ft	6 ft 2 ft	4 ft	6 ft (5)	4 ft	6 ft (5)
Minimum Width for Bridges to Remain in Place (6) (7) (8)	24 ft (9)	26 ft (9)	24 ft (9)	26 ft (10)	48 ft (9)	50 ft (9) (11)	50 ft (9) (11)	54 ft (10) (11)
Minimum Width for Rehabilitation of Bridges to Remain in Place (6) (8) (12)	28 ft (9)	30 ft (9)	28 ft (9)	32 ft (10)	54 ft (9)	60 ft (9) (11) (13)	56 ft (9) (11)	64 ft (10) (11) (13)
Minimum Width for Replacement	Full Design Level Applies (14)							
Access Control	See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Access Management Classification Report							

Notes:

(1) If current ADT is approaching a borderline condition, consider designing for the higher classification.

(2) Parking restricted when ADT is over 15,000.

(3) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft. In urban areas, see Chapter 440. On designated bicycle routes the minimum shoulder width is 4 ft (See Chapter 1020).

(4) For lanes 11 ft or more in width, the minimum shoulder width to the face of the curb is 1 ft on the left.

(5) May be reduced by 2 ft under urban conditions.

(6) Width is the clear distance between curbs or rails, whichever is less.

(7) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only.

(8) For median widths 25 ft or less, see Chapter 1120.

(9) Add 11 ft for each additional lane.

(10) Add 12 ft for each additional lane.

(11) Includes a 4 ft median, which may be reduced by 2 ft under urban conditions.

(12) Use these widths when a bridge within the project limits requires any work beyond the treatment of the deck such as bridge rail replacement, deck replacement, or widening.

(13) Includes 6 ft shoulders — may be reduced by 2 ft on each side under urban conditions.

(14) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

Modified Design Level for Multilane Highways and Bridges
Figure 430-3

	Two-Lane Highways					
	Trucks Under 10%			Trucks 10% and Over		
Design Class	MDL-9	MDL-10	MDL-11	MDL-12	MDL-13	MDL-14
Current ADT (1)	Under 1000	1000-4000	Over 4000	Under 1000	1000-4000	Over 4000
Design Speed	See Figure 430-A					
Traffic Lane Width (2)	11 ft	11 ft	11 ft	11 ft	11 ft	12 ft
Parking Lanes Urban	8 ft	8 ft	8 ft (3)	8 ft	8 ft	8 ft (3)
Shoulder Width (4)	2 ft	3 ft (5)	4 ft	2 ft	3 ft (5)	4 ft
Minimum Width for Bridges to Remain in Place (6)(7)	22 ft (8)	24 ft	28 ft	22 ft (8)	24 ft	28 ft
Minimum Width for Rehabilitation of Bridges to Remain in Place (7)(9)	28 ft (10)	32 ft	32 ft	28 ft (10)	32 ft	32 ft
Minimum Width for Replacement	Full Design Level Applies (11)					
Access Control	See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Management Classification Report.					

Notes:

(1) If current ADT is approaching a borderline condition, consider designing for the higher classification.

(2) See Figures 430-5 and 430-6 for turning roadways.

(3) Parking restriction recommended when ADT exceeds 7,500.

(4) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft. In urban areas, see Chapter 440. On designated bicycle routes the minimum shoulder width is 4 ft (See Chapter 1020).

(5) For design speeds of 50 mph or less on roads of 2,000 ADT or less, width may be reduced by 1 ft, with justification.

(6) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only.

(7) Width is the clear distance between curbs or rails, whichever is less.

(8) 20 ft when ADT 250 or less.

(9) Use these widths when a bridge within the project limits requires any work beyond the treatment of the deck such as bridge rail replacement, deck replacement, or widening.

(10) 26 when ADT 250 or less.

(11) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

Modified Design Level for Two-Lane Highways and Bridges
Figure 430-4

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