Washington State Department of Transportation

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What's Changed?
See the back of this form for a summary description of the major policy changes.

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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	
	Page #s	Sheets	Page #s	Sheets
Foreword	iii	1	iii	1
Letter's List	November 2007	1	May 2008	1
Contents	1 – 23	13	1 - 23	12
315, "Value Engineering"	1 – 8	4	1 - 8	4
440, "Full Design Level"	5 - 21	9	5 - 22	9
650, "Sight Distance"	1-12	6	1-16	8
850, "Traffic Control Signals"	13 - 14	1	13 – 14	1
850, "Traffic Control Signals"	17 – 18	1	17 – 18	1
850, "Traffic Control Signals"	27 - 28	1	27 – 28	1
850, "Traffic Control Signals"	35 – 36	1	35 – 36	1

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Administrative and Engineering Publications	(360) 705-7430 FAX: 705-6861	**/s/ Chris Schroedel**

Chapter	Remove		Insert	
	Page #s	Sheets	Page #s	Sheets
910, "Intersections At Grade"	37 - 38	1	37 – 38	1
915, "Roundabouts"	5 – 6	1	5 – 6	1
1055, "HOV Direct Access"	9 - 10	1	9 – 10	1
1055, "HOV Direct Access"	25 - 26	1	25 – 28	2
Index	1 - 18	9	1 – 18	9
DM Supplement Safety improvements	Insert entire supplement after existing matrices in chapter 325			

SUMMARY OF CHANGES – MAY 2008

Ch 315 Value Engineering: Revised to incorporate Value Engineering requirements contained in SAFETEA-LU. Chapter 315 now states that VE studies are required for:

- Projects with a total cost of $25 million or more (on all routes);
- Bridge projects with a total cost of $20 million or more;
- Design-Build projects meeting the above criteria; also specifying the VE study must occur prior to issuing the project RFP.

Ch 440 Full Design Level: Revised to better clarify selection of design speed.

Ch 650 Sight Distance: Revised to better clarify selection of sight distance criteria.

- Allows use of 2-foot object height in conjunction with traffic barrier.
- Added guidance for overlapping horizontal and crest vertical curves.

Ch 850 Traffic Control Signals: Revised chapter to:

- Retire previous *Design Manual* Supplement "Overhead Sign Illumination" by incorporation (Page 850-13).
- Update Figure 850-11b to be consistent with MUTCD Section 8D.07, 2003 Edition (changed 120' to 200'.)
- Correct numeric value in Figure 850-15; correct figure reference to 850-14a.

Ch 910 Intersections At Grade: Corrected lane width value in Figure 910-16.

Ch 915 Roundabouts: Corrected pavement marking arrows shown in Figures 915-6b & 6c.

Ch 1055 HOV Direct Access: Revised chapter to reflect current requirements for signing Direct HOV Access connections.

- Resulted in new Figures 17, 18, 19, and 20, replacing Figure 1055-17a & b.
- Page 10 of the text was revised to update reference to the revised figure numbers.

***Design Manual* Supplement:** This new supplement provides guidance to designers of safety projects programmed for the '09-'11 Biennium. New design matrices are included. See supplement for more information.

Washington State
Department of Transportation

TECHNICAL MANUAL

Design Manual

M 22-01.03

May 2008

Environmental and Engineering Programs

Design Office

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Foreword

The *Design Manual* is for use by Washington State Department of Transportation engineering personnel. It provides policies, procedures, and methods for developing and documenting the design of improvements to the transportation network in Washington. It has been developed for state facilities and may not be appropriate for all county roads or city streets that are not state highways.

The *Design Manual* supplements the engineering analyses and judgment that must be applied to improvement and preservation projects. It provides uniform procedures for documenting and implementing design decisions.

The Federal Highway Administration (FHWA) has agreed to approve designs that follow the guidance in the *Design Manual*; therefore, following the guidance presented is mandatory for state highway projects. When proposed designs meet the requirements contained in the *Design Manual,* little additional documentation is required.

The design environment changes rapidly, often without warning to the practitioner. To track every change, and to make improvements based upon each change, is not feasible. The intent of this manual is to provide recommended values for critical dimensions. Flexibility is permitted to encourage independent design tailored to individual situations. However, when flexibility is applied to a proposed design and the critical dimensions do not meet *Design Manual* criteria, additional documentation is required to record the decision-making process.

The addition of new or modified design criteria to the *Design Manual* through the revision process does not imply that existing features are deficient or inherently dangerous. Nor does it suggest or mandate immediate engineering review or initiation of new projects.

The *Design Manual* emphasizes cost-effective, environmentally conscious, and context sensitive design. Designers are encouraged to view the highway corridor beyond the vehicular movement context, so guidance regarding the use of the highway corridor by transit, pedestrians, and bicyclists is included. To accommodate multimodal use, the criteria provided for one mode is to be appropriately adapted to individual locations.

The complexity of transportation design requires the designer to make fundamental trade-off decisions that balance competing considerations. Although this adds to the complexity of design, it acknowledges the unique needs of specific projects and the relative priorities of various projects and programs. Improvements must necessarily be designed and prioritized in light of finite transportation funding.

Updating the *Design Manual* is an ongoing process and revisions are issued regularly. Comments, questions, and improvement ideas are welcomed. Use the comment form on the following page, or the online version at the Design Policy Internet Page: www.wsdot.wa.gov/design/policy

/s/ Pasco Bakotich III

Pasco Bakotich III, P.E.
State Design Engineer

Comment Form

From: ______________________________ Date: ______________

______________________________ Phone: ______________

____

To: WSDOT
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Mail Stop 47329
PO Box 47329
Olympia, WA 98504-7329

Subject: *Design Manual* Comment

Comment (marked copies attached):

Preserve this original for future use • Submit copies only

Washington State Department of Transportation

Design Manual Supplements and Instructional Letters

May, 2008

Don't forget — to make your *Design Manual* complete you must have the Supplements and Instructional Letters that are in effect.

Design Manual Supplements or Instructional Letters are issued as interim guidance until they are incorporated into the *Design Manual*.

Subject/Title	**Impacted Chapter(s)**	**Effective Date**	**Document Type**
Safety Improvement Projects	325	5/01/2008	Supplement
Public Art	1360	8/06/2007	Supplement
Systems Engineering for Intelligent Transportation Systems	860	12/30/2005	Supplement
Overhead Sign illumination (Lighting)	820 850	**Retired (1)** **Retired (1)**	Supplement

(1) This supplement has been fully incorporated into the *Design Manual* with the May 2008 revision and is no longer in effect.

The *Design Manual* is available online through the Engineering Publications website:

www.wsdot.wa.gov/Publications/Manuals/index.htm

You can also download individual chapter files, known technical errata, and *Design Manual* Supplements here:

www.wsdot.wa.gov/design/policy

Contents

Division 4 Project Design Criteria

Division 5 Soils and Paving

Division 6 Geometrics

Division 8 Traffic Safety Elements

Division 10 Auxiliary Facilities

Division 13 Roadside Development

Division 14 Right of Way and Access Control

Figures

Division 3 Project Documentation (continued) Page

Division 4 Project Design Criteria

Division 5 Soils and Paving

Division 5 — Soils and Paving (continued) — Page

Division 6 — Geometrics

Division 9 Interchanges and Intersections (continued) — Page

Division 10 Auxiliary Facilities Page

Division 10 Auxiliary Facilities (continued)

Division 11 Structures

Division 13 Roadside Development Page

Division 14 Right of Way and Access Control

Chapter 315 Value Engineering

315.01 General

Value Engineering (VE) is a systematic process using a team from a variety of disciplines to improve the value of a project through the analysis of its functions. The VE process incorporates, to the extent possible, the values of design; construction; maintenance; contractor; state, local and federal approval agencies; other stakeholders; and the public.

The primary objective of a Value Engineering study is value improvement. The value improvements might relate to scope definition, functional design, constructibility, coordination (both internal and external), or the schedule for project development. Other possible value improvements are reduced environmental impacts, reduced public (traffic) inconvenience, or reduced project cost.

Value Engineering can be applied during any stage of a project's development, although the greatest benefits and resource savings are typically achieved early in development during the planning or scoping phases.

Value Engineering may be applied more than once during the life of the project. Early application of a VE study helps to get the project started in the right direction, and repeated applications help to refine the project's direction based on new or changing information. The later a VE study is conducted in project development, the more likely it is that implementation costs will increase.

A VE study may be applied as a quick response study to address a problem or as an integral part of an overall organizational effort to stimulate innovation and improve performance characteristics.

315.02 References

(1) Federal/State Laws and Codes

23 USC 106 Project approval and oversight

(2) Design Guidance

Value Engineering for Highways, Study Workbook, U.S. Department of Transportation, FHWA

Value Standard and Body of Knowledge, SAVE International, The Value Society: www.value-eng.org/

WSDOT Value Engineering web site: www.wsdot.wa.gov/design/ValueEngineering/

315.03 Definitions

Value Engineering (VE) A systematic process used by a multidisciplinary team to improve the value of a project through the analysis of its functions. The team identifies the functions of a project, establishes a worth for each function, generates alternatives through the use of creative thinking, and provides the needed functions to accomplish the original purpose — thus ensuring the lowest life cycle cost without sacrificing safety, necessary quality, or environmental attributes. Value Engineering is sometimes referred to as Value Analysis (VA) or Value Management (VM).

project The portion of a transportation facility that WSDOT proposes to construct, reconstruct, or improve, as described in the *State Highway System Plan* or applicable environmental documents. A project may consist of several contracts or phases over several years that are studied together as *one project*.

315.04 Procedure

The VE process uses the Seven-Phase Job Plan shown in Figure 315-1. Phase 7 is discussed in this chapter. A detailed discussion of Phases 1 through 6 can be found in the document, *Value Standard and Body of Knowledge,* developed by SAVE International, The Value Society. This document can be downloaded at the SAVE web site: www.value-eng.org/

(1) Project Selection

(a) **Requirements**

Projects for VE studies may be selected from any of the categories identified in the Highway Construction Program, including Preservation and Improvement projects, depending on the size and/or complexity of the project. In addition to the cost, other issues adding to the complexity of the project design are considered in the selection process. They include critical constraints, difficult technical issues, expensive solutions, external influences, and complicated functional requirements.

The Federal Highway Administration (FHWA) requires a VE study for all design-bid-build and design-build projects that meet the following criteria:

- Each project on the federal-aid system with a *total* estimated cost of $25 million or more.
- A bridge project with a *total* estimated cost of $20 million or more.
- Any other project the United States Secretary of Transportation determines to be appropriate (23 USC 106).

Additionally, WSDOT policy requires a VE study for any non-NHS project with a *total* estimated cost of $25 million or more. This *total* estimated cost includes preliminary engineering, construction, right of way, and utilities. Other projects that should be considered for Value Engineering have a *total* estimated cost exceeding $5 million and include one or more of the following:

- Alternative solutions that vary the scope and cost
- New alignment or bypass sections
- Capacity improvements that widen the existing highway
- Major structures
- Interchanges

- Extensive or expensive environmental or geotechnical requirements
- Materials that are difficult to acquire or that require special efforts
- Inferior materials sources
- New/Reconstruction projects
- Major traffic control requirements or multiple construction stages

(b) **Statewide VE Study Plan**

On an annual basis, the State VE Manager coordinates with the Region VE Coordinators to prepare an annual VE Study Plan, with specific projects scheduled quarterly. The VE Study Plan is the basis for determining the projected VE program needs, including team members, team leaders, and training. The Statewide VE Study Plan is a working document, and close coordination is necessary between Headquarters (HQ) and the regions to keep it updated.

The Region VE Coordinator:

- Identifies potential projects for VE studies from the Project Summaries and the available planning documents for future work.
- Makes recommendations for the VE study timing.
- Presents a list of the identified projects to region management to prioritize into a regional annual VE Study Plan.

The State VE Manager:

- Reviews the regional annual VE Study Plan regarding the content and schedule of the plan.

The State VE Coordinator:

- Incorporates the regional annual VE Study plans and the HQ Study plans to create the Statewide VE Study Plan.

(c) **VE Study Timing**

Selecting the project at the appropriate stage of development (the timing of the study) is very important to the success of the VE study. Value can be added by performing a VE study at any time during project development; however, the WSDOT VE program identifies three windows of opportunity for performing a VE study.

1. **Scoping Phase**

   As soon as preliminary engineering information is available and the specific deficiencies or drivers are identified, the project scope and preliminary cost are under consideration. This is the best time to consider the various alternatives or design solutions, with the highest potential that the related recommendations of the VE team can be implemented. At the conclusion of the VE study, the project scope, preliminary cost, and major design decisions can be based on the recommendations.

   When conducting a study during the scoping phase of a project, the VE study focuses on issues affecting project drivers. This stage often provides an opportunity for building consensus with stakeholders.

2. **Start of Design**

   At the start of design, the project scope and preliminary cost have already been established and the major design decisions have been made. Some Plans, Specifications, and Estimates (PS&E) activities may have begun, and coordination has been initiated with the various service units that will be involved with the design. At this stage, the established project scope, preliminary cost, and schedule will define the limits of the VE study and there is still opportunity for the study to focus on the technical issues of the specific design elements.

3. **Design Approval**

   After the project receives Design Approval, most of the important project decisions have been made and the opportunity to affect the project design is limited. The VE study focuses on constructibility, construction sequencing, staging, traffic control, and any significant design issues that have been identified during design development.

   An additional VE study may be beneficial late in the development stage when the estimated cost of the project exceeds the project budget. The Value Engineering process can be applied to the project to lower the cost while maintaining the value and quality of the design.

4. **Design-Build Projects**

   For design-build projects on which a VE study is required, the study must be performed prior to issuing the Request for Proposal (RFP). It is not practicable to perform a VE study in the design-build contract phase.

(d) **Study Preparation**

To initiate a VE study, the project manager submits a Request for Value Engineering Study form to the Region VE Coordinator at least two months before the proposed study date. The form may be downloaded from the WSDOT Value Engineering web site: www.wsdot.wa.gov/design/ValueEngineering/Tools/

The Region VE Coordinator then works with the State VE Coordinator to determine the team leader and team members for the VE study.

The design team prepares a study package of project information for each of the team members. (A list of potential items is shown in Figure 315-2.) The VE team members should receive this information at least one week prior to the study so they have time to review the material.

The region provides a facility and the equipment for the study (see Figure 315 2).

(e) **Team Leader**

The quality of the VE study is dependent on the skills of the VE team leader. This individual guides the team's efforts and is responsible for its actions during the study. The best VE team leader is knowledgeable and proficient in transportation design and construction and in the VE study process for transportation projects.

The VE team leader's responsibilities include the following:

- Plan, lead, and facilitate the VE Study
- Ensure proper application of a value methodology and follow the Job Plan
- Guide the team through the activities needed to complete the prestudy, the VE study, and the poststudy stages of a VE study
- Schedule a preworkshop meeting with the project team and prepare the agenda for the VE study

For best results, the team leader should be certified by the Society of American Value Engineers (SAVE) as a Certified Value Specialist (CVS) or as a Value Methodology Practitioner (VMP).

Team leadership can be supplied from within the region, from another region, or from Headquarters. A statewide pool of qualified team leaders is maintained by the State VE Coordinator, who works with the Region VE Coordinator to select the team leader. When no qualified team leader is available, or it is deemed beneficial for a particular study, consultants or other qualified leaders outside WSDOT may be employed.

(f) **Team Members**

The VE team is usually composed of five to ten people with diverse expertise relevant to the specific study. The team members may be selected from the regions; Headquarters; other local, state, and federal agencies; or the private sector.

Team members are selected on the basis of the expertise needed to address the major functional areas and critical high-cost issues of the study. All team members must be committed to the time required for the study. For best results, team members should have attended Value Engineering Module 1 training before participating in a VE study.

(g) **VE Study Requirements**

The time required to conduct a VE study varies with the complexity and size of the project, but typically ranges from three to five days. The VE team leader working with the project manager will determine the best length for the study.

The VE study Final Report includes an executive summary; a narrative description of project information; the background, history, constraints, and controlling decisions; the VE team focus areas; a discussion of the team speculation and evaluation processes; and the team's final recommendations. All of the team's evaluation documentation (including sketches, calculations, analyses, and rationale for recommendations) is included in the Final Report. A copy of the Final Report shall be included in the Project File. The project manager will specify the number of copies to be provided to the project team. The State VE Manager also provides a copy of the report to the FHWA for projects on the National Highway System or federal-aid system.

(2) Implementation

The project manager will review and evaluate the VE team's recommendation(s) that are included in the Final Report. The project manager shall complete the VE Recommendation Approval form included in the Final Report.

For each recommendation that is not approved or is modified by the project manager, justification needs to be provided in the form of a VE Decision Document. The VE Decision Document includes a specific response for each of the disapproved or modified recommendations. Responses include a summary statement containing the project manager's decision not to use the recommendation in the project.

The completed VE Recommendation Approval form and, if necessary, the VE Decision Document shall be sent to the State VE Manager by September 1 of each year so the results can be included in the annual WSDOT VE report to FHWA. If a VE Decision Document was submitted, it shall be forwarded to the State Design Engineer for review. The VE Recommendation Approval form and VE Decision Document are to be included in the Design Documentation Package.

315.05 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev

1.	**Information/Investigation Phase**	Gather information. Investigate the background information, technical input reports, and field data. Develop team focus and objectives.
2.	**Function Analysis Phase**	Define the project functions using a two-word active verb/measurable noun context. Review and analyze these functions to determine which need improvement, elimination, or creation to meet the project's goals.
3.	**Creative/Speculation Phase**	Be creative and brainstorm alternative proposals and solutions.
4.	**Evaluation Phase**	Analyze design alternatives, technical processes, life cycle costs, documentation of logic, and rationale.
5.	**Development Phase**	Develop technical and economic supporting data to prove the feasibility of the desirable concepts. Develop team recommendations. Recommend long-term as well as interim solutions.
6.	**Presentation Phase**	Present the recommendations of the VE team to the project team and region management in an oral presentation, and provide a written report.
7.	**Implementation Phase 315.04(2)**	Evaluate the recommendations. Prepare an implementation plan (VE Decision Document), including the response of the managers and a schedule for accomplishing the decisions based on the recommendations.

Note: Phases 1–6 are performed during the study; see Value Standard and Body of Knowledge for procedures during these steps

Seven-Phase Job Plan for VE Studies
Figure 315-1

Project-Related Input* (Study Package)
Design File
Quantities
Estimates
Right of Way Plans
Geotechnical Reports
Plan Sheets
Environmental Documents
Cross Sections and Profiles
Land Use Maps
Contour Maps
Quadrant Maps
Accident Data
Traffic Data
Large-Scale Aerial Photographs
Vicinity Map
Hydraulic Report
Aerial Photos
Existing As-Built Plans
Study-Related Facilities and Equipment
Room with a large table and adequate space for the team
Telephone
Network computer access (if available)
Vehicle or vehicles with adequate seating to transport the VE team for a site visit**
Easel(s) and easel paper pads
Marking pens
Computer projector
Masking and clear tape
Design Manual
AASHTO Green Book
Standard Plans
Standard Specifications
MP Log
Bridge List
Scales, straight edges, and curves
Field Tables
Calculators
Power strip(s) and extension cords

* Not all information listed may be available to the team, depending on the stage of the project.
** If a site visit is not possible, provide video of the project.

VE Study Team Tools
Figure 315-2

440.06 Geometric Design Data

(1) State Highway System

For projects on all highways in rural design areas and on limited access highways in urban design areas, the geometric design data is controlled by the functional class and traffic volume (see Figures 440-5 through 440-8). The urban managed access highway design class, based on traffic volume and design speed (see Figure 440-9), may be used on managed access highways in urban design areas, regardless of the functional class.

(2) City Streets as State Highways

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 *Design Manual* criteria as the minimum for the functional class of the route. For facilities not on the NHS, the *Local Agency Guidelines* may be used as the minimum design criteria; however, the use of *Design Manual* 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, including access, outside of curb, or outside the paved shoulder where no curb exists, using the *Local Agency Guidelines.*

(3) City Streets and County Roads

Plan and design facilities that cities or counties will be requested to accept as city streets or county roads according to the applicable design criteria shown in:

- WAC 468-18-040.
- *Local Agency Guidelines*.
- The standards of the local agency that will be requested to accept the facility.

440.07 Design Speed

Vertical and horizontal alignment, sight distance, and superelevation will vary with design speed. Such features as traveled way width, shoulder width, and lateral clearances are usually not affected. For the relationships between design speed, geometric plan elements, geometric profile elements, superelevation, and sight distance, see Chapters 620, 630, 642, 650, 910 and 940.

The choice of a design speed is primarily influenced by functional classification, posted speed, operating speed, terrain classification, traffic volumes, accident history, access control, and economic factors. A geometric design that adequately allows for future improvements is also a major criterion. Categorizing a highway by a terrain classification often results in arbitrary reductions of the design speed, when, in fact, the terrain would allow a higher design speed without materially affecting the cost of construction. Savings in vehicle operation and other costs alone might be sufficient to offset the increased cost of right of way and construction.

It is important to consider the geometric conditions of adjacent sections. Maintain a uniform design speed for a significant segment of highway.

For projects on all rural highways and limited access highways in urban design areas on new or reconstructed alignment (vertical or horizontal) or full width pavement reconstruction, the design speed for each design class is given in Figures 440-5 through 440-8.

For other projects, the desirable design speed is not less than that given in Figure 440-1. Do not select a design speed less than the posted speed.

When terrain or existing development limits the ability to achieve the design speed for the design class, use a corridor analysis to determine the appropriate design speed.

On urban managed access highways, the design speed is less critical to the operation of the facility. Closely spaced intersections and other operational constraints usually limit vehicular speeds more than the design speed.

For managed access facilities in urban design areas, select a design speed based on Figure 440-1. In cases where the Figure 440-1 design speed does not fit the conditions, use a corridor analysis to select a design speed. Select a design speed not less than the posted speed that is 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 (such as a change in roadside development) at logical points.

Route Type	Posted Speed	Desirable Design Speed
Freeways	All	10 mph over the posted speed
Nonfreeways	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

440.08 Traffic Lanes

Lane width and condition influence safety and comfort. The minimum lane width is based on the highway design class, terrain type, and whether it is in a rural or urban design area. Lanes 12 feet wide provide desirable clearance between large vehicles where traffic volumes are high and sizable numbers of large vehicles are expected. The added cost for 12-foot lanes is offset, to some extent, by the reduction in shoulder maintenance costs due to the lessening of wheel load concentrations at the edge of the lane.

Highway capacity is also affected by the width of the lanes. With narrow lanes, drivers must operate their vehicles closer (laterally) to each other than they normally desire. To compensate, drivers increase the headway, which results in reduced capacity.

Figures 440-5 through 440-8 give the minimum lane widths for the various design classes for use on all rural highways and limited access highways in urban design areas. Figure 440-9 gives the minimum lane widths for urban managed access highways.

The roadway on a curve may need to be widened to make the operating conditions comparable to those on tangents. For guidance on width requirements on turning roadways, see Chapter 641.

440.09 Shoulders

Shoulder width is controlled by the functional classification of the roadway, the traffic volume, and the shoulder function.

The more important shoulder functions and the associated minimum widths are given in Figure 440-2. In addition to the functions in Figure 440-2, shoulders also:

- Provide space to escape potential accidents or reduce their severity.
- Provide a sense of openness, contributing to driver ease and freedom from strain.
- Reduce seepage adjacent to the traveled way by discharging stormwater farther away.

Contact the Region Maintenance Office to determine the shoulder width for maintenance operations. When shoulder widths wider than called for in Figures 440-5 through 440-9 are requested, compare the added cost of the wider shoulders to the added benefits to maintenance operations, as well as other benefits that may be derived. When the Maintenance Office requests a shoulder width different than the design class, justify the width selected.

Shoulder Function	Minimum Shoulder Width
Stopping out of the traffic lanes	8 ft
Minimum lateral clearance	2 ft[1]
Pedestrian or bicycle use	4 ft[2]
Large-vehicle off-tracking on curves	See Chapters 641 & 910
Maintenance operations	Varies[3]
Law enforcement	8 ft[4]
Bus stops	See Chapter 1060
Slow-vehicle turnouts and shoulder driving	See Chapter 1010
Ferry holding	8 ft[5]
For use as a lane during reconstruction of the through lanes	8 ft[5]
Structural support	2 ft
Improve sight distance in cut sections	See Chapter 650
Improve capacity	See Chapter 610

Notes:

[1] See Chapters 700 and 710.

[2] Minimum usable shoulder width for bicycles. For additional information, see Chapter 1020 for bicycles and Chapter 1025 for pedestrians.

[3] 10-ft usable width to park a maintenance truck out of the through lane; 12-ft clearance (14 ft preferred) for equipment with outriggers to work out of traffic.

[4] For additional information, see Chapters 1040 and 1050.

[5] Minimum usable shoulder width (10 ft preferred).

Minimum Shoulder Width
Figure 440-2

Minimum shoulder widths for use on all rural highways and limited access highways in urban design areas are based on functional classification and traffic volume (see Figures 440-5 through 440-8). Figure 440-9 gives the minimum shoulder widths for urban managed access highways without curb.

When curb with a height less than 24 inches is present on urban managed access highways, provide the minimum shoulder widths shown in Figure 440-3. For information on curbs, see 440.11.

When traffic barrier with a height of 2 feet 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 feet. Additional width for traffic barrier shy distance (see Chapter 710) is normally not required on urban managed access highways.

Where there are no sidewalks, the minimum shoulder width is 4 feet. Shoulder widths less than 4 feet will require that wheelchairs using the roadway encroach on the through lane. For additional information and requirements regarding pedestrians and accessible routes, see Chapter 1025.

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

Notes:

[1] When mountable curb is used on routes with a posted speed of 35 mph or less, shoulder width is desirable; however, with justification, curb may be placed at the edge of traveled way.

[2] 1 ft for curbs with a height of 8 inches or less. 2 ft for curbs or barriers with a height between 8 and 24 inches.

[3] 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.

[4] When bikes are not a consideration, width may be reduced to 2 ft with justification.

[5] Measured from the edge of traveled way to the face of curb.

Shoulder Width for Curbed Sections[5] in Urban Areas
Figure 440-3

The usable shoulder width is less than the constructed shoulder width when vertical features (such as traffic barrier or walls) are at the edge of the shoulder. This is because drivers tend to shy away from the vertical feature. For traffic barrier shy distance widening, see Chapter 710.

Shoulders on the left between 4 feet and 8 feet wide are less desirable. A shoulder in this width range might appear to a driver to be wide enough to stop out of the through traffic, when it is not. To reduce the occurrence of this situation, when the shoulder width and any added clearance result in a width in this range, consider increasing the width to 8 feet.

Provide a minimum clearance to roadside objects so that the shoulders do not require narrowing. At existing bridge piers and abutments, a shoulder less than full width to a minimum of 2 feet is a design exception. For Design Clear Zone and safety treatment requirements, see Chapter 700.

For routes identified as local, state, or regional significant bicycle routes, provide a minimum 4-foot shoulder. Maintain system continuity for the bicycle route, regardless of jurisdiction and functional class. For additional information on bicycle facilities, see Chapter 1020.

Shoulder widths greater than 10 feet may encourage use as a travel lane. Therefore, use shoulders wider than this only where required to meet one of the listed functions (see Figure 440-2).

When walls are placed adjacent to shoulders, see Chapter 1130 for barrier requirements.

440.10 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 on multilane limited access highways and multilane managed access highways when the design hourly volume (DHV) is over 2000.

The primary functions of a median are to:

- Separate opposing traffic.
- Provide for recovery of out-of-control vehicles.
- Reduce head-on accidents.
- Provide an area for emergency parking.
- Allow space for left-turn lanes.
- Minimize headlight glare.
- Allow for future widening.
- Control access.

Medians may be depressed, raised, or flush with the through lanes. For maximum efficiency, make medians highly visible both night and day.

The width of a median is measured from edge of traveled way to edge of traveled way and includes the shoulders. The desirable median width is given in Figure 440-4. The minimum width is the width required for shoulders and barrier (including required shy distance) or ditch.

When selecting a median width, consider future needs such as wider left shoulders when widening from four to six lanes. A median width of 22 feet is desirable on a four-lane highway when additional lanes are anticipated. The minimum width required to provide additional lanes in the median, without widening to the outside, is 46 feet. 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 the addition of a lane in each direction, if required by traffic increase after the 20-year period.

A two-way left-turn lane (TWLTL) may be used as a nonrestrictive median for an undivided managed access highway (see Figure 440-9). The desirable width of a TWLTL is 13 feet, with a minimum width of 11 feet. For more information on traffic volume limits for TWLTLs on managed access highways, see Chapter 1435. For additional information on TWLTL design, see Chapter 910.

A common form of restrictive median on urban managed access highways is the raised median. The width of a raised median can be minimized by using a dual-faced cement concrete traffic curb, a precast traffic curb, or an extruded curb. For more information on traffic volume limits for restrictive medians on managed access highways, see Chapter 1435.

Median Usage	Desirable Width (ft)[1]
Separate opposing traffic on freeways and expressways	
Rural	60[2]
Urban – 4-lane	18
Urban – 6 or more lanes	22
Allow for future widening	46[4]
Left-turn lanes[3]	13[2]
Control access on divided multilane urban managed access highways	
Design speed 45 mph or less with raised medians	3[5][6]
Design speed greater than 45 mph or barrier separated	10[6]

Notes:

[1] The minimum width is the width required for shoulders and barrier (including required shy distance) or ditch. For barrier requirements, see Chapter 710.

[2] Additional width required at rural expressway intersections for storage of vehicles crossing expressway or entering expressway with a left turn.

[3] For additional information, see Chapter 910.

[4] Narrower width will require widening to the outside for future lanes.

[5] Using a Dual-Faced Cement Concrete Traffic Curb 1 ft face of curb to face of curb.

[6] 12 ft preferred to allow for left-turn lanes.

Median Width
Figure 440-4

At locations where the median will be used to allow vehicles to make a U-turn, consider increasing the width to meet the needs of the vehicles making the U-turn. For information on U-turn locations, see Chapter 910.

Widen medians at intersections on rural divided multilane highways. Provide sufficient width to store vehicles crossing the expressway or entering the expressway with a left turn.

For undivided multilane highways, desirable median width is 4 feet in rural design areas and 2 feet in urban design areas. When signing is required in the median of six-lane undivided multilane highways, the minimum width is 6 feet. If barrier is to be installed at a future date, median widths for the ultimate divided highway are desirable.

When the median is to be landscaped or where rigid objects are to be placed in the median, see Chapter 700 for traffic barrier and clear zone requirements. When the median will include a left-turn lane, see Chapter 910 for left-turn lane design.

440.11 Curbs

(1) General

Curbs are designated as either *vertical* or *sloped*. Vertical curbs have a face batter not flatter than 1H:3V. Sloped curbs have a sloping face that is more readily traversed.

Curbs can also be classified as *mountable*. Mountable curbs are sloped curb with a height of 6 inches or less, preferably 4 inches or less. When the face slope is steeper than 1H:1V, the height of a mountable curb is limited to 4 inches or less.

Where curbing is to be provided, ensure that surface water that collects at the curb will drain and not pond or flow across the roadway.

For all existing curb, evaluate the continued need for the curb. Remove all curbing that is no longer needed.

When an overlay will reduce the height of a vertical curb, evaluate grinding to maintain curb height (or replacing the curb) versus the need to maintain the height of the curb.

Curbs can hamper snow-removal operations. The area Maintenance Superintendent's review and approval is required for the use of curbing in areas of heavy snowfall.

For curbs at traffic islands, see Chapter 910.

(2) Curb Usage

Curbing is used for the following purposes:

- Control drainage
- Delineate the roadway edge
- Delineate pedestrian walkways
- Delineate islands
- Reduce right of way
- Assist in access control
- Inhibit midblock left turns

Avoid using curbs if the same objective can be attained with pavement markings.

In general, curbs are not used on facilities with a posted speed greater than 45 mph. The exceptions are for urban design areas where sidewalks are provided or where traffic movements are to be restricted. Justify the use of curb when the posted speed is greater than 45 mph.

Do not use vertical curbs along freeways or other facilities with a posted speed greater than 45 mph. When curb is needed, use mountable curb with the height limited to 4 inches and located no closer to the traveled way than the outer edge of the shoulder. Provide sloping end treatments where the curb is introduced and terminated.

(a) Vertical curbs with a height of 6 inches or more are required:
   - To inhibit or at least discourage vehicles from leaving the roadway.
   - For walkway and pedestrian refuge separations.
   - For raised islands on which a traffic signal or traffic signal hardware is located.

(b) Consider vertical curbs with a height of 6 inches or more:
- To inhibit midblock left turns.
- For divisional and channelizing islands.
- For landscaped islands.

(c) Provide mountable curbs where a curb is needed but higher vertical curb is not justified.

440.12 Parking

In urban design areas and rural communities, land use might require parking along the highway. In general, on-street parking decreases capacity, increases accidents, and impedes traffic flow; therefore, it is desirable to prohibit parking.

Although design data for parking lanes are included in Figures 440-6 through 440-9, consider them only in cooperation with the municipality involved. The lane widths given are the minimum for parking; provide wider widths when feasible.

Angle parking is not permitted on any state route without WSDOT approval (RCW 46.61.575). This approval is delegated to the State Traffic Engineer. Angle parking approval is to be requested through the Headquarters (HQ) Design Office. Provide an engineering study, approved by the Region Traffic Engineer, with the request documenting that 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.

440.13 Pavement Type

The pavement types given in Figures 440-5 through 440-8 are those recommended for each design class. (See Chapter 520 for information on pavement type selection.) When a roadway is to be widened and the existing pavement will remain, the new pavement type may be the same as the existing without a pavement type determination.

440.14 Structure Width

Provide a clear width between curbs on a structure not less than the approach roadway width (lanes plus shoulders). The structure widths given in Figures 440-5 through 440-9 are the minimum structure widths for each design class.

Additional width for barriers is not normally added to the roadway width on structures. When a structure is in a run of roadside barrier with the added width, consider adding the width on shorter structures to prevent narrowing the roadway.

440.15 Right of Way Width

Right of way width must be sufficient to accommodate all roadway elements and required appurtenances necessary for the current design and known future improvements. To allow for construction and maintenance activities, provide 10 feet desirable, 5 feet minimum, wider than the slope stake for fill and slope treatment for cut. For slope treatment information, see Chapter 640 and the *Standard Plans*.

The right of way widths given in Figures 440-5 through 440-8 are desirable minimums for new alignment requiring purchase of new right of way. For additional information and consideration on right of way acquisition, see Chapter 1410.

440.16 Grades

Grades can have a pronounced effect on the operating characteristics of the vehicles negotiating them. Generally, passenger cars can readily negotiate grades as steep as 5% without appreciable loss of speed from that maintained on level highways. Trucks, however, travel at the average speed of passenger cars on the level roadway but display up to a 5% increase in speed on downgrades and a 7% or greater decrease in speed on upgrades (depending on length and steepness of grade as well as weight-to-horsepower ratio).

The maximum grades for the various functional classes and terrain conditions are shown in Figures 440-5 through 440-8. For the effects of these grades on the design of a roadway, see Chapters 630, 650, 910, 940, and 1010.

440.17 Fencing

Remove rigid top rails and brace rails from existing fencing and retrofit with a tension wire design. For information on fencing, see Chapter 1460.

440.18 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/

Divided Multilane		
Design Class	I-1	
Design Year	[1]	
Access Control[2]	Full	
Separate Cross Traffic		
Highways	All	
Railroads	All	
Design Speed (mph)[3]		
Rural	80[4]	
Urbanized	70[5]	
Traffic Lanes		
Number	4 or more divided	
Width (ft)	12	
Median Width (ft)[6]	Minimum width is as required for shoulders and barrier (including required shy distance) or ditch (see 440.10).	
Shoulder Width (ft)[7]	4 lanes	6 or more lanes
Right of Traffic	10[8]	10[8]
Left of Traffic	4	10[8][9]
Pavement Type[10]	High	
Right of Way[11]		
Rural – Width (ft)	63 from edge of traveled way	
Urban – Width (ft)	As required[12]	
Structures Width (ft)[13]	Full roadway width each direction[14]	

Type of Terrain	Design Speed (mph)						
	50	55	60	65	70	75	80
	Grades (%)[15]						
Level	4	4	3	3	3	3	3
Rolling	5	5	4	4	4	4	4
Mountainous	6	6	6	6	5	5	5

Interstate Notes:

[1] The design year is 20 years after the year the construction is scheduled to begin.

[2] For access control requirements, see Chapter 1430.

[3] For existing roadways, see 440.07.

[4] 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.

[5] 70 mph is the desirable design speed; 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.

[6] Independent alignment and grade are desirable in all rural areas and where terrain and development permit in urban areas.

[7] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by up to 4 inches.

[8] 12-ft shoulders are desirable when the truck DDHV is 250 or greater.

[9] For existing 6-lane roadways, an existing 6-ft left shoulder is a design exception when the shoulder is not being reconstructed and no other widening is required.

[10] For pavement type determination, see Chapter 520.

[11] Desirable width. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut (see 440.15).

[12] In urban areas, make right of way widths not less than those required for necessary cross section elements.

[13] For minimum vertical clearance, see Chapter 1120.

[14] For median widths 26 ft or less, address bridge(s) in accordance with Chapter 1120.

[15] Grades 1% steeper may be provided in urban areas and mountainous terrain with critical right of way controls.

Geometric Design Data: Interstate
Figure 440-5

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	Over 1500		Over 700[3]		Over 201[4]		61–200		60 and Under		Over 700[3]	
Non-NHS					Over 301		101–300		100 and Under			
Access Control[5]	Full		Partial[6]									
Separate Cross Traffic												
Highways	All		Where Justified		Where Justified		Where Justified		Where Justified		Where Justified	
Railroads[7]	All		All		All[8]		Where Justified[9]		Where Justified[9]		Where Justified[9]	
Design Speed (mph)[10]												
Desirable[11]	80		70		70	60	70	60	60	60	70	60
Minimum[12]	60[13]		50[14]		50	40[14]	50	40[14]	40	30[14]	40	30[14]
Traffic Lanes												
Number	4 or more divided		4 or 6 divided		2		2		2		4	4 or 6
Width (ft)	12		12		12		12		12		12	11[15]
Shoulder Width (ft)[16]												
Right of Traffic	10[17]		10		8		6		4		8	8[18]
Left of Traffic	Variable[19][20]		Variable[19][20]									
Median Width (ft)	Minimum width is as required for shoulders and barrier (including required shy distance) or ditch. (See 440.10.)										(See 440.10)	
Parking Lanes Width (ft) – Minimum	None		None		None		None	10	None	10	None	10[21]
Pavement Type[22]	High				High or Intermediate							
Right of Way[23] – Width (ft)	[24]	[25]	[24]	[25]	120	80	120	80	100	80	150	80
Structures Width (ft)[26]	Full Roadway Width[27]				40		40		32		Full Roadway Width	
Other Design Considerations–Urban					[28]		[28]		[28]		[28]	

Type of Terrain	Rural – Design Speed (mph)									Urban – Design Speed (mph)						
	40	45	50	55	60	65	70	75	80	30	35	40	45	50	55	60[29]
	Grades (%)[30]															
Level	5	5	4	4	3	3	3	3	3	8	7	7	6	6	5	5
Rolling	6	6	5	5	4	4	4	4	4	9	8	8	7	7	6	6
Mountainous	8	7	7	6	6	5	5	5	5	11	10	10	9	9	8	8

Geometric Design Data: Principal Arterial
Figure 440-6

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] When considering a multilane highway, perform an investigation to determine whether a truck-climbing lane or passing lane will satisfy the need (see Chapter 1010).

[4] Where DHV exceeds 700, consider 4 lanes. When the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future 4-lane facility. When considering truck-climbing lanes on a P-3 design class highway, perform an investigation to determine whether a P-2 design class highway is justified.

[5] For access control requirements, see Chapters 1430 and 1435 and the Master Plan for Limited Access Highways. Contact the HQ Design Office Access & Hearings Unit for additional information.

[6] Full or modified access control may also be used.

[7] Contact the Rail Office of the Public Transportation and Rail Division for input on railroad needs.

[8] All main line and major spur railroad tracks will be separated. Consider allowing at-grade crossings at minor spur railroad tracks.

[9] Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad gradeseparations.

[10] For existing roadways, see 440.07.

[11] These are the design speeds for level and rolling terrain in rural design areas. They are the preferred design speeds for mountainous terrain and urban design areas. Higher design speeds may be selected, with justification.

[12] 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.

[13] 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.

[14] In urban design 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.

[15] 12-ft lanes are required when the truck DDHV is 150 or greater.

[16] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by 4 inches.

[17] 12-ft shoulders are desirable when the truck DDHV is 250 or greater.

[18] When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.

[19] Minimum left shoulder width is to be as follows: 4 lanes – 4 ft: 6 or more lanes – 10 ft. Consider 12-ft shoulders on facilities with 6 or more lanes and a truck DDHV of 250 or greater.

[20] For existing 6-lane roadways, an existing 6-ft left shoulder is a design exception when the shoulder is not being reconstructed and no other widening is required

[21] Restrict parking when DHV is over 1500.

[22] For pavement type determination, see Chapter 520.

[23] Desirable width. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut (see 440.15).

[24] 63 ft from edge of traveled way.

[25] Make right of way widths not less than those required for necessary cross section elements.

[26] For the minimum vertical clearance, see Chapter 1120.

[27] For median widths 26 ft or less, address bridges in accordance with Chapter 1120.

[28] 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.

[29] For grades at design speeds greater than 60 mph in urban design areas, use rural criteria.

[30] Grades 1% steeper may be used in urban design areas and mountainous terrain with critical right of way controls.

Geometric Design Data: Principal Arterial
Figure 440-6 (continued)

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	Over 700[3]		Over 201[4]		61–200		60 and Under		Over 700[3]	
Non-NHS			Over 401		201–400		200 and Under			
Access Control[5]	Partial[6]									
Separate Cross Traffic										
Highways	Where Justified		Where Justified		Where Justified		Where Justified		Where Justified	
Railroads[7]	All		All[8]		Where Justified[9]		Where Justified[9]		Where Justified[9]	
Design Speed (mph)[10]										
Desirable[11]	70		70	60	70	60	60	60	70	60
Minimum[12][13]	50		50	40	50	40	40	30	40	30
Traffic Lanes										
Number	4 or 6 divided		2		2		2		4	4 or 6
Width (ft)	12		12		12		12		12	11[14]
Shoulder Width (ft)[15]										
Right of Traffic	10		8		6		4		8	8[16]
Left of Traffic	Variable[17][18]									
Median Width (ft)	[19]								[19]	
Parking Lanes Width (ft) – Minimum	None		None		None	10	None	10	None	10[20]
Pavement Type[21]	High		As Required						High or Intermediate	
Right of Way[22] – Width (ft)	[23]	[24]	120	80	120	80	100	80	150	80
Structures Width (ft)[25]	Full Roadway Width[26]		40		40		32		Full Roadway Width	
Other Design Considerations–Urban			[27]		[27]		[27]		[27]	

Type of Terrain	Rural – Design Speed (mph)									Urban – Design Speed (mph)					
	40	45	50	55	60	65	70	75	80	30	35	40	45	50	55	60[28]
	Grades (%)[29]															
Level	5	5	4	4	3	3	3	3	3	8	7	7	6	6	5	5
Rolling	6	6	5	5	4	4	4	4	4	9	8	8	7	7	6	6
Mountainous	8	7	7	6	6	5	5	5	5	11	10	10	9	9	8	8

Geometric Design Data: Minor Arterial
Figure 440-7

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] When considering a multilane highway, perform an investigation to determine whether a truck-climbing lane or passing lane will satisfy the need (see Chapter 1010).

[4] Where DHV exceeds 700, consider 4 lanes. When the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future 4-lane facility. When considering truck-climbing lanes on an M-2 design class highway, perform an investigation to determine whether an M-1 design class highway is justified.

[5] For access control requirements, see Chapters 1430 and 1435 and the Master Plan for Limited Access Highways. Contact the HQ Design Office Access & Hearings Unit for additional information.

[6] Full or modified access control may also be used.

[7] Contact the Rail Office of the Public Transportation and Rail Division for input on railroad needs.

[8] All main line and major spur railroad tracks will be separated. Consider allowing at-grade crossings at minor spur railroad tracks.

[9] Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.

[10] For existing roadways, see 440.07.

[11] These are the design speeds for level and rolling terrain in rural design areas. They are the preferred design speeds for mountainous terrain and urban design areas. Higher design speeds may be selected, with justification.

[12] In urban design 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] 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.

[14] When the truck DDHV is 150 or greater, consider 12-ft lanes.

[15] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by 4 inches.

[16] When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.

[17] The minimum left shoulder width is 4 ft for 4 lanes and 10 ft for 6 or more lanes.

[18] For existing 6-lane roadways, an existing 6 ft left shoulder is a design exception when the shoulder is not being reconstructed and no other widening is required.

[19] Minimum median width is as required for shoulders and barrier (including required shy distance) or ditch (see 440.10).

[20] Restrict parking when DHV is over 1500.

[21] For pavement type determination, see Chapter 520.

[22] Desirable width. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut (see 440.15).

[23] 63 ft from edge of traveled way.

[24] Make right of way widths not less than those required for necessary cross section elements.

[25] For the minimum vertical clearance, see Chapter 1120.

[26] For median widths 26 ft or less, address bridges in accordance with Chapter 1120.

[27] 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.

[28] For grades at design speeds greater than 60 mph in urban design areas, use rural criteria.

[29] Grades 1% steeper may be used in urban design areas and mountainous terrain with critical right of way controls.

Geometric Design Data: Minor Arterial
Figure 440-7 (continued)

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	Over 900[2]		Over 301[3]		201–300		200 and Under	
Non-NHS			Over 501		301–500		300 and Under	
Access Control	[4]		[4]		[4]		[4]	
Separate Cross Traffic								
Highways	Where Justified		Where Justified		Where Justified		Where Justified	
Railroads[5]	Where Justified[6]		All[6]		Where Justified[6]		Where Justified[6]	
Design Speed (mph)[7]								
Desirable[8]	70	60	70	60	70	60	60	60
Minimum[9][10]	40	30	50	40	50	40	40	30
Traffic Lanes								
Number	4	4 or 6	2		2		2	
Width (ft)	12	11[11]	12		12		12	
Shoulder Width (ft)[12]	8	8[13]	8		6		4	
Median Width (ft)	[14]							
Parking Lane Width (ft) – Minimum	None	10	None		None	10	None	10
Pavement Type[15]	High or Intermediate		As Required					
Right of Way (ft)[16]	150	80	120	80	120	80	100	80
Structures Width (ft)[17]	Full Roadway Width		40		40		32	
Other Design Considerations – Urban	[18]		[18]		[18]		[18]	

Type of Terrain	Rural – Design Speed (mph)										Urban – Design Speed (mph)								
	25	30	35	40	45	50	55	60	65	70	20	25	30	35	40	45	50	55	60[19]
	Grades (%)[20]																		
Level	7	7	7	7	7	6	6	5	5	4	9	9	9	9	9	8	7	7	6
Rolling	10	9	9	8	8	7	7	6	6	5	12	12	11	10	10	9	8	8	7
Mountainous	11	10	10	10	10	9	9	8	8	6	14	13	12	12	12	11	10	10	9

Geometric Design Data: Collector
Figure 440-8

Collector Notes:

[1] The design year is 20 years after the year the construction is scheduled to begin.

[2] When considering a multilane highway, perform an investigation to determine whether a truck-climbing lane or passing lane will satisfy the need (see Chapter 1010).

[3] Where DHV exceeds 900, consider 4 lanes. When the volume/capacity ratio is equal to or exceeds 0.85, consider the needs for a future 4-lane facility. When considering truck-climbing lanes on a C-2 design class highway, perform an investigation to determine whether a C-1 design class highway is justified.

[4] For access control requirements, see Chapters 1430 and 1435 and the Master Plan for Limited Access Highways. 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 railroad needs.

[6] Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.

[7] For existing roadways, see 440.07.

[8] These are the design speeds for level and rolling terrain in rural design areas. They are the preferred design speeds for mountainous terrain and urban design areas. Higher design speeds may be selected, with justification. Do not select a design speed that is less than the posted speed.

[9] In urban design 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.

[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] Consider 12-ft lanes when the truck DDHV is 200 or greater.

[12] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by 4 inches.

[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] Minimum median width is as required for shoulders and barrier (including required shy distance) or ditch (see 440.10).

[15] For pavement type determination, see Chapter 520.

[16] Desirable width. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut (see 440.15).

[17] For the minimum vertical clearance, see Chapter 1120.

[18] 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.

[19] For grades at design speeds greater than 60 mph in urban design areas, use rural criteria.

[20] Grades 1% steeper may be used in urban design areas and mountainous terrain with critical right of way controls.

Geometric Design Data: Collector
Figure 440-8 (continued)

Design Class	Divided Multilane		Undivided Multilane		Two-Lane	
	$U_{M/A}$-1	$U_{M/A}$-2	$U_{M/A}$-3	$U_{M/A}$-4	$U_{M/A}$-5	$U_{M/A}$-6
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)[8]						
Right of Traffic[9]	10	10	8	8	8[10]	4
Left of Traffic	4	4				
Median Width (ft)[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] When curb section is used, see Figure 440-3.

[9] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced <u>by</u> 4 inches.

[10] When DHV is 200 or less, may be reduced to 4 ft.

[11] Minimum width is as required for shoulders and barrier or ditch (see 440.10).

[12] 2 ft 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 is desirable.

[15] Prohibit parking when DHV is over 500.

[16] For minimum vertical clearance, see Chapter 1120.

[17] For median requirements, see Chapter 1120.

[18] For bicycle requirements, see Chapter 1020. For pedestrian and sidewalk requirements, see Chapter 1025. Lateral clearances from face of curb to obstruction are in Chapter 700. For railroad and other roadway grade separation, maximum grade, and pavement type for the functional class, see Figures 440-6 through 440-8. Make right of way widths not less than required for necessary cross section elements.

Geometric Design Data: Urban Managed Access Highways

Figure 440-9

Chapter 650 Sight Distance

650.01 General

The driver of a vehicle needs to see far enough ahead to assess developing situations and take actions appropriate for the conditions. For the purposes of design, sight distance is considered in terms of stopping sight distance, passing sight distance, and decision sight distance.

For additional information, see the following chapters:

Chapter	Subject
910	Sight distance at intersections at grade
915	Sight distance at roundabouts
920	Sight distance at road approaches
930	Sight distance at railroad crossings
1020	Sight distance for paths and trails

650.02 References

(1) Design Guidance

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)

(2) Supporting Information

A Policy on Geometric Design of Highways and Streets, AASHTO, 2004

650.03 Definitions

For definitions of design speed, roadway, rural design area, suburban area, and urban design area, see Chapter 440.

decision sight distance The distance for a driver to detect an unexpected or difficult to perceive condition, interpret and recognize the condition, select an appropriate maneuver, and complete the maneuver.

passing sight distance The distance (on a two lane highway) for a vehicle to execute a normal passing maneuver based on design conditions and design speed.

sight distance The length of highway visible to the driver.

stopping sight distance The distance to stop a vehicle traveling at design speed.

650.04 Stopping Sight Distance

(1) Design Criteria

Stopping sight distance is provided when the sight distance available to a driver equals or exceeds
the stopping distance for a passenger car traveling at the design speed. Stopping distance for design
is calculated in a conservative fashion with lower deceleration and slower perception reaction time
than normally expected.

Note: Provide design stopping sight distance at all points on all highways and on all intersecting roadways.

(a) **Stopping distance** is the sum of two distances: the distance traveled during perception and reaction time and the distance required to stop the vehicle. The perception and reaction distance used in design is the distance traveled in 2.5 seconds at the design speed. The design stopping distance is calculated using the design speed and a constant deceleration rate of 11.2 feet/second^2. (For stopping distances on grades less than 3%, see Figure 650-1; for grades 3% or greater, see Figure 650-3.)

(b) **Sight distance** is calculated for a passenger car using an eye height (h_1) of 3.50 feet and an object height (h_2) of 0.50 foot. The object height is the height of the largest object invisible to the driver at the stopping distance. In urban design areas, with justification, the object height (h_2) may be increased to 2.00 feet. Also, the 2.00-foot object height (h_2) is used when the sightline obstruction is barrier.

(c) **Design stopping sight distance**. Figure 650-1 gives the design stopping sight distances for grades less than 3%, the minimum curve length for a 1% grade change to provide the sight distance (using h_2=0.50 feet) for a crest (K_C) and sag (K_S) vertical curve, and the minimum length of vertical curve for the design speed (VCL_m). For sight distances when the grade is 3% or greater, see 650.04(2).

Design Speed (mph)	Design Stopping Sight Distance (ft)	K_C	K_S	VCL_m (ft)
25	155	18	25	75
30	200	30	36	90
35	250	47	49	105
40	305	70	63	120
45	360	98	78	135
50	425	136	96	150
55	495	184	115	165
60	570	244	136	180
65	645	313	157	195
70	730	401	180	210
75	820	506	206	225
80	910	623	231	240

Design Stopping Sight Distance
Figure 650-1

(d) **Existing stopping sight distance**. The costs, environmental impacts, and traffic impacts to increase sight distance on existing roadways are often higher than to provide that sight distance when building a new roadway. The existing roadway can be analyzed to determine whether there is a correctable collision trend. The less conservative existing stopping sight distance criteria may be used when the vertical and horizontal alignments are unchanged, the sightline obstruction is existing, the sight distance will not be reduced, and there is no identified correctable collision trend. The stopping distance for existing criteria is based on a travel speed less than the design speed. Also, the 2.00-foot object height (h_2) is used for existing criteria. For additional information, see 650.04(7).

(e) **Stopping sight distance design criteria selection**. Figure 650-2 gives guidance for the selection of stopping sight distance design criteria.

Type	Stopping Sight Distance	Object Height
Rural	Figures 650-1 & 650-3	0.50 ft
Urban desirable	Figures 650-1 & 650-3	0.50 ft
Urban[1]	Figure 650-1	2.00 ft
Existing[2]	Figures 650-1 & 650-3	2.00 ft
Traffic Barrier	Figure 650-13	2.00 ft
[1] Justification required. [2] See 650.04(1)(d).		

Stopping Sight Distance: Design Criteria Selection
Figure 650-2

(2) Effects of Grade

The grade of the highway has an effect on the vehicle's stopping sight distance. The stopping distance is increased on downgrades and decreased on upgrades. Figure 650-3 gives the stopping sight distances for grades of 3% and steeper. When evaluating sight distance with a changing grade, use the grade for which the longest sight distance is needed.

Design Speed (mph)	Stopping Sight Distance (ft)					
	Downgrade			Upgrade		
	-3%	-6%	-9%	3%	6%	9%
25	158	165	173	147	143	140
30	205	215	227	190	184	179
35	258	271	288	237	229	222
40	315	333	354	289	278	269
45	378	401	428	345	331	320
50	447	474	508	405	389	375
55	520	553	594	470	450	433
60	599	638	687	539	515	495
65	683	729	786	612	585	561
70	772	826	892	690	658	631
75	867	928	1004	773	736	705
80	966	1037	1123	860	818	782

Design Stopping Sight Distance on Grades
Figure 650-3

For stopping sight distances on grades between those listed, interpolate between the values given or use the equation in Figure 650-4.

$$S = 1.47Vt + \frac{V^2}{30\left[\left(\frac{a}{32.2}\right) \pm \frac{G}{100}\right]}$$

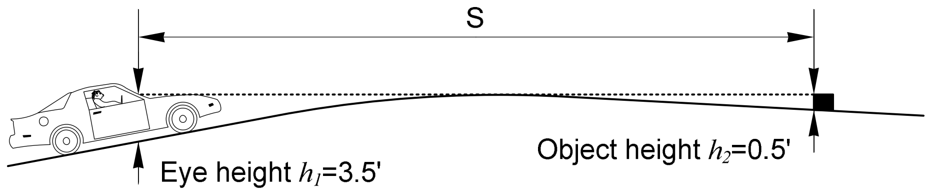
Where:
S = Stopping sight distance on grade (ft)
V = Design speed (mph)
t = Perception/reaction time (2.5 sec)
a = Deceleration rate (11.2 ft/sec^2)
G = Grade (%)

Stopping Sight Distance on Grades
Figure 650-4

(3) Crest Vertical Curves

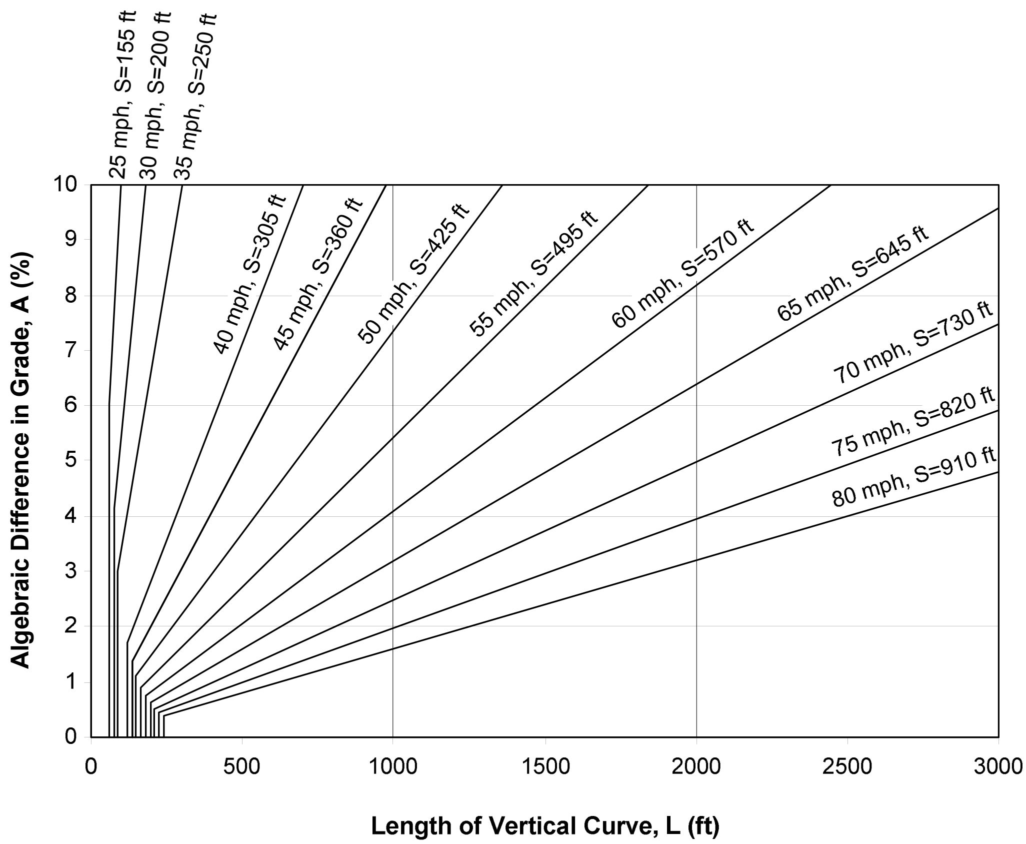
Use Figure 650-5 or the equations in Figure 650-6 to find the minimum crest vertical curve length to provide stopping sight distance when given the algebraic difference in grades. When using the equations in Figure 650-6, use h_1=3.50 feet and h_2=0.50 foot. Figure 650-5 does not use the sight distance greater than the length of curve equation. When the sight distance is greater than the length of curve and the length of curve is critical, the S>L equation given in Figure 650-6 may be used to find the minimum curve length.

When a new crest vertical curve is built or an existing one is rebuilt with grades less than 3%, provide design stopping sight distance from Figure 650-1. For grades 3% or greater, provide stopping sight distance from 650.04(2).



The minimum length can also be determined by multiplying the algebraic difference in grades by the K_C value from Figure 650-1 ($L=K_C*A$). Both the figure and the equation give approximately the same length of curve. Neither use the S>L equation.

* This chart is based on a 0.50-foot object height. When a higher object height is allowed (see 650.04(3) for guidance), the equations in Figure 650-6 must be used.



Stopping Sight Distance for Crest Vertical Curves

Figure 650-5

In urban design areas, with justification, an object height (h_2) of 2.00 feet may be used with the equations in Figure 650-6.

When evaluating an existing roadway, see 650.04(7).

When S>L	
$L = 2S - \frac{200\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}{A}$	$S = \frac{L}{A} + \frac{100\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}{A}$
When S<L	
$L = \frac{AS^2}{200\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}$	$S = \sqrt{\frac{200L\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}{A}}$

Where:
L = Length of vertical curve (ft)
S = Sight distance (ft)
A = Algebraic difference in grades (%)
h_1 = Eye height (3.50 ft)
h_2 = Object height—*see text* (ft)

Sight Distance: Crest Vertical Curve
Figure 650-6

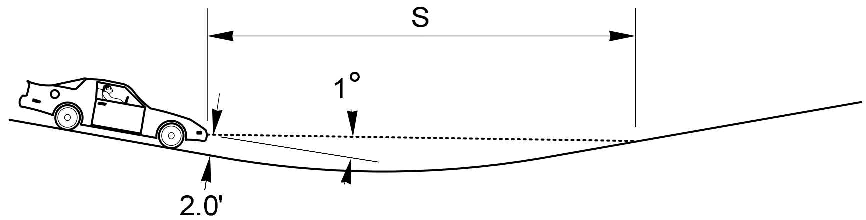
(4) Sag Vertical Curves

Sight distance is not restricted by sag vertical curves during the hours of daylight. Therefore, headlight sight distance is used for the sight distance design criteria at sag vertical curves. In some cases, a lesser length may be allowed. For guidance, see Chapter 630.

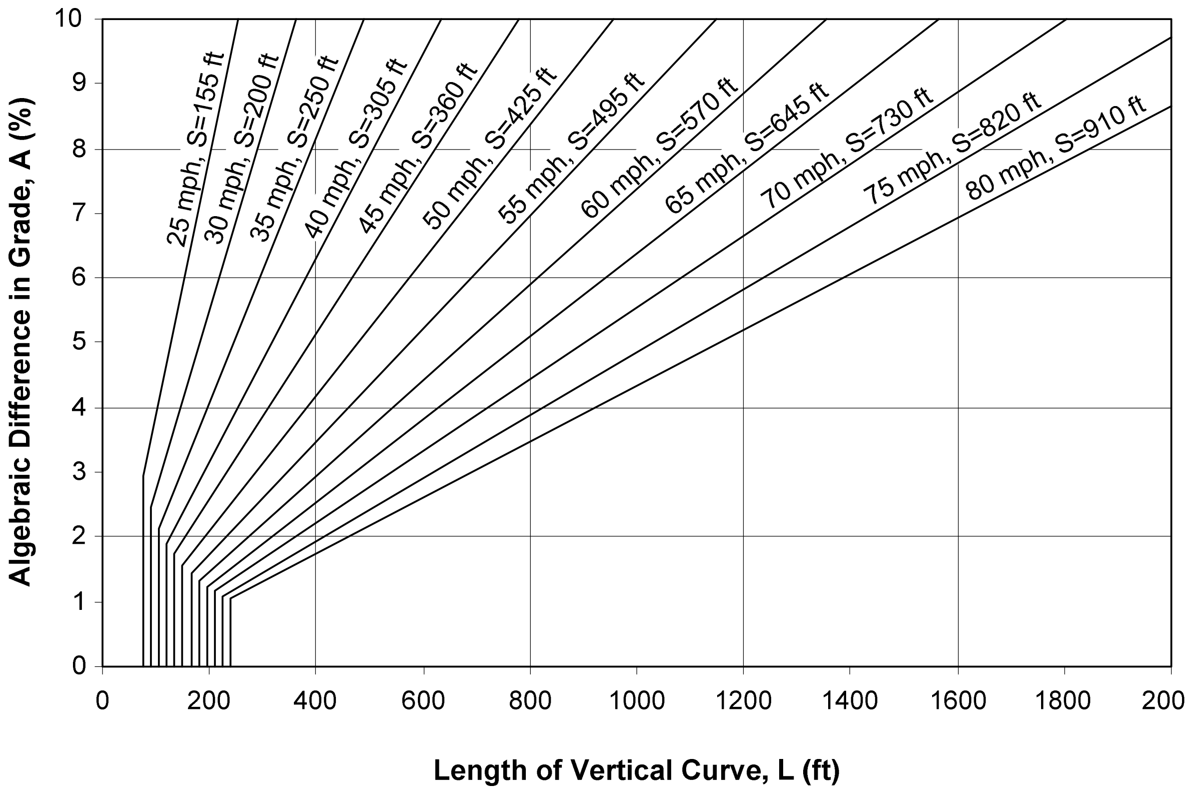
Use Figure 650-7 or the equations in Figure 650-8 to find the minimum length for a sag vertical curve to provide the headlight stopping sight distance when given the algebraic difference in grades. The sight distance greater than the length of curve equation is not used in Figure 650-7. When the sight distance is greater than the length of curve and the length of curve is critical, the S>L equation given in Figure 650-8 may be used to find the minimum length of curve.

When a new sag vertical curve is built or an existing one is rebuilt with grades less than 3%, provide design stopping sight distance from Figure 650-1. For grades 3% or greater, provide stopping sight distance from 650.04(2).

When evaluating an existing roadway, see 650.04(7).



The minimum length can also be determined by multiplying the algebraic difference in grades by the K_S value from Figure 650-1 ($L=K_S*A$). Both the figure and equation give approximately the same length of curve. Neither use the S>L equation.



Stopping Sight Distance for Sag Vertical Curves
Figure 650-7

Where S>L

$$L = 2S - \frac{400 + 3.5S}{A} \qquad S = \frac{LA + 400}{2A - 3.5}$$

Where S<L

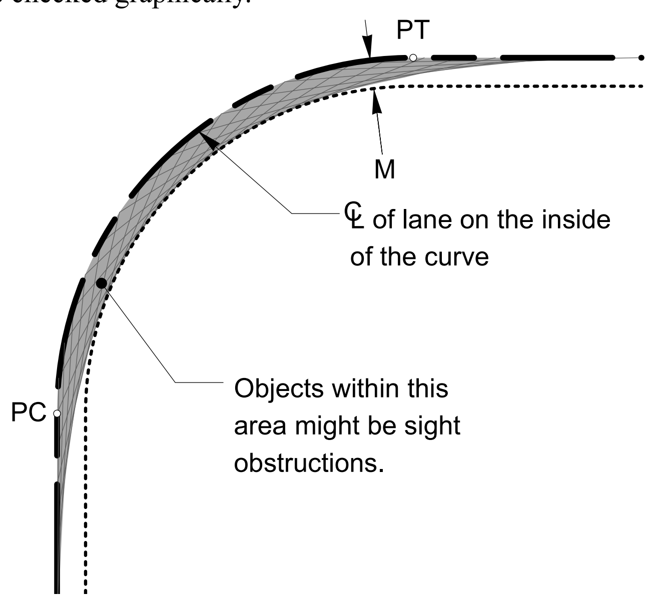
$$L = \frac{AS^2}{400 + 3.5S} \qquad S = \frac{3.5L \pm \sqrt{(3.5L)^2 + 1600AL}}{2A}$$

Where:
L = Curve length (ft)
A = Algebraic grade difference (%)
S = Sight distance (ft)

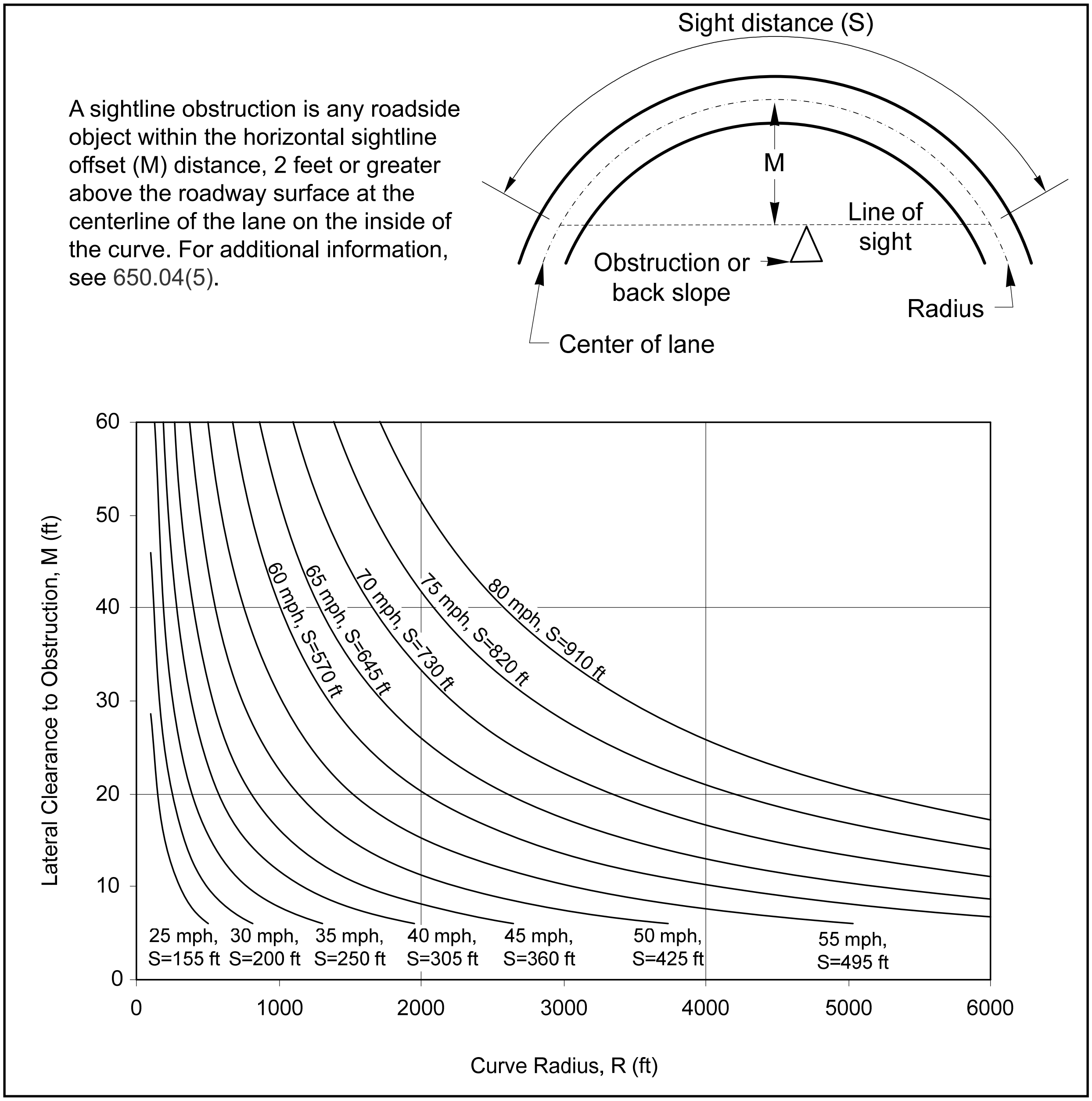
Sight Distance, Sag Vertical Curve
Figure 650-8

(5) Horizontal Curves

Use Figure 650-10 or the equation in Figure 650-11 to check for adequate stopping sight distance where sightline obstructions are on the inside of a curve. A stopping sight distance sightline obstruction is any roadside object within the horizontal sightline offset (M) distance (such as median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings), 2 feet or greater above the roadway surface at the centerline of the lane on the inside of the curve (h_o). Figure 650-10 and the equation in Figure 650-11 are for use when the length of curve is greater than the sight distance and the sight restriction is more than half the sight distance from the end of the curve. When the length of curve is less than the stopping sight distance or the sight restriction is near either end of the curve, the desired sight distance may be available with a lesser M distance (see Figure 650-9). When this occurs, the sight distance can be checked graphically.



Sight Distance Area on Horizontal Curves
Figure 650-9



Horizontal Stopping Sight Distance
Figure 650-10

When the road grade is less than 3%, provide design stopping sight distance from Figure 650-1.
When the grade is 3% or greater, provide stopping sight distance from 650.04(2).

In urban design areas, with justification, or when the sightline obstruction is a traffic barrier, a 2.00 foot object height (h_2) may be used. When h_2=2.00 feet, roadside objects with a height (h_o) between 2.00 feet and 2.75 feet might not be a stopping sight distance sightline obstruction. When h_2=2.00 feet, objects with an h_o between 2.00 feet and 2.75 feet can be checked graphically to determine whether they are stopping sight distance sightline obstructions.

Where a sightline obstruction exists and site characteristics preclude design modifications to meet
criteria, consult with the Region Traffic Engineer and Assistant State Design Engineer for a determination of appropriate action.

When evaluating an existing roadway, see 650.04(7).

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

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

Where:
M = Horizontal sightline offset measured from the centerline of the inside lane of the curve to the sightline obstruction (ft)
R = Radius of the curve (ft)
S = Sight distance (ft)

Sight Distance, Horizontal Curves
Figure 650-11

(6) Overlapping Horizontal and Vertical Curves

A vertical curve on a horizontal curve will affect which a roadside objects will become sightline obstructions. A crest vertical curve will make roadside objects more likely to become sightline obstructions. A sag vertical curve will make roadside objects less likely to be sightline obstructions.

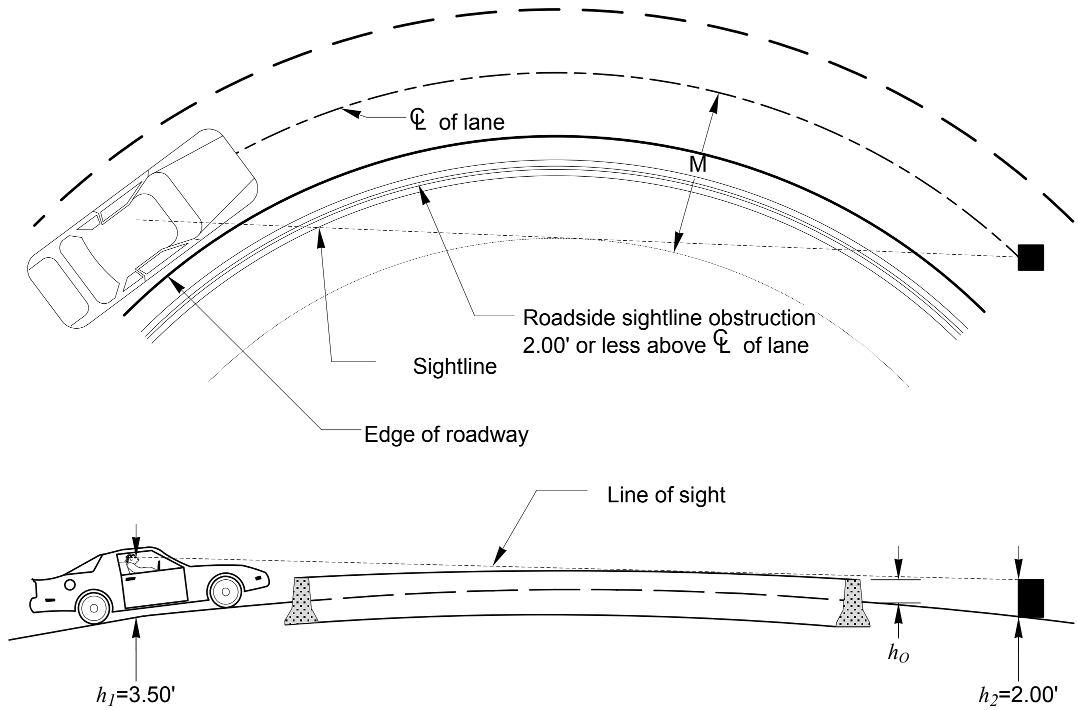
Figure 650-12 can be used to determine the sight distance for crest vertical curves on horizontal curves with:

- Sightline obstructions inside the M distance.
- Sightline obstruction height (h_o) of 2.00 feet or less.
- Object height (h_2) of 2.00 feet.

For other locations, the sight distance can be checked graphically.

(7) Existing Stopping Sight Distance

Figure 650-13 gives the values for existing stopping sight distance and the associated K_C and K_S values. Use an object height (h_2) of 2.00 feet with existing stopping sight distance criteria.



The following equation may be used to determine the sight distance for roadside sightline obstructions inside the horizontal sightline offset (M) distance (see Figure 650-11) with a height of 2.00 feet or less above the centerline of the lane on the inside of the curve on overlapping horizontal and crest vertical curves.

$$S = \sqrt{\frac{100L\left[\sqrt{2(h_1 - h_o)} + \sqrt{2(h_2 - h_o)}\right]^2}{A}}$$

Where:
L = Length of vertical curve (ft)
S = Sight distance (ft)
A = Algebraic difference in grades (%)
h_1 = Eye height (3.50 ft)
h_2 = Object height (0.50 ft or 2.00 ft) (see 650.04(1))
h_o = Height of roadside sightline obstructions above the centerline of the inside curve lane (ft)

Note: The above equation cannot be used for sightline obstruction height (h_o) more than 2 feet above the centerline of the lane on the inside of the curve. The available sight distance must be checked graphically for these sightline obstructions.

Overlapping Horizontal and Crest Vertical Curves: Stopping Sight Distance
Figure 650-12

(a) **For crest vertical curves** where there is no identified correctable collision trend, the existing vertical alignment is retained, and the existing roadway pavement is not reconstructed, existing stopping sight distance values in Figure 650-13 may be used. The minimum length of an existing crest vertical curve may be found using the equations in Figure 650-6 and h_2=2.00 feet, or using the K_C values from Figure 650-13.

(b) **For sag vertical curves** where there is no identified correctable collision trend, the existing vertical alignment is retained, and the existing roadway pavement is not reconstructed, existing stopping sight distance values in Figure 650-13 may be used. The minimum length of an existing sag vertical curve may be found using the equations in Figure 650-8, or using the K_S values from Figure 650-13. In some cases, when continuous illumination is provided, a lesser length may be allowed.
For guidance, see Chapter 630.

(c) **For horizontal curves**, existing stopping sight distance values from Figure 650-13 may be used at locations where all of the following are met at the curve:

- There is no identified correctable collision trend
- The existing vertical and horizontal alignment is retained
- The existing roadway pavement is not reconstructed
- The roadway will not be widened, except for minor shoulder widening requiring no work past the bottom of the ditch
- The sightline obstruction is existing
- Roadside improvements to sight distance do not require additional right of way

A sightline obstruction is any roadside object within the horizontal sightline offset (M) distance from the equation in Figure 650-11 with a height (h_o) of 2.00 feet or more above the centerline of the inside lane. Roadside objects with an h_o between 2.00 feet and 2.75 feet might not be a sightline obstruction. Objects with an h_o between 2.00 feet and 2.75 feet can be checked graphically to determine whether they are sightline obstructions.

Design Speed (mph)	Existing Stopping Sight Distance (ft)	K_C	K_S
20	115	6	16
25	145	10	23
30	180	15	31
35	220	22	41
40	260	31	52
45	305	43	63
50	350	57	75
55	400	74	89
60	455	96	104
65	495	114	115
70	540	135	127
75	585	159	140
80	630	184	152

Existing Stopping Sight Distance
Figure 650-13

650.05 Passing Sight Distance

(1) Design Criteria

Passing sight distance is the sum of the following four distances:

- The distance traveled by the passing vehicle during perception and reaction time and initial acceleration to the point of encroachment on the opposing lane
- The distance the passing vehicle travels in the opposing lane
- The distance an opposing vehicle travels during two-thirds of the time the passing vehicle is in the opposing lane
- A clearance distance between the passing vehicle and the opposing vehicle at the end of the passing maneuver

Sight distance for passing is calculated for a passenger car using an eye height (h_1) of 3.50 feet and an object height (h_2) of 3.50 feet. Figure 650-14 gives the passing sight distances for various design speeds.

Design Speed (mph)	Passing Sight Distance (ft)
20	710
25	900
30	1090
35	1280
40	1470
45	1625
50	1835
55	1985
60	2135
65	2285
70	2480
75	2580
80	2680

Passing Sight Distance
Figure 650-14

On two-lane two-way highways, provide passing opportunities to meet traffic volume demands. This can be accomplished with sections that provide passing sight distance or by adding passing lanes at locations that would provide the greatest benefit to passing (see Chapter 1010).

In the design stage, passing sight distance can be provided by adjusting the alignment either vertically or horizontally to increase passing opportunities.

These considerations also apply to multilane highways where staged construction includes a two-lane two-way operation as an initial stage. Whether auxiliary lanes are provided, however, depends on the time lag proposed between the initial stage and the final stage of construction.

(2) Vertical Curves

Figure 650-15 gives the length of crest vertical curve needed to provide passing sight distance for two lane highways. The distance from Figure 650-14 and the equations in Figure 650-6, using 3.50 feet for both eye height (h_1) and object height (h_2), may also be used to determine the minimum length of vertical curve to meet the passing sight distance criteria.

Sag vertical curves are not a restriction to passing sight distance.

(3) Horizontal Curves

Passing sight distance can be restricted on the inside of a horizontal curve by sightline obstructions that are 3.50 feet or more above the roadway surface. Use the distance from Figure 650-14 and the equation in Figure 650-11 to determine whether the object is close enough to the roadway to be a restriction to passing sight distance. The equation assumes that the curve length is greater than the sight distance. Where the curve length is less than the sight distance, the desired sight distance may be available with a lesser sightline offset (M) distance.

(4) No-Passing Zone Markings

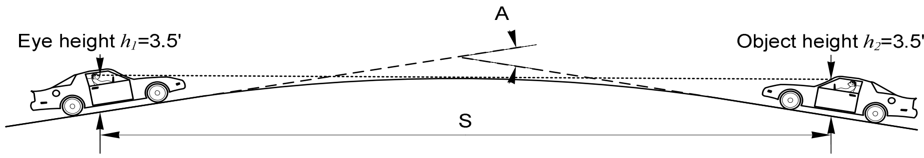
Knowledge of the practices used for marking no passing zones on two lane roads is helpful in designing a reasonably safe highway, consult with the region traffic engineer as appropriate. The values in Figure 650-14 are the passing sight distances starting where the passing maneuver begins. The values in the MUTCD are regulatory for no passing zone marking limits and start where passing must be completed. The values in the MUTCD are lower than the Figure 650-14 values.

650.06 Decision Sight Distance

Decision sight distance values are greater than stopping sight distance values because they give the driver an additional margin for error and afford sufficient length to maneuver at the same or reduced speed rather than to just stop.

Provide decision sight distance at locations where there is high likelihood for driver error in information reception, decision making, or control actions. Examples include interchanges; intersections; major changes in cross section (such as at toll plazas and drop lanes); and areas of concentrated demand where sources of information compete (for example, those from roadway elements, traffic, traffic control devices, and advertising signs). If site characteristics allow, locate these highway features where decision sight distance can be provided. If this is not practicable, use suitable traffic control devices and positive guidance to give advanced warning of the conditions.

Use the decision sight distances in Figure 650-16 at locations that require complex driving decisions.



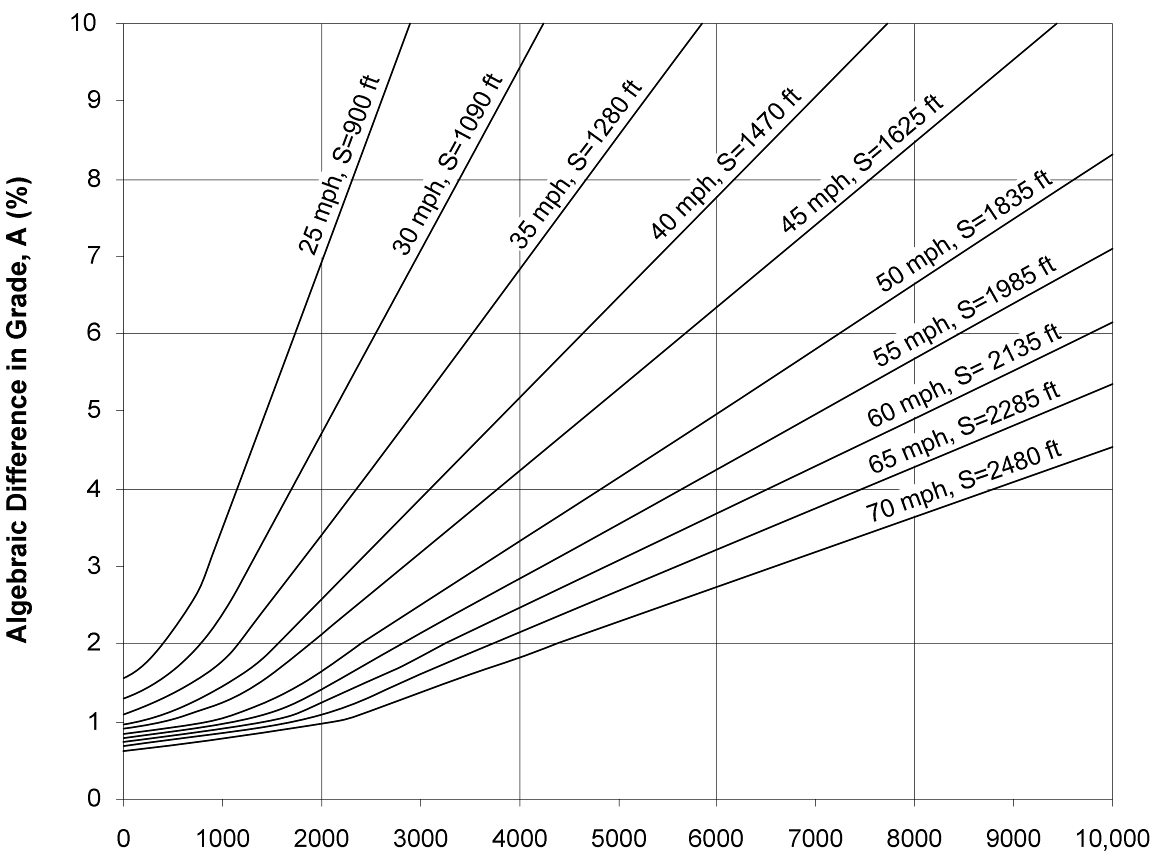
Where S>L

$$L = 2S - \frac{2800}{A} \qquad S = \frac{L}{2} + \frac{1400}{A}$$

Where S<L

$$L = \frac{AS^2}{2800} \qquad S = \sqrt{\frac{2800L}{A}}$$

Where:
L = Curve length (ft)
A = Algebraic grade difference (%)
S = Sight distance (ft)



Passing Sight Distance for Crest Vertical Curves
Figure 650-15

Design Speed (mph)	Decision Sight Distance for Maneuvers (ft)				
	A	B	C	D	E
30	220	490	450	535	620
35	275	590	525	625	720
40	330	690	600	715	825
45	395	800	675	800	930
50	465	910	750	890	1030
55	535	1030	865	980	1135
60	610	1150	990	1125	1280
65	695	1275	1050	1220	1365
70	780	1410	1105	1275	1445
75	875	1545	1180	1365	1545
80	970	1685	1260	1455	1650

Decision Sight Distance
Figure 650-16

The maneuvers in Figure 650-16 are as follows:

A. Rural stop
B. Urban stop
C. Rural speed/path/direction change
D. Suburban speed/path/direction change
E. Urban speed/path/direction change

Decision sight distance is calculated using the same criteria as stopping sight distance: h_1=3.50 feet and h_2=0.50 foot. Use the equations in Figures 650-6, 8, and 11 to determine the decision sight distance for crest vertical curves, sag vertical curves, and horizontal curves.

650.07 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/

the roadway surface to the bottom of the signal housing with 12-inch sections are shown in Figure 850-1.

Distance	Signal Display	Maximum Height
Signal displays 40 feet from the stop bar	Vertical 3 section	17.3 feet
	Vertical 4 section	16.9 feet
	Vertical 5 section*	16.5 feet
Signal displays 45 feet from the stop bar	Vertical 3 section	19.1 feet
	Vertical 4 section	17.9 feet
	Vertical 5 section*	16.8 feet
Signal displays 50 feet from the stop bar	Vertical 3 section	20.9 feet
	Vertical 4 section	19.7 feet
	Vertical 5 section*	18.5 feet
Signal displays 53 to 150 feet from the stop bar	Vertical 3 section	21.9 feet
	Vertical 4 section	20.7 feet
	Vertical 5 section*	19.6 feet
* Note: The 5 section cluster display is the same height as a vertical 3-section signal display.		

Signal Display Maximum Heights
Figure 850-1

Install an advanced signalized intersection warning sign assembly to warn motorists of a signalized intersection when either of the two following conditions exists:

- The visibility requirements in Table 4-1 of the MUTCD are not achievable.
- The 85th percentile speed is 55 mph or higher and the nearest signalized intersection is more than two miles away.

This warning sign assembly consists of a W3-3 sign, with Type IV reflective sheeting and two continuously flashing beacons. Locate the sign in advance of the intersection in accordance with Table II-1 (Condition A) of the MUTCD.

(9) Signal Supports

Signal supports for vehicle displays consist of metal vertical shaft standards (Type I), cantilevered mast arm standards (Type II, Type III, and Type SD Signal Standards), metal strain poles (Type IV and Type V Signal Standards), or timber strain poles. See the Standard Plans. Mast arm installations are preferred because they provide greater stability for signal displays in high wind areas and reduce maintenance costs. Preapproved mast arm signal standard designs are available with arm lengths up to 65 ft. Use mast arm standards for permanent installations unless display requirements cannot be met. Metal strain poles are allowed when signal display requirements cannot be achieved with mast arm standards or the installation is expected to be in place less than 5 years. Timber strain pole supports are generally used for temporary installations that will be in place less than 2 years.

Pedestrian displays can be mounted on the shafts of vehicle display supports or on individual vertical shaft standards (Type PS). The push buttons used for the pedestrian detection system can also be mounted on the shafts of other display supports or on individual pedestrian push button posts. Do not place the signal standard at a location that blocks pedestrian or wheelchair activities. Locate the pedestrian push buttons so they are ADA accessible to pedestrians and persons in wheelchairs.

Terminal cabinets mounted on the shafts of mast arm standards and steel strain poles are recommended. The cabinet provides electrical conductor termination points between the controller cabinet and signal displays that allows for easier construction and maintenance. Terminal cabinets are usually located on the back side of the pole to reduce conflicts with pedestrians and bicyclists.

In the placement of signal standards, the primary consideration is the visibility of signal faces. Place the signal supports as far as practicable from the edge of the traveled way without adversely affecting signal visibility. The MUTCD provides additional guidance for locating signal supports. Initially, lay out the location for supports for vehicle display systems, pedestrian detection systems, and pedestrian display systems independently to determine the optimal location for each type of support. If conditions allow and optimal locations are not compromised, pedestrian displays and pedestrian detectors can be installed on the vehicular display supports.

Another important consideration that can influence the position of signal standards is the presence of overhead and underground utilities. Verify the location of these lines during the preliminary design stage to avoid costly changes during construction.

Mast arm signal standards are designed based on the total wind load moment on the mast arm. The moment is a function of the XYZ value and this value is used to select the appropriate mast arm fabrication plan. The preapproved mast arm fabrication plans are listed in the special provisions. To determine the XYZ value for a signal standard, the cross sectional area for each component mounted on the mast arm is determined. Each of these values is then multiplied by its distance from the vertical shaft. These values are then totaled to determine the XYZ value. All signal displays and mast arm mounted signs, including street name signs, are included in this calculation. The effect of emergency preemption detectors and any required preemption indicator lights are negligible and are not included. For mast arm mounted signs, use the actual sign area to determine the XYZ value. An example of this calculation is shown in Figure 850-13. Cross sectional areas for vehicle displays are shown in Figure 850-2.

Signal Display	Area
Vertical 3 section	8.7 sq ft
Vertical 4 section	11.0 sq ft
Vertical 5 section	13.1 sq ft
5 section cluster	14.4 sq ft

Signal Display Areas
Figure 850-2

Foundation design is a critical component of the signal support. A soils investigation is required to determine the lateral bearing pressure and the friction angle of the soil and whether ground water might be encountered. The XYZ value is used in determining the foundation depth for the signal standard. Select the appropriate foundation depth from Figure 850-13. A special foundation design for a mast arm signal standard is required if the lateral bearing pressure is less than 1000 psf or the friction angle is less than 26 degrees. The regional materials group determines if these unusual soil conditions are present and a special foundation design is required. They then send this information to the OSC Materials Office for confirmation. That office forwards the findings to the OSC Bridge and Structures Office and requests the special foundation design. The Bridge and Structures Office designs foundations for the regions and reviews designs submitted by private engineering groups performing work for the regions.

Steel strain poles are used in span wire installations and are available in a range of pole classes. A pole class denotes the strength of the pole. The loads and resultant forces imposed on strain poles are calculated and a pole class greater than that load is specified. Figures 850-14a and 850-14b show the procedure for determining the metal strain pole class and foundation. Figure 850-15 shows an example of the method of calculation. The foundation depth is a product of the pole class and the soil bearing pressure. A special design is required for metal strain pole or timber strain pole support systems if the span exceeds 150 ft, the tension on the span exceeds 7200 lbs, or the span wire attachment point exceeds 29 ft in height. Contact the OSC Bridge and Structures Office for assistance.

(10) Preliminary Signal Plan

Develop a preliminary signal plan for the project file. Include with the preliminary signal plan a discussion of the problem that is being addressed by the project. Provide sufficient level of detail on the preliminary signal plan to describe all aspects of the signal installation, including proposed channelization modifications. Use a plan scale of 1 inch = 20 feet and include the following information:

- Stop bars
- Crosswalks
- Left-turn radii, including beginning and ending points
- Corner radii, including beginning and ending points
- Vehicle detector locations

Responsibility for Various Types of Facilities on State Highways				
Area	**Responsibility**	**Emergency vehicle signals**	**Traffic signals, school signals, & intersection control beacons**	**Reversible lane signals & moveable bridge signals**
Cities with less than 22,500 population	Finance Construct Maintain Operate	ESD(1) ESD(1) ESD(1) ESD(1)	State State State State	State State State State
Cities with 22,500 or greater population	Finance Construct Maintain Operate	ESD(1) ESD(1) ESD(1) ESD(1)	City(2) City(2) City(2) City(2)	City(2) City(2) City(2) City(2)
Beyond corporate limits	Finance Construct Maintain Operate	ESD(1) ESD(1) ESD(1) ESD(1)	State County(3) State State State	State State State State
Access control	Finance Construct Maintain Operate	ESD(1) ESD(1) ESD(1) ESD(1)	State State State State	State State State State

Notes:

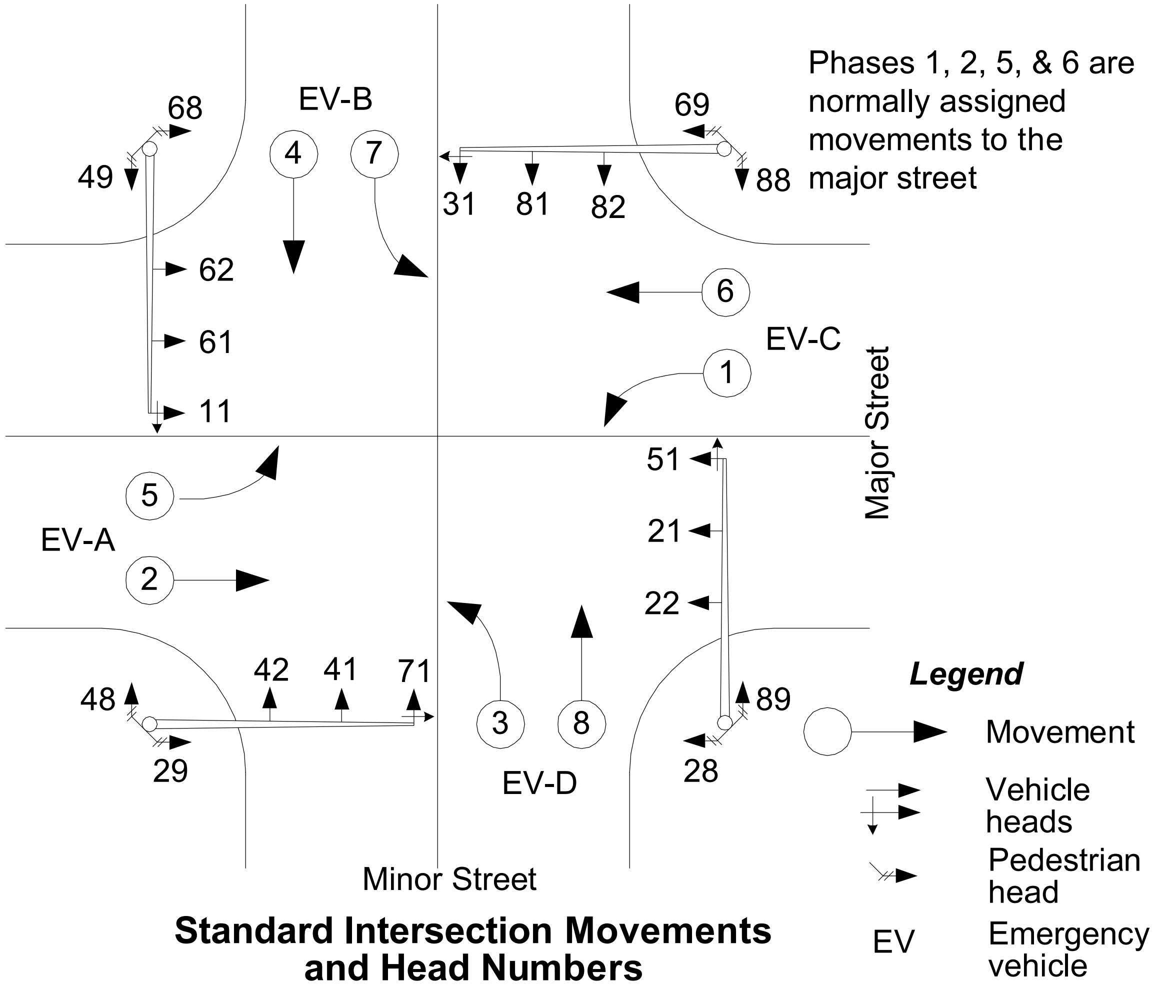
(1) ESDrefers to the applicable Emergency Service Department.

(2) State highways without established limited access control. See 850.04(2)b.

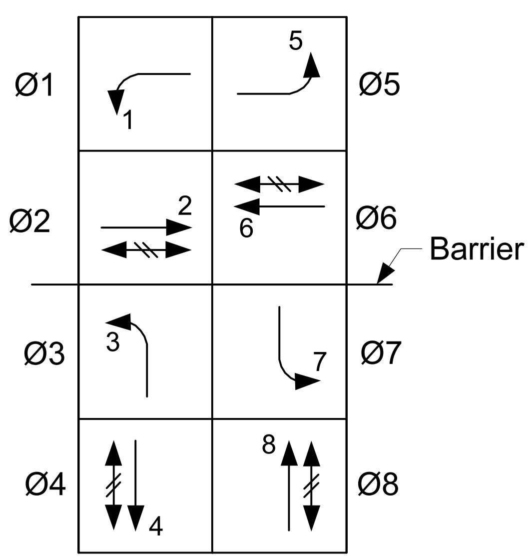
(3) See 850.04(2)d.

Responsibility for Facilities

Figure 850-3

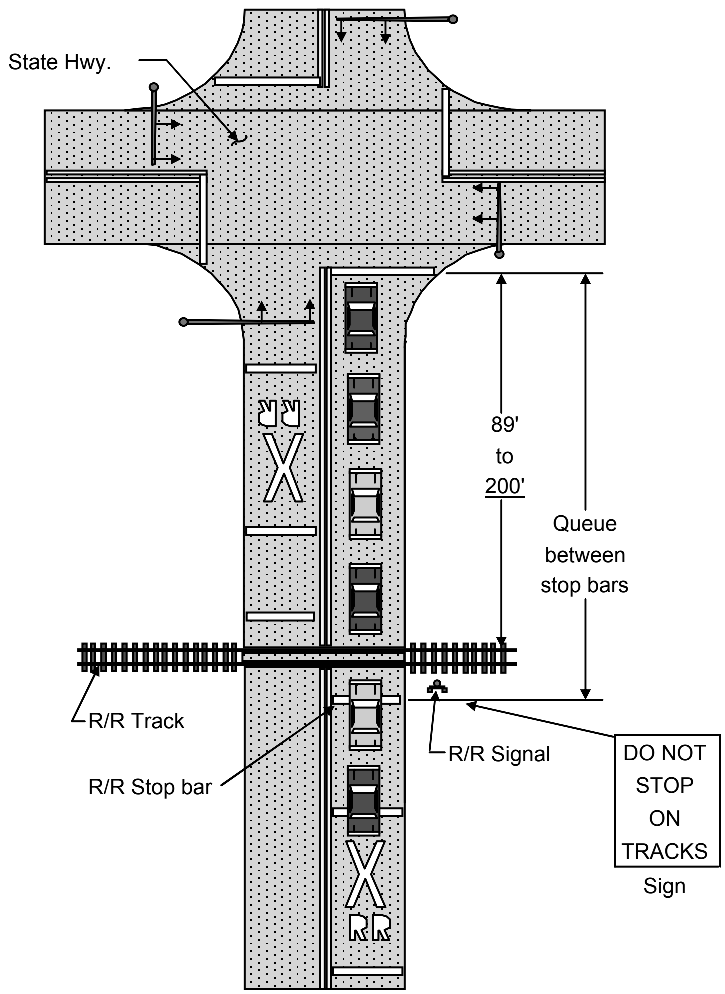


Standard Intersection Movements and Head Numbers



Standard Eight Phase Operation

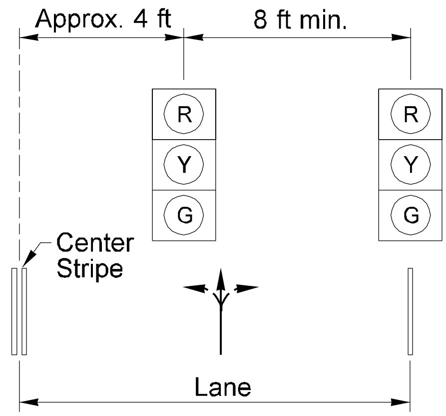
Standard Intersection Movements and Head Numbers
Figure 850-4



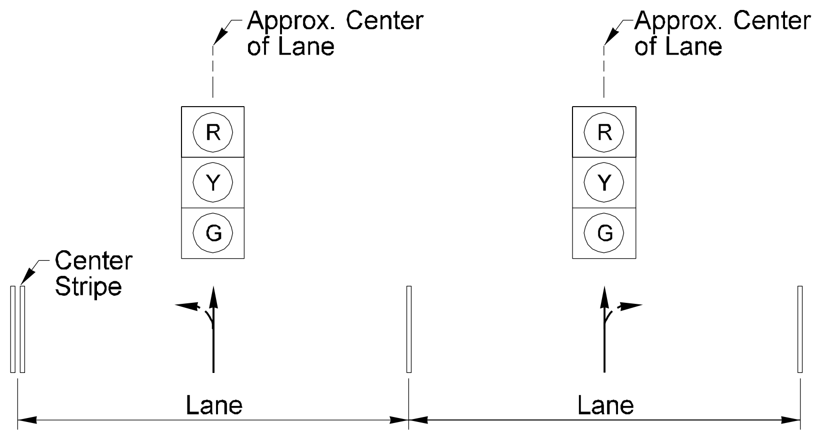
Railroad Crossing more than 88 feet from Intersection

Intersections With Railroad Crossings

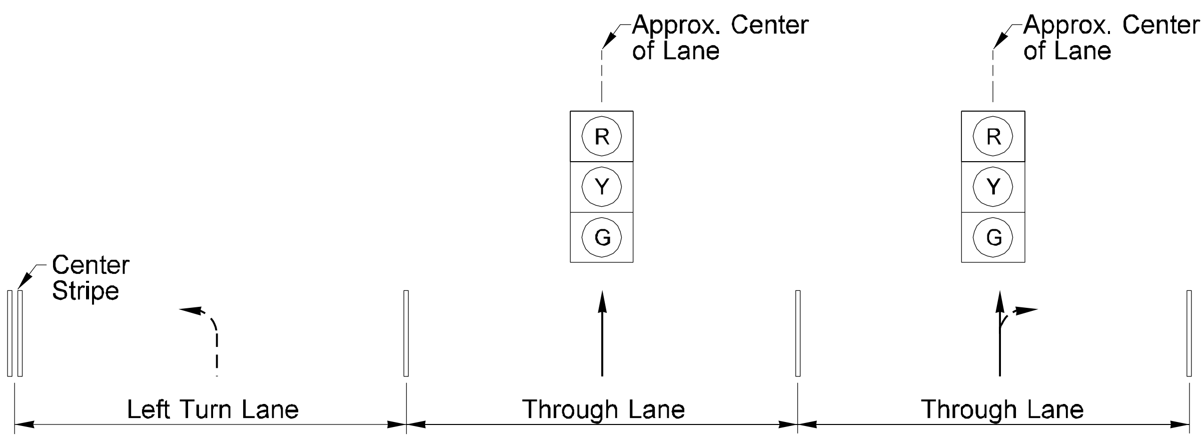
Figure 850-11b



One Through Lane
With Permissive Left Turn



Two Through Lanes
With Permissive Left Turn



Two Through Lanes and One Left Turn Storage Lane
With Permissive Left Turn

Traffic Signal Display Placements
Figure 850-12a

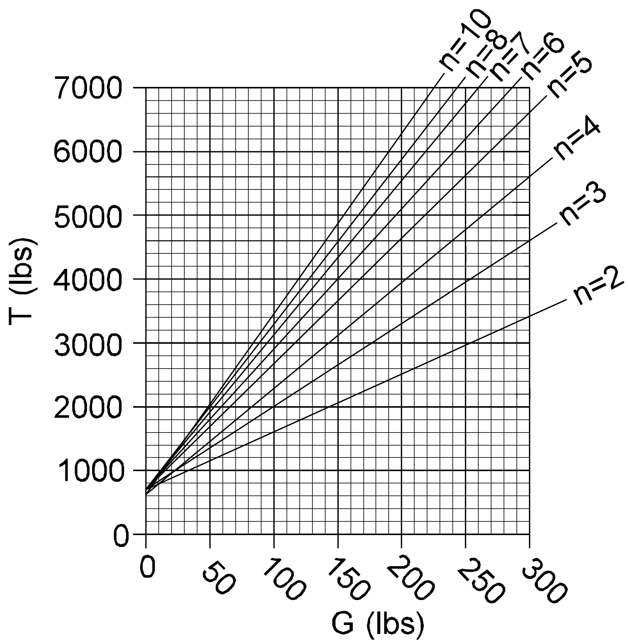


Chart 1 - Span Length 90' and Less

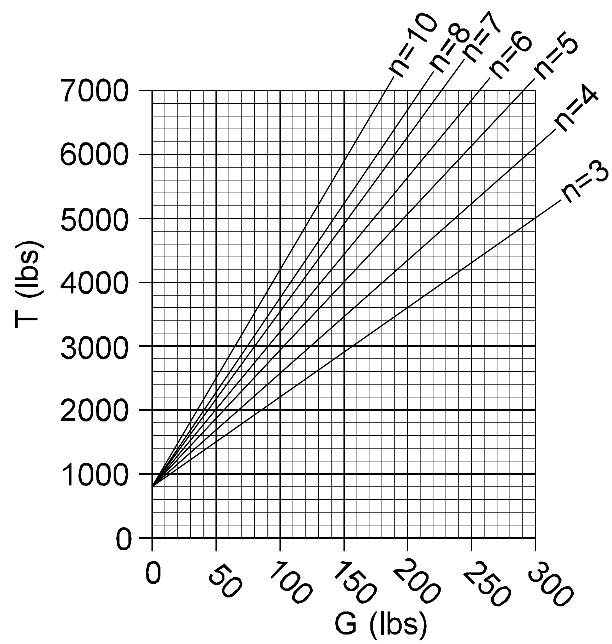


Chart 2 - Span Length 91' to 120'

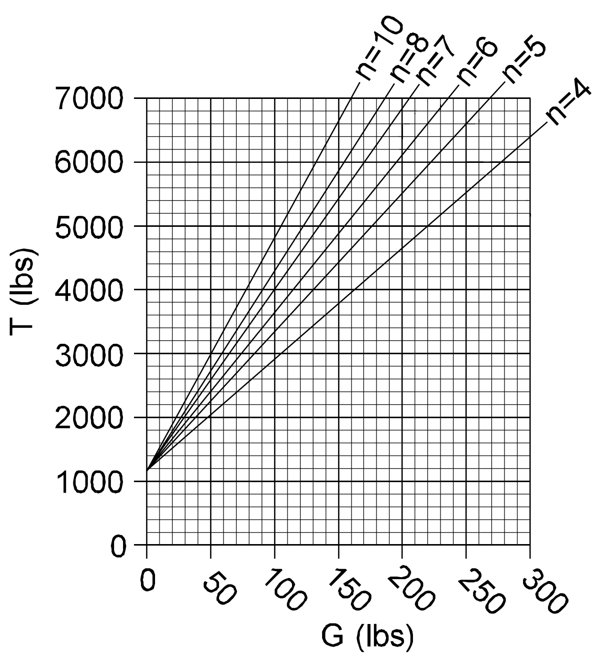
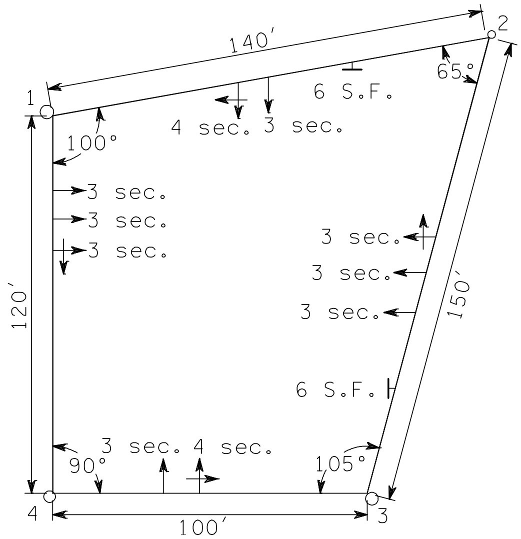


Chart 3 - Span Length 121' to 150'

Strain Pole and Foundation Selection Procedure
Figure 850-14b

Given: Figures 850-14a and 850-14b, and the following diagram.



Determine the following:

- Cable Tensions (T)
- Pole Loads (PL)
- Pole Classes
- Foundation Depths (D)

Step 1. Span lengths given above.

Step 2. Calculate (P) and (G) values.

Span 1-2, n = 3

7 sections x 40 lbs/sec =	280 lbs
6 s.f. sign x 6.25 lbs/s.f. =	38 lbs
Total (P) =	318 lbs
G = P/n = 318/3 =	106 lbs

Span 2-3, n = 4

9 sections x 40 lbs/sec =	360 lbs
6 s.f. sign x 6.25 lbs/s.f. =	38 lbs
Total (P) =	398 lbs
G = P/n = 398/4 =	100 lbs

Span 3-4, n = 2

7 sections x 40 lbs/sec =	280 lbs
Total (P) =	280 lbs
G = P/n = 280/2 =	140 lbs

Span 4-1, n = 3

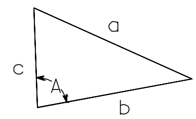
9 sections x 40 lbs/sec =	360 lbs
Total (P) =	360 lbs
G = P/n = 360/3 =	120 lbs

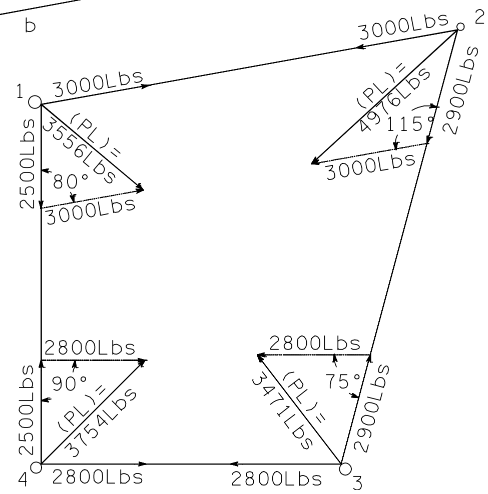
Step 3. Determine Cable Tensions (T) values

Span	Length	G	Chart	n	min n	T
1-2	140'	106 lbs	3	3	4	3000 lbs
2-3	150'	100 lbs	3	4	4	2900 lbs
3-4	<u>100'</u>	140 lbs	2	2	3	2800 lbs
4-1	120'	120 lbs	2	3	3	2500 lbs

Step 4.
Calculate (PL) values by computing the vector resultant of the (T) values.

$$a = \sqrt{b^2 + c^2 - 2bc(\cos A)}$$





Step 5.
Select the pole class from the Foundation Design Table (Figure 850-14<u>a</u>).

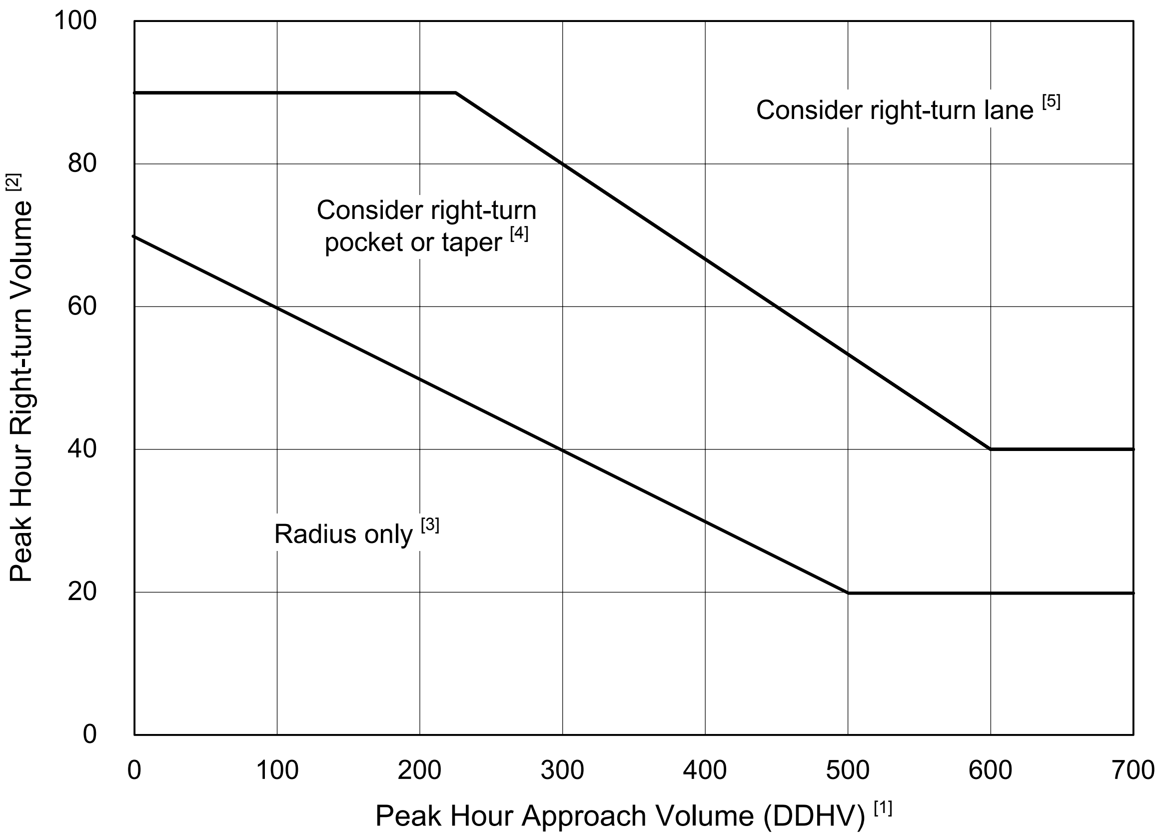
Pole Number	(PL)	Pole Class
1	3556 lbs	3700 lbs
2	4976 lbs	5600 lbs
3	3471 lbs	3700 lbs
4	3754 lbs	4800 lbs

Step 6.
Calculate the required foundation depths.
Given: (S) = 1000 psf

$$D = a\frac{DT}{\sqrt{S}}$$

Pole No.	Pole Class	DT	Foundation Depths (D) 3' Rd (a = 50)	4' Rd (a = 43)	3' Sq (a = 41)
1	3700 lbs	8'	13'	11'	11'
2	5600 lbs	10'	16'	14'	13'
3	3700 lbs	8'	13'	11'	11'
4	4800 lbs	9'-6"	15'	13'	13'

Strain Pole and Foundation Selection Example
Figure 850-15



Notes:

[1] For two-lane highways, use the peak hour DDHV (through + right-turn).
For multilane, high-speed highways (posted speed 45 mph or above), use the right-lane peak hour approach volume (through + right-turn).

[2] When all three of the following conditions are met, reduce the right-turn DDHV by 20.
- The posted speed is 45 mph or less
- The right-turn volume is greater than 40 VPH
- The peak hour approach volume (DDHV) is less than 300 VPH

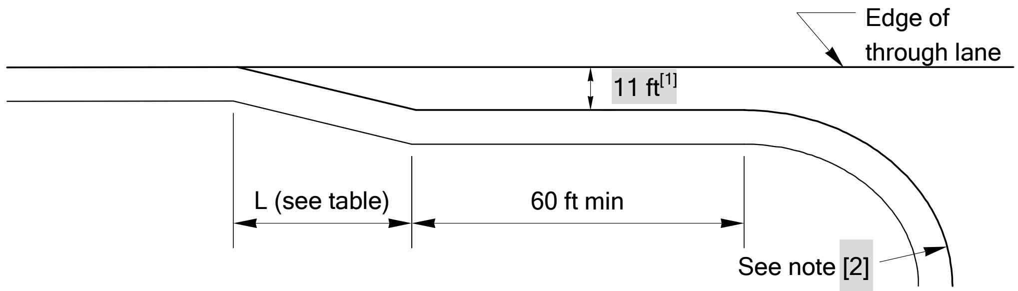
[3] For right-turn corner design, see Figure 910-11.

[4] For right-turn pocket or taper design, see Figure 910-16.

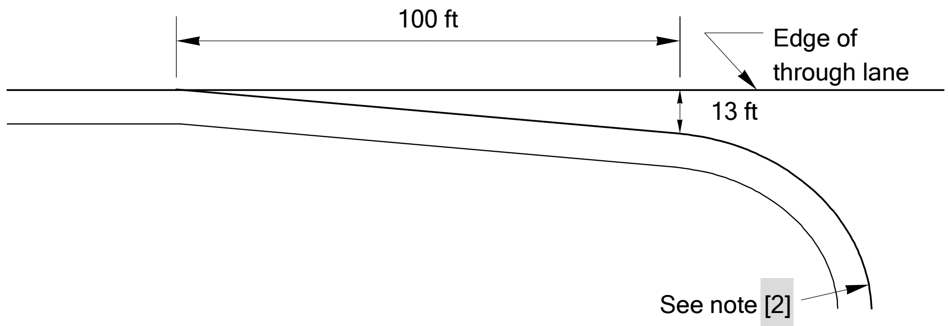
[5] For right-turn lane design, see Figure 910-17.

[6] For additional guidance, see 910.07(3).

Right-Turn Lane Guidelines[6]
Figure 910-15



Right-Turn Pocket



Right-Turn Taper

Posted Speed Limit	L
Below 40 mph	40 ft
40 mph or above	100 ft

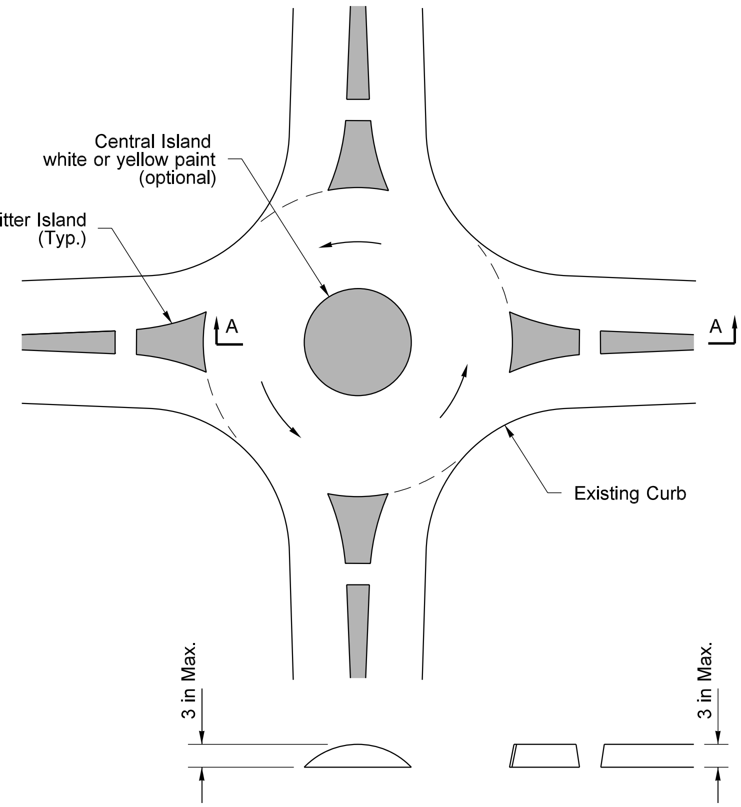
Notes:

[1] 12 ft desirable.

[2] See Figure 910-11 for right-turn corner design.

Right-Turn Pocket and Right-Turn Taper

Figure 910-16

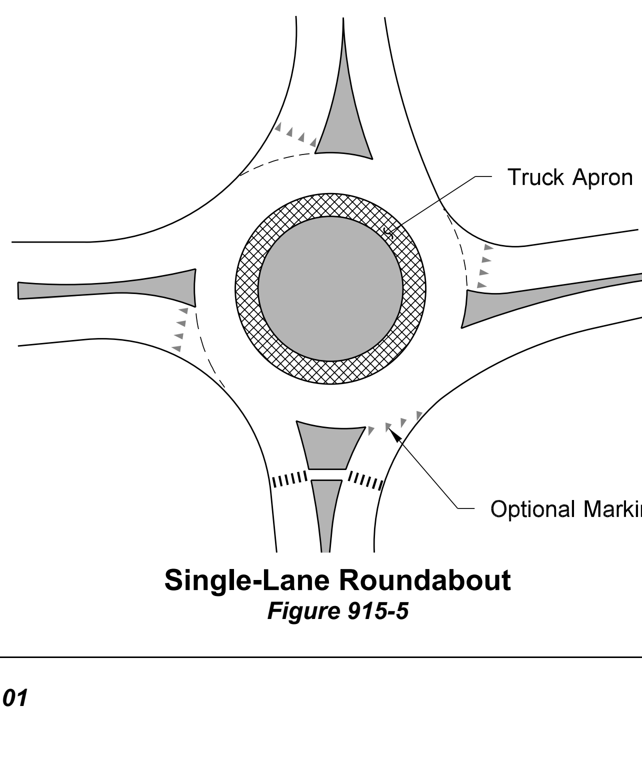


Section A-A
(not to scale)

Notes:

- The central island and splitter island are mountable islands.
- A mini roundabout has similar details as a single-lane roundabout, except all islands are mountable and existing curb and sidewalk at the intersection can remain.

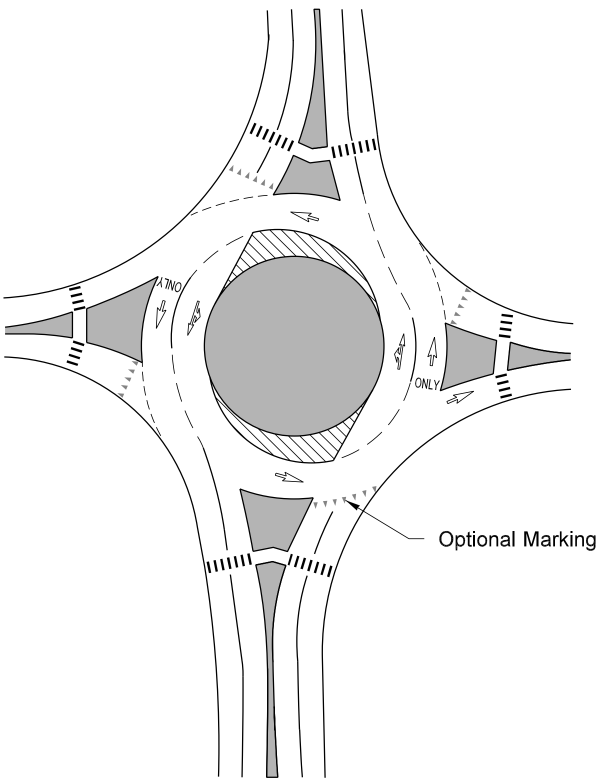
Mini Roundabout
Figure 915-4



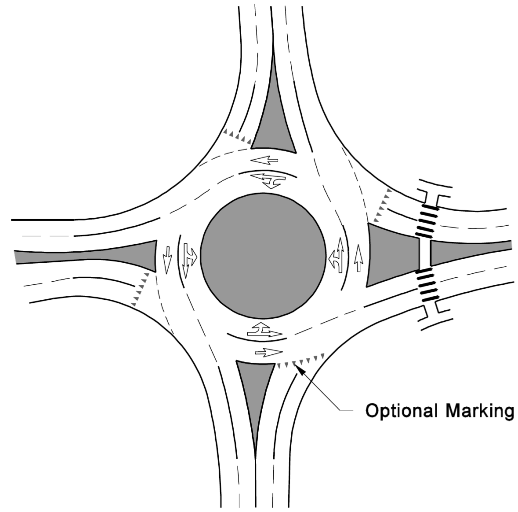
Single-Lane Roundabout
Figure 915-5

(3) Multilane Roundabouts

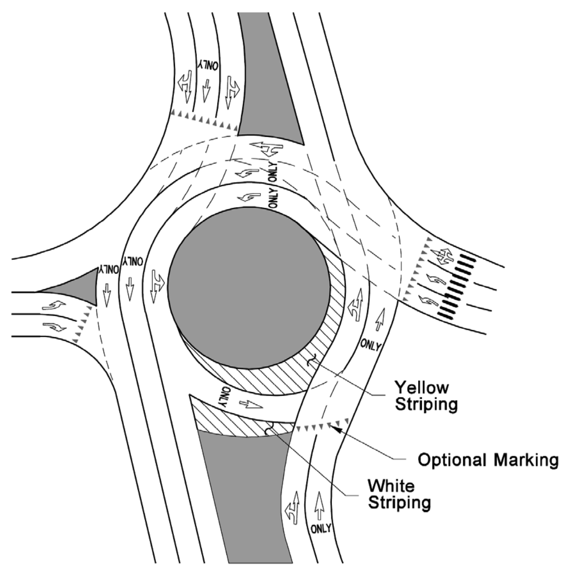
Multilane roundabouts have at least one entry or exit with two or more lanes and more than one circulating lane (see Figures 915-6a, 6b, and 6c). To balance the needs of passenger cars and trucks and provide safety, the current operational practice is normally for trucks negotiating roundabouts to encroach on adjacent lanes (see Figure 915-14b).



Multilane Roundabout
Figure 915-6a



Multilane Roundabout
Figure 915-6b



Multilane Roundabout
Figure 915-6c

For bike-bus-bike commuter access to a transit facility, design bicycle access facilities in conjunction with the access for the disabled. (See Chapters 1020 and 1025.)

Locate bicycle parking outside of the passenger walkways. See Chapter 1060.

Locations near colleges and universities and locations with good bicycle access, especially near trails, will attract bicyclists. Contact the region Bicycle Coordinator for information on the predicted number of bicycle parking spaces needed and the types of bicycle racks available.

1055.07 Traffic Design Elements

Traffic design elements are critical to the safe and efficient use of HOV direct access facilities. The following discusses the elements of traffic design that might be different for HOV direct access facilities.

(1) Traffic Barriers

Separate the main line from the HOV direct access facilities with a traffic barrier. Whenever possible, separate opposing traffic lanes in the facility by using traffic barrier. (See Chapter 710.) This is especially important in areas where opposing traffic is changing speeds to or from main line speeds. Concrete barrier is generally preferable on these facilities due to lower maintenance requirements.

The approach ends of traffic barriers must have crashworthy end treatments. In areas where the operating speed is greater than 35 mph, an impact attenuator is required. (See Chapter 720.) Consider concrete barrier and low maintenance impact attenuators, such as the REACT 350 or QuadGuard Elite, where there is a potential for frequent impacts, such as in gore areas.

When the operating speed is 25 mph or less, and where an at-grade pedestrian crossing transit stop has an opening in a concrete barrier, a sloped-down end as shown in the Standard Plans is acceptable.

When a break in the barrier is required for turning maneuvers, consider the sight distance requirements when determining the location for stopping the barrier. (See Chapter 650.)

In areas where headlight glare is a concern, consider glare screens, such as taller concrete barrier. Other glare screen options that mount on the top of a barrier tend to be high maintenance items and are discouraged.

Taller barrier might also be desirable in areas where pedestrian access is discouraged such as between opposing flyer stops and between a flyer stop and the main line.

(2) Signing

It is essential that the design and placement of HOV signing clearly indicate whether the signs are intended for motorists in the HOV lane or the general-purpose lanes. The purposes of the signs include:

- To enhance safety.
- To convey the message that HOV lanes are restricted to HOVs.
- To provide clear directions for entrances and exits.
- To define vehicle occupancy requirements or other restrictions.

Because HOV facilities are not found in many regions, the signing not only considers the commuter but also the occasional user of the facility who might be unfamiliar with the HOV facility and its operation.

(a) **Safety**

Much of HOV signing relates to enhancing safety for the motorists. Not only are geometrics often minimized due to the lack of right of way, but there are unusual operational characteristics such as the differential speed between the HOV vehicle and the adjacent general purpose traffic. The lack of passing opportunities in the HOV lane and the necessity for frequent merging and weaving actions require designers to use messages that are clear and concise, and use symbols wherever possible.

Because left-side off-connections are unusual, advance warning signing that an exit is on the left becomes more important.

For T ramps, provide traffic control at the T to assign priority to one of the conflicting left-turn movements and to avert wrong way movements.

(b) **Diamond Symbols**

The diamond symbol is used to designate all HOV facilities where carpools are allowed. For all signs, whether regulatory, guide, or warning, the symbol is always white on a black background to convey the restrictive nature of the HOV lane and to make the signs more uniformly recognizable. The use of the symbol with all HOV signs also informs drivers that the message is intended for HOVs. The diamond symbol is only for HOV lanes where carpools are allowed, not used for bus, taxi, or bicycle preferential lanes.

(c) **Selection and Location**

The signing details, Figures 1055-16 through 20, provide for the HOV geometric configurations used within the right of way. Signing for other types of HOV facilities (such as those used for reversible-flow, and HOV direct access between freeways and temporary HOV lanes used during construction) is designed on a case-by-case basis requiring consultation with the appropriate Headquarters and region traffic personnel. The design of signing for HOV direct access between freeways will include HOV guide signs, both advance and action, in addition to the normal regulatory signs.

(d) **Regulatory Signs**

Regulatory signs for HOV facilities follow the normal regulatory signing principles; black legend with a white reflective background on a rectangular panel. Keep in mind that messages conveyed by the HOV signs (such as signs concerning violations and those indicating the beginning of an HOV lane downstream) are not necessarily intended only for the HOV vehicle. Therefore, it might be prudent to place additional signs on the right side of the freeway where this conforms to sound engineering practice.

(e) **Guide Signs**

Guide signs for the HOV facilities are generally used at intermediate on and off locations to inform HOV motorists of upcoming freeway exits and the appropriate location to exit the HOV lane. For HOV direct access to and from arterials, guide signs are used in a fashion similar to normal arterial interchange signing practice. The guide signs for HOV facilities have a black nonreflective legend on a white reflective background. The exception is the diamond, where the white reflective symbol is on a black nonreflective background. For all HOV related guide signs, the diamond is placed in the upper left-hand corner of the sign.

(3) Lighting

Illumination of HOV direct access facilities is required for ramps, loading platforms at transit stops, major parking lots, and walkways as defined in Chapter 840.

(4) Intelligent Transportation Systems

Intelligent transportation systems (ITS) are used to collect traffic data, maintain freeway flow, and disseminate traveler information. Transit information systems for passengers and transit facility surveillance are not normally a part of WSDOT's ITS system, but implementation of these components may be considered for some locations.

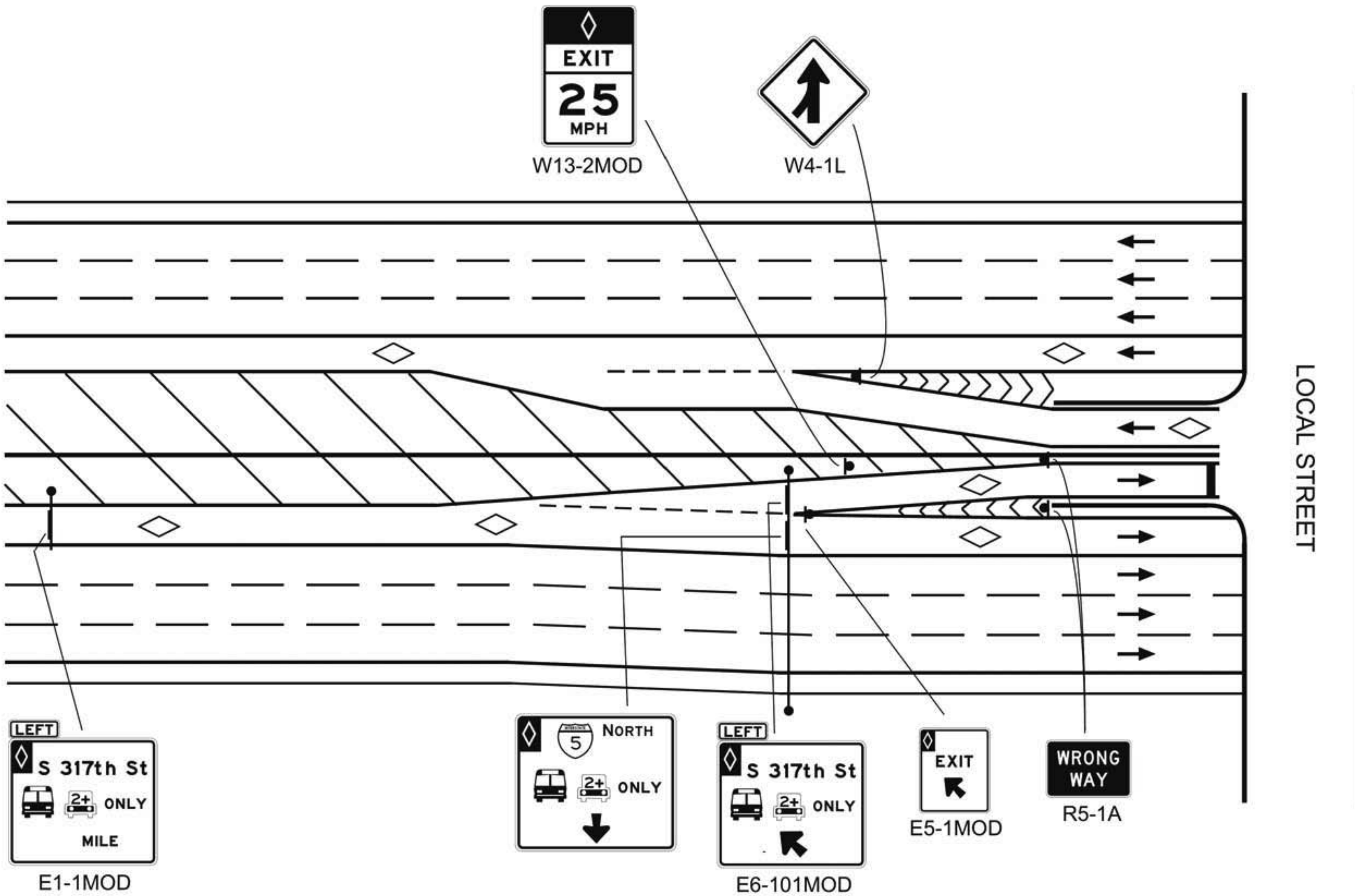
Design of HOV direct access facilities, like all HOV facilities, should fully utilize available ITS elements. Need for ITS elements vary depending on project features, such as facility design and operation, and whether the site has existing ITS components.

ITS elements that might be applicable to HOV direct access facilities include: closed circuit television surveillance, ramp metering, data collection, exit queue detection and override, dynamic signing, transit signal priority, and automatic vehicle identification and location.

Guidance on the development of ITS elements is found in Chapter 860. Include the region's Traffic Office, transit operator, and affected local agency in the coordination for design and implementation of ITS elements.

1055.08 Documentation

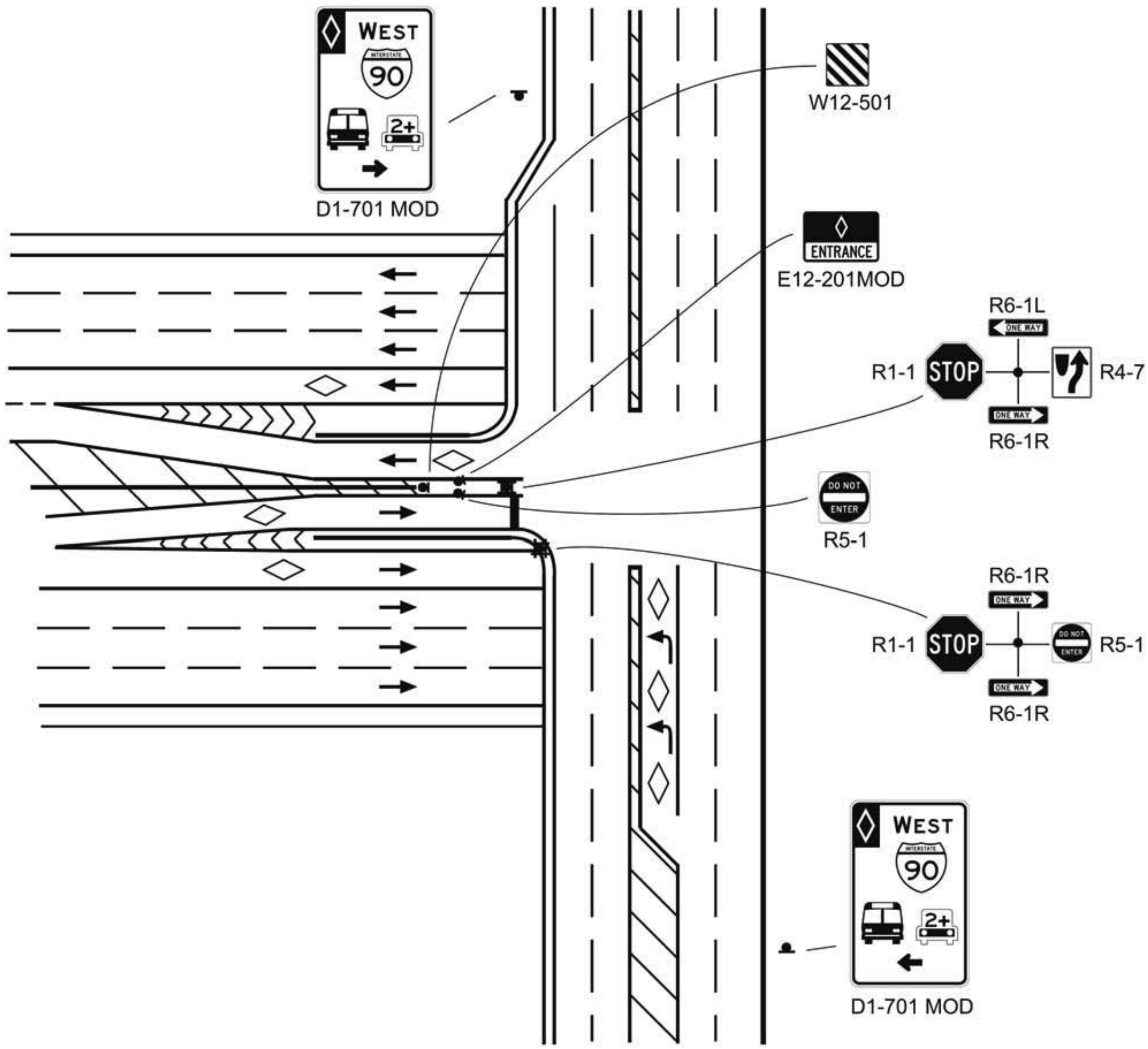
For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/



Notes:

1. Sign placement shall be in accordance with the MUTCD.
2. See the Sign Fabrication Manual (M55-05) for non-HOV sign details.
3. See Figures 1055-19 & 20 for modified sign details.

HOV Direct Access Signing: Main Line
Figure 1055-17

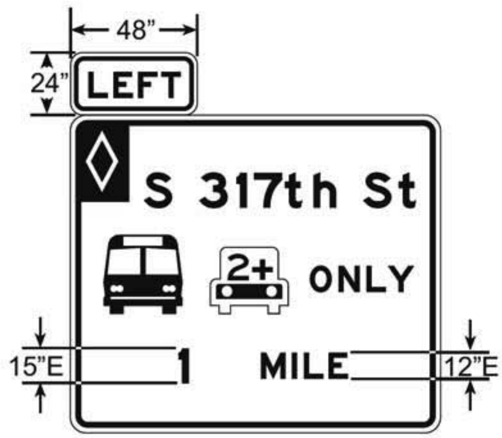


Notes:

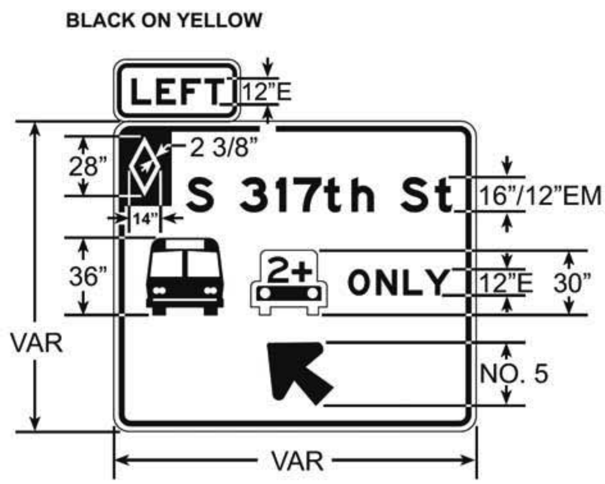
1. Sign placement shall be in accordance with the MUTCD.
2. See the Sign Fabrication Manual (M55-05) for non-HOV sign details.
3. See Figures 1055-19 & 20 for modified sign details.

HOV Direct Access Signing: Local Street & Ramp Terminal

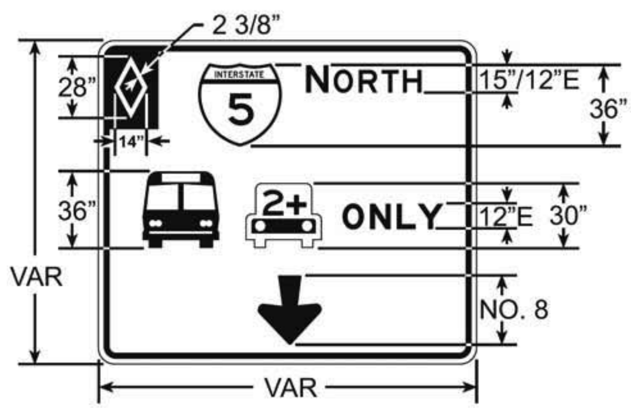
Figure 1055-18



E1-1 MOD.
BLACK ON WHITE

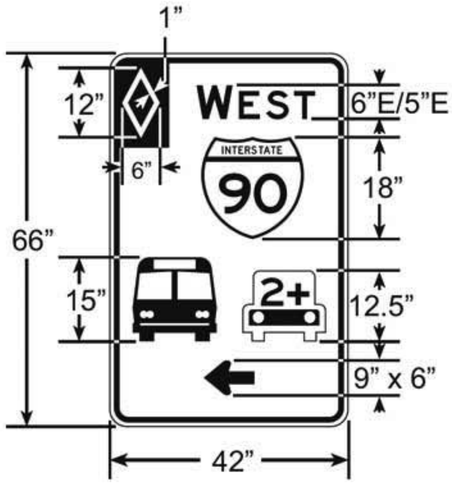


E6-101 MOD.
BLACK ON WHITE

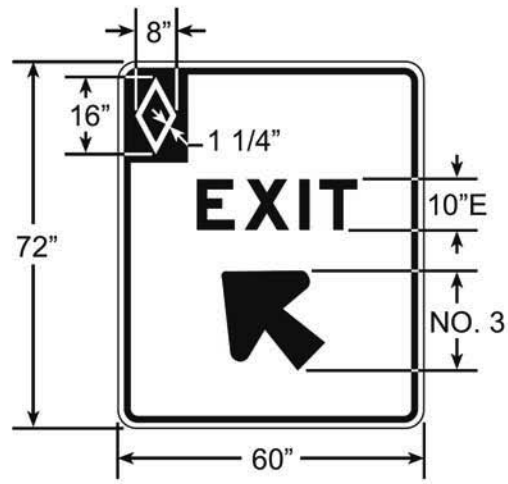


E6-2 MOD.
BLACK ON WHITE

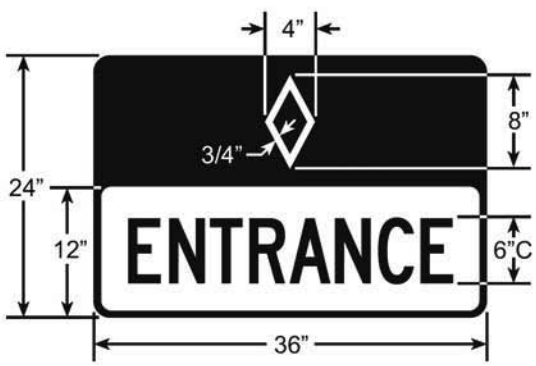
HOV Direct Access Overhead Signs
Figure 1055-19



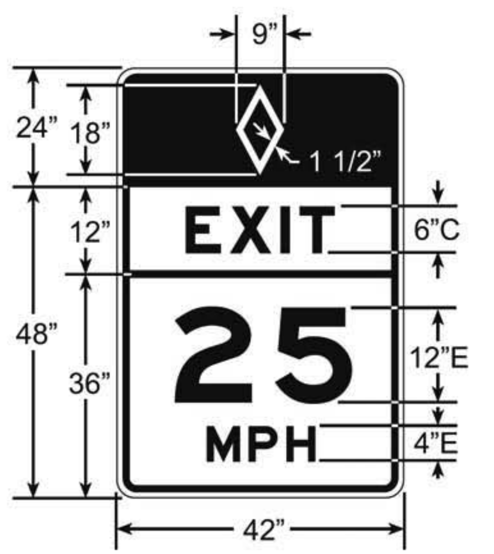
D1-701 MOD.
BLACK ON WHITE



E5-1 MOD.
BLACK ON WHITE



E12-201 MOD.
BLACK ON WHITE



W13-2 MOD.
WHITE ON BLACK &
BLACK ON YELLOW

HOV Direct Access Shoulder Mounted Signs
Figure 1055-20

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Washington State Department of Transportation

Design Manual Supplement

/s/ Pasco Bakotich III
State Design Engineer

Effective Date: May 1, 2008

Safety Improvement Projects

I. Introduction

A. Purpose

The purpose of this *Design Manual* Supplement is to revise the design policy related to safety projects on state transportation facilities. This supplement:

- Applies to projects programmed for the 09-11 Biennium or after.
- Revises the Design Matrices for Intersection and Corridor safety improvements.
- Provides for the greatest safety benefit with limited funding.

B. References

None.

C. Background

Design Matrices 3, 4, and 5 in Chapter 325 of the *Design Manual* include rows for crash reduction projects that are identified based on historical crash occurrences. There are rows for Non-Interstate Freeways (3-11, 4-10, and 5-13), Intersections (3-12, 4-11, and 5-14), and Corridors (3-13, 4-12, and 5-15).

The intent of these projects has been to address all of the design elements identified on the matrix rows. There are no similar rows for the Interstate facilities.

D. Discussion

In an effort to provide the greatest safety benefit with limited funding, this supplement revises WSDOT policy to focus highway safety project modifications on improvements that have the greatest potential to reduce severe or fatal injuries.

The intent of this policy change is to:

- Address the elements that are associated with severe injury crashes.

- Consider a range of solutions that include minor operational modifications, lower-cost improvements such as channelization, and higher-cost improvements such as signalization and widening.
- Recognize the substantial tradeoffs that must be made with the numerous competing needs and costs a highway designer faces in project development.

Because projects programmed for the 09-11 Biennium will be developed on a "need" basis, a matrix approach might not be the most efficient method of scoping these projects. It is proposed that the elements be determined and documented in a Project Analysis. This Project Analysis will:

- Include an analysis of the crash history.
- Identify operational, low-cost, and high-cost solutions.[1]
- Propose the appropriate solution based on a benefit/cost analysis as part of the Project Analysis.

Sites With Potential for Improvement (SWPI) are developed for the purpose of identifying potential project locations. These sites have been identified through a system-wide analysis. Only the sites with correctible contributing factors, traffic movements, or locations will be addressed. The SWPIs that may benefit from a safety-focused highway modification include the following:

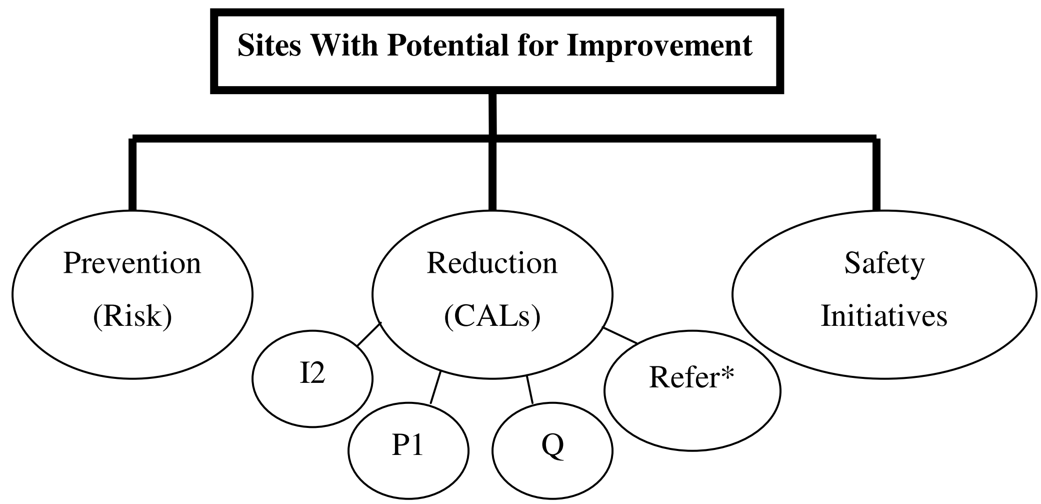
- Collision Prevention
- Collision Reduction (including Collision Analysis Locations [CAL])
- System Improvements (such as safety initiatives)

All SWPIs are analyzed incorporating additional collision and risk data to determine contributing factors. Proposed countermeasures are developed to specifically address those contributing factors and locations.

Analyze the SWPIs and proposed countermeasures using the Project Analysis early in the scoping process; ensure there is enough detail for a reasonable cost estimate; and have scoping reviewed by the responsible design or traffic operations approval authority. Those projects identified through the process above will fall under several categories, as shown in the diagram below.

- For I2-funded projects, see the Design Matrices (Design manual Supplement May 2008).
- For spot improvements in P1, see Chapter 410.
- For Q projects, see Chapter 340.

[1] Guidance on developing and using Project Analysis documents is forthcoming.



E. Implementation

This change is effective for SWPI projects programmed for the 09-11 Biennium.

II. Instructions

A. Insert this entire Supplement behind the existing matrices in Chapter 325.

The Contents and Index sections remain unchanged for this supplement. They will be updated with the next regularly scheduled *Design Manual* revision.

* Some locations without a highway improvement solution will be referred to Enforcement and Education agencies for consideration.

⇩ Project Type																Bridges			Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width [13]	On/Off Conn.	Median Width	Cross Slope Lane	Cross Slope Shldr	Fill/Ditch Slopes	Clear Zone	Sign. [10]	Delini. [9]	Illumin.	Vert. Clear. [11]	Bike & Ped.	Lane Width	Shldr Width	Structural Capacity	Term. & Trans. Section [12]	Std Run	Bridge Rail [14][19]
(1-1) Preventive Maintenance																					
Pavement Restoration																					
(1-2) Diamond Grinding										EU	EU	F		DE					F	EU	F
(1-3) Milling with HMA Inlays									EU	F	EU	F		DE					F	EU	F
(1-4) Nonstructural Overlay				DE			EU	EU	EU	F	EU	F		F					F	F	F
Pavement Rehab./Resurf.																					
(1-5) HMA Structural Overlays	EU	DE	F	F	F[17]	DE	F	EU	F	F	EU	F	F	F		F	DE		F	F	F
(1-6) PCCP Overlays	EU	DE	F	F	F[17]	DE	F	EU	F	F	EU	F	F	F		F	DE		F	F	F
(1-7) Dowel Bar Retrofit	EU	DE	F	F	F[17]	DE	DE		F	F	EU	F	F	DE			DE		F	F	F
Bridge Rehabilitation																					
(1-8) Bridge Deck Rehabilitation												F		F		F	DE	[11]	F[6]	F[22]	F
Safety																					
(1-9) Median Barrier				DE															F[20]	F[20]	
(1-10) Guardrail Upgrades				DE						F									F	F[23]	
(1-11) Bridge Rail Upgrades																			F	F[22]	F
(1-12) Collison Analysis Locations*	Design Elements determined based on a Project Analysis (See Note 27)																				
Reconstruction (16)																					
(1-13) New/Reconstruction	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

☐ Not Applicable

F Full design level (see Chapter 440).

DE Design Exception to full design level.

EU Evaluate Upgrade to full design level.

(6) Applies only to bridge end terminals and transition sections.

(9) Continuous shoulder rumble strips required in rural areas (see Chapter 700).

(10) See Chapter 820.

(11) See Chapter 1120.

(12) Impact attenuators are considered as terminals.

(13) See Chapters 440 and 640.

(14) Includes crossroad bridge rail (see Chapter 710).

(16) For design elements not in the matrix headings, apply full design level as found in the applicable chapters and see 325.03(2).

(17) DE for existing acceleration/deceleration lanes when length meets posted freeway speed and no significant accidents (see Chapter 940).

(19) The funding sources for bridge rail are a function of the length of the bridge. Consult programming personnel.

(20) Applies to median elements only.

(22) Upgrade barrier, if necessary, within 200 ft of the end of the bridge.

(23) See description of Guardrail Upgrades Project Type, 325.03(1) regarding length of need.

(27) A Project Analysis is used to document the needs at a location and determine the appropriate design elements to address these needs

* Collision Analysis Locations are those sites identified through a system-wide analysis that have a high severity collision history. These sites are created with the intent to modify, where appropriate, specific highway elements that have a high potential to reduce the identified high severity collisions.

Design Matrix 1

Interstate Routes (Main Line)

(Supplement to be used on projects programmed for '09-'11 biennium)

⇩ Project Type	Ramps and Collector Distributors																				Cross Road										
															Ramp Terminals			Barriers											Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane Tran-sition	On/Off Conn.	Cross Slope Lane	Cross Slope Shldr	Fill/ Ditch Slopes	Limited Access	Clear Zone	Sign., Del., Illumin. (9)(10)	Vertical Clear. (11)	Bike & Ped.	Turn Radii	Angle	I/S Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail (14)(19)	Lane Width	Shldr Width	Fill/ Ditch Slopes	Limited Access	Clear Zone	Sign., Del., Illumin. (10)	Vert. Clear. (11)	Ped. & Bike	Term. & Trans. Section (12)	Std Run	Bridge Rail (14)(19)
(2-1) Preventive Maintenance																															
Pavement Restoration																															
(2-2) Diamond Grinding											EU	F(15)						F	EU	F					EU	F(15)			F	EU	F
(2-3) Milling with HMA Inlays									EU		F	F(15)	F	M				F	F	F			EU		F	F(15)		M	F	F	F
(2-4) Nonstructural Overlay							EU	EU	EU		F	F(15)	F	M				F	F	F			EU		F	F(15)		M	F	F	F
Pavement Rehab./Resurf.																															
(2-5) HMA Structural Overlays	EU	DE	F	F	F	F(17)	F	EU	F	F	F	F(15)	F	M	F	F	F	F	F	F	DE	DE	DE	F	F	F(15)	F	M	F	F	F
(2-6) PCCP Overlays	EU	DE	F	F	F	F(17)	F	EU	F	F	F	F(15)	F	M	F	F	F	F	F	F	DE	DE	DE	F	F	F(15)	F	M	F	F	F
(2-7) Dowel Bar Retrofit	DE		DE	DE	F	F(17)	DE		F	F	F	F(15)	DE		F	F	F	F	F	F				F		F(15)			F	F	F
Bridge Rehabilitation																															
(2-8) Bridge Deck Rehabilitation													F	M				F(6)	F(22)	F							F	M	F(6)	F(22)	F
Safety																															
(2-9) Intersection			F	F	F				F	F	F	F		M	F	F	F	F	F	F			F	F	F	F	F	M	F	F	F
(2-10) Guardrail Upgrades				DE							F							F	F(23)										F	F(23)	
(2-11) Bridge Rail Upgrades																		F	F(22)	F									F	F(22)	F
(2-12) CollisionAnalysis Locations*	Design Elements determined based on a Project Analysis (See Note 27)																														
Reconstruction (16)																															
(2-13) New/Reconstruction	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

☐ Not Applicable
F Full design level (see Chapter 440).
M Modified design level. See Chapter 430.
DE Design Exception to full design level.
EU Evaluate Upgrade to full design level.

(6) Applies only to bridge end terminals and transition sections.
(9) Continuous shoulder rumble strips required in rural areas (see Chapter 700).
(10) See Chapter 820.
(11) See Chapter 1120.
(12) Impact attenuators are considered as terminals.
(14) Includes crossroad bridge rail (see Chapter 710).
(15) EU for signing and illumination.
(16) For design elements not in the matrix headings, apply full design level as found in the applicable chapters and see 325.03(2).
(17) DE for existing acceleration/deceleration lanes when length meets posted freeway speed and no significant accidents (see Chapter 940).
(19) The funding sources for bridge rail are a function of the length of the bridge. Consult programming personnel.
(22) Upgrade barrier, if necessary, within 200 ft of the end of the bridge.
(23) See description of Guardrail Upgrades Project Type, 325.03(1) regarding length of need.
(27) A Project Analysis is used to document the needs at a location and determine the appropriate design elements to address these needs.
* Collision Analysis Locations are those sites identified through a system-wide analysis that have a high severity collision history. These sites are created with the intent to modify, where appropriate, specific highway elements that have a high potential to reduce the identified high severity collisions.

Design Matrix 2
Interstate Interchange Areas

(Supplement to be used on projects programmed for '09-'11 biennium)

⇩ Project Type																Bridges (11)				Intersections			Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane Tran-sition	On/Off Conn.	Median Width	Cross Slope Lane	Cross Slope Shldr	Fill/ Ditch Slopes	Access (3)	Clear Zone (18)	Sign., Del., Illumin.	Basic Safety	Bike & Ped.	Lane Width	Shldr Width	Vertical Clear-ance	Structural Capacity	Turn Radii	Angle	I/S Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail (14)(19)
Preservation																									
Roadway																									
(3-1) Non-Interstate Freeway	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F		B	B		DE/F	DE/F	F					F	B	F
(3-2) HMA/PCCP/BST Overlays	DE/M	DE/M	DE/M	DE/M	DE/F	DE/F	DE/M	DE/M	DE/M	DE/M			B	B	M	DE/M	DE/M	F				B	F	B	F
(3-3) Replace HMA w/ PCCP at I/S	DE/M	DE/M	EU/M	EU/M	DE/F		DE/M	EU/M	DE/M	DE/M			B	B	M	DE/M	DE/M	F				B	F	B	F
Structures																									
(3-4) Bridge Replacement	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F(2)		F	F		F	F(2)	F(2)	F	F	F(2)	F(2)	F	F	F	F
(3-5) Bridge Deck Rehab.													B	B	M			F					F(6)	F(22)	F
Improvements (16)																									
Mobility																									
(3-6) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F
(3-7) Urban	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F (2)	F	F	F (2)	F (2)	F	F	F	F
(3-8) Rural	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F (2)	F	F	F (2)	F (2)	F	F	F	F
(3-9) HOV	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F (2)	F	F	F (2)	F (2)	F	F	F	F
(3-10) Bike/Ped. Connectivity	(5)	(5)	(5)	(5)	(5)			(5)	(5)	(5)	(5)	(5)	(5)		F	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Safety																									
(3-11) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F		F	F	F	F	F	F
(3-12) Intersection (1)			F(2)	F(2)	F					F (2)	F	F	F		M					F	F	F	F	F	F
(3-13) Corridor (1)(24)	M(4)	M(4)	M(4)	M(4)	F	F(17)	M(4)	M(4)	M(4)	M(4)	F	F	F		F	M(4)	M(4)	F		M(4)	M(4)	F	F	F	F
(3-14) Median Barrier				DE/F																			F(20)	F(20)	
(3-15) Guardrail Upgrades				DE/F																			F	F(23)	
(3-16) Bridge Rail Upgrades																							F	F(22)	F
(3-17) Risk: Roadside										F	EU/F	F	F										F	F	F
(3-18) Risk: Sight Distance	F/M(21)	F/M(21)	F/M(21)	F/M(21)						F/M(21)	F(21)	F(21)	F		F	F(21)	F(21)	F(21)		F/M(21)	F/M(21)	F(21)	F	F	F
(3-19) Risk: Roadway Width			F/M(21)	F/M(21)	F(21)	F(21)	F/M(21)	F/M(21)	F/M(21)	F/M(21)	F	F	F		F	F(21)	F(21)	F(21)		F/M(21)	F/M(21)	F(21)	F	F	F
(3-20) Risk: Realignment	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F(2)	F		F(2)	F(2)	F(2)	F	F	F
(3-26) Collision Analysis Locations*	Design Elements determined based on a Project Analysis (See Note 1)																								
Economic Development																									
(3-21) Freight & Goods (Frost Free)(8)	F(2)	F(2)	F(2)	F(2)	F	F (2)	F(2)	F(2)	F(2)	F(2)	EU/F	F	B		EU/F(26)	DE/F	DE/F	F	F	EU/F	EU/F	EU/F	F	F	F
(3-22) Four-Lane Trunk System	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F
(3-23) Rest Areas (New)	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F		F	F	F	F	F	F
(3-24) Bridge Restrictions	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F(2)		F	F		EU/F(26)	F(2)	F(2)	F	F	F(2)	F(2)	F	F	F	F
(3-25) Bike Routes (Shldrs)			EU/M	(7)	EU/F				EU/M	EU/M			B	B	F	EU/M	EU/M	F				B	F	B	EU/F

☐ Not Applicable

F Full design level (see Chapter 440).

M Modified design level. See Chapter 430.

B Basic design level. See Chapter 410.

F/M Full for freeways/Modified for non-freeway

DE Design Exception to full design level.

EU Evaluate Upgrade to full design level.

(1) Collision Analysis Locations (CALs) require a Project Analysis to document the needs at a location and determine the appropriate design elements to address these needs.

(2) Modified design level may apply based on a corridor or project analysis (see 325.03(5)).

(3) If designated as L/A acquired in the Access Control Tracking System, limited access requirements apply. If not, managed access applies (see 325.03(5)).

(4) Full design level may apply based on a corridor or project analysis (see 25.03(5)).

(5) For bike/pedestrian design see Chapters 1020 and 1025.

(6) Applies only to bridge end terminals and transition sections.

(7) 4 ft minimum shoulders.

(8) If all weather structure can be achieved with spot digouts and overlay, modified design level applies to NHS highways and basic design level applies to non-NHS highways.

(11) See Chapter 1120.

(12) Impact attenuators are considered as terminals.

(14) Includes crossroad bridge rail (see Chapter 710).

(16) For design elements not in the matrix headings, apply full design level as found in the applicable chapters and see 325.03(2).

(17) DE for existing acceleration/deceleration lanes when length meets posted freeway speed and no significant accidents (see Chapter 940).

(18) On managed access highways within the limits of incorporated cities and towns, City and County Design Standards apply to areas outside the curb or outside the paved shoulder where no curb exists.

(19) The funding sources for bridge rail are a function of the length of the bridge. Consult programming personnel.

(20) Applies to median elements only.

(21) Analyses required. See 325.03(5) for details.

(22) Upgrade barrier, if necessary, within 200 ft of the end of the bridge.

(23) See description of Guardrail Upgrades Project Type, 325.03(1) regarding length of need.

(24) Apply Full design level to projects that realign or reconstruct significant portions of the alignment.

(26) Sidewalk ramps must be addressed for ADA compliance (see Chapter 1025).

* Collision Analysis Locations are those sites identified through a system-wide analysis that have a high severity collision history. These sites are created with the intent to modify, where appropriate, specific highway elements that have a high potential to reduce the identified high severity collisions.

Design Matrix 3

Main Line NHS Routes (Except Interstate)

(Supplement to be used on projects programmed for '09-'11 biennium)

⇩ Project Type	Ramps and Collector Distributors																				Cross Road											
															Ramp Terminals			Barriers												Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane Tran-sition	On/Off Conn.	Cross Slope Lane	Cross Slope Shldr	Fill/ Ditch Slopes	Access (3)	Clear Zone	Sign, Del., Illumin.	Basic Safety	Bike & Ped.	Turn Radii	Angle	I/S Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail (14)(19)	Lane Width	Shldr Width	Fill/ Ditch Slopes	Access (3)	Clear Zone	Sign., Del., Illumin.	Basic Safety	Vert. Clear. (11)	Ped. & Bike	Term. & Trans. Section (12)	Std . Run	Bridge Rail (14)(19)
Preservation																																
Roadway																																
(4-1) Non-Interstate Freeway	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F		B	B	M	DE/F	DE/F	DE/F	F	B	F	DE/F	DE/F	DE/F			B	B	F	M	F	B	F
(4-2) HMA/PCCP/BST Overlays Ramps												B	B	M			B	F	B	F						B	B	F	M	F	B	F
Structures																																
(4-3) Bridge Replacement	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F	F	F	F	F	F	F(2)	F(2)	F(2)	F	F	F		F	F	F	F	F
(4-4) Bridge Deck Rehab.												B	B	M				F(6)	F(22)	F						B	B	F	M	F(6)	F(22)	F
Improvements (16)																																
Mobility																																
(4-5) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F
(4-6) Urban	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F(2)	F	F	F	F	F(2)	F(2)	F(2)	F	F	F		F	F	F	F	F
(4-7) Rural	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F(2)	F	F	F	F	F(2)	F(2)	F(2)	F	F	F		F	F	F	F	F
(4-8) HOV By Pass	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F(2)	F	F	F	F	F(2)	F(2)	F(2)	F	F	F		F	F	F	F	F
(4-9) Bike/Ped. Connectivity	(5)	(5)	(5)	(5)	(5)		(5)	(5)	(5)	(5)	(5)	(5)		F	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)			(5)		(5)	F	(5)	(5)	(5)
Safety																																
(4-10) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F		M	F	F	F	F	F	F	F	F	F	F	F	F		F	M	F	F	F
(4-11) At Grade (1)(25)	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F(2)	F	F	F	F	F(2)	F(2)	F(2)	F	F	F		F	F	F	F	F
(4-12) Intersection (1)			F(2)	F(2)	F				F(2)	F	F	F		M	F	F	F	F	F	F			F(2)	F	F	F		F	M	F	F	F
(4-13) Guardrail Upgrades				DE/F														F	F(23)											F	F(23)	
(4-14) Bridge Rail Upgrades																														F	F(22)	F
(4-15) Risk: Roadside									F	EU/F	F	F											F	EU/F	F	F				F	F	F
(4-16) Risk: Sight Distance	F/M(21)	F/M(21)	F/M(21)	F/M(21)					F/M(21)	F(21)	F(21)	F		F	F/M(21)	F/M(21)	F	F	F	F			F/M(21)	F(21)	F(21)			F(21)	F			
(4-21) Collision Analysis Locations*	Design Elements determined based on a Project Analysis (See Note 1)																															
(4-17) Risk: Roadway Width			F/M(21)	F/M(21)	F	F(21)	F/M(21)	F/M(21)	F/M(21)	F	F	F		F	F/M(21)	F/M(21)	F	F	F	F	F/M(21)	F/M(21)	F/M(21)	F	F			F(21)	F	F	F	F
(4-18) Risk: Realignment	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F/M(21)	F/M(21)	F	F	F	F	F(2)	F(2)	F(2)	F	F			F(21)	F	F	F	F
(4-19) Risk: Realignment																																
Economic Development																																
(4-20) Four-Lane Trunk System	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F	F	F		F		F	F	F

☐ Not Applicable

F Full design level (see Chapter 440).

M Modified design level. See Chapter 430.

B Basic design level. See Chapter 410.

F/M Full for freeways/Modified for non-freeway

DE Design Exception to full design level.

EU Evaluate Upgrade to full design level.

(1) Collision Analysis Locations (CALs) require a Project Analysis to document the needs at a location and determine the appropriate design elements to address these needs.

(2) Modified design level may apply based on a corridor or project analysis (see 325.03(5)).

(3) If designated as L/A acquired in the Access Control Tracking System, limited access requirements apply. If not, managed access applies (see 325.03(5)).

(4) Full design level may apply based on a corridor or project analysis (see 325.03(5)).

(5) For bike/pedestrian design see Chapters 1020 and 1025.

(6) Applies only to bridge end terminals and transition sections.

(11) See Chapter 1120.

(12) Impact attenuators are considered as terminals.

(14) Includes crossroad bridge rail (see Chapter 710).

(16) For design elements not in the matrix headings, apply full design level as found in the applicable chapters and see 325.03(2).

(19) The funding sources for bridge rail are a function of the length of the bridge. Consult programming personnel.

(21) Analyses required. See 325.03(5) for details.

(22) Upgrade barrier, if necessary, within 200 ft of the end of the bridge.

(23) See description of Guardrail Upgrades Project Type, 325.03(1) regarding length of need.

(25) For main line, use the Project Type row for Safety, Non-Interstate Freeway on Matrix 3 for NHS and on Matrix 5 for non-NHS.

* Collision Analysis Locations are those sites identified through a system-wide analysis that have a high severity collision history. These sites are created with the intent to modify, where appropriate, specific highway elements that have a high potential to reduce the identified high severity collisions.

Design Matrix 4

Interchange Areas, NHS (Except Interstate) and Non-NHS

(Supplement to be used on projects programmed for '09-'11 biennium)

⇩ Project Type															Bridges (11)				Intersections			Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane Tran-sition	Median Width	Cross Slope Lane	Cross Slope Shldr	Fill/ Ditch Slopes	Access (3)	Clear Zone (18)	Sign, Del., Illumin.	Basic Safety	Bike & Ped.	Lane Width	Shldr Width	Vertical Clear.	Structural Capacity	Turn Radii	Angle	I/S Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail (19)
Preservation																								
Roadway																								
(5-1) HMA/PCCP												B	B	M			F				B	F	B	F
(5-2) BST																								
(5-3) BST Routes/Basic Safety												B	B								B	F	B	F
(5-4) Replace HMA with PCCP at I/S			EU/M	EU/M		DE/M	EU/M					B	B	M			F					F	B	F
Structures																								
(5-5) Bridge Replacement	M	F	M	M	F		M	M	M		F	F		F	F(2)	F(2)	F	F	M	M	F	F	F	F
(5-6) Bridge Repl. (Multilane)	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)		F	F		F	F(2)	F(2)	F	F	F(2)	F(2)	F	F	F	F
(5-7) Bridge Deck Rehab												B	B	M								F(6)	F(22)	F
Improvements (16)																								
Mobility																								
(5-8) Urban (Multilane)	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F(2)	F	F	EU/F	EU/F	F	F	F	F
(5-9) Urban	M	M	M	M	F		M	M	M	F	F	F		F	M	M	F	F	EU/M	EU/M	F	F	F	F
(5-10) Rural	M	M	M	M	F	M	M	M	M	F	F	F		F	M	M	F	F	EU/M	EU/M	F	F	F	F
(5-11) HOV	M	M	M	M	F	M	M	M	M	F	F	F		F	M	M	F	F	EU/M	EU/M	F	F	F	F
(5-12) Bike/Ped. Connectivity	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)		F	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Safety																								
(5-13) Non-Interstate Freeway	F(2)	F(2)	F(2)	F(2)	F(2)	F(2)	F(2)	F(2)	F(2)	F	F	F		F	F(2)	F(2)	F		F(2)	F(2)	F	F	F	F
(5-14) Intersection (1)			M(4)	M(4)	F				M(4)	F	F	F		M					M(4)	M(4)	F	F	F	F
(5-15) Corridor (1)	M(4)	M(4)	M(4)	M(4)	F	M(4)	M(4)	M (4)	M(4)	F	F	F		M	M(4)	M(4)	F		M(4)	M(4)	F	F	F	F
(5-16) Median Barrier				DE/F																		F(20)	F(20)	
(5-17) Guardrail Upgrades				DE/F																		F	F(23)	
(5-18) Bridge Rail Upgrades																						F	F(22)	F
(5-19) Risk: Roadside									M(4)	EU/F	F	F										F	F	F
(5-20) Risk: Sight Distance	F/M(21)	F/M(21)	F/M(21)	F/M(21)					F/M(21)	F(21)	F(21)	F		F	F(21)	F(21)	F(21)		F/M(21)	F/M(21)	F(21)	F	F	F
(5-21) Risk: Roadway Width			F/M(21)	F/M(21)	F	F/M(21)	F/M(21)	F/M(21)	F/M(21)	F	F	F		F	F(21)	F(21)	F(21)		F/M(21)	F/M(21)	F(21)	F	F	F
(5-22) Risk: Realignment	F/M	F/M	F/M	F/M	F	F/M	F(2)	F(2)	F/M	F	F	F		F	F(21)	F(21)	F(21)		F/M(21)	F/M(21)	F(21)	F	F	F
(5-27) Collision Analysis Locations*	Design Elements determined based on a Project Analysis (See Note 1)																							
Economic Development																								
(5-23) Freight & Goods (Frost Free) (8)	EU/M	EU/M	EU/M	EU/M	EU/F	EU/M	M	M	EU/M		F	B	B	EU/F(26)	DE/M	DE/M	F		EU/M	EU/M	EU/F	F	B	F
(5-24) Rest Areas (New)	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F			F	F	F	F	F	F
(5-25) Bridge Restrictions	M	F	M	M	F	M	M	M	M		F	F		EU/F(26)	M	M	F	F	M	M	F	F	F	F
(5-26) Bike Routes (Shldrs)			EU/M	(7)	EU/F			EU/M	EU/M			B	B	F	EU/M	EU/M					B	F	B	EU/F

☐	Not Applicable
F	Full design level (see Chapter 440).
M	Modified design level. See Chapter 430.
F/M	Full for freeways/Modified for non-freeway
B	Basic design level. See Chapter 410.
DE	Design Exception to full design level.
EU	Evaluate Upgrade to full design level.

(1) Collision Analysis Locations (CALs) require a Project Analysis to document the needs at a location and determine the appropriate design elements to address these needs.

(2) Modified design level may apply based on a corridor or project analysis (see 325.03(5)).

(3) If designated as L/A acquired in the Access Control Tracking System, limited access requirements apply. If not, managed access applies (see 325.03(5)).

(4) Full design level may apply based on a corridor or project analysis (see 325.03(5)).

(5) For bike/pedestrian design see Chapters 1020 and 1025.

(6) Applies only to bridge end terminals and transition sections.

(7) 4 ft minimum shoulders.

(8) If all weather structure can be achieved with spot digouts and overlay, modified design level applies to NHS highways and basic design level applies to non-NHS highways.

(11) See Chapter 1120.

(12) Impact attenuators are considered as terminals.

(16) For design elements not in the matrix headings, apply full design level as found in the applicable chapters and see 325.03(2).

(18) On managed access highways within the limits of incorporated cities and towns, City and County Design Standards apply to areas outside the curb or outside the paved shoulder where no curb exists.

(19) The funding sources for bridge rail are a function of the length of the bridge. Consult programming personnel.

(20) Applies to median elements only.

(21) Analyses required. See 325.03(5) for details.

(22) Upgrade barrier, if necessary, within 200 ft of the end of the bridge.

(23) See description of Guardrail Upgrades Project Type, 325.03(1) regarding length of need.

(26) Sidewalk ramps must be addressed for ADA compliance (see Chapter 1025).

* Collision Analysis Locations are those sites identified through a system-wide analysis that have a high severity collision history. These sites are created with the intent to modify, where appropriate, specific highway elements that have a high potential to reduce the identified high severity collisions.

Design Matrix 5
Main Line Non-NHS Routes

(Supplement to be used on projects programmed for '09-'11 biennium)