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330.01 General

The project file contains the documentation of planning, project definition, programming, design, approvals, contract assembly, utility relocation, needed right-of-way, advertisement, award, construction, and maintenance of a project. A project file is completed for all project and follows the project until a new project supersedes it.

Design documentation is a part of the project file. It documents design decisions and the design process followed. Design documentation is retained in a permanent retrievable file at a central location in each region. For operational changes and developer projects, design documentation is required and is retained by the region.

330.02 References

Construction Manual, M 41-01, WSDOT

Directional Documents Publication Index, D 00-00, WSDOT

Washington State Department of Transportation Certification Acceptance Approval from FHWA, December 4, 1978, and subsequent revisions

FHWA Washington Stewardship Plan, WSDOT 1993

Master Plan for Limited Access, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

Route Development Plan, WSDOT

State Highway System Plan, WSDOT

Highway Runoff Manual, WSDOT

330.03 Purpose

Design documentation is prepared to record the evaluations by the various disciplines that result in design recommendations. Design assumptions and decisions made prior to and during the project definition phase are included. Changes that occur throughout the project development process are documented. Justification and approvals, if required, are also included.

The design documentation identifies:

- The condition or problem that generated the purpose and need for the project (as noted in the Project Summary)
- The design alternatives considered
- The project design selected
- The work required to satisfy the commitments made in the environmental documents
- The conformity of the selected design to departmental policies and standard practices
- The supporting information for any design variances
- The internal and external coordination

The design documentation is used to:

- Examine estimates of cost
- Prepare access and right of way plans
- Assure that all commitments are provided for in the recommended design
- Plan for maintenance responsibilities as a result of the project
- Provide supporting information for design variances
- Explain design decisions
- Document the project development process and design decisions
- Preserve a record of the project's development for future reference
- Prepare plans, specifications, and estimate (PS&E)

430.01 General

Modified design level (M) preserves and improves existing roadway geometrics, safety, and operational elements. This chapter provides the design guidance that is unique to the modified design level.

Design elements that do not have modified design level guidance include:

- Access control, see Chapter 1420
- Access management, see Chapter 920
- Basic safety, see Chapter 410
- Clear zone, see Chapter 700
- Traffic barriers, see Chapter 710
- Gore area lighting, see Chapter 840
- Interchange areas, see Chapter 940

Design elements that have both modified and full design level components include:

- Horizontal alignment, see Chapter 620
- Superelevation and shoulder cross slope, see Chapter 640
- Vertical alignment, see Chapter 630

430.02 Design Speed

When applying modified design level to a project, select a design speed for use in the design process that reflects the character of the terrain and the type of highway. Select a speed that is not less than the posted speed, the proposed posted speed, or the operating speed, whichever is higher.

430.03 Roadway Widths

The design of a project must not decrease the existing roadway width.

Lane and shoulder widths are shown in Figures 430-3 and 4. Consider joint use with other modes of transportation in shoulder design.

Review route continuity and roadway widths. Select widths on the tangents to be consistent throughout a given section of the route. Make any changes where the route characteristics change.

(1) Turning Roadway Widths

It may be necessary to widen the roadway on curves to accommodate large vehicles. The total two-lane roadway width of a curve may not be less than that shown in Figure 430-5 or, if the internal angle (delta) is less than 90 degrees, Figure 430-6. The proposed roadway width for a curve may not be less than that of the adjacent tangent sections.

The total roadway width from Figure 430-5 or Figure 430-6 may include the shoulder. When the shoulder is included, full-depth pavement is required.

Widening of the total roadway width of a curve by less than 0.6 m is not required for existing two-lane roadways that are to remain in place.

(2) Median Width

See Figure 430-3.

430.04 Ramp Lane Widths

Ramp lane widths are shown in Figure 430-1 and in Figure 430-10. For ramps with radii less than 100 m apply full design level see Chapter 640.

Curve Radius	Lane Width
Tangent - 1200 m	3.9 m
900 m - 600 m	4.2 m
300 m - 100 m	4.5 m

Turning Ramp Lane Widths
Modified Design Level
Figure 430-1

430.05 Stopping Sight Distance

(1) Existing Stopping Sight Distance for Vertical Curves

For crest vertical curves use the existing algebraic difference in grades and the length of curve to compare the existing condition to Figure 430-7. If corrective action is required by Figure 430-7, apply full design level and see Chapter 650.

When modified design level is being applied, sag vertical curves are not normally addressed.

(2) Stopping Sight Distance for Horizontal Curves

For modified design level, use the existing lateral clearance to the sight obstruction and the curve radius to compare the existing condition to Figure 430-8. If corrective action is required by Figure 430-8, apply full design level and see Chapter 650.

For Figure 430-8, an obstruction is any object with a height of 0.6 m or more above the roadway surface on the inside of a curve. Examples of possible obstructions are median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings.

430.06 Profile Grades

When applying modified design level, profile grades generally are not flattened. However, corrective action may be justified for combinations of steep grades and restricted horizontal or vertical curvature. Identify major modifications to horizontal and vertical alignment in the Project Decisions Summary. Total removal of pavement and reconstruction of the subgrade are examples of major modifications.

430.07 Cross Slope

On all tangent sections, the normal cross slopes of the traveled way are 2 percent. Cross slopes up to 2 percent have a barely perceptible effect on vehicle steering, but cross slopes steeper than 2 percent can be noticeable.

The algebraic difference in cross slopes is an operational factor during a passing maneuver on a two-lane road. Its influence increases when increased traffic volumes decrease the number and size of available passing opportunities.

If a longitudinal contiguous section of pavement is to be removed or is on a reconstructed alignment, or if a top course is to be placed over existing pavement, design the restored pavement to a cross slope of 2 percent.

A somewhat steeper cross slope may be necessary to facilitate pavement drainage in areas of intense rainfall, even though this might be less desirable from the operational point of view. In such areas, the design cross slopes may be increased to 2.5 percent with an algebraic difference of 5 percent.

For existing pavements, cross slopes within a range of 1 to 3 percent may remain if there are no operational or drainage problems and— on a two-way, two-lane road — the following conditions are met:

- The algebraic difference is not greater than 4 percent where the ADT is greater than 2000.
- The algebraic difference is not greater than 5 percent where the ADT is 2000 or less.
- The algebraic difference is not greater than 6 percent and the road is striped or signed for no passing.

If the existing pavement does not meet the conditions above, correct the cross slope(s) to be within the range of 1.5 to 2.5 percent. For a two-way, two-lane road, provide an algebraic difference to meet the appropriate conditions stated above except when facilitating drainage in areas of intense rainfall. When applying modified design level to a road with bituminous surface treatment (BST), cross slope correction is not required on the basis of algebraic differences alone.

To maintain or restore curb height, consider lowering the existing pavement level and correcting cross slope by grinding before an asphalt overlay. On urban highways, the cross slope of the outside shoulder may be steepened to minimize curb height and other related impacts. The shoulder may be up to 6 percent with a rollover between the traveled way and the shoulder of no more than 8 percent.

430.08 Fill Slopes and Ditch Inslopes

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

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

430.09 Intersections

(1) General

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

(2) Design Vehicle

The following is provided as a guide for determining the design vehicle.

Intersection Type	Design Vehicle
Junction of Major Truck Routes	WB-20
Junction of State Routes	WB 12
Ramp Terminals	WB-12
Other Rural	SU[1]
Urban Industrial	SU[1]
Urban Commercial	P[1]
Residential	P[1]

[1]When the intersection is on a transit route, use the BUS design vehicle. See Chapter 1060 for additional guidance for transit facilities and for the BUS turning path templates.

Design Vehicles
Modified Design Level
Figure 430-2

(3) Angle

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

430.10 Structures

The minimum widths for bridges are shown in Figure 430-4. Consider joint use with other modes of transportation in lane and shoulder design. See Chapter 1020, Facilities for Nonmotorized Transportation, Chapter 1050, High Occupancy Vehicle Facilities, and Chapter 1060, Transit Benefit Facilities.

Principal Arterial Notes:

1 Justify the selection of a P-6 standard.
2 The design year is 20 years after the year the construction is scheduled to begin.
3 Where DHV exceeds 700, provide four lanes. For lower volumes, when the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future four-lane facility. When considering truck climbing lanes on a P-3 design class highway, perform an investigation to determine if a P-2 design class highway is justified.
4 When considering a multilane highway, perform an investigation to determine if a truck climbing lane will satisfy the need.
5 See Chapter 1420 for access control requirements.
6 All main line and major-spur railroad tracks will be separated. Consider allowing at-grade crossings at minor-spur railroad tracks.
7 Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
8 The preferred design speed is within the range. Design speeds above the range may be selected, with justification. The lower end of the range is the minimum design speed for the design class.
9 3.6 m lanes are required when the truck DHV is 6% or grater.
10 Minimum left shoulder width is to be as follows: four lanes — 1.2 m: six or more lanes — 3.0 m. For 6-lane roadways, existing 1.8 m left shoulders may remain when no other widening is required.
11 When curb section is used, a 1.8 m shoulder outside the face of curb is acceptable. See Chapter 910 for shy distances at curbs.
12 On freeways or expressways requiring less than eight lanes within the 20-year design period, provide sufficient median or lateral clearance and right of way to permit addition of a lane in each direction if required by traffic increase after the 20-year period.
13 When signing is required in the median of a six-lane section, the minimum width is 1.8 m. If barrier is to be installed at a future date, a 2.4 m minimum median is required.
14 Parking restricted when ADT is over 15,000.
15 Submit Form 223-528, Pavement Type Determination.
16 Provide right of way width 3 m desirable, 1.5 m minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
17 19 m from edge of traveled way.
18 Make right of way widths not less than those required for necessary cross section elements.
19 See Chapter 1120 for the minimum vertical clearance.
20 For median widths 7.8 m or less, address bridges in accordance with Chapter 1120.
21 For pedestrian, bicycle, and sidewalk requirements see Chapter 1020. Curb requirements are in Chapter 910. Lateral clearances from the face of curb to obstruction are in Chapter 700.
22 Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

Geometric Design Data, Principal Arterial

Figure 440-4b

Design Class	Divided Multilane		Two-Lane						Undivided Multilane	
	M-1		M-2		M-3		M-4		M-5(1)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year(2) NHS Non NHS	Over 701		201-700(3) 401-700		61-200(4) 201-400		60 and Under 200 and Under		Over 701	
Access Control(5)	Partial		Partial		Partial or None		None		Special Cases	
Separate Cross Traffic Highways Railroads	 Where Warranted All		 Where Warranted All(6)		 Where Warranted Where Warranted(7)		 Where Warranted Where Warranted(7)		 Where Warranted Where Warranted (7)	
Design Speed Range (mph)(8)	70 50		70 50	60 40	70 50	60 40	60 40	60 30	70 40	60 30
Traffic Lanes Number Width (m)	 4 or 6 divided 3.6		 2 3.6		 2 3.6		 2 3.6		 4 3.6	 4 or 6 3.3(9)
Shoulder Width (m) Right of Traffic Left of Traffic	 3.0 Variable(10)		2.4		1.8		1.2		2.4	2.4(11)
Median Width (m) 4 lane 6 lane	 18 18	 4.8 6.6							1.2	0.6(12)
Parking Lanes Width (m) — Minimum	None		None		None	3.0	None	3.0	None	3.0(13)
Pavement Type(14)	High		As required						High or Intermediate	
Right of Way(15) — Min Width (m)	(16)	(17)	36	24	36	24	30	24	45	24
Structures (m)(18)	Full Roadway Width(19)		12.0		10.8		9.6		Full Roadway Width	
Other Design Considerations-Urban			(20)		(20)		(20)		(20)	

Grades (%)(21)									
	Rural — Design Speed (mph)					Urban — Design Speed (mph)			
Type of Terrain	40	50	60	70	80	30	40	50	60
Level	5	4	3	3	3	8	7	6	5
Rolling	6	5	4	4	4	9	8	7	6
Mountainous	8	7	6	5	5	11	10	9	8

Geometric Design Data, Minor Arterial
Figure 440-5a

510.01 General

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

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

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

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

510.02 References

Construction Manual, M 41-01, WSDOT

Hydraulics Manual, M 23-03, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

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

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

WSDOT Pavement Guide for Design, Evaluation and Rehabilitation

510.03 Materials Sources

(1) General

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

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

- The site. (Consider the adequacy of the work area.)
- The quality of the material.

- The quantity of the material. (Consider the needs of the immediate project and the needs to support future maintenance and construction work in the area.)
- Reclamation requirements.
- Aesthetic considerations.
- Economic factors.
- Ability to preserve or enhance the visual quality of the highway and local surroundings.

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

(2) Materials Source Approval

The RME submits the materials source report to the OSC Geotechnical Branch for review and approval.

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

510.04 Geotechnical Investigation, Design, and Reporting

(1) General

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

(2) Key Contacts for Initiating Geotechnical Work

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

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

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

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

(3) Scheduling Considerations for Geotechnical Work

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

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

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

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

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

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

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

(a) Project description.

(b) Plan sheets showing the following:

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

(c) Electronic files, or cross sections every 15 to 20 m or as appropriate, to define existing and new ground line above and below the wall, cut, fill, and other pertinent information.

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

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

(e) Due date and work order number.

(f) Contact person.

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

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

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

The region's project office is also responsible for providing the stations, offsets, and elevations of test holes to the nearest 0.3 m once the test holes have been drilled. Provide test hole locations using state plane coordinates as well, if available.

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

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

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

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

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

(6) Earthwork

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

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

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

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

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

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

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

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

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

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

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

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

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

(7) Hydraulic Structures and Environmental Mitigation

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

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

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

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

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

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

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

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

The project designer uses the geotechnical information to:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1. General description of the regional and site geology
2. Summary of the investigation
3. Boring logs
4. Laboratory tests and results
5. Soil/rock unit descriptions
6. Ground water conditions

7. Retaining wall/reinforced slope and noise wall recommendations

- Recommended geometry for stability
- Stability and settlement mitigation requirements, if needed
- Foundation type and capacity
- Estimated amount and rate of settlement
- Design soil parameters
- Construction staging requirements
- Effects of site constraints
- Monitoring needs
- Material and compaction requirements
- Subgrade preparation

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

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

(11) Unstable Slopes

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

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

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

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

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

- Plan sheet showing the station and location of the proposed unstable slope mitigation project.
- If requested, Digital Terrain Model (DTM) files necessary to define the on-ground

topography of the project site. The limits of the DTM will have been defined during the project definition phase.

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

The OSC Geotechnical Branch provides the following information as part of the project geotechnical report (as applicable):

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

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

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

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

(12) Rockslope Design

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

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

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

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

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

The OSC Geotechnical Branch provides the following information as part of the project geotechnical report (as applicable):

1. General site description and summary of site geology.

2. Summary of the field investigation.

3. Boring logs.

4. Laboratory tests and results.

5. Rock units encountered within the project limits.

6. Rock slope design analysis and recommendations.

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

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

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

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

(13) Bridge Foundations

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

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

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

The Bridge and Structures and region offices can expect to receive the following from the OSC Geotechnical Branch:

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

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

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

The Bridge Office is responsible for delivering the following project information, based on bridge site data received from the region's project office, to the OSC Geotechnical Branch:

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

The Bridge Office can expect to receive:

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

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

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

The Bridge Office is responsible for delivering the following project information to the OSC Geotechnical Branch:

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

The Bridge Office can expect to receive:

- Bridge geotechnical foundation report

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

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

(14) Geosynthetics

See Chapter 530 for geosynthetic design guidance.

(15) Washington State Ferries Projects

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

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

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

WSF can expect to receive:

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

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

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

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

(b) **PS&E Development**

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

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

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

WSF can expect to receive:

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

WSF uses this information to complete the PS&E.

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

510.05 Use of Geotechnical Consultants

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

510.06 Geotechnical Work by Others

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

510.07 Surfacing Report

Detailed criteria and methods that govern pavement rehabilitation can be found in *WSDOT Pavement Guide for Design, Evaluation and Rehabilitation*, Volume 1, pages 2-22 through 2-26. The RME provides the surfacing report to the region’s project office. This report provides recommended pavement types, surfacing depths, pavement drainage recommendations, and pavement repair recommendations.

510.08 Documentation

(1) Design Documentation

When a project requires investigation of soils or surfacing materials, the results of the investigations are to be preserved in the project file. (See Chapter 330.) This includes all reports, forms, and attachments.

- ☐ Materials source report and approvals
- ☐ Geotechnical reports
- ☐ Surfacing report

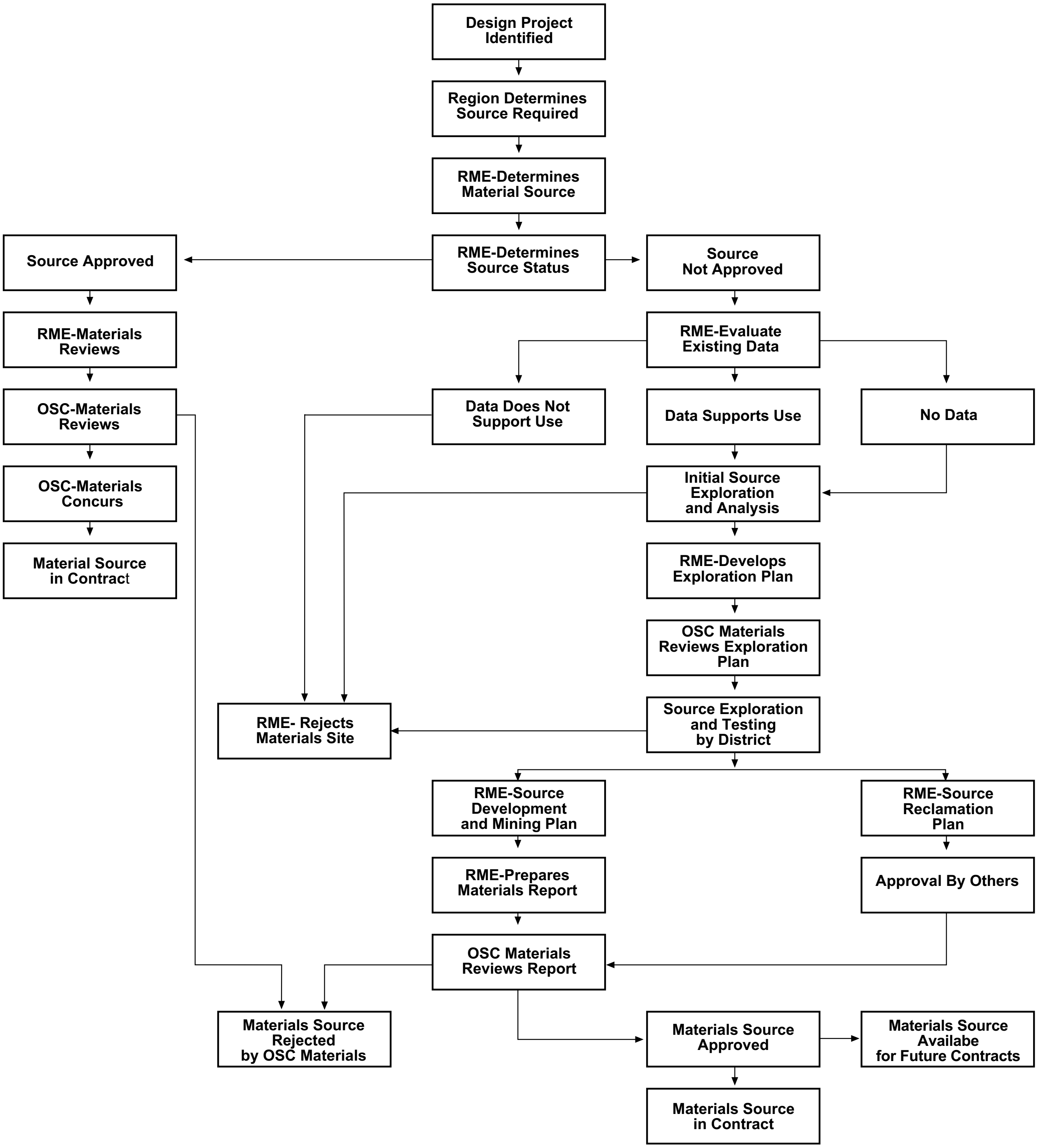
(2) Final Geotechnical Project Documentation and Geotechnical Information Included as Part of the Construction Contract

Once a project PS&E is near completion, all of the geotechnical design memorandums and reports are compiled together to form the Final

Geotechnical Project Documentation, to be published for the use of prospective bidders. The detailed process for this is located in the *Plans Preparation Manual*.

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

P65:DP/DMM



Material Source Development Plan

Figure 510-1

Unit Dry Weight				
Type of Material	Truck Measure		Compacted on Roadway	
	kg/m³	T/m³	kg/m³	T/m³
Ballast	1850	1.85	2300	2.30
Crushed Surfacing Top Course	1700	1.70	2200	2.20
Crushed Surfacing Base Course	1750	1.75	2200	2.20
Screened Gravel Surfacing			2200	2.20
**GraveL Base			2000 - 2250	2.00 - 2.25
Shoulder Ballast			1650	1.65
Maintenance Sand 10 mm - 0	1700	1.70		
Mineral Aggregate 51 mm - 25 mm	1550	1.55		
Mineral Aggregate 44 mm - 19 mm	1550	1.55		
Mineral Aggregate 40 mm - 19 mm	1500	1.50		
Mineral Aggregate 25 mm - 19 mm	1500	1.50		
Mineral Aggregate 19 mm - 13 mm	1400	1.40		
Mineral Aggregate 32 mm - 6 mm	1550	1.55		
Mineral Aggregate 25 mm - 6 mm	1550	1.55		
Mineral Aggregate 22 mm - 6 mm	1500	1.50		
Mineral Aggregate 19 mm - 6 mm	1500	1.50		
Mineral Aggregate 16 mm - 6 mm	1550	1.55		
Mineral Aggregate 13 mm - 6 mm or #4	1550	1.55		
Mineral Aggregate 6 mm or #4 - 0	1700	1.70		
Concrete Aggregate NO. 2 (32 mm - #4)	1800	1.80		
Concrete Sand (Fine Aggregate)	1700	1.70		
Crushed Cover Stone	1700	1.70		

**2,200 kg/m³ (2.20 T/m³) is recommended as the most suitable factor; however, if the grading approaches the coarseness of ballast, the factor would approach 2,250 kg/m³ (2.25 T/m³), and if the grading contains more than 45% sand, the factor would decrease, approaching 2,000 kg/m³ (2.00 T/m³) for material that is essentially all sand.

Mineral Aggregate in Stockpile * (metric tons/km)								
Class	Pavement Compacted Depth (mm)	Agg. Size (mm)	Approx Mix Ratio (%)	Roadway Width (m)				
				3.0	3.3	3.6	6.6	7.2
A & B	30	19 - 6	35	80	88	96	175	191
		6 - 0	65	148	163	177	325	355
D	12	12.5 - 0	100	91	100	109	200	218
E	30	32 - 6	50	114	125	136	250	273
		6 - 0	50	114	125	136	250	273
F	30	19 - 6	35	80	88	96	175	191
		6 - 0	65	148	163	177	325	355
G	30	10 - 0	100	227	250	273	500	546

* 94% by weight of complete mix (92.5% min - 96% max) {(75.8 kg/m²/30 mm = 2.53 T/m³)}

Includes 10% handling loss.

Mineral filler 1% of wearing course for Class B.

General Notes

Weights shown are dry weights and corrections are required for water contents.

The tabulated weights for the materials are reasonably close; however, corrections should be applied in the following order:

For specific gravity:

$$\text{Wt.} = \frac{\text{tabular wt. x specific gravity on surface report}}{2.65}$$

For water content:

Wt. = tabular wt. x (1 + free water % in decimals)

Required quantities should be increased by 10 percent to allow for waste if they are to be stockpiled.

Attention should be directed to the inclusion of crushed surfacing top course material that may be required for keystone when estimating quantities for projects having ballast course.

Estimating — Miscellaneous Tables

Figure 520-1

General Data [1,2,3]

Asphalt Concrete Pavement

Complete Mix

Class of Mix	Depth (mm)	Spread Per sq. m: kg	Spread Per sq. m: T	m^2 per T	T/km Width (m): 3.0	3.3	3.6
A, B, E, F & G	30	73.2	0.073	13.67	219	241	263
D	12	24.0	0.024	41.62	72	79	86

Primecoats and Tackcoats

	Asphalt						Aggregate [4]							
Application	Type of Asphalt[5]	Application liters[6] per m^2	T per m^2	T/km Width (m) 3.0	3.3	3.6	Application kg per m^2	T/km Width (m) 3.0	3.3	3.6	m^3 per m^2	m^3/km WIDTH (m) 3.0	3.3	3.6
Prime Coat	MC-250	1.13	0.001089	3.3	3.6	3.9	16.3	49	54	59	0.0096	29	32	35
Tack Coat	CSS-1	0.23	0.000226	0.7	0.7	0.8								
Class D Tack Coat	CSS-1	0.45	0.000452	1.4	1.5	1.6								
Fog Seal	CSS-1	0.18	0.000181	0.5	0.6	0.7								
Total	CSS-1	0.63	0.000634	1.9	2.1	2.3								

Specific Data [1,2,3]

Asphalt Concrete Paving Quantities (metric tons/km)*

Width (m)	Depth of Pavement (mm): 30	45	60	75	90	105	120	135	150	165	180	195	210	225
1.2	88	132	176	220	264	307	351	395	439	483	527	571	615	659
1.8	132	198	264	329	395	461	527	593	659	725	791	856	922	988
2.4	176	264	351	439	527	615	703	791	878	966	1054	1142	1230	1318
3.0	220	329	439	549	659	769	878	988	1098	1208	1318	1427	1537	1647
3.3	242	362	483	604	725	845	966	1087	1208	1329	1449	1570	1691	1812
3.6	264	395	527	659	791	922	1054	1186	1318	1449	1581	1713	1845	1976
6.6	483	725	966	1208	1449	1691	1932	2174	2416	2657	2899	3140	3382	3623
7.2	527	791	1054	1318	1581	1845	2108	2372	2635	2899	3162	3426	3689	3953

*Based on 73.2 kg/ m^2 of 30 mm compacted depth = 2.44 T/m^3

[1]The specific gravity of the aggregate will affect the weight of aggregate in the completed mix.

[2]The percentage of fine mineral in the coarse aggregate will affect the ratio of course to fine. If the coarse aggregate produced contains an excessive amount of fines (6 mm to 0), the percentage of coarse aggregate should be increased and the fines decreased accordingly.

[3]Quantities shown do not provide for widening, waste from stockpile, or thickened edges.

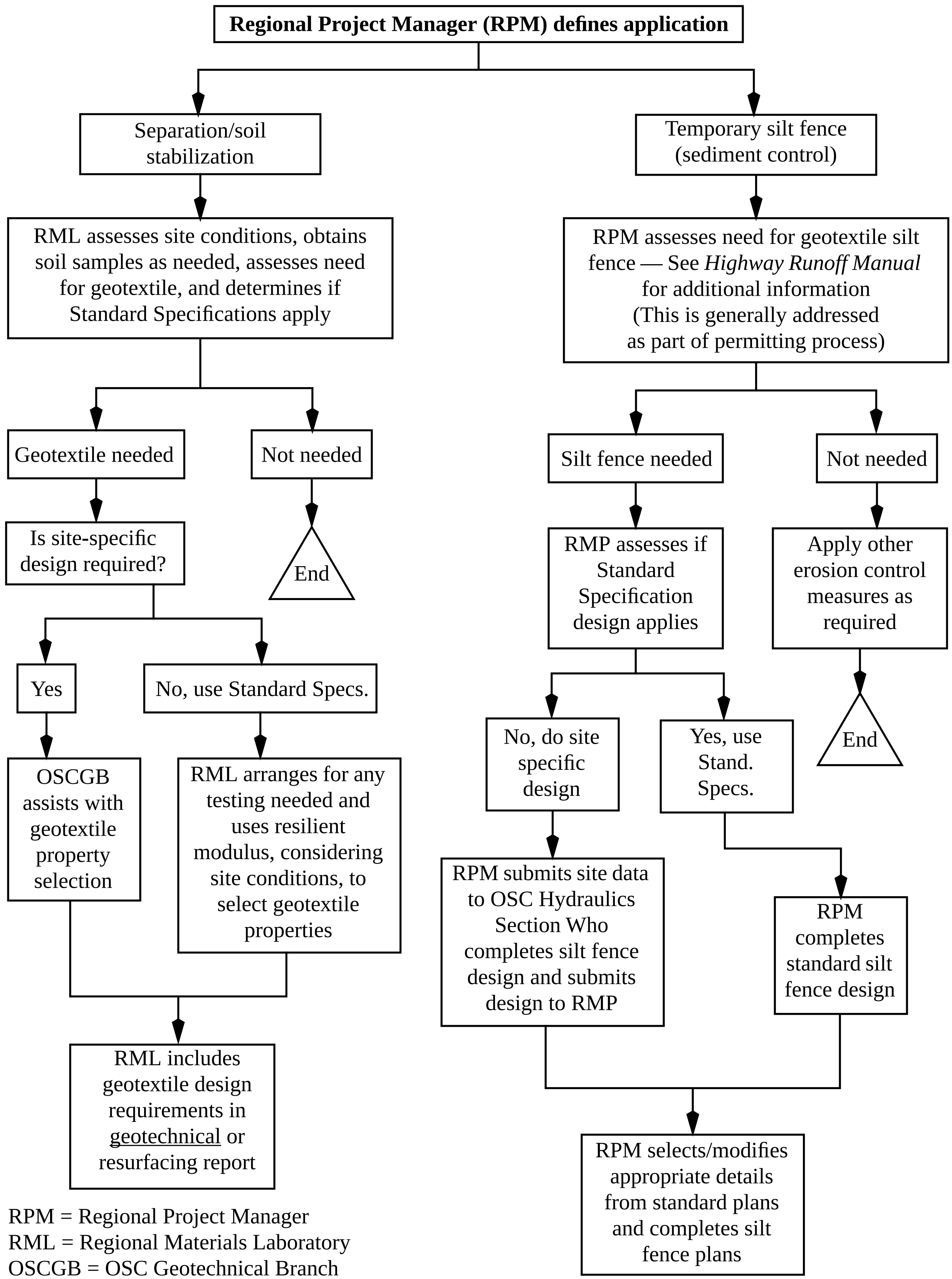
[4]See miscellaneous tables for the average weights of mineral aggregates used in calculation of the data.

[5]The column "Type of Asphalt" is shown for the purpose of conversion to proper weights for the asphalt being used and does not imply that the particular grade shown is required for the respective treatment.

[6]Quantities shown are retained asphalt.

Estimating — Asphalt Concrete Pavement and Asphalt Distribution Tables

Figure 520-2a



Design Process for Separation, Soil Stabilization, and Silt Fence

Figure 530-5

620.01 General

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

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

620.02 References

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

Utilities Manual, M 22-87, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, M 24-01, WSDOT

Right of Way Manual, M 26-01, WSDOT

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

A Policy on Geometric Design of Highways and Street, 1994, AASHTO

620.03 Definitions

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

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

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

outer separation The area between the outside edge of the through highway lanes and the inside edge of a frontage road

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

620.04 Horizontal Alignment

(1) General

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

Figures 620-1a and 1c show both desirable and undesirable alignment examples for use with the following considerations:

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

(2) Basic Number of Lanes

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

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

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

(3) Auxiliary Lanes

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

To ensure efficient operation of auxiliary lanes see the following:

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

620.07 Pavement Transitions

(1) Lane Transitions

To narrow a lane or to reduce the number of lanes, a transition is required. The following guidelines apply:

- Locate transitions where decision sight distance exists, preferably on a tangent section and on the approach side of any crest vertical curve (except the end of climbing lanes which are transitioned in accordance with Chapter 1010).
- Supplement the transition with traffic control devices.
- Reduce the number of lanes by dropping only one at a time from the right side in the direction of travel. (When dropping a lane on the left side, an approved deviation is required.) See the MUTCD when more than one lane in a single direction must be dropped.
- Use the following formula to determine the minimum length of the lane transition for high speed conditions (45 mph or more):

  $L = VT$

  Where:

  L = length of transition (m)
  V = design speed (mph)
  T = tangential offset width (m)
- Use a tangential rate of change of 1:25 or flatter for low speed conditions (less than 45 mph).

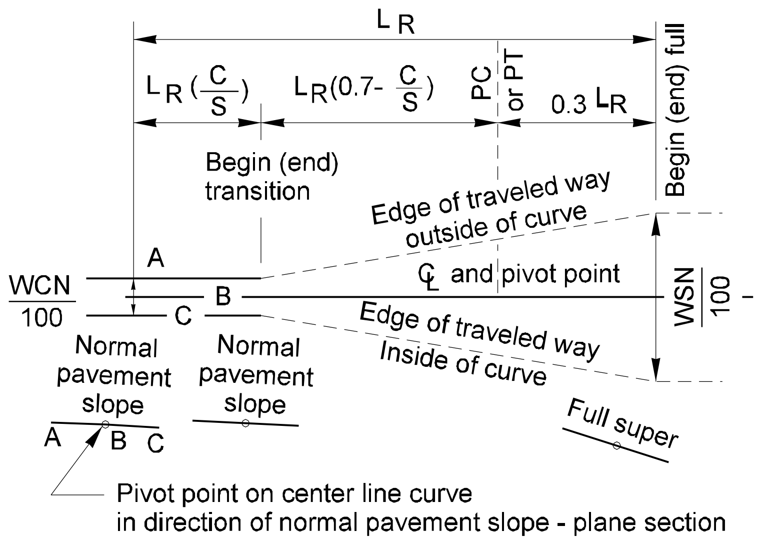
To widen a lane or to increase the number of lanes, a tangential rate of change in the range of 1:4 to 1:15 is sufficient. Aesthetics are the main consideration.

(2) Median Width Transitions

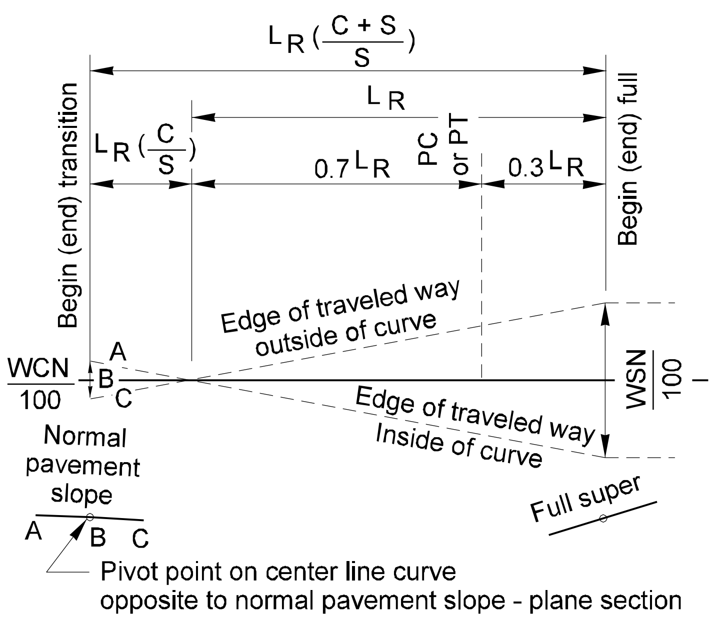
Whenever two abutting sections have different median widths, use long, smooth transitions ($L = VT$ or flatter). When horizontal curves are present, this can be accomplished by providing the transition throughout the length of the curve. When required on a tangent section, the transition may be applied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

620.08 Procedures

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



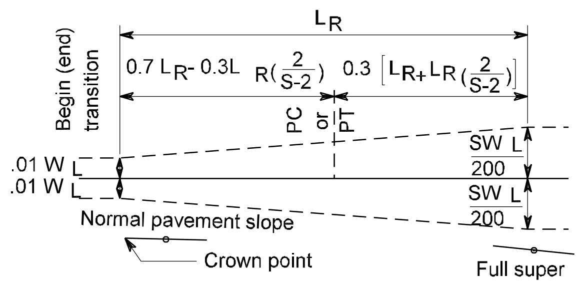
Design C[1]



Design C[2]

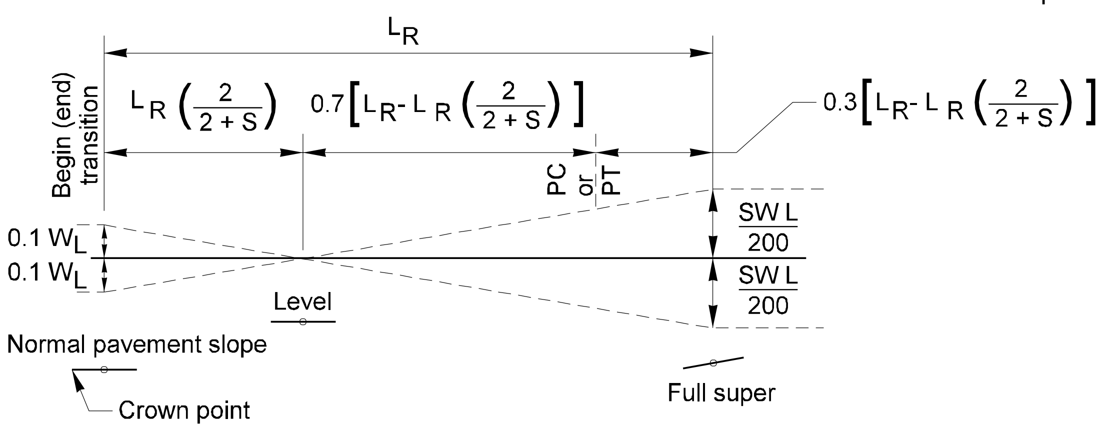
C = Normal crown (%)
S = Superelevation rate (%)
N = Number of lanes between points
W = Width of lane

Superelevation Transitions for Highway Curves
Figure 640-13c



S (%)	20 mph		25 mph		30 mph		35 mph		40 mph		45 mph		50 mph		≥ 55 mph	
	Length of transition in meters for Design Speed of:															
	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T
3	3	20	4	25	4	35	4	35	4	40	5	45	5	50	5	50
4	6	20	7	25	7	35	8	35	8	40	9	45	9	50	10	50
5	9	20	10	25	11	35	11	35	12	40	13	45	14	50	15	50
6	12	20	13	25	14	35	15	35	16	40	17	45	18	50	20	50
7	15	20	16	25	17	35	19	35	20	40	22	45	23	50	24	50
8	18	20	20	25	21	35	22	35	24	40	26	45	27	50	29	50
9	21	21	23	25	24	35	26	35	28	40	30	45	32	50	34	50
10	24	24	26	26	27	35	30	35	32	40	34	45	36	50	39	50

Table 1 Pivot Point on Center Line — Curve in Direction of Normal Pavement Slope



S (%)	20 mph		25 mph		30 mph		35 mph		40 mph		45 mph		50 mph		≥ 55 mph	
	Length of transition in meters for Design Speed of:															
	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T
2	12	20	13	25	14	35	15	35	16	40	17	45	18	50	20	50
3	15	20	16	25	17	35	19	35	20	40	22	45	23	50	24	50
4	18	20	20	25	21	35	22	35	24	40	26	45	27	50	29	50
5	21	21	23	25	24	35	26	35	28	40	30	45	32	50	34	50
6	24	24	26	26	27	35	30	35	32	40	34	45	36	50	39	50
7	27	27	29	29	31	35	33	35	36	40	38	45	41	50	44	50
8	30	30	32	32	34	35	37	37	40	40	43	45	45	50	48	50
9	33	33	36	36	38	38	41	41	44	44	47	47	50	50	53	53
10	36	36	39	39	41	41	44	44	48	48	51	51	54	54	58	58

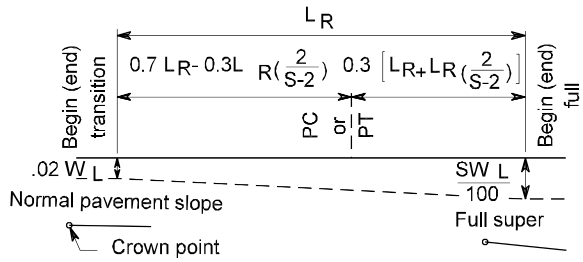
Table 2 Pivot Point on Center Line — Curve in Direction Opposite to Normal Pavement Slope

$L_R = L_B * (1+0.13889x)$ Where: x = width of lane greater than 4.5 m.

W_L = width of ramp lane

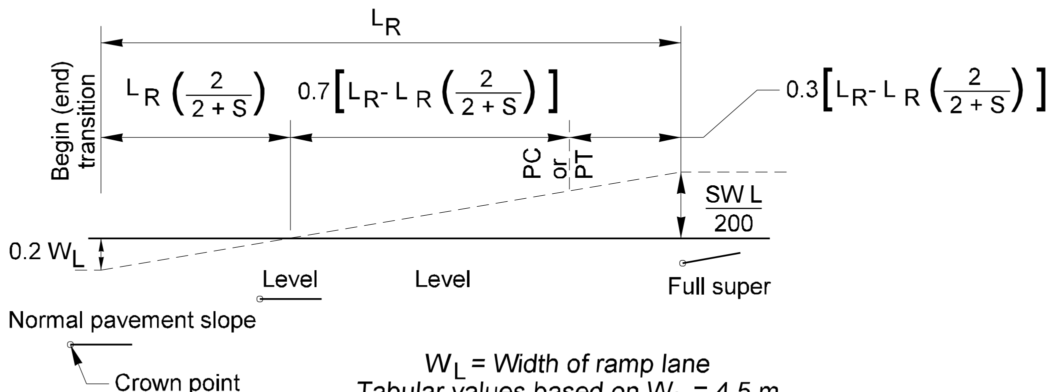
Superelevation Transitions for Ramp Curves

Figure 640-14a



S	Length of transition in meters for Design Speed of:															
	20 mph		25 mph		30 mph		35 mph		40 mph		45 mph		50 mph		≥ 55 mph	
(%)	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T
3	6	20	7	25	7	35	8	35	8	40	9	45	9	50	10	50
4	12	20	13	25	14	35	15	35	16	40	17	45	18	50	20	50
5	18	20	20	25	21	35	22	35	24	40	26	45	27	50	29	50
6	24	24	26	26	27	35	30	35	32	40	34	45	36	50	39	50
7	30	30	32	32	34	35	37	37	40	40	43	45	45	50	48	50
8	36	36	39	39	41	41	44	44	48	48	51	51	54	54	58	58
9	42	42	45	45	48	48	52	52	56	56	60	60	63	63	68	68
10	48	48	51	51	54	54	59	59	63	63	68	68	72	72	77	77

Table 3 Pivot Point on Edge of Lane — Curve in Direction of Normal Pavement Slope



W_L = Width of ramp lane
Tabular values based on W_L = 4.5 m

S	Length of transition in meters for Design Speed of:															
	20 mph		25 mph		30 mph		35 mph		40 mph		45 mph		50 mph		≥ 55 mph	
(%)	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T	L_B	L_T
2	24	24	26	26	27	35	30	35	32	40	34	45	36	50	39	50
3	30	30	32	32	34	35	37	37	40	40	43	45	45	50	48	50
4	36	36	39	39	41	41	44	44	48	48	51	51	54	54	58	58
5	42	42	45	45	48	48	52	52	56	56	60	60	63	63	68	68
6	48	48	51	51	54	54	59	59	63	63	68	68	72	72	77	77
7	54	54	58	58	61	61	66	66	71	71	76	76	81	81	87	87
8	60	60	64	64	68	68	74	74	79	79	85	85	90	90	96	96
9	66	66	71	71	75	75	81	81	87	87	93	93	99	99	106	106
10	72	72	77	77	81	81	88	88	95	95	102	102	108	108	116	116

Table 4 Pivot Point on Edge of Lane — Curve in Direction Opposite to Normal Pavement Slope

$L_R = L_B*(1+0.13889x)$ Where: x = width of lane greater than 4.5 m.

W_L = width of ramp lane

Superelevation Transitions for Ramp Curves

Figure 640-14b

When a new crest vertical curve is built or an existing one is rebuilt, provide Design Stopping Sight Distance from Figure 650-2. An existing crest vertical curve with Existing Stopping Sight Distance from Figure 650-3 may remain in place.

(4) Sag Vertical Curves

Use Figure 650-8 to find the minimum length for a sag vertical curve when given the stopping sight distance and the algebraic difference in grades. The minimum length for a sag vertical curve can also be determined by multiplying the algebraic difference in grades by the K_S value from Figure 650-2 for design or 650-3 for existing ($L=K_S*A$). Both the figure and the equation give approximately the same length of curve. Neither the figure nor the equation uses 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 on 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, provide Design Stopping Sight Distance from Figure 650-2. An existing sag vertical curve with Existing Stopping Sight Distance from Figure 650-3 may remain in place.

(5) Horizontal Curves

Use Figure 650-9 to check for adequate stopping sight distance where sight obstructions are on the inside of a curve. A stopping sight distance obstruction is any object 610 mm or greater above the roadway surface (such as median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings). Figure 650-9 (both the equation and the graph) 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 less than half the stopping sight distance into the curve, the desired sight distance may be available with a lesser M distance. When this occurs, the sight distance can be checked graphically.

Provide Design Stopping Sight Distance from Figure 650-2 for horizontal curves as follows:

- For all new roadways
- When the roadway is widened
- When there is an alignment shift
- For new features (such as median barrier, bridges, walls, or guardrail)
- When additional right of way is required for roadside improvements

When design stopping sight distance is not required, existing features that have Existing Stopping Sight Distance from Figure 650-3, may remain in place.

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 where highway features create a likelihood for error in information reception, decision making, or control actions. Example highway features include interchanges and intersections; changes in cross section at toll plazas, drop lanes, etc.; and areas of concentrated demand where sources of information compete, as those from roadway elements, traffic, traffic control devices, and advertising signs. If possible, locate these highway features where decision sight distance can be provided. If this is not possible, use suitable traffic control devices and positive guidance to give advanced warning of the conditions.

Use the decision sight distances in Figure 650-5 where highway features require complex driving decisions.

anchor with the Weak Post Intersection Design. (See 710.06(4) Cases 12 and 13.) The Type 7 anchor is used to develop tensile strength in the middle of a guardrail run when the guardrail curves and weak posts are used. (See 710.06(4) cases 9, 12, and 13.)

Locations where crossroads and driveways cause gaps in the guardrail require special consideration. Elimination of the need for the barrier is the preferred solution. Otherwise, a barrier flare may be required to provide sight distance. If the slope is 1:2 or flatter and there are no hazards on or at the bottom of the slope, a terminal can be used to end the rail. Place the anchor of this installation as close as possible to the road approach radius PC. If there is a hazard at or near the bottom of the slope that cannot be mitigated, then the Weak Post Intersection Design (see 710.04(4) and the *Standard Plans*) can be used. This system can also be used at locations where a crossroad or road approach is near the end of a bridge and installing a standard bridge approach guardrail placement (guardrail transition and terminal) is not possible.

(e) **Evaluating Existing Terminals.** There are several older terminal designs that may be encountered on our highways. The predominant terminal on our highways is the Breakaway Cable Terminal (BCT). This system used a parabolic flare similar to the SRT with a Type 1 anchor. Type 1 anchor posts are wood set in a steel tube or a concrete foundation.

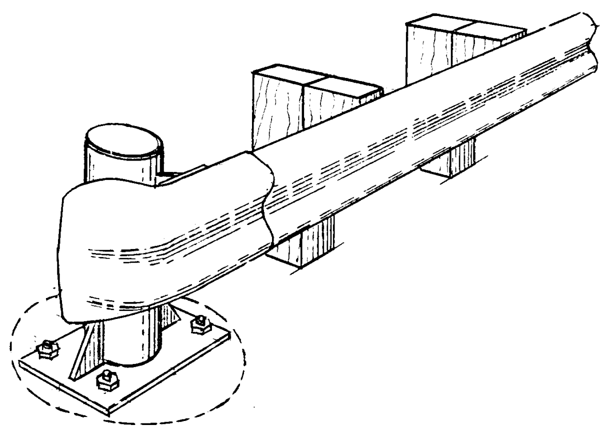
BCTs that have at least a 1 m offset may remain in place unless the guardrail run or anchor is being reconstructed or reset. (Raising the rail element is not considered reconstruction or resetting.) BCTs with less than a 1 m offset must be replaced.

Replace existing buried terminals that slope down such that the guardrail height is reduced to less than 600 mm.

Replace guardrail ends that do not have a crashworthy design with a crash worthy guardrail terminal. Common features of noncrashworthy designs are as follows:

- No cable anchor.
- A cable anchored into concrete in front of the first post.
- Second post not breakaway (CRT).
- Design A end section (Design C end sections are acceptable to be left in place).
- Beam guardrail on both sides of the posts (two sided).

The old Type 3 anchor, which was primarily used at bridge ends. (See Figure 710-5.) This anchor consisted of a steel pipe mounted vertically in a concrete foundation. Bridge approach guardrail was then mounted on the steel pipe. On one-way highways, these anchors were usually positioned so that neither the anchor nor the bridge rail posed a snagging hazard. In these cases, the anchor may remain in place if a stiffened transition section is provided at the connection to the post. On two-way highways the anchor may present a snagging hazard. In these cases, install a connection from the anchor to the bridge rail if the offset from the bridge rail to the face of the guardrail is 460 mm or less. If the offset is greater than 460 mm, remove the anchor and install a new transition and connection.



Old Type 3 Anchor
Figure 710-5

(3) Transitions and Connections

When there is an abrupt change from one barrier type to a more rigid barrier type, a vehicle hitting the more flexible barrier is likely to be caught in the deflected barrier pocket and directed into the more rigid barrier. This is commonly referred to as pocketing. A transition stiffens the more flexible barrier by decreasing the post spacing, increasing the post size, and using stiffer beam elements to eliminate the possibility of pocketing.

820.01 General

Signing is a primary mechanism for regulating, warning, and guiding traffic. Signing must be in place when any section of highway is open to the motoring public. Each highway project has unique and specific signing requirements. For statewide signing uniformity and continuity, it is sometimes necessary to provide signing beyond the project limits. Design characteristics of the facility determine the size and legend for a sign. As the design speed increases, larger sign sizes are necessary to provide adequate message comprehension time. The MUTCD, the *Traffic Manual*, and the *Sign Fabrication Manual* contain standard sign dimensions, specific legends, and reflective sheeting types for all new signs. Guide signing provides the motorist with guidance to destinations. This information is always presented in a consistent manner. In some cases, there are specific laws, regulations, and policies governing the content of the messages on these signs. All proposed guide signs for a project require the approval of the region's Traffic Engineer. The use of nonstandard signs is strongly discouraged and their use requires the approval of the State Traffic Engineer.

The Design Matrices identify the design levels for signing on all preservation and improvement projects. These levels are indicated in the column "Signing" for Interstate main line and the column "Signing, Delineation, and Illumination" for all other routes.

Review and update existing signing within the limits of all preservation and improvement projects as indicated in the matrices. Provide standard signing on projects with either a "B" (basic design level) or "EU" (evaluate upgrade) matrix designation by applying the following criteria to determine the need to replace or modify existing signs:

- Lack of nighttime retroreflectivity.
- Substantial damage, vandalism, or deterioration.
- Age of signs (seven to ten years old).
- A change in sign use policy.
- Improper location.
- Message or destination changes necessary to satisfy commitments to public or local agencies.
- Substandard mounting height.
- Change in jurisdiction, for example a county road becomes a state route.

Address sign support breakaway features when identified in the "Clear Zone" columns of the Matrices. When the "F" (full design level) matrix designation is present, the preceding criteria are still applicable and all existing signing is required to conform to the current policy for reflective sign sheeting requirements. Remove or replace signing not conforming to this policy.

820.02 References

Revised Code of Washington (RCW) 47.36.030, Traffic control devices

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT, Washington DC, 1988, including the *Washington State Modifications to the MUTCD*, M 24-01, WSDOT, 1996

Traffic Manual, M 51-02, WSDOT

Sign Fabrication Manual, M 55-05, WSDOT

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

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

Plans Preparation Manual, M 22-31, WSDOT

Directive D 32-20, "State Route Mileposts," WSDOT

820.03 Design Components

(1) Location

The MUTCD contains the guidelines for positioning signs. Check sign locations to ensure that the motorist's view of the sign is not obscured by other roadside appurtenances. Also, determine if the proposed sign will obstruct the view of other signs or limit the motorist's sight distance of the roadway. Reposition existing signs, when necessary, to satisfy these visibility requirements. Where possible, locate signs behind existing traffic barriers, on grade separation structures, or where terrain features will minimize their exposure to errant vehicles.

(2) Longitudinal Placement

The MUTCD and the *Traffic Manual* provide guidelines for the longitudinal placement of signs that are dependent on the type of sign. Select a location to fit the existing conditions to ensure visibility and adequate response time. In most cases, signs can be shifted longitudinally to enhance safety without compromising their intended purpose.

(3) Lateral Clearance

The MUTCD contains minimum requirements for the lateral placement of signs. These requirements are shown in Figures 820-1a and 820-1b. When possible, position the signs at the maximum practical lateral clearance for safety and reduced maintenance costs. Locate large guide signs and motorist information signs beyond the Design Clear Zone, when limited right of way or other physical constraints are not a factor. See Chapter 700. On steep fill slopes, an errant vehicle is likely to be partially airborne from the slope break near the edge of shoulder to a point 3.6 m down the slope. When signs are placed on fill slopes steeper than 1:6, locate the support at least 3.6 m beyond the slope break. Use breakaway sign support features, when required, for signs located within the Design Clear Zone and for signs located beyond this zone where there is a possibility they might be struck by an errant vehicle. Breakaway features are not necessary on sign posts located behind traffic barriers. Install longitudinal barrier to shield signs without breakaway features within the Design Clear Zone when no other options are available.

Sign bridges and cantilever sign structures have limited span lengths. Locate the vertical components of these structures as far from the traveled way as possible and, where appropriate, install traffic barriers or land forms. See Chapter 710.

Do not locate sign posts in the bottom of a ditch or where the posts will straddle the ditch. The preferred location is beyond the ditch or on the ditch backslope. In high fill areas, where conditions require placement of a sign behind a traffic barrier, consider adding embankment material to reduce the length of the sign supports.

(4) Sign Heights

For ground-mounted signs installed at the side of the road, provide a mounting height of at least 2.1 m, measured from the bottom of the sign to the edge of traveled way. Supplemental plaques, when used, are mounted directly below the primary sign. At these locations, the minimum mounting height of the plaque is 1.5 m.

Do not attach supplemental guide signs to the posts below the hinge mechanism or saw cut notch on multiple post installations. The location of these hinges or saw cuts on the sign supports are shown in the Standard Plans.

A minimum 2.1 m vertical height from the bottom of the sign to the ground directly below the sign is necessary for the breakaway features of the sign support to function properly when struck by a vehicle. The minimum mounting height for new signs located behind longitudinal barriers is 2.1 m, measured from the bottom of the sign to the edge of traveled way. A lower mounting height of 1.5 m may be used when replacing a sign panel on an existing sign assembly located behind longitudinal barrier.

Signs used to reserve parking for people with disabilities are installed at each designated parking stall and are mounted between 0.9 m and 2.1 m above the surface at the sign location. Figures 820-1a and 820-1b show typical sign installations.

(5) Foundations

Foundation details for wood and steel ground mounted sign supports are shown in the Standard Plans. That manual also contains foundation designs for truss-type sign bridges and cantilever sign structures. Three designs, Types 1, 2, and 3, are shown for each structure.

An investigation of the foundation material is necessary to determine the appropriate foundation design. The Type 1 foundation design uses a large concrete shaft and is the preferred installation when the lateral bearing pressure of the soil is 120 MPa or greater. The Type 2 foundation has a large rectangular footing design and is an alternate to the Type 1 foundation when the concrete shaft is not suitable. The Type 3 foundation is used in poorer soil conditions where the lateral bearing pressure of the soil is between 72 MPa and 120 MPa. Use the data obtained from the geotechnical report to select the foundation type.

If a nonstandard foundation or monotube structure design is planned, forward the report to the Bridge and Structures Office for their use in developing a suitable foundation design. See Chapter 510.

(6) Sign Posts

Ground mounted signs are installed on either wood posts, laminated wood box posts, or steel posts. The size and number of posts required for a sign installation are based on the height and surface area of the sign, or signs, being supported. Use the information in Figures 820-2, 820-3, and 820-4 to determine the posts required for each installation. Use steel posts with breakaway supports that are multidirectional if the support is likely to be hit from more than one direction. Design features of breakaway supports are shown in the Standard Plans. Steel posts with Type 2A and 2B bases have multidirectional breakaway features.

820.04 Overhead Installation

Conditions justifying the use of overhead sign installations are noted in the MUTCD. Where possible, mount overhead signs on grade separation structures rather than sign bridges or cantilever supports.

Details for the construction of truss-type sign bridges and cantilever sign supports are shown in the Standard Plans.

The Bridge and Structures Office designs structure mounted sign mountings, monotube sign bridges, and monotube cantilever sign supports. For overhead sign installation designs, provide sign dimensions, horizontal location in relation to the roadway, and the location of the lighting fixtures, to facilitate design of the mounting components by the Bridge and Structures Office.

(1) Illumination

In urban areas, all overhead signs on multilane highways are illuminated. In rural areas, all overhead regulatory and warning signs including guide signs with “Exit Only” panels on both multilane and conventional highways are illuminated. All other overhead signs are only illuminated when one of the following conditions is present:

- Sign visibility is less than 240 m due to intervening sight obstructions such as highway structures or roadside features
- Ambient light from a non-highway light source interferes with the sign’s legibility
- The sign assembly includes a flashing beacon

Sign illumination is provided with sign lighting fixtures mounted directly below the sign. The light source of the fixture is a 175 watt mercury vapor lamp. Provide one sign light for a sign with a width of 4.8 m or less. For wider signs, provide two or more sign lights with a spacing not exceeding 4.8 m. If two or more closely spaced signs are in the same vertical plane on the structure, consider the signs as one unit and use a uniform light fixture spacing for the entire width.

Voltage drops can be significant when the electrical service is not nearby. See Chapter 840 for guidance in calculating electrical line loss.

In areas where an electrical power source is more than 800 m away, utility company installation costs can be prohibitive. Reconsider the benefit of an overhead sign installation at these locations.

(2) Vertical Clearance

The minimum vertical clearance from the roadway surface to the lowest point of an overhead sign assembly is 5.3 m. The maximum clearance is 6.4 m.

(3) Horizontal Placement

Consider roadway geometrics and anticipated traffic characteristics in order to locate signs above the lane, or lanes, to which they apply. Install advance guide signs and exit direction signs that require an EXIT ONLY and "down arrow" panel directly above the drop lanes. To reduce driver confusion as to which lane is being dropped, avoid locating a sign with an EXIT ONLY panel on a horizontal curve.

(4) Service Walkways

Walkways are provided on structure-mounted signs, truss-type sign bridges, and truss-type cantilever sign supports where the roadway and traffic conditions prohibit normal sign maintenance activities. Normally, monotube sign bridges and cantilever sign supports do not have service walkways.

Vandalism of signs, particularly in the form of graffiti, can be a major problem in some areas. Vandals sometimes use the service walkways. Maintenance costs in cleaning or replacing vandalized signs at these locations can exceed the benefit of providing the service walkway.

820.05 Mileposts

Milepost markers are a part of a statewide system for all state highways and are installed in accordance with the Directive D 32-20, State Route Mileposts.

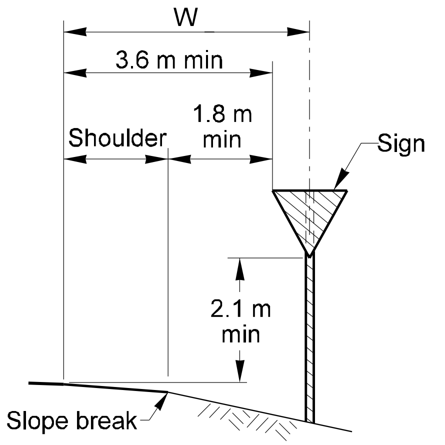
820.06 Guide Sign Plan

A guide sign plan is used by the region to identify existing and proposed guide signing on state highways. The plan provides an easily understood graphic representation of the signing and allows assessment of the continuity in signing to motorist destinations, activities, and services. It is also used to identify deficiencies or poorly defined routes of travel. A guide sign plan for safety and mobility improvement projects is desirable. When proposed highway work affects signing to a city or town, the guide sign plan can be furnished to the official governing body for review and consideration. The guide sign plan is reviewed and approved by the region's Traffic Engineer.

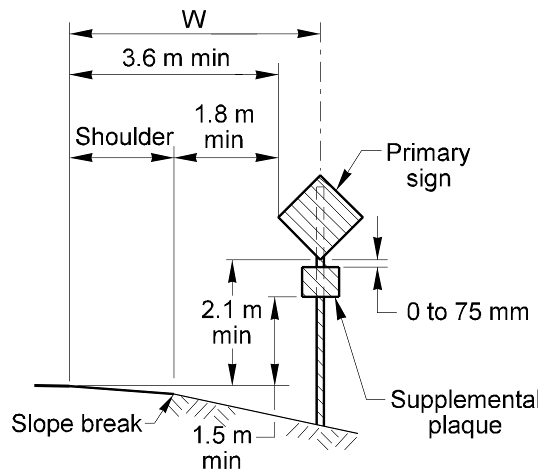
820.07 Documentation

Include the following items in the project file:

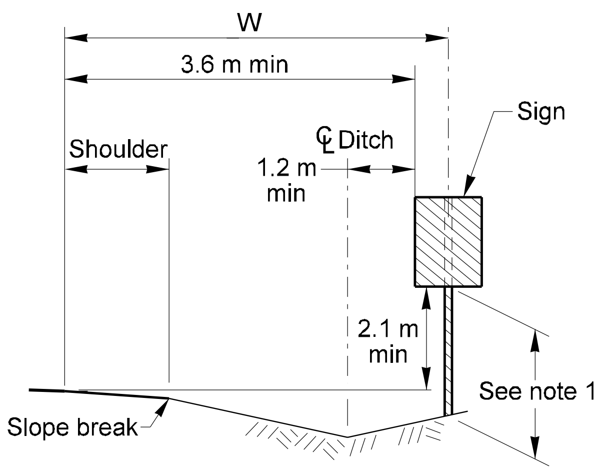
- ☐ An inventory of all existing signing within the project limits
- ☐ Approval of proposed guide signs
- ☐ Approval of non-standard signs
- ☐ Soils investigations for all sign bridge and cantilever sign supports



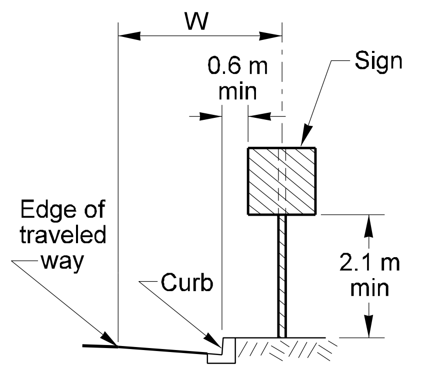
Sign Installation in Fill Section



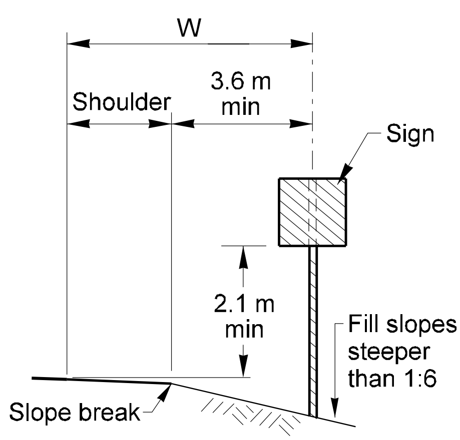
Sign with Supplemental Plaque Installation in Fill Section



Sign Installation in Ditch section



Sign Installation in Curb Section



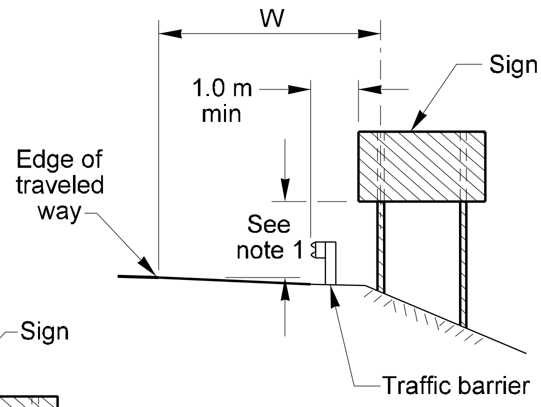
Sign Installation on Steep Fill Slopes

Notes

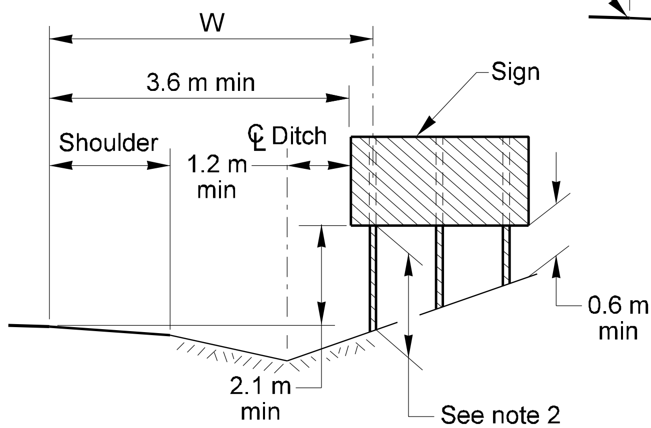
1. 2.1 m min vertical clearance for sign supports with breakaway features

Sign Support Locations

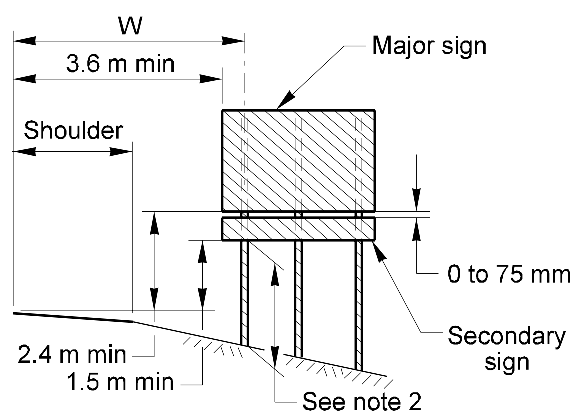
Figure 820-1a



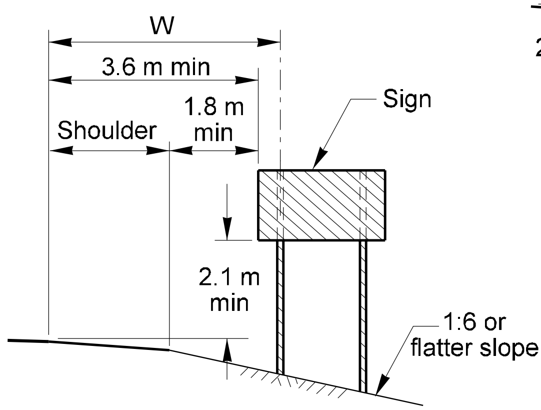
Sign Installation
Behind Traffic Barrier



Multiple Sign Post Installation
in Ditch Section



Guide or Directional Sign with
Secondary Sign Installation on
Expressways and Freeways

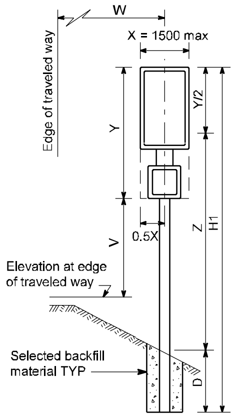


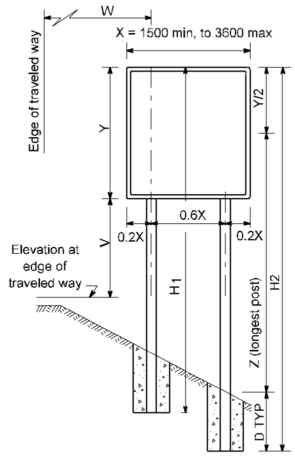
Multiple Sign Post Installation
in Fill Section

Notes

1. 2.1 m min for new sign installations
   1.5 m min for existing sign installations
2. 2.1 m min vertical clearance for sign supports with breakaway features

Sign Support Locations
Figure 820-1b





For the purpose of post selection, X and Y are as follows:

Single sign, or back-to-back signs, X and Y are the overall dimensions of the sign.

Multiple sign installations, X and Y are the dimensions of a rectangle enclosing all signs.

Z is the height from ground line to mid-height of sign at the longest post.

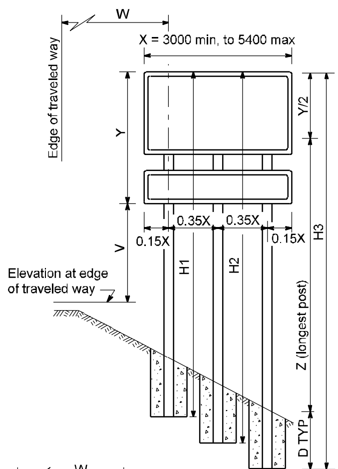
H1 + H2, etc., equals overall post length.

D is the required post embedment depth.
V is the vertical clearance from edge of traveled way.

Post size	(X)(Y)(Z) in m^3 **				D
	1 Post	2 Post	3 Post	4 Post	
4x4	1.7*	3.8	5.0	6.6	1.0
4x6	5.0*	10.0	15.0	20.0	1.2
6x6	6.0	12.0	18.0	24.0	1.2
6x8	8.5	24.0	36.3	48.1	1.2
6x10	11.0	33.5	50.1	66.8	1.5
8x10	16.3	45.6	68.3	91.0	1.5
8x12	22.0	65.5	98.1	130.8	1.8

*Single post application utilizing Western Red Cedar has (X)(Y)(Z) allowable of 1.4 and 4.4 respectively.

**Values shown are the maximum permitted. If the quantity (X)(Y)(Z) exceeds the limit for 8X12 posts, use steel post installations.



When sign is to be located in the clear zone or outside of the clear zone, but in an area where it is likely to be struck by an errant vehicle, the following configurations are not permitted:

1. Timber posts larger than 6X8.

2. Signs less than 3.6 m wide and three 6X6 or larger posts.

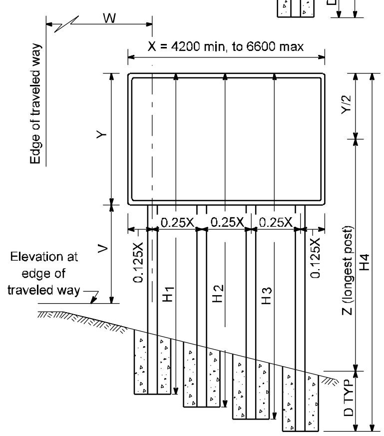
3. Signs less than 5.1 m wide and four 6X6 or larger posts.

Use steel or laminated wood posts in these situations.

Design Example

Given: 900 wide, 1200 high sign with a 450 wide, 600 high sign mounted 75 below. 2.4 m shoulder with 2% slope and a 1:6 embankment. W = 4500, V=1500.

Solution: Use single post. X=900, Y=1875. Z=1875/2+ (0.02X2400)+ 1500+2100/6=2835. (X)(Y)(Z)=0.9 mX1.875 mX2.835 m=4.78 m^3. From table, select smallest post having (X)(Z) of 4.78 m^3 or more. Use 4X6 post H=Z+ Y/2+D=2835+1875/2+1200=4973. Use 6X6 when using Western Red Cedar.



Design Example

Given: 3000 wide. 1200 high sign, 3.0 m shoulder with 2% slope and a 1:6 embankment. W=10500. V=2100. Assume sign is inside of clear zone.

Solution: Try two posts. X=3000, Y=1200.
Z=1200/2+2100+(0.02x3000)+(7500+0.6X3000)/6=4310.
(X)(Y)(Z)=3 mX1.2 mX4.31 m=15.52 m^3. From table, select smallest post having (X)(Y)(Z) of 15.52 m^3 or more. Two 6X6 posts are not sufficient use two 6X8 posts because three 6X6 posts would require a traffic barrier.

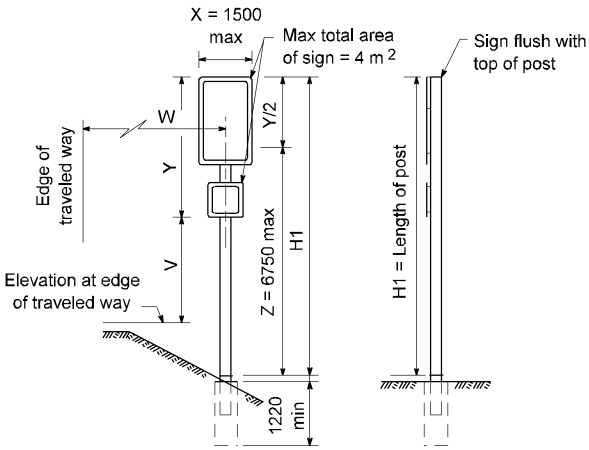
H2=4310+600+1200=6110

H1=6110-(0.6X3000)/6=5810

All dimensions are in millimeters (mm) unless otherwise noted.

Wood Posts

Figure 820-2



For the purpose of post selection, X and Y are as follows:

Single sign, or back-to-back signs, X and Y are the overall dimensions of the sign.

Multiple sign installations, X and Y are the dimensions of a rectangle enclosing all signs.

Z is the height from the base connection (64 mm above the post foundation) to mid-height of sign at the longest post.

H1, H2, etc., equals overall post length (base connection to top of sign).

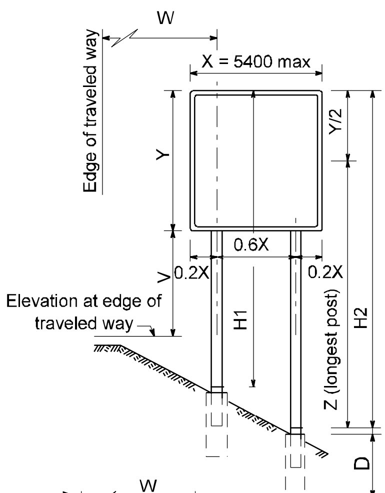
D is the required post embedment depth (see standard plans).

V is the vertical clearance from the edge of traveled way.

Single Post Signs

For 1.8 m^2 or smaller signs, use 100 mm standard pipe for Z less than 5550 or 125 mm standard pipe for Z greater than 5550.

For 4 m^2 or smaller signs, use 125 mm standard pipe for Z less than 4500 or 150 standard pipe for Z greater than 4500.



Two and Three post signs

Post Selection		Post size	
(X)(Y)(Z) in m^3 *			
2 Posts	3 Posts	* *	AASHTO M183
44.45	66.68	W150x13	W150x18
79.57	119.49	W150x18	W150x24
139.88	209.82	W200x27	W200x31
214.64	321.96	W250x33	W250x39

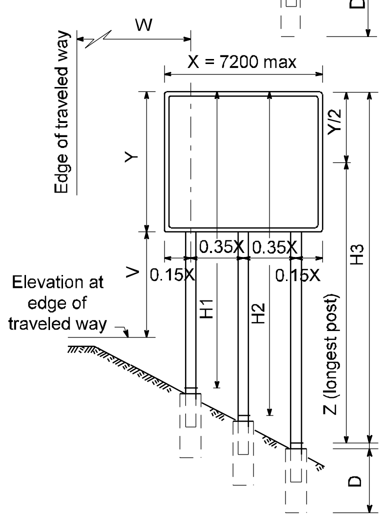
*Values shown are the maximum permitted.
**AASHTO M222 or M223 may be used as an acceptable alternate to AASHTO M183 at the sizes listed.

Design Example

Given: 6.6 m wide, 3.6 m high sign. 3.0 m shoulder with 2% slope and a 1:3 embankment slope. W=9.6m, V=2.1m.

Solution: Use three posts. X=6600, Y=3600, V=2100, Z=3600/2+2100+(0.02x3000)+(6600+0.70x 6600)/3-65 =7.64m. (X)(Y)(Z)=6.6 mX3.6 mX7.64m=181.53 m^3. From table, sele smallest post having (X)(Y)(Z) of 181.53 m^3 or more. Use W200x27 (AASHTO M222 or M223) or W200x31 (AASHTO M183) posts.

H3=7635+1800=9435
H2=9435-(0.35x6600)/3=8665
H1=9435-(0.70x6600)/3=7895

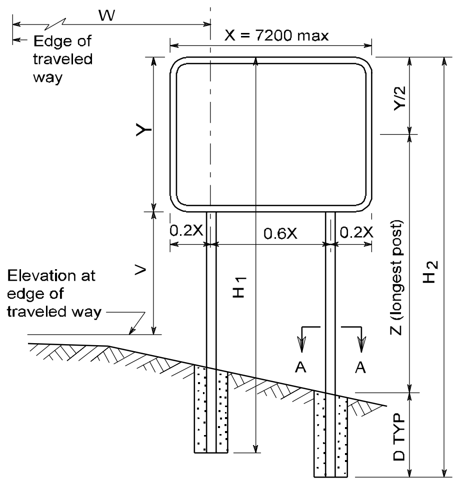


For any sign installation located within the clear zone distance of the lane edge, the total weight of all the posts in the 2100 wide path shall not exceed a combined post weight of 67 kg/m. If the proposed sign post configuration does not meet this criteria, relocate, resize or provide additional protection for the proposed installation.
Use the following table to determine post weights.
All dimensions are in millimeters (mm) unless otherwise noted.

Wide Flange Beam Dimensions

Beam size	Weight kg/m
W150x13	13
W150x18	18
W150x24	24
W200x27	27
W200x31	31
W250x33	33
W250x39	39

Steel Posts
Figure 820-3



For the purpose of post selection, X and Y are as follows:

Single sign, or back-to-back signs. X and Y are the overall dimensions fo the sign.

Multiple sign installations, X and Y are the dimenions of a rectangle enclosing all signs.

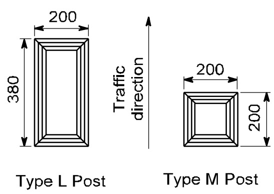
Z is the height from ground line to mid-height of sign at the longest post.

H_1 and H_2 equal overall post length.

D is the required post embedment depth.

V is the vertical clearance from edge of traveled way.

Box Post Type	Z (m)	(X)(X)(Z) m^3*
M	4.58 to 9.14	37.66
M	4.57 or less	47.03
L	4.58 to 9.14	99.16
L	4.57 or less	123.97



SECTION A-A

Design Example

Given: 4800 wide, 1800 high sign. 3.0 m shoulder with 2% slope and a 1:6 embankment. W = 7500, V = 2100.

Solution: Use two posts. X = 4800, Y=1800.

For two posts: Z = 1800/2 + 2100 + (0.02 x 3000) + (4500 + 0.6 x 4800)/6 = 4.29 m.
(X)(Y)(Z) = 4.8 m x 1.8 m x 4.29 m = 37.07 m^3 .
From table, select smallest post having (X)(Y)(Z) of 37.07 m^3 or more, and meets the "Z" requirements.

Use two M posts.

H_2 = Z + Y/2 + D = 4.29 m + 0.9 m +1.8 m = 6.99 m.
H_1 = 6.99 - (0.6 x 4.8 m)/6 = 6.51 m.

Design Example

Given: 5400 wide, 2400 high sign, 3.0 m shoulder with 2% slope and a 1:6 embankment. W = 7500, V = 2100.

Solution: Use two posts. X = 5400, Y=2400.

For two posts: Z = 2400/2 + 2100 + (0.02 x 3000) + (4500 + 0.6 x 5400)/6 = 4.65 m.
(X)(Y)(Z) = 5.4 m x 2.4 m x 4.65 m = 60.26 m^3 .
From table, select smallest post having (X)(Y)(Z) of 60.26 or more, and meets the "Z" requirements.

Use two L posts.

H_2 = Z + Y/2 + D = 4.65 m + 1.2 m + 2.7 m = 8.55 m.
H_1 = 8.55 - (0.6 x 5.4 m)/6 = 8.01 m.

Z (m)	Total Sign Area (M^2)					
	Up to 4.7	4.7 to 9.3	9.4 to 13.9	14.0 to 18.6	18.7 to 23.2	23.3 to 26.9
2.7 to 3.7	1.8	1.8	2.1	2.4	2.7	3.1
3.71 to 4.6	1.8	1.8	2.3	2.7	3.1	
4.61 to 5.5	2.1	2.3	2.7			
5.51 to 6.7	2.1	2.4	3.1	Not Permitted		
6.71 to 7.9	2.3	2.6				

Laminated Post Embedment Depth

All dimensions are in millimeters (mm) unless otherwise noted.

Laminated Wood Box Posts

Figure 820-4

860.01 General

Intelligent Transportation Systems (ITS) apply advanced technologies in communications and computer science to optimize the safety and efficiency of the existing surface transportation network. In highway design, this goal is achieved by collecting and using traffic data to develop predictive models, regulating access to the freeway system, and providing timely information on traffic conditions to motorists. Previously, this technology was called Surveillance, Control, and Driver Information (SC&DI). In the context of highway design, ITS and SC&DI are synonymous.

The Transportation Equity Act (TEA-21) requires ITS projects to comply with the standards being developed in association with the federal government and private industry. These standards will be known as the National ITS Architecture. These standards are intended to ensure interoperability and efficiency to the maximum extent practicable for the many different types of ITS devices under development. The National ITS Architecture organizes a "system of subsystems" and makes managing ITS deployment easier. The Architecture helps agencies communicate complex ideas by providing a common language and definitions. One benefit of using the National ITS Architecture is that it helps identify all agencies and jurisdictions that should be included in ITS projects.

The ITS program in Washington State is known as "Venture Washington." It focuses on five areas within Washington State. These areas were chosen because they each have unique characteristics and problems associated with traffic. These five areas are:

- The Greater Puget Sound Region
- The Spokane Area
- The Vancouver Area
- Other Statewide Urban Areas
- Rural Areas and Intercity Corridors

An intelligent transportation system can be implemented in stages, starting with a small project for immediate benefit and then expanding the system as needed. Consider installing an ITS at any of the following locations:

- Where congestion frequently causes accidents.
- At freeway on-ramps where merging problems routinely occur.
- Where heavy traffic volumes occur between closely spaced on-ramps.
- Where the motorist would benefit from information on traffic conditions or alternative routes.

The initial stage of an intelligent transportation system can be as simple as installing a dynamic message sign that warns motorists of unusual driving conditions. Appropriate messages can be displayed on the sign using information obtained by direct observation of road conditions or by reports from law enforcement agencies.

Automated systems incorporate a traffic data collection system. The data collection system provides basic data to determine traffic volumes, vehicular speeds, and levels of congestion. The traffic data can be analyzed and used to verify the locations of traffic problems. This data can also be used in freeway computer models to predict the impacts of proposed improvements.

Design each stage of the system so that the associated technology can be used in subsequent, more sophisticated stages. For example, the stage following data collection could be the installation of closed circuit television cameras (CCTV) to monitor freeway locations where congestion is commonplace. The CCTV monitoring is used to detect or confirm incidents noted by other forms of data collection. The installation of motorist information devices such as dynamic message signs or highway advisory radio provides a means of transmitting this information to the motorist. Eventually, as traffic congestion increases, ramp meters are installed to control the traffic flow entering the facility.

When planning a staged system, attempt to determine the ultimate communication system to the degree that underground conduit size and quantity are known and can be installed in the initial construction. Consider long-term maintenance issues and component standardization.

The Northwest Region Traffic Systems Management Center (TSMC) is an example of a traffic operations center (TOC). Because a TOC usually works best with existing radio communication, it is located adjacent to or as part of a radio communication office. In addition to the location of a TOC, consider the work force and equipment costs required to operate and maintain the entire system. The size of a TOC is dependent on the complexity of the system and can vary from a single person at a desk to a large room with advanced equipment requiring continuous staffing.

860.02 References

Transportation Equity Act (TEA-21) of 1998

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT,

SC&DI Design Guide, WSDOT Northwest Region

SC&DI Operations Guide, WSDOT Northwest Region

I-90 Seattle to Spokane, ITS Corridor Study, WSDOT Advanced Technology Branch

I-5 Seattle to Vancouver, BC, ITS Corridor Study, WSDOT Advanced Technology Branch

Portland/Vancouver to Boise, ITS Corridor Study Plan, WSDOT Advanced Technology Branch

Application of Advanced Transportation Technology Within Washington State: Discussion and Policy Recommendations, WSDOT Advanced Technology Branch

State-Wide Communications Strategic Plan, WSDOT Advanced Technology Branch

Seattle to Portland Inter-City ITS Corridor Study and Communications Plan, WSDOT Advanced Technology Branch

Venture Washington, WSDOT Advanced Technology Branch

860.03 Traffic Data Collection

Loop detectors, placed in traffic lanes, are the most common devices used to collect traffic data. In general, data stations are spaced at 800 m intervals between interchanges. Alternative methods of detection include video detection cameras, microwave detectors, and other newer technologies. This information can be augmented with cellular phone calls from motorists, Washington State Patrol (WSP) reports, and commercial traffic reporters.

The loops sense the amount of time a vehicle is over them. This is called *occupancy* and is recorded by a data station in a nearby roadside cabinet. The data station periodically transmits the data to a central computer. The information from the detection system is transmitted over leased phone lines, WSDOT phone lines, fiber optic lines, or microwave transmitters to a traffic operations center. A spread spectrum radio is another method of transmitting data. The central computer translates these data into an indication of traffic congestion for incident detection and traffic flow information.

A single loop provides traffic volumes and lane occupancy from which, given some basic assumptions, speeds can be computed. Two loops spaced a known distance apart, longitudinally, provide better determinations of traffic speeds.

CCTV is used by the department to manage the freeway system. It is not usually used as a traffic law enforcement tool. The primary function of CCTV is to confirm or detect incidents. As a secondary function, this information can be provided to the WSP, incident response teams, maintenance forces, and the local media.

860.04 Traffic Flow Control

During peak traffic volume periods, freeway on-ramps are metered with either roadside or overhead traffic signals. These ramp meters control or regulate the flow of traffic entering the freeway. The metering prevents the entering traffic from exceeding freeway capacity by limiting the number of vehicles that enter within a specific time period. The meters also keep long platoons of cars from merging onto the freeway. This process makes on-ramp merges safer and allows freeway traffic to move at a more efficient speed.

Ramp meters are traffic control signals and an approved traffic signal permit is required. The approval procedures for traffic signal permits are noted in Chapter 850.

Consider the available area for vehicle storage on the ramp when locating a ramp meter. If the arrival rate of the entering traffic exceeds the metered flow rate, traffic queues will develop. A common concern is that this queue might extend onto the crossroads and interfere with local traffic. Chapter 1050 provides guidance on the placement of the ramp meter. This guidance, however, only addresses the required acceleration needed to merge onto the freeway. The storage area needed at the meter varies at each location and is determined separately. If it is not possible to provide an adequate storage length on the ramp, consider alternate methods of addressing the problem.

(1) Adjust the ramp metering rate to temporarily increase the rate.

(2) Allow two vehicles to pass the meter at a time.

(3) Widen to two metered lanes.

(4) Provide storage lanes on the crossroad.

(5) Provide alternate routes for local traffic.

(6) Provide HOV bypass lanes.

(1) **Adjust Rate.** Ramp metering uses information from the detection loops to determine freeway congestion adjacent to and downstream from the ramps. Data from the loops are sent to a central computer or a local computer that adjusts the metering rate for the traffic congestion and transmits this rate to the ramp meter controllers. The ramp controllers implement the metering rate and control the signal. A ramp metering rate can be determined in two ways: remote metering and standby metering.

For remote metering, the metering rates of all ramp meter locations are determined by the local controller and adjusted by the central computer at the TOC. This is the normal mode of operation for the Seattle system. The central computer is capable of adjusting upstream metering rates on the basis of downstream conditions. A metering rate at an upstream location is decreased if traffic congestion develops downstream. Metering start and end times, as well as metering rates, can be remotely adjusted from the TOC with an override function.

Standby metering, also called local control, is used when communications with the central computer are interrupted or when that computer is not in service. In these cases, each ramp meter determines a metering rate for its on-ramp according to local traffic conditions or by a pre-determined rate based on a time of day table. These time of day tables are developed to predict averages of the actual traffic volume peaking characteristics of the on-ramp. In standby metering, each ramp meter operates independently without coordinating with other controllers.

Single lane metering rates normally vary between 4 and 15 vehicles per minute (240 and 900 vehicles per hour). If a ramp has heavier traffic volumes and queue storage is not adequate, several actions can be taken.

(2) **Two Vehicles**. The metering capacity can be increased by allowing two vehicles to enter during each green cycle. This can increase a single lane ramp meter maximum capacity to about 1,100 vehicles per hour. This procedure is a temporary, operational solution and is not a recommended design practice.

(3) **Widen**. The metering capacity can be increased by widening the ramp to install additional lanes. Widening a single-lane on-ramp to create two lanes can double the metered traffic volume to 1,800 vehicles per hour, provided no downstream traffic congestion develops. Changes in ramp access to the freeway might require an access point decision report. (See Chapter 1425.)

(4) **Storage Lanes**. If adequate storage length cannot be provided on the ramp, it might be possible to provide storage as turn lanes on the crossroad and adjust the ramp terminal traffic signal timing to limit freeway access movements.

(5) **Diversion**. Diversion of some ramp traffic to local arterial streets might can be desirable, assuming a suitable alternate route is available. When diversion occurs, modification of traffic signal timing and coordination plans on the alternative routes might be necessary. Coordinate efforts with the local agency and, if appropriate, initiate public meetings to identify needs and impacts.

(6) **HOV Bypass.** Wherever possible, provide bypass lanes for high occupancy vehicles (HOV) around the traffic queue at the ramp meter. The HOV bypass allows transit vehicles to maintain schedules and indirectly provides an incentive for carpooling. (See Chapter 1050.)

860.05 Motorist Information

Motorist information includes dynamic message signs, highway advisory radio, telephone traffic information lines, commercial radio and television messages, and Internet access for personal computers. These are all used to transmit traffic conditions to freeway users. The motorist information system is also used to alert drivers to short term construction and maintenance activities that might affect normal travel patterns. It can also be used to suggest alternative travel routes.

(1) Dynamic Message Signs

Dynamic message signs (DMS) are used to provide motorists with current road and traffic conditions. Accidents, incidents, construction and maintenance activities, reversible lane status, traffic congestion, and traction device requirements are examples of this information. Because motorists receive many distractions while driving, consider the location of the DMS. The best location for a DMS is on a tangent section of roadway with few roadside distractions. Overhead installations have more visual impact. When possible, use sign bridges, cantilever sign structures, or bridge mounts on existing overcrossings for DMSs. Use the message displays and sign location requirements contained in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) and Chapter 820.

(2) Highway Advisory Radio

The highway advisory radio (HAR) system uses car radios to provide information to motorists. Warning signs, usually with flashing beacons, direct motorists to select a specific AM radio station for information. HAR has an advantage over DMS because longer messages with more detailed information can be relayed to the motorist. The major disadvantages are that not all vehicles have radios that can receive HAR frequencies, and some motorists might not use the radio for this information. HAR works best when used in conjunction with DMS.

HAR locations and assigned radio frequencies are restricted to prevent interference with other frequencies in use. HAR message content is restricted by federal regulations and WSDOT restricts HAR messages to noncommercial voice information pertaining to roadway and mountain pass conditions, major incidents, traffic hazards, and travel advisories.

(3) Additional Public Information Components

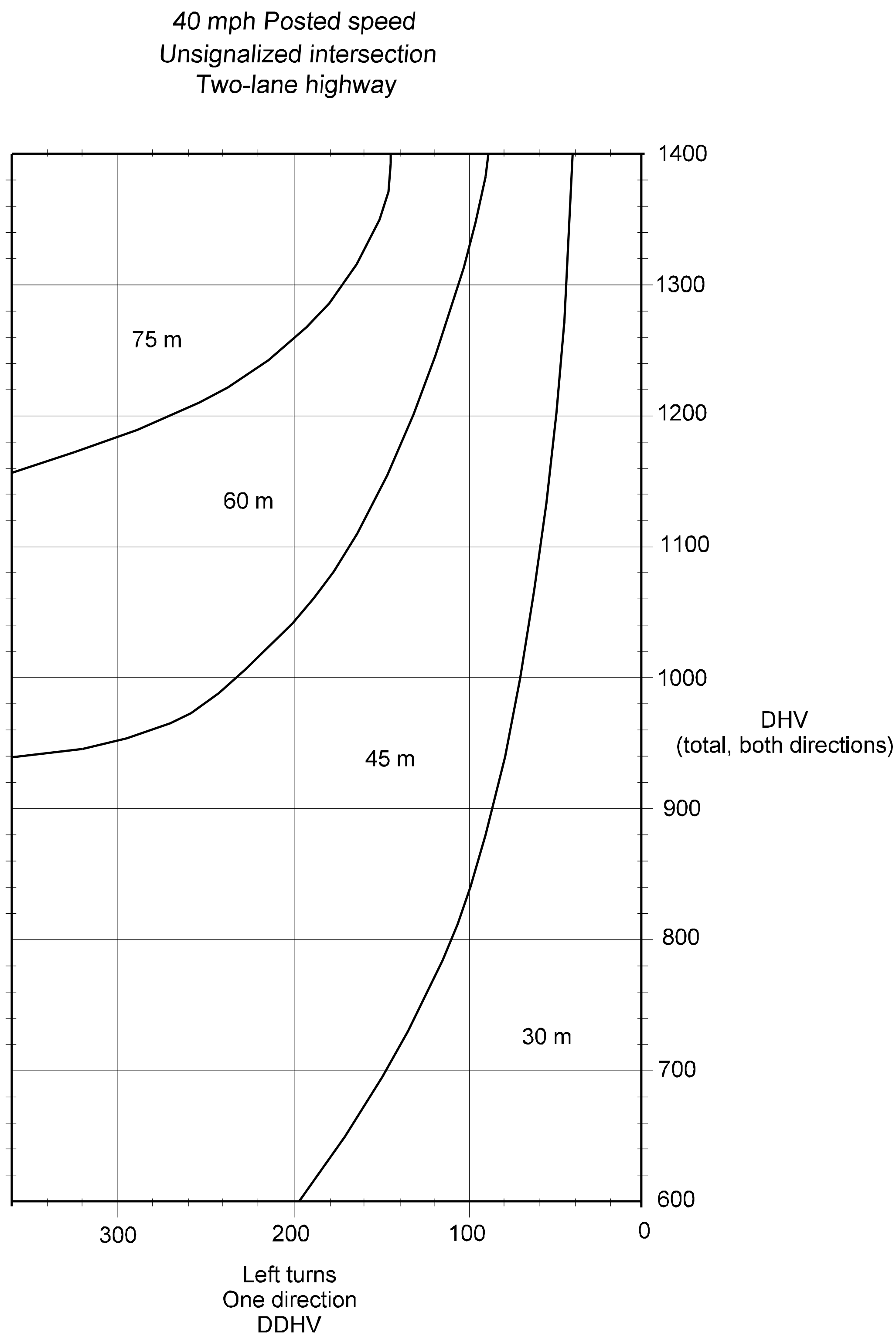
A telephone number can be provided to give the same prerecorded messages as the HAR and can also include transit and carpool information. A computer generated flow map can be developed, using the data collection system, to graphically depict actual traffic flows within a geographical area. The flow map can be made accessible to the public by providing links to a WSDOT web site.

860.06 Documentation

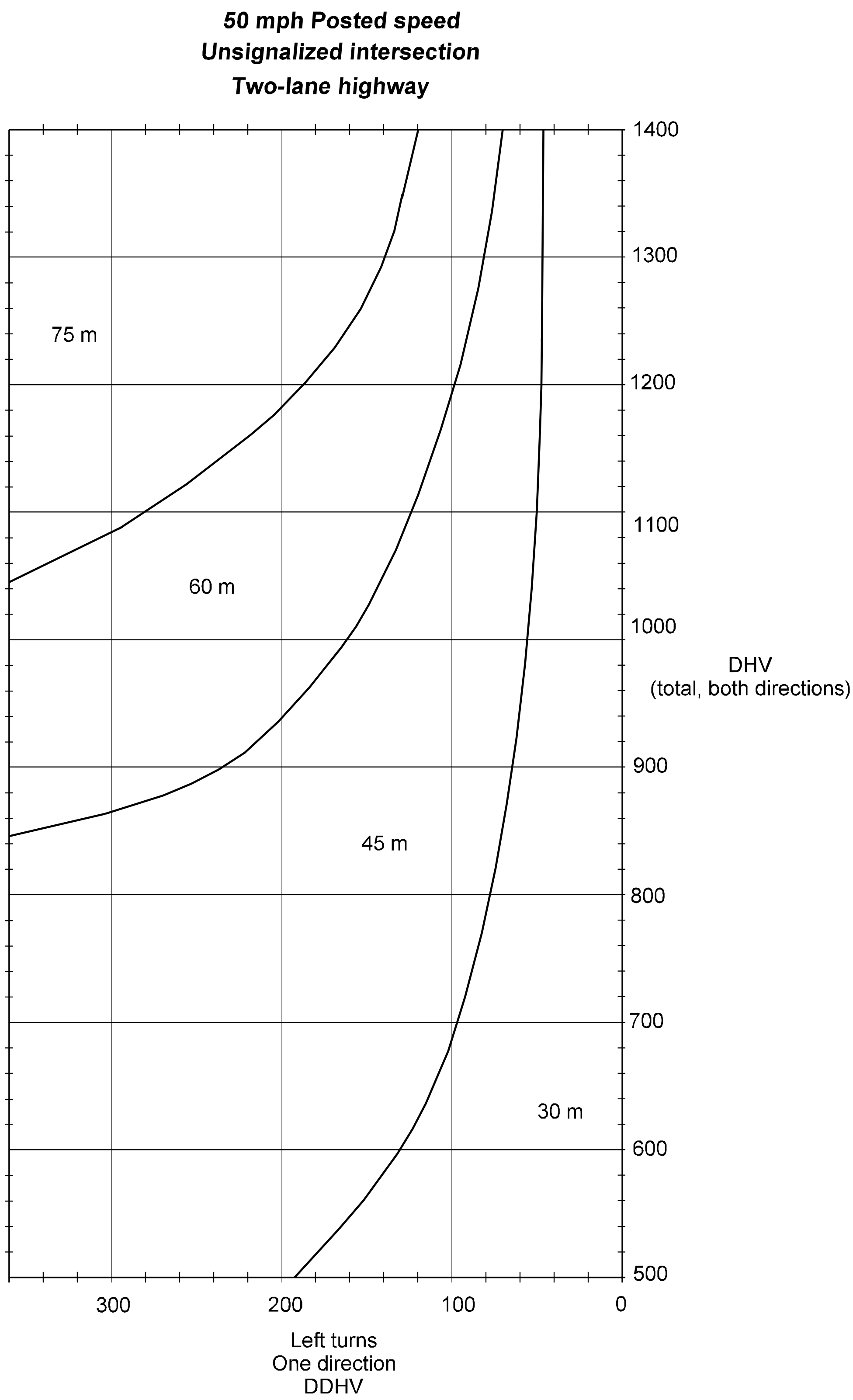
Preserve the following documents in the project file: See Chapter 330.

- ☐ Justification for the installation of ramp meters.
- ☐ Approved traffic signal permit for ramp meters.
- ☐ All correspondence and coordination with local agencies.
- ☐ Designs for the ultimate system when staged implementation is used.

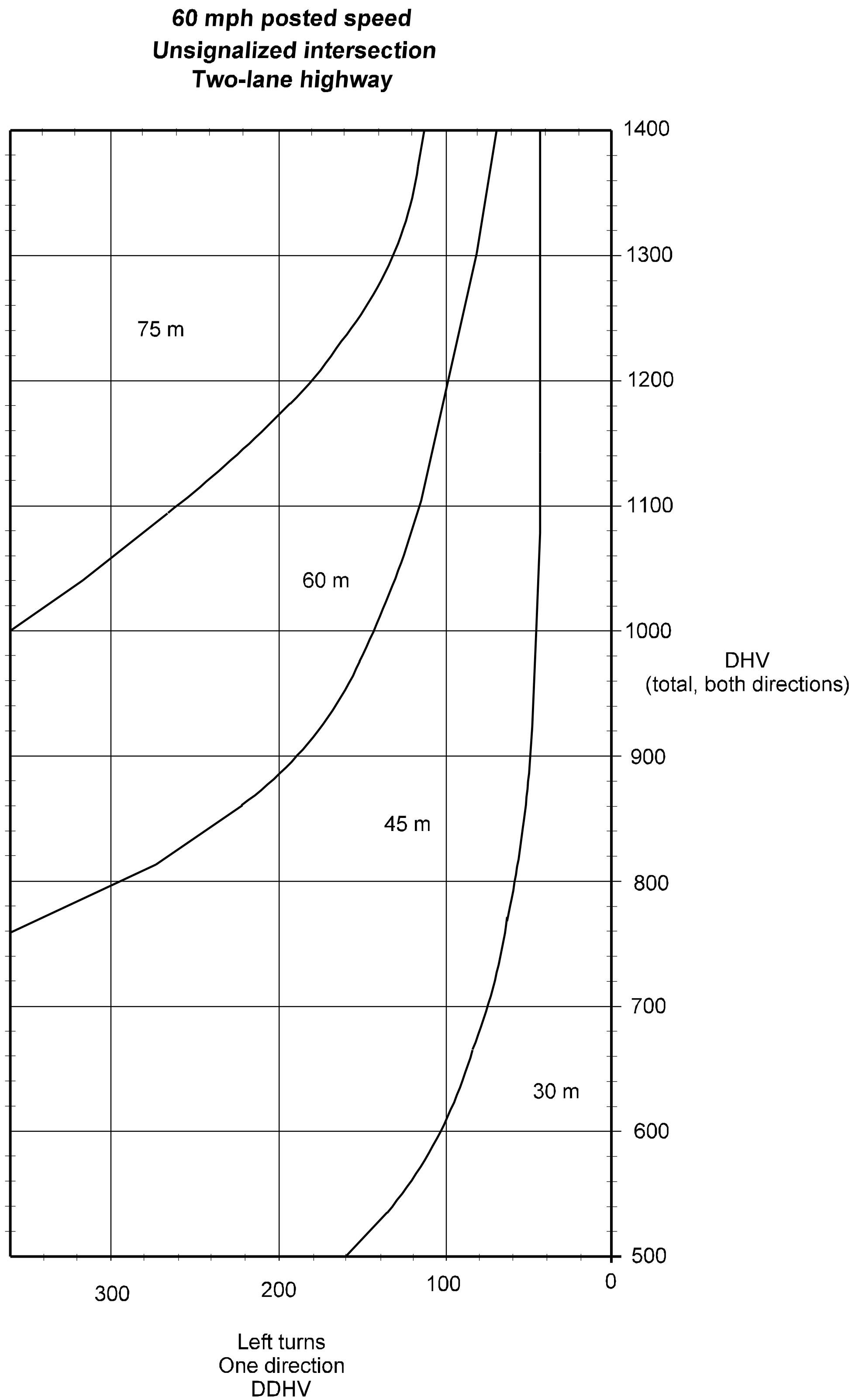
P65:DP/DMM



Left-Turn Storage Length
Figure 910-9a



Left-Turn Storage Length
Figure 910-9b



Left-Turn Storage Length
Figure 910-9c

Channelization Widening
Figure 910-10a

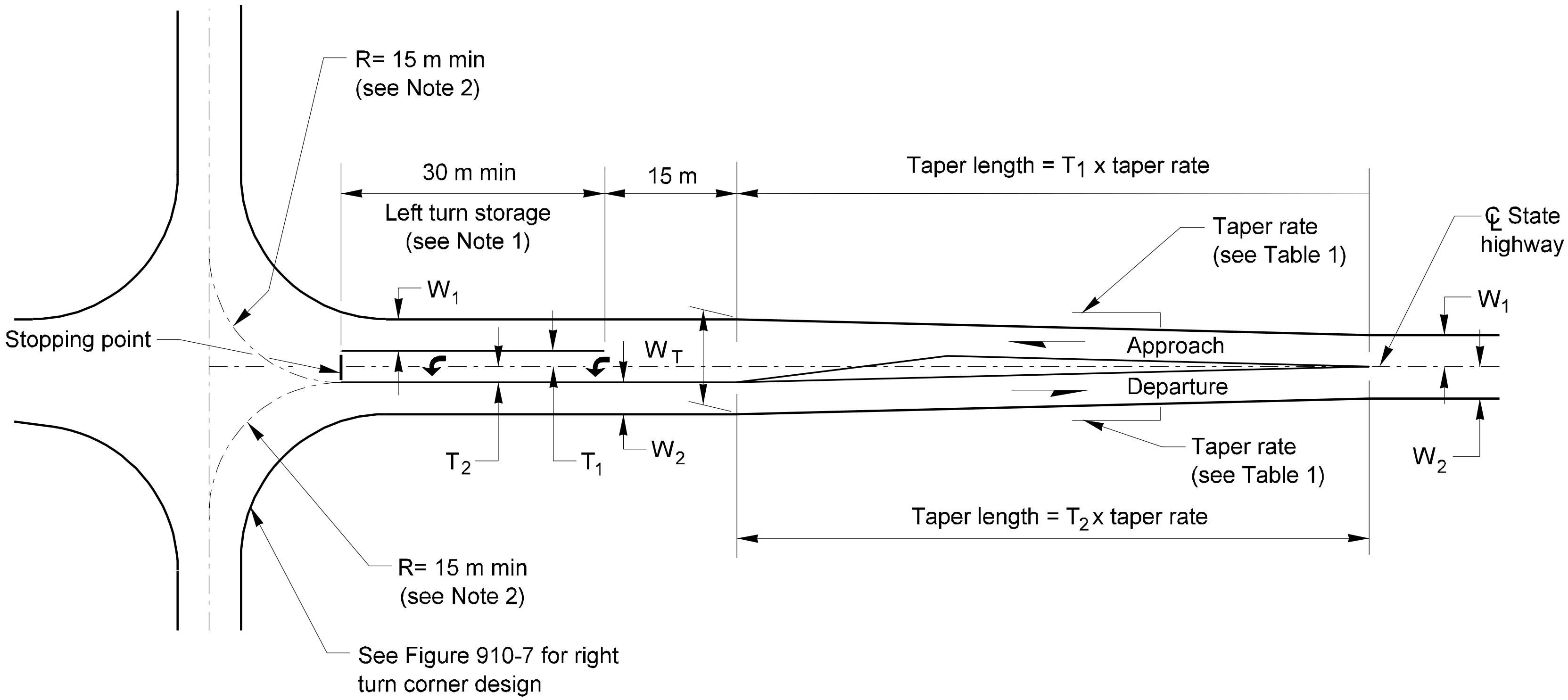


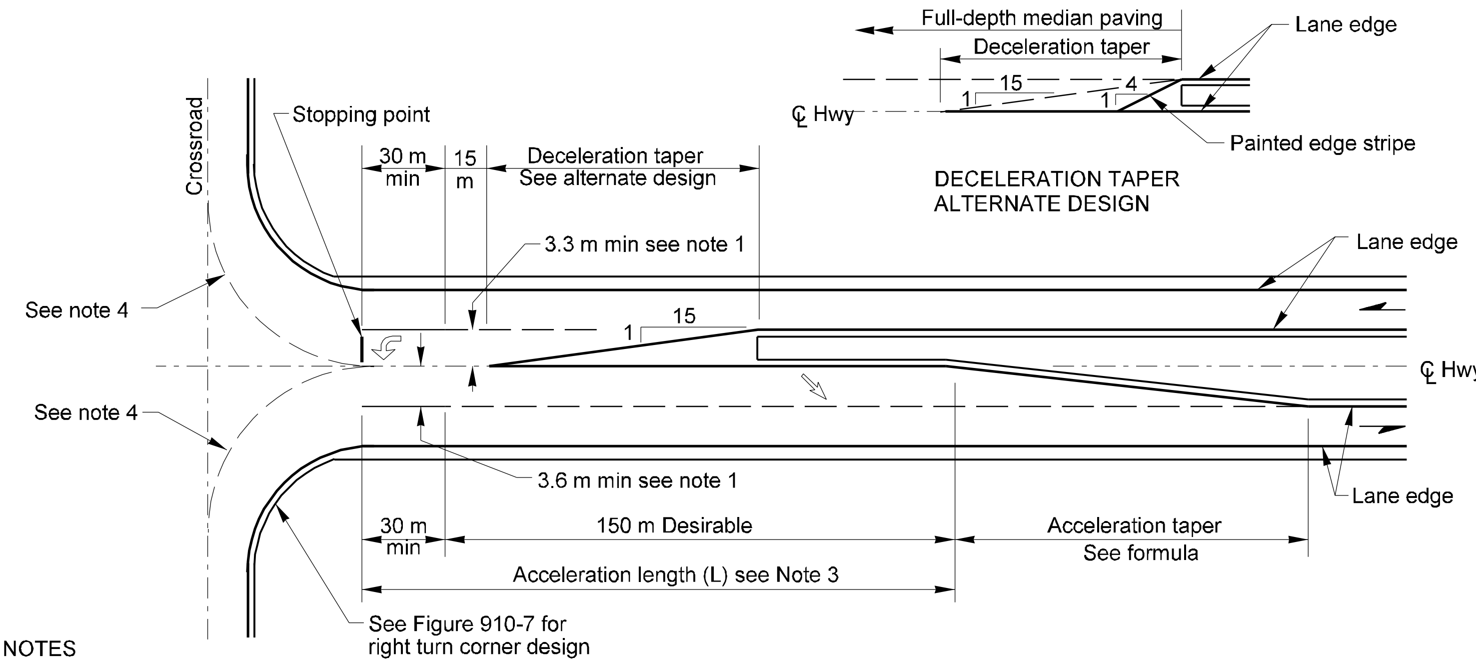
Table 1

Posted Speed	Taper Rate
55 mph	55:1
50 mph	50:1
45 mph	45:1
40 mph	40:1
35 mph	35:1
30 mph	30:1
25 mph	25:1

Notes:

1. The minimum width of the left turn storage lane (T_1 + T_2) is 3.3 m. The desirable width is 3.6 m. See Figures 910-9a-9d for left turn storage length.
2. Use templates for WB-20 design vehicles.
3. See Standard Plans and MUTCD for striping details.

W_1 = Approaching through lane
W_2 = Departing lane
T_1 = Width of left turn lane on approach side of ℄
T_2 = Width of left turn lane on departure side of ℄
W_T = Total width of channelization (W_1+W_2+T_1+T_2)



NOTES

1. Lane widths of 3.9 m are desirable for both the left turn storage lane and the median acceleration lane.
2. For increased storage capacity, the left turn deceleration taper alternate design should be considered.
3. The total length of the median acceleration lane shall not be less than the minimum acceleration lane length shown in Figure 910-13.
4. R = 15 m MIN; use templates for WB-20 design vehicles.

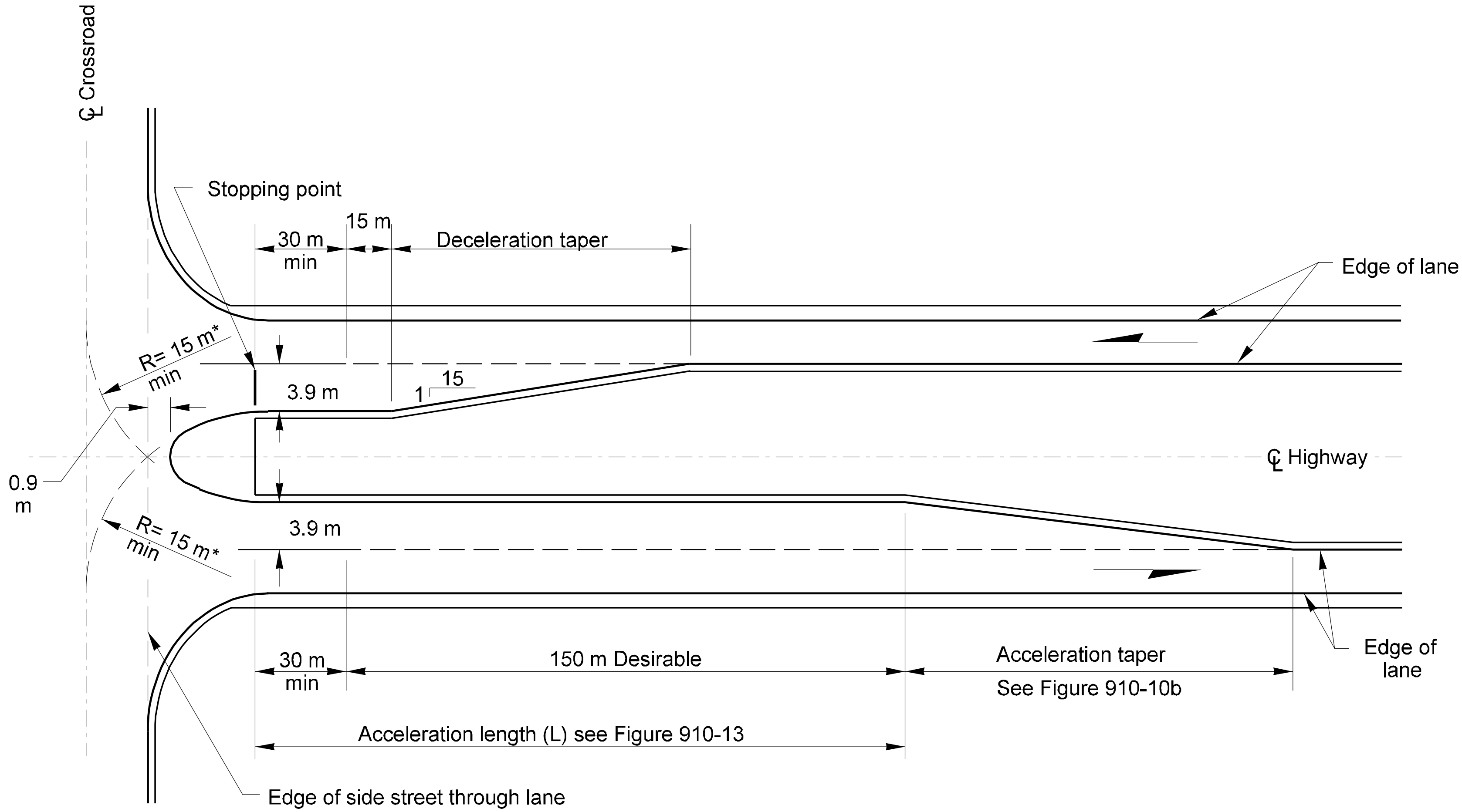
ACCELERATION TAPER FORMULA

When posted speed is 45 mph or higher:
Taper length = lane width x posted speed (mph)

When posted speed is less than 45 mph:

$$\text{Taper length} = \frac{\text{Lane width} \times (\text{posted speed})^2}{60}$$

Median Channelization — Median Width 7 m to 8 m
Figure 910-10b

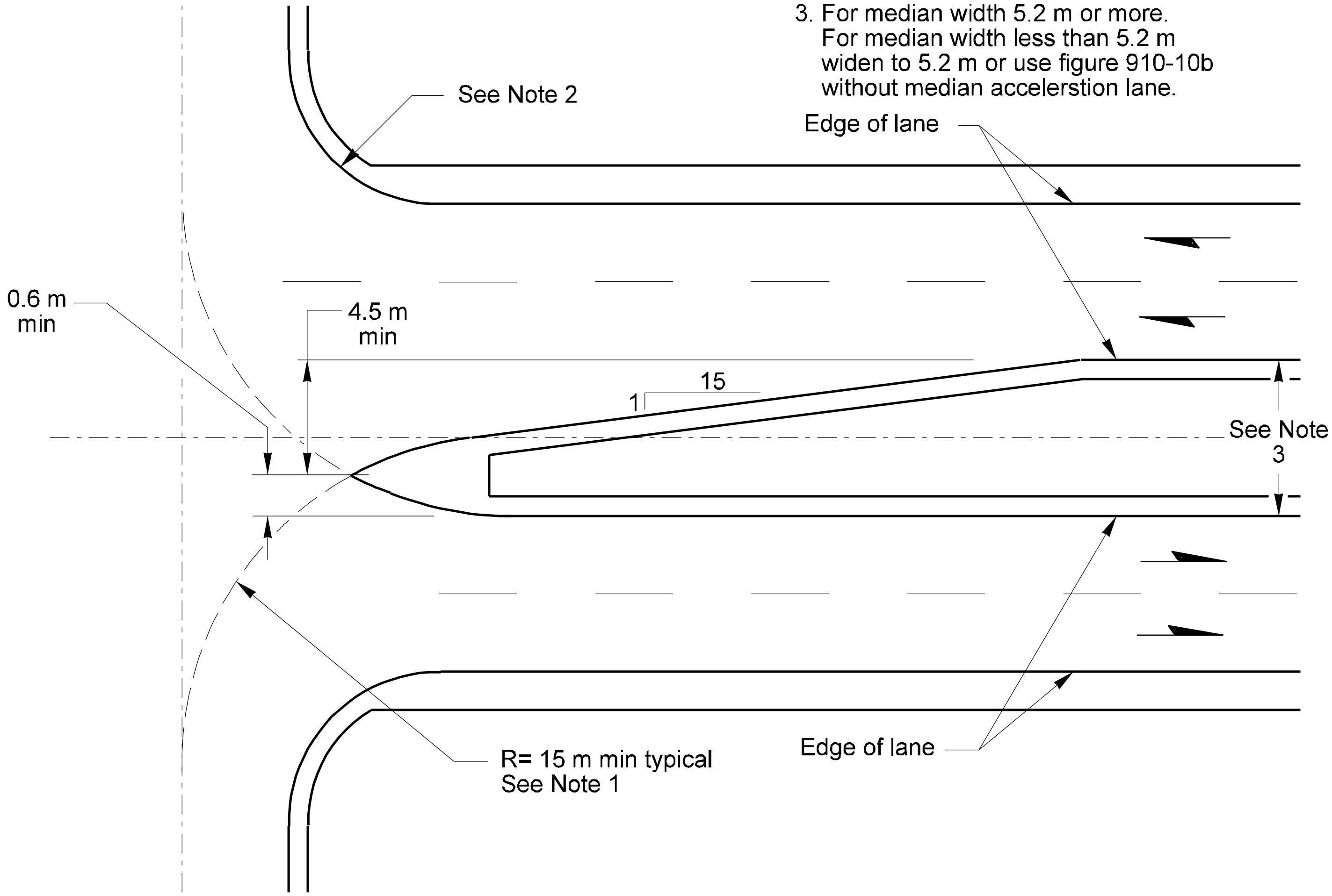


* Use templates for WB-20 design vehicles.

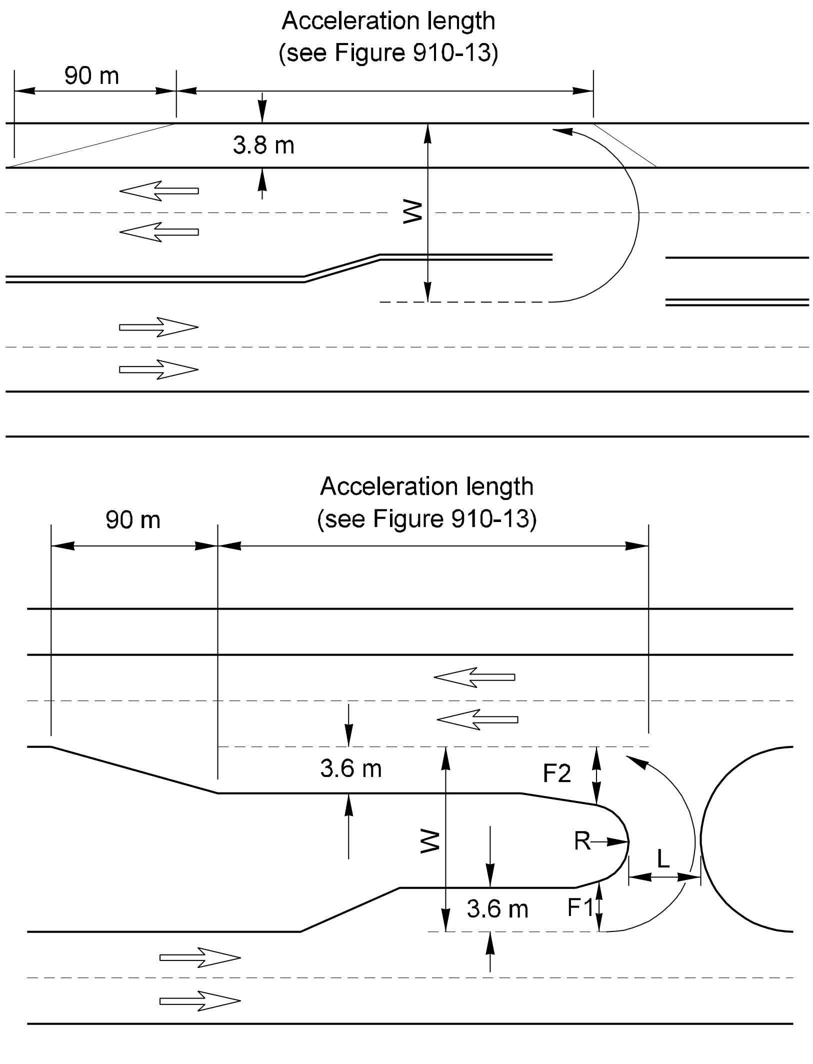
Median Channelization — Median Width of More Than 8 m
Figure 910-10c

NOTES

1. Use templates for WB-20 design vehicle.
2. See Figure 910-7 for right-turn corner esign.
3. For median width 5.2 m or more. For median width less than 5.2 m widen to 5.2 m or use figure 910-10b without median accelerstion lane.

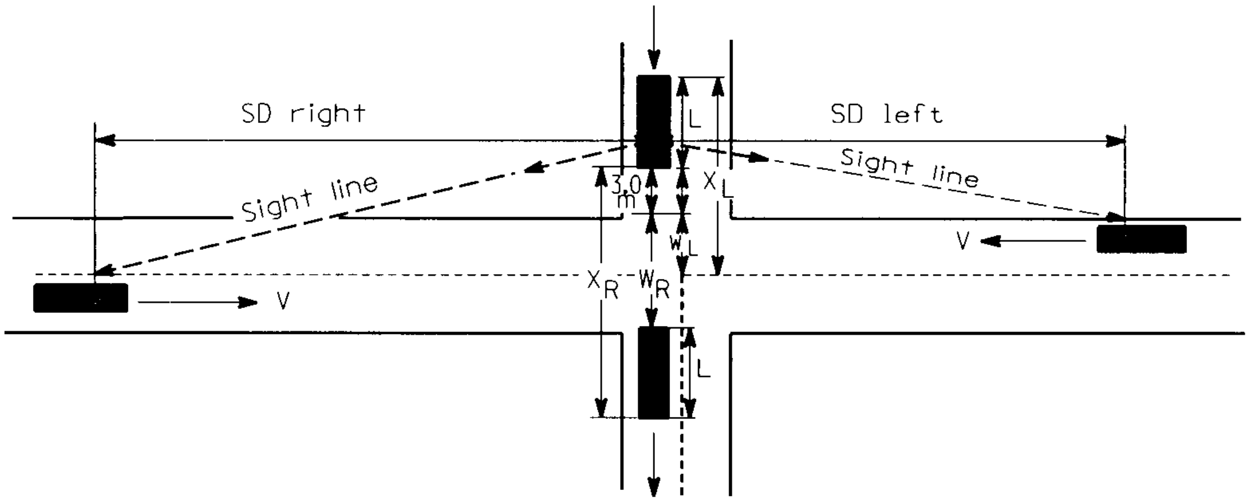


Minor Intersection on Divided Highway
Figure 910-10d



Vehicle	W	R	L	F1	F2	Taper
P	15.6	4.2	4.2	3.6	3.6	—
SU	26.6	9.0	5.9	4.0	4.6	10:1
BUS	26.6	8.5	7.0	4.1	5.5	10:1
WB-12	25.4	7.5	8.0	4.4	6.2	6:1
WB-15	28.4	8.0	9.5	4.9	7.7	6:1
WB-20	28.4	6.8	14.8	4.5	10.5	6:1
MH	25.4	8.0	5.9	4.5	4.9	10:1
P/T	15.6	3.3	3.8	3.6	5.4	6:1
MH/B	31.4	11.0	6.5	4.5	5.0	10:1

U-Turn Locations
Figure 910-15



SD = Sight Distance
ta = Time for acceleration
V = Design speed on the through highway
L = Length of vehicle
X = Length of vehicle travel

L Values		
P	=	5.8 m
SU	=	9.1 m
WB-15	=	16.7 m
WB-20	=	21.0 m

Note: If the crossroad is not level, multiply ta by the adjustment factor to consider the grade.

Sight Distance Adjustment Factor					
Design Vehicle	**Crossroad Grade, Percent -4**	**-2**	**0**	**+2**	**+4**
P	0.7	0.9	1.0	1.1	1.3
SU	0.8	0.9	1.0	1.1	1.3
WB-12	0.8	0.9	1.0	1.2	1.7

Example

Given:

Two - 3.6 m lanes to be crossed by a WB-15.
Intersection angle approximately 90°.
Through highway design speed = 70 mph

Find:

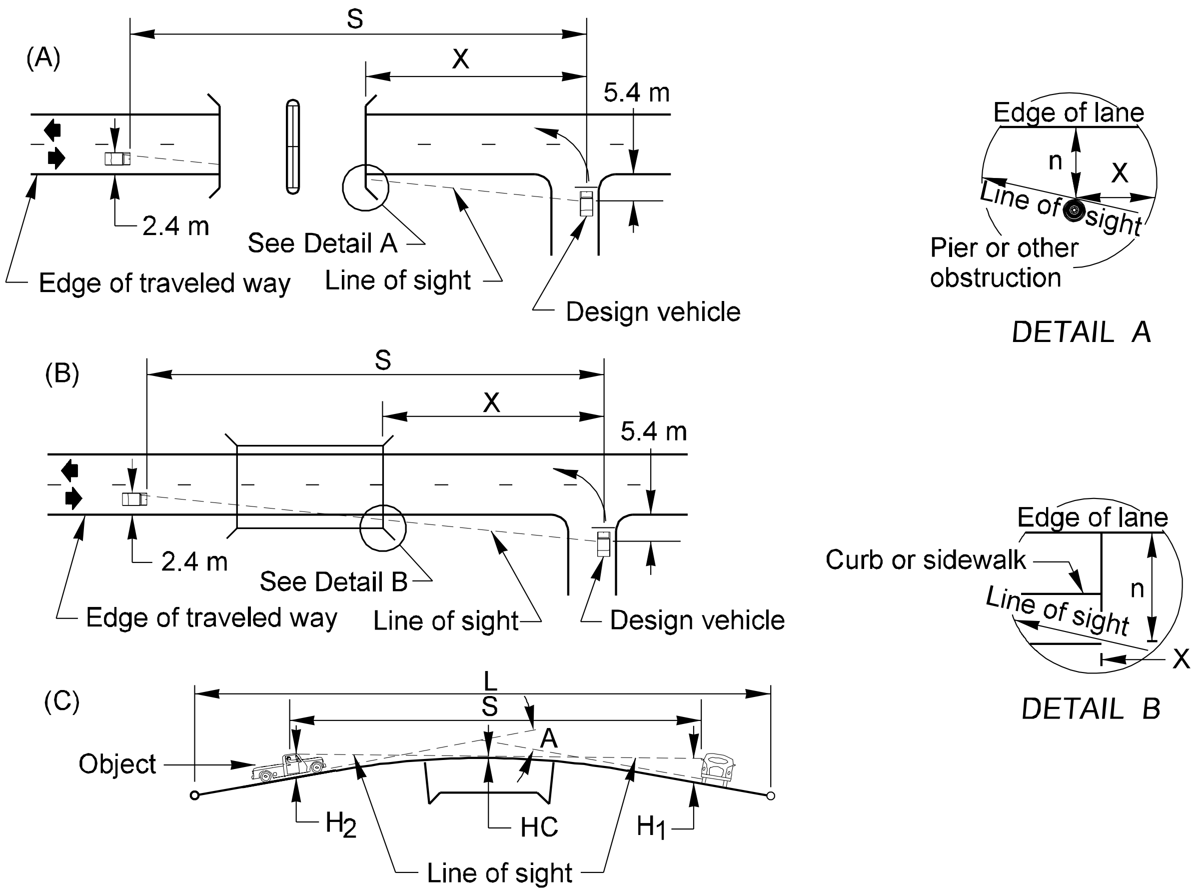
The minimum required sight distance.

Solution:

X_{right} = 3.0 + W_R + L = 3.0 + 7.2 + 16.7 = 26.9 m
X_{left} = 3.0 + W_L + L = 3.0 + 3.6 + 16.7 = 23.3 m

From the charts as shown, the required minimum SD = 380 m right and 360 m left.

Sight Distance for Grade Intersection With Stop Control
Figure 910-16a



For bridge pier or bridge rail:

$$S = \frac{7.8(x)}{5.4 - n}$$

Where:
- S = Available sight distance (m)
- n = Offset from sight obstruction to edge of lane (m)
- x = Distance from center line of lane to sight obstruction (m)

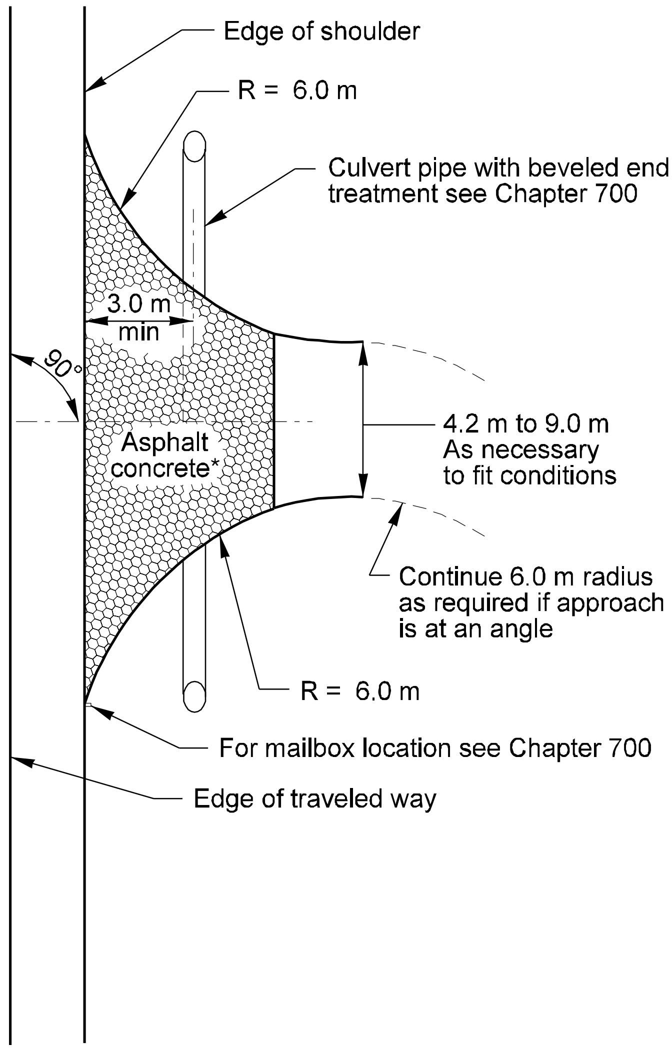
For crest vertical curve over a curb where S<L:

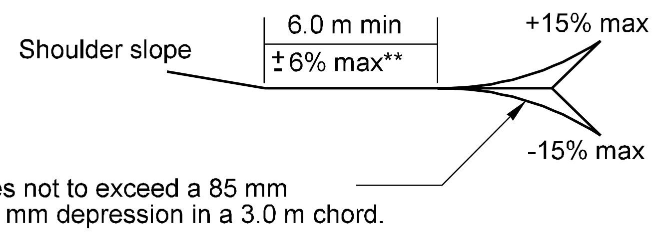
$$S = \sqrt{\frac{0.1L\left[\sqrt{2(H_1 - HC)} + \sqrt{2(H_2 - HC)}\right]^2}{A}}$$

$$L = \frac{AS^2}{0.1\left[\sqrt{2(H_1 - HC)} + \sqrt{2(H_2 - HC)}\right]^2}$$

Where:
- S = Available sight distance (m)
- H_1 = Eye height (1070 mm)
- H_2 = Object height (1300 mm)
- HC = Curb height (mm)
- L = Vertical curve length (m)
- A = Algebraic difference in grades (%)

Sight Distance at Intersections
Figure 910-16c



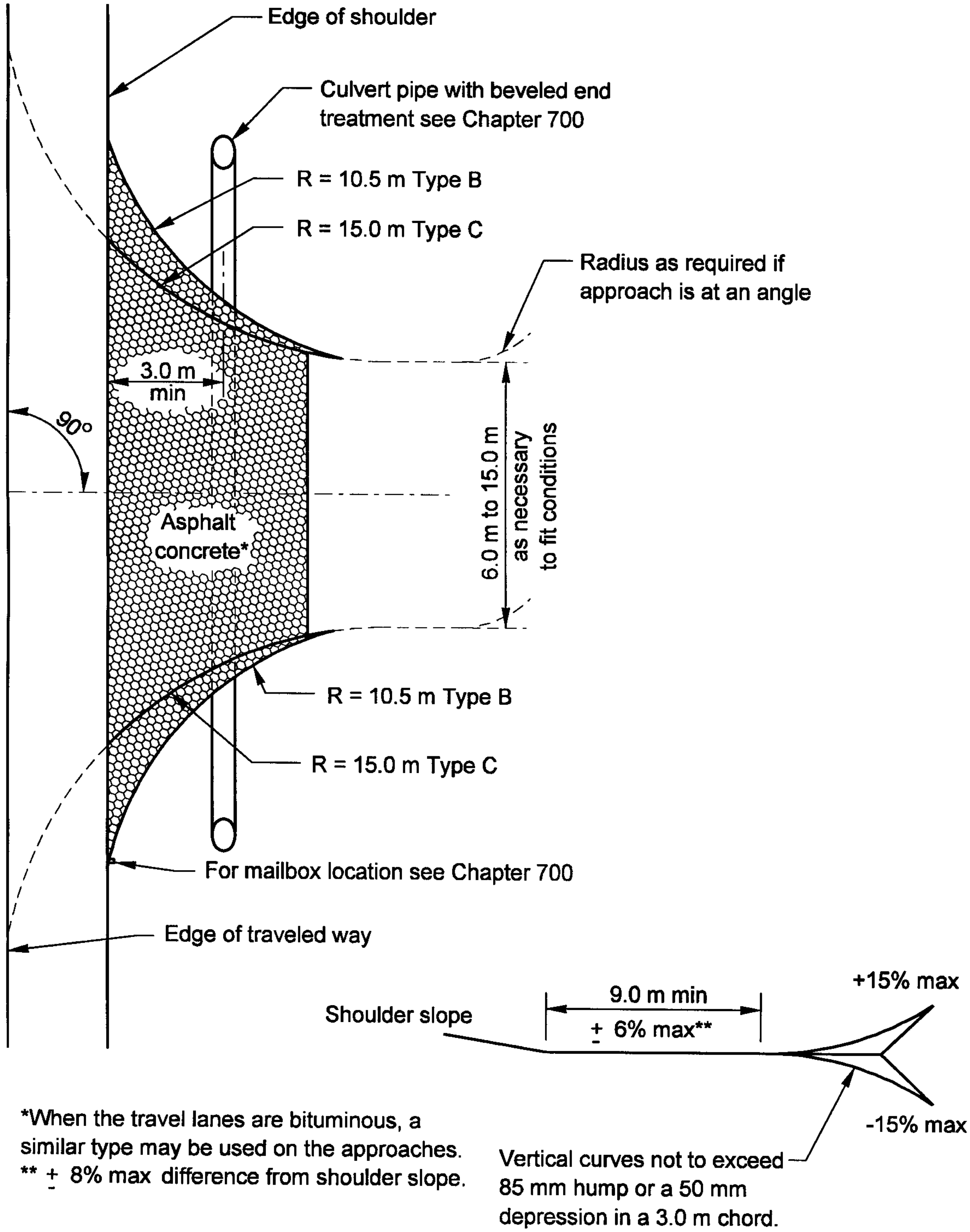


*When the travel lanes are bituminous, a similar type may be used on the approaches.

** ± 8% max difference from shoulder slope.

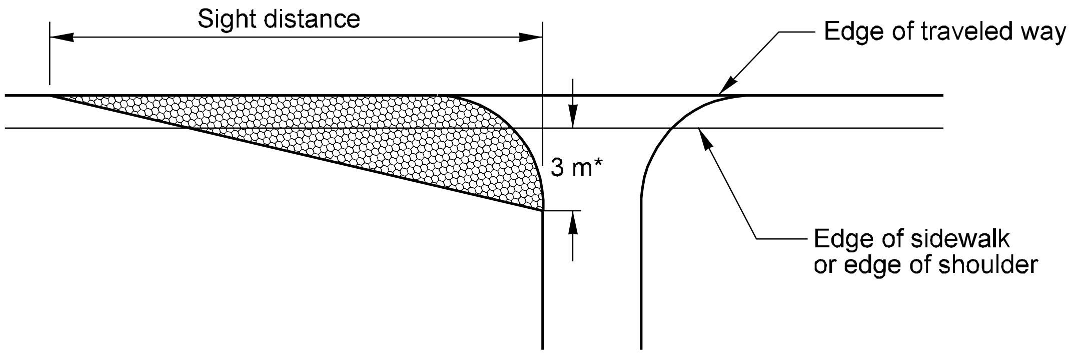
Noncommercial Approach Design Template A

Figure 920-3



*When the travel lanes are bituminous, a similar type may be used on the approaches.
** ± 8% max difference from shoulder slope.

Noncommercial Approach Design Template B and C
Figure 920-4



*Not to exceed 5.4 m from the edge of traveled way.

Posted Speed Limit (mph)	25	30	35	40	50	60	70
Category I Road Approach	45	55	70	85	115	155	190
Category II Road Approach	45	60	80	100	145	195	260

These distances require an approaching vehicle to reduce speed or stop to prevent a collision.

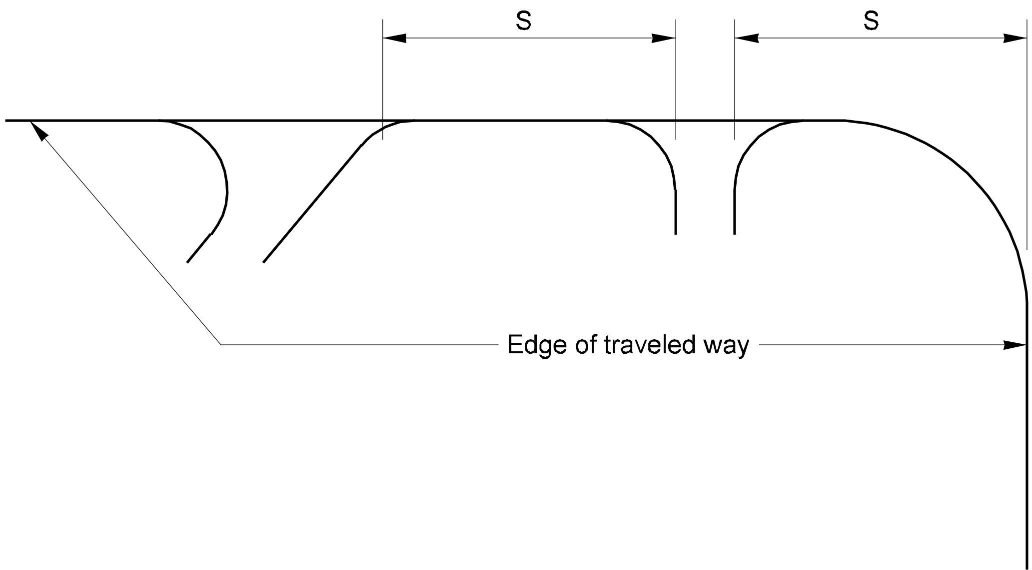
Design Category III road approach sight distance as an intersection (see Chapter 910).

For road approaches where left turns are not allowed, a sight triangle need only be provided to the left, as shown.

For road approaches where left turns are allowed, provide a sight triangle to the right in addition to the one to the left. The sight distance to the right is measured along the center line of the roadway.

For additional information on calculating the sight triangle, see Chapter 910.

Road Approach Sight Distance
Figure 920-6



Highway Access Management Class	1	2	3	4	5
S	402.4 m	201.2 m	100.6 m	76.2 m	38.1 m
	1320 ft	660 ft	330 ft	250 ft	125 ft

Road Approach Spacing and Corner Clearance

Note:

For Road Approach Spacing, S is the distance between closest edge of the traveled way of the two road approaches, measured along the edge of the traveled way of the highway.

For corner clearance, S is measured from the closest edge of the traveled way of the crossroad to the closest edge of the traveled way of the road approach, measured along the edge of the traveled way of the highway.

Road Approach Spacing and Corner Clearance
Figure 920-7

Ramp Design Speed (mph)	25-30	35-40	45 and above
Desirable Grade (%)	5	4	3
Maximum Grade (%)	7	6	5
On one-way ramps down grades may be 2% greater.			

Maximum Ramp Grade
Figure 940-2

(4) Cross Section

Provide the minimum ramp widths given in Figure 940-3. Ramp traveled ways may require additional width to these minimums as one-way turning roadways. See Chapter 640 for additional information and roadway sections.

Number of Lanes		1	2
Traveled Way[1]		4.5[2]	7.5[3]
Shoulders	Right Left	2.4 0.6	2.4 1.2
Medians[4]		1.8	1.8

[1]See Chapter 1050 for additional width when an HOV lane is present.
[2]May be reduced to 3.6 on tangents.
[3]Add 3.6 m for each additional lane.
[4]In addition to shoulder width.

Ramp Widths
Figure 940-3

Cross slope and superelevation requirements for ramp traveled way and shoulders are as given in Chapter 640 for roadways.

Whenever feasible, make the ramp cross slope at the ramp beginning or ending station equal to the cross slope of the through lane pavement. Where space is limited and superelevation runoff is long or when parallel connections are used, the superelevation transition may be ended beyond (for on-ramps) or begun in advance of (for off-ramps) the ramp beginning or ending station, provided that the algebraic difference in cross slope at the edge of the through lane and the cross slope of the ramp does not exceed 4%. In such cases, ensure smooth transitions for the edge of traveled way.

(5) Ramp Lane Increases

When off-ramp traffic and left-turn movements volume at a crossroad terminal cause congestion, it may be desirable to add lanes to the ramp to reduce the queue length caused by turning conflicts. Make provision for the addition of ramp lanes whenever ramp exit or entrance volumes, after the design year, are expected to result in poor service. See Chapter 620 for width transition design.

(6) Ramp Meters

Ramp meters are used to allow a measured or regulated amount of traffic to enter the freeway. When operating in the “measured” mode, they release traffic at a measured rate to keep down-stream demand below capacity and improve system travel times. In the “regulated” mode, they break up platoons of vehicles that occur naturally or result from nearby traffic signals. Even when operating at near capacity, a freeway main line can accommodate merging vehicles one or two at a time, while groups of vehicles will cause main line flow to break down.

The location of the ramp meter is a balance between the storage and acceleration requirements. Locate the ramp meter to maximize the available storage and so that the acceleration lane length, from a stop to the freeway main line design speed, is available from the stop bar to the merging point. With justification, the main line design speed may be reduced to the average running speed during the hours of meter operation. See 940.06(4) for information on the design of on-connection acceleration lanes. See Chapter 860 for additional information on the design of ramp meters.

Driver compliance with the signal is required for the ramp meter to have the desired results. Consider enforcement areas with ramp meters.

Consider HOV bypass lanes with ramp meters. See Chapter 1050 for design data for ramp meter bypass lanes.

- Design and construct temporary ramps as if they were permanent unless second stage construction is planned to rapidly follow the first. In all cases, design the connection to meet the safety needs of the traffic. (See Figure 940-16.)

940.09 Interchange Plans

Figure 940-17 is a sample showing the general format and data required for interchange design plans.

Compass directions (W-S Ramp) or crossroad names (E-C Street) may be used for ramp designation to realize the most clarity for each particular interchange configuration and circumstance.

Include the following as applicable:

- Classes of highway and design speeds for main line and crossroads (Chapter 440).
- Curve data on main line, ramps, and crossroads.
- Numbers of lanes and widths of lanes and shoulders on main line, crossroads, and ramps.
- Superelevation diagrams for the main line, the crossroad, and all ramps (may be submitted on separate sheets).
- Channelization (Chapter 910).
- Stationing of ramp connections and channelization.
- Proposed right of way and access control treatment (Chapter 1420).
- Delineation of all crossroads, existing and realigned (Chapter 910).
- Traffic data necessary to justify the proposed design. Include all movements.

Prepare a preliminary contour grading plan for each completed interchange. Show the desired contours of the completed interchange including details of basic land formation, slopes, graded areas or other special features. Coordinate the contour grading with the drainage design and the roadside development plan.

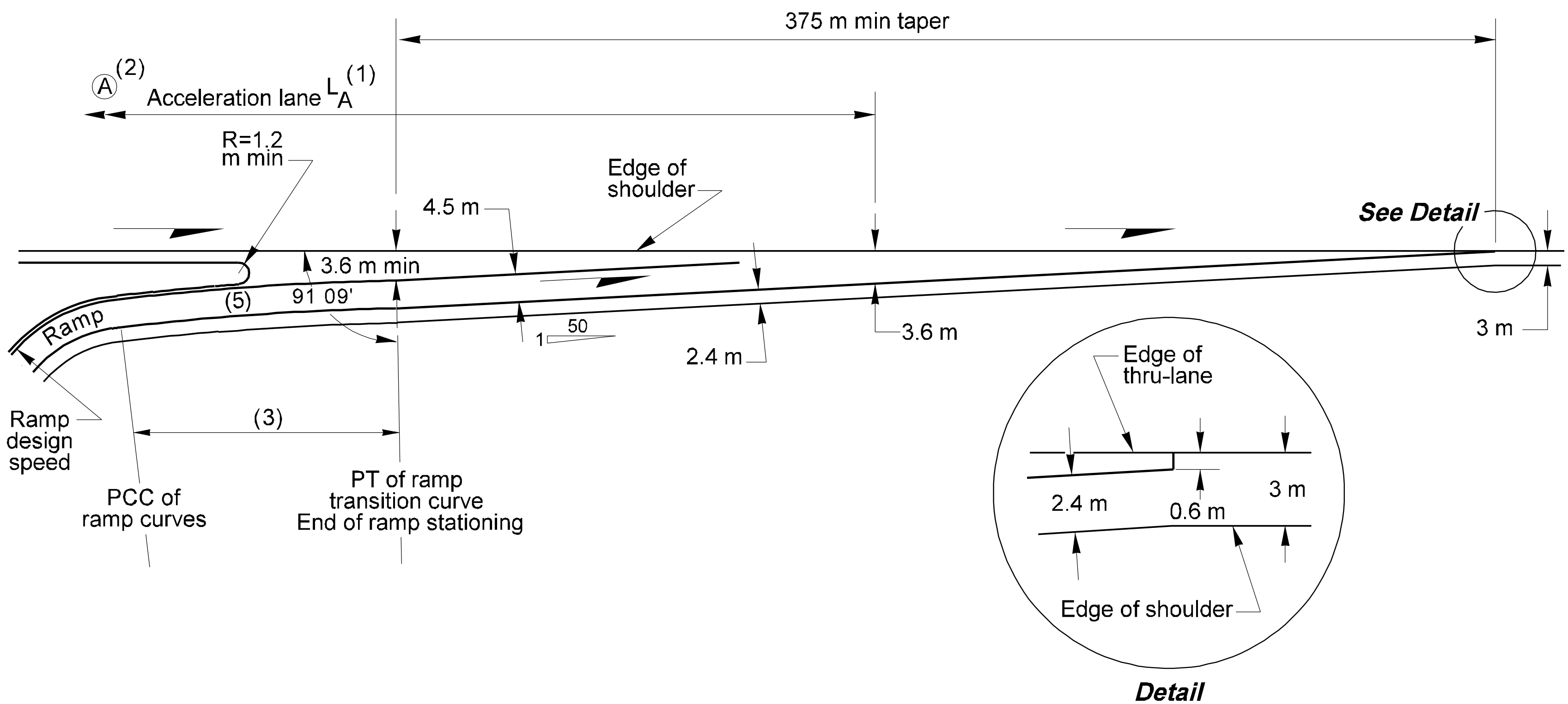
Alternative designs considered, studied, and rejected may be shown as reduced scale diagrams with a brief explanation of the advantages and disadvantages of the alternative designs, including the recommended design.

940.10 Documentation

The following documents are to be preserved in the project file. See Chapter 330.

- ☐ Interchange plan
- ☐ Access Point Decision Report (Chapter 1425)
- ☐ On-connection type justification
- ☐ Off-connection type justification
- ☐ Justification for ramp metering main line speed reduction
- ☐ Weaving analysis and design
- ☐ Alternative discussion and analysis

P65:DP/DMM



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

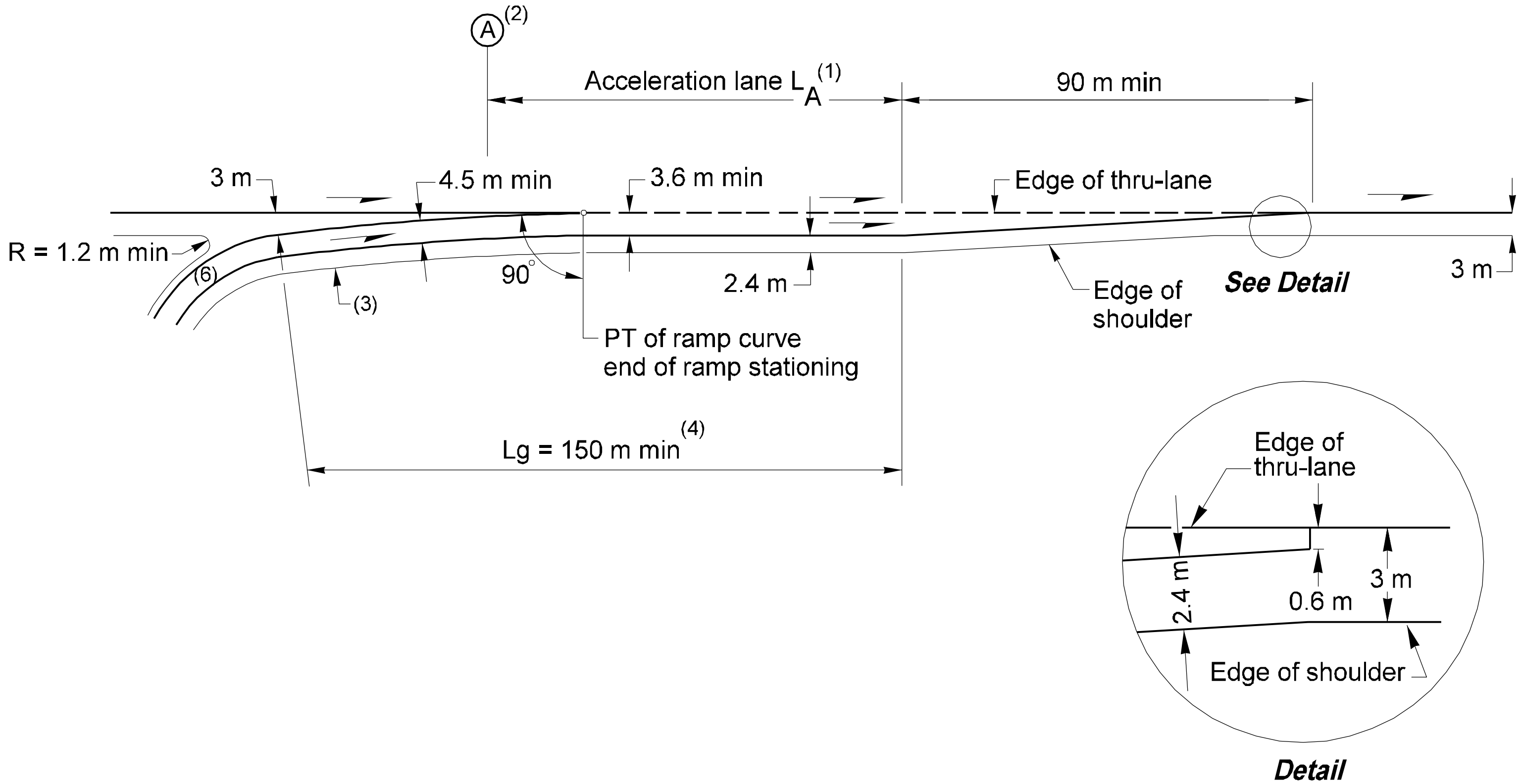
(2) Point A is the PT of the last curve designed at the ramp design speed.

(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

On-Connection (Single-Lane, Taper Type)
Figure 940-9a



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point (A) is the PT of the last curve designed at the ramp design speed.

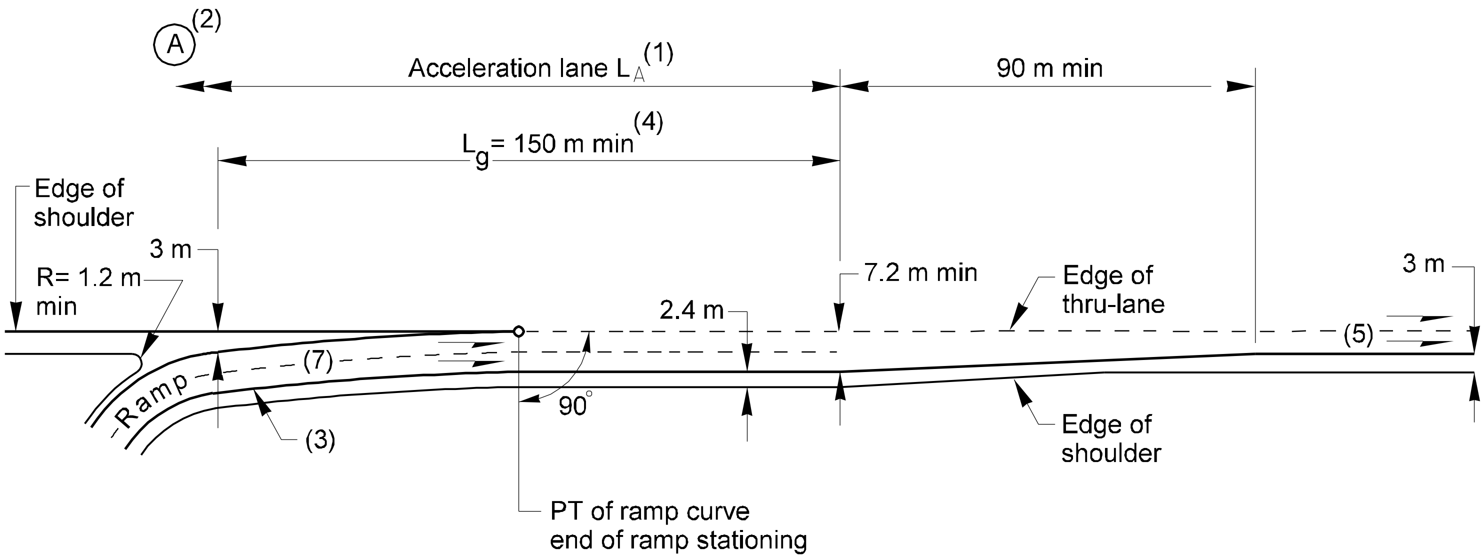
(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) L_g is the gap acceptance length. It is desirable that 90 m be provided from the ramp PT to the end of the on-connection lane.

(5) For striping, see the Standard Plans

(6) For ramp lane and shoulder widths, see Figure 940-3.

On-Connection (Single-Lane, Parallel Type)
Figure 940-9b



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point (A) is the PT of the last curve designed at the ramp design speed.

(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) L_g is the gap acceptance length. It is desirable that 90 m be provided from the ramp PT to the end of the on-connection lane.

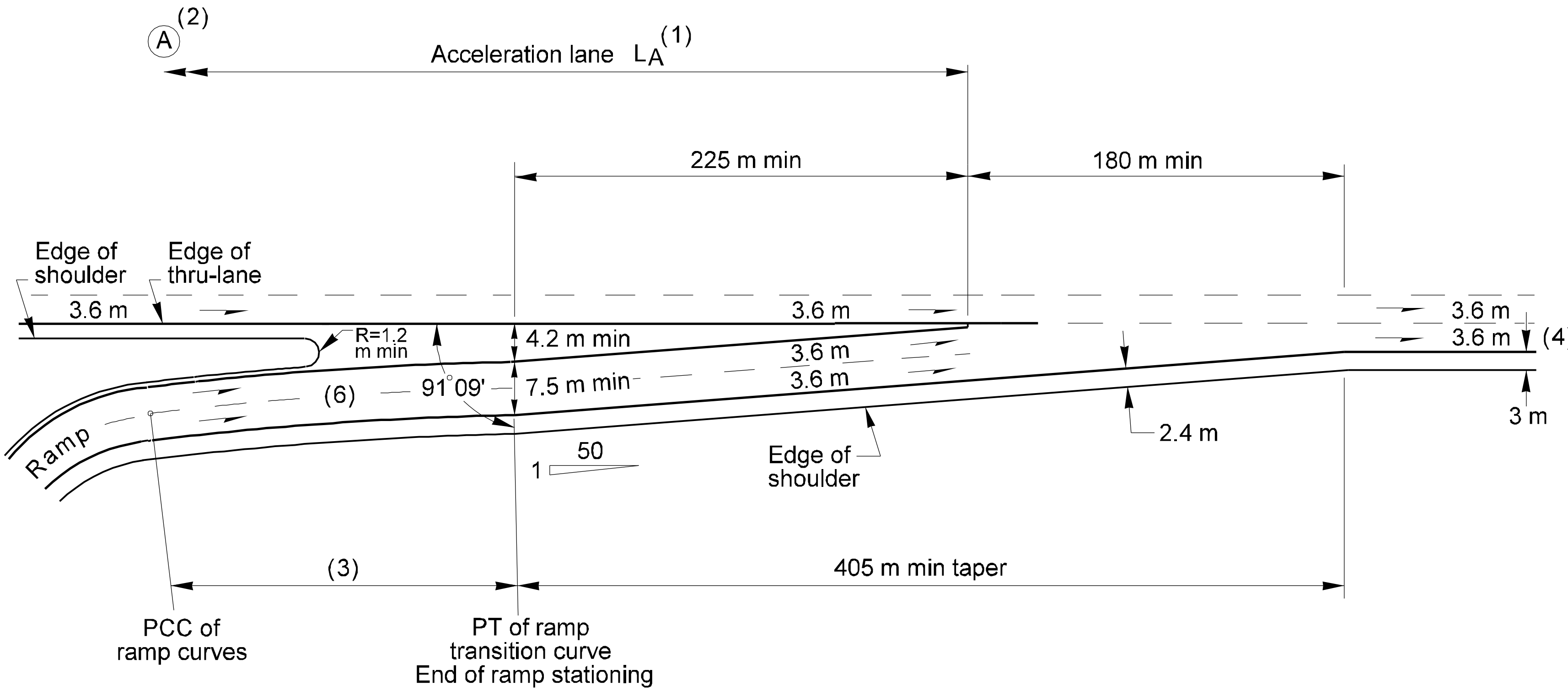
(5) Added lane or 450 m auxiliary lane, plus 180 m taper.

(6) For striping, see the Standard Plans

(7) For ramp lane and shoulder widths, see Figure 940-3.

On-Connection (Two-Lane, Parallel Type)

Figure 940-9c



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point Ⓐ is the PT of the last curve designed at the ramp design speed.

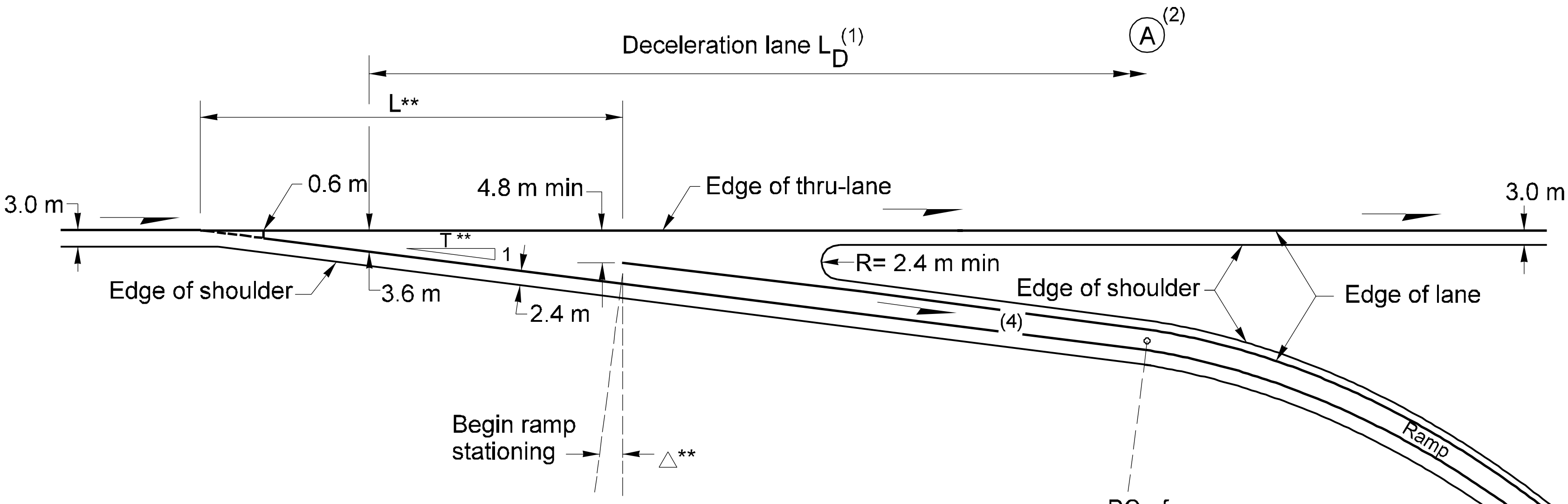
(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) Added lane or 450 m auxiliary lane, plus 180 m taper.

(5) For striping, see the Standard Plans

(6) For ramp lane and shoulder widths, see Figure 940-3.

On-Connection (Two-Lane, Taper Type)
Figure 940-9d



	T	min L	△
**Desirable	20	186 m	2° 52'
Minimum	15	139.5 m	3° 49'

Notes:

(1) See Figure 940-10 for <u>deceleration</u> lane length L_D.

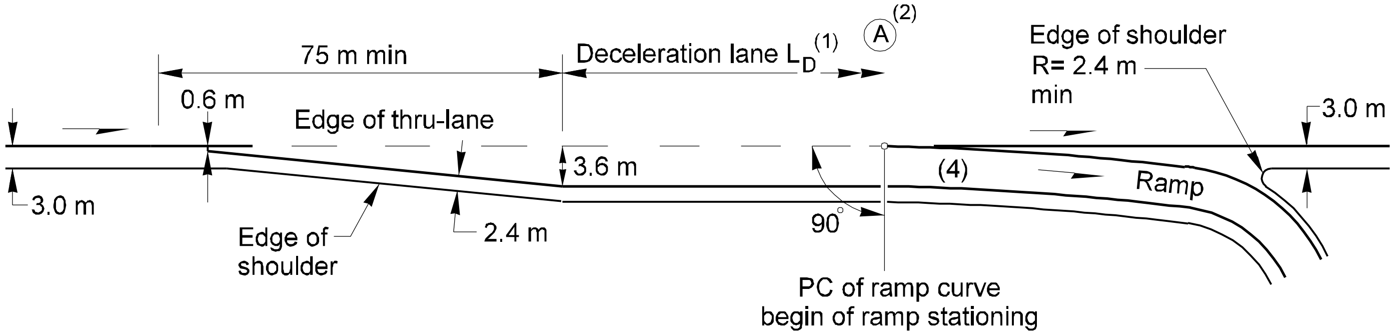
(2) Point A is the PC of the first curve designed at the ramp design speed.

(3) For striping, see the Standard Plans

(4) For ramp lane and shoulder widths, see Figure 940-3.

Off-Connection (Single-Lane, Taper Type)

Figure 940-12a



Notes:

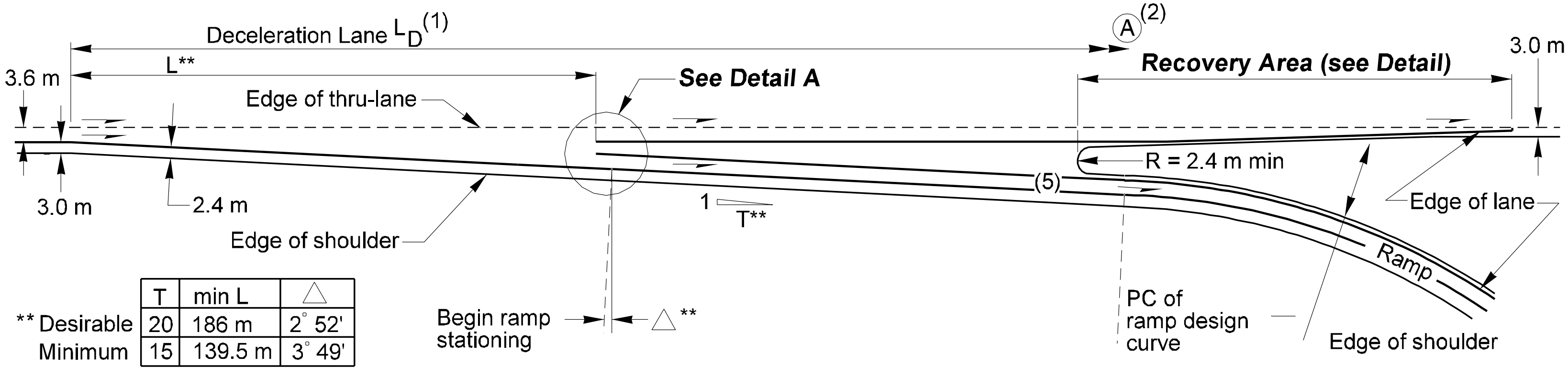
(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point Ⓐ is the PC of the first curve designed at the ramp design speed.

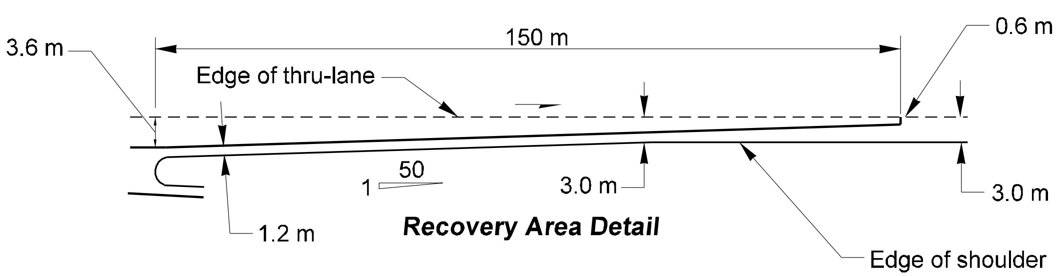
(3) For striping, see the Standard Plans.

(4) For ramp lane and shoulder widths, see Figure 940-3.

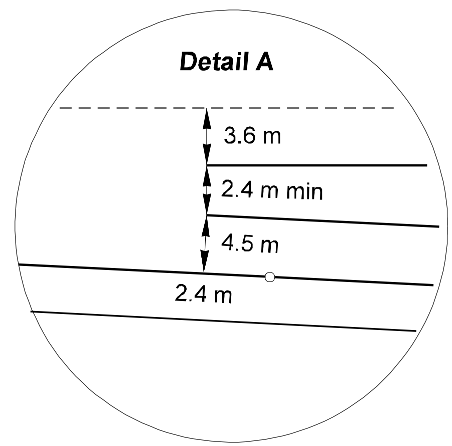
Off-Connection (Single Lane, Parallel Type)
Figure 940-12b



	T	min L	△
** Desirable	20	186 m	2° 52'
Minimum	15	139.5 m	3° 49'



Recovery Area Detail



Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point A is the PC of the first curve designed at the ramp design speed.

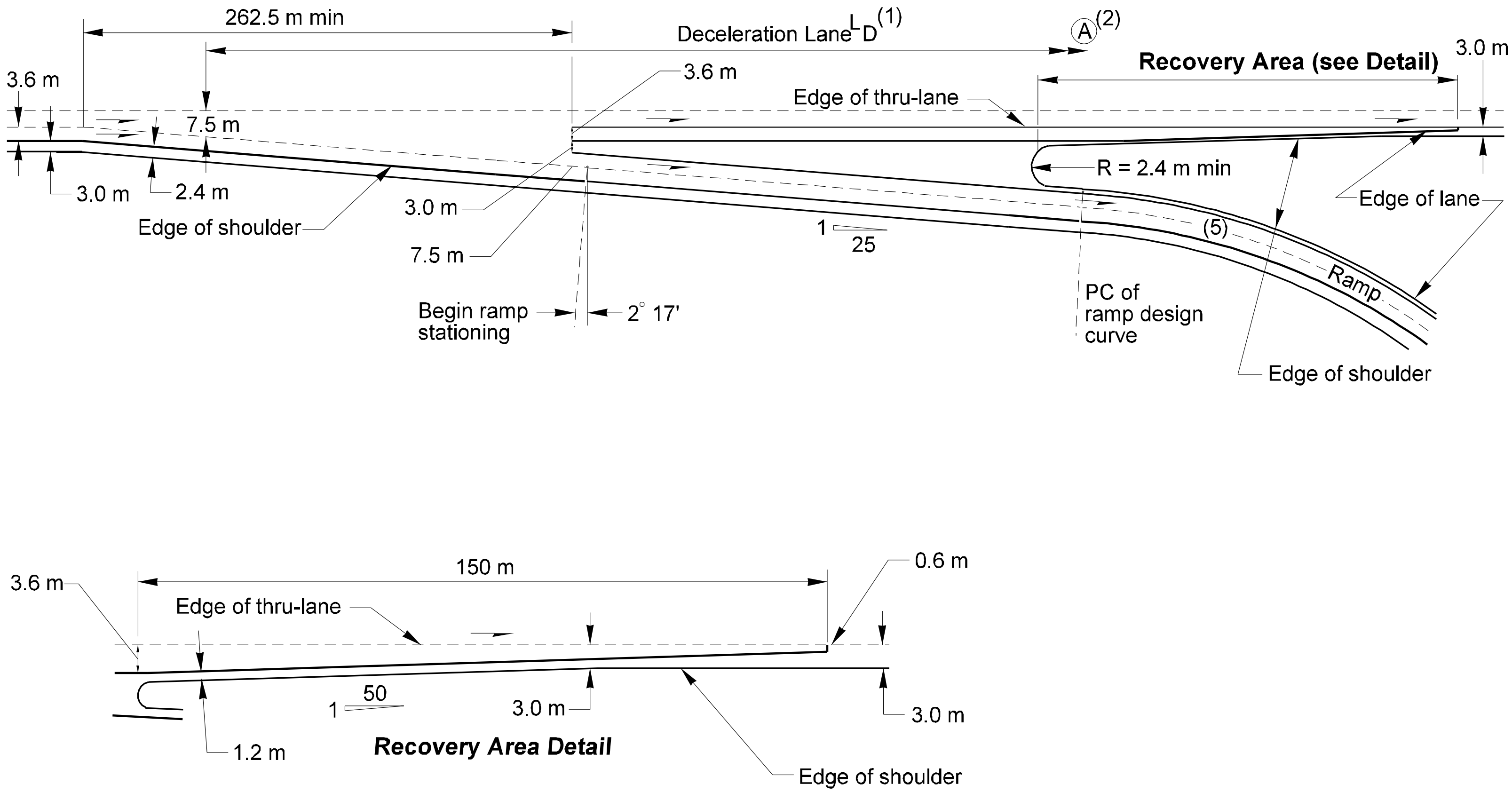
(3) Auxiliary lane between closely spaced interchanges to be dropped.

(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

Off-Connection (Single-Lane, One-Lane Reduction)

Figure 940-12c



Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

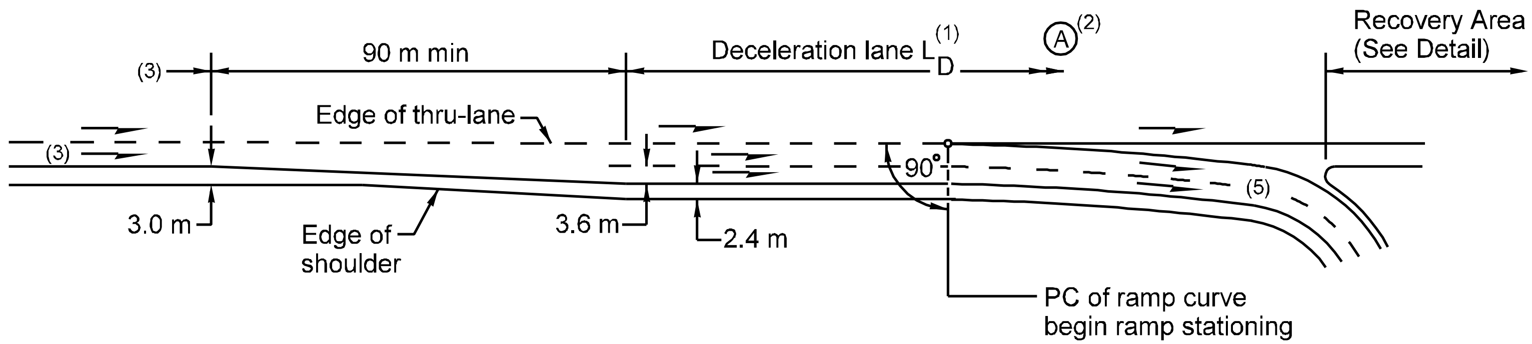
(2) Point Ⓐ is the PC of the first curve designed at the ramp design speed.

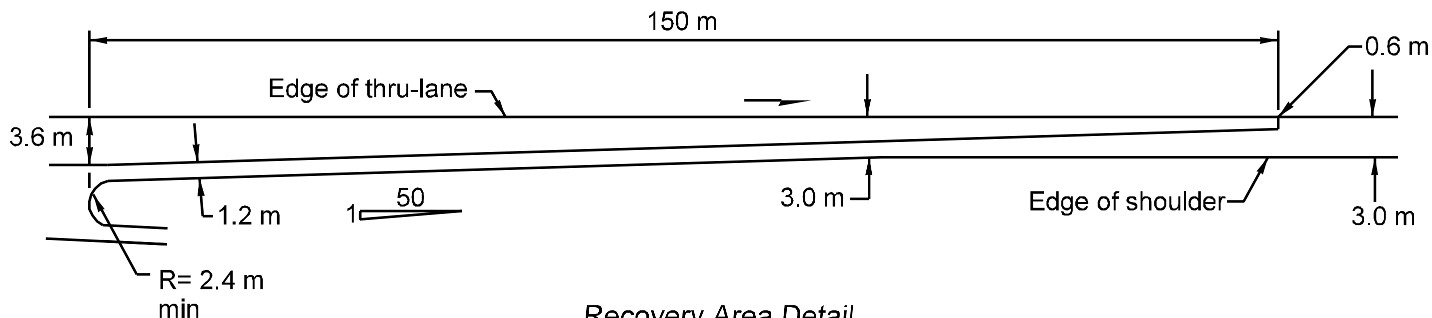
(3) Lane to be dropped or auxiliary lane with a minimum length of 450 m with a 90 m taper.

(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

Off-Connection (Two-Lane, Taper Type)
Figure 940-12d





Recovery Area Detail

Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point (A) is the PC of the first curve designed at the ramp design speed.

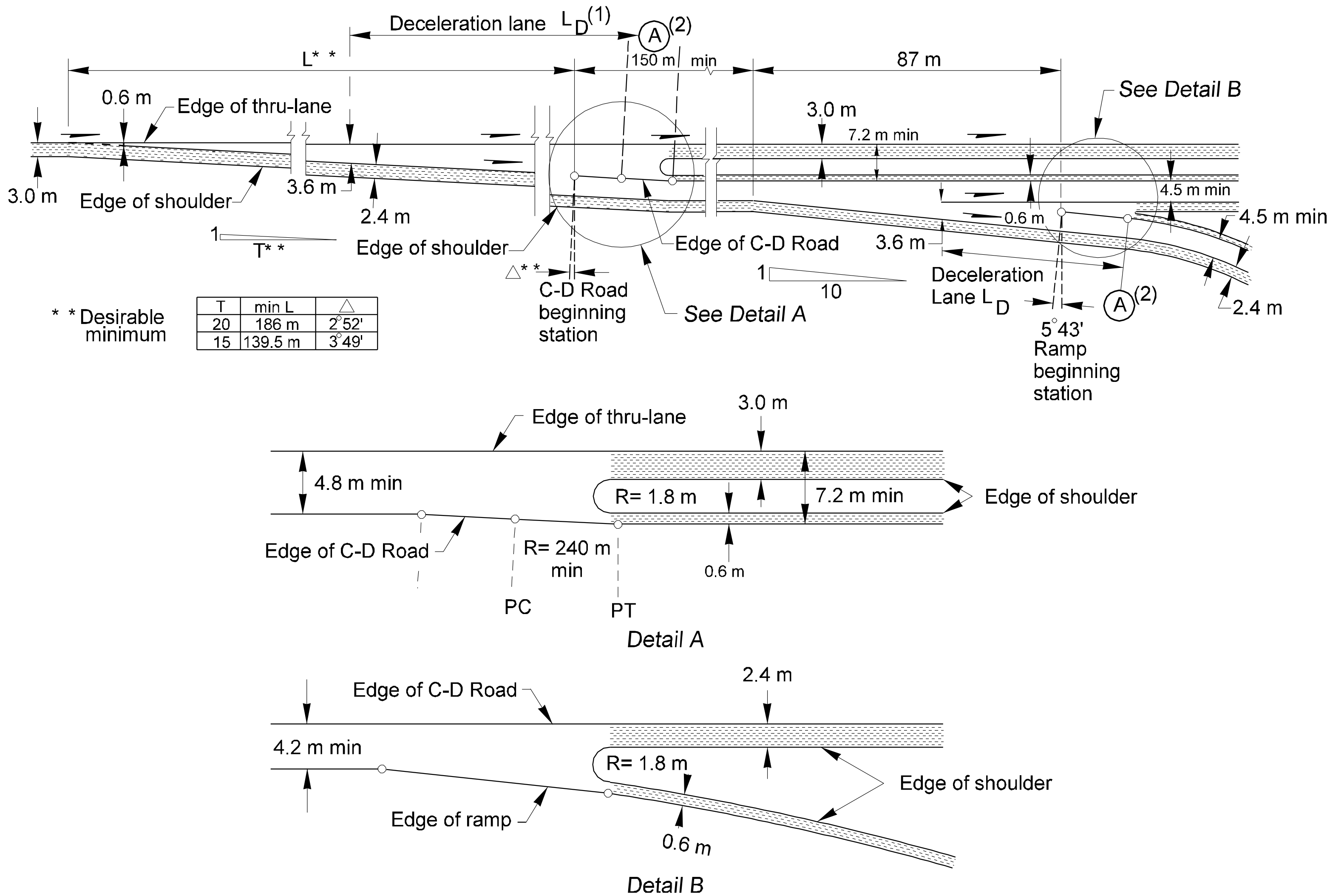
(3) Lane to be dropped or auxiliary lane with a minimum length of 400 m with a 90 m taper.

(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

Off-Connection (Two-Lane, Parallel Type)

Figure 940-12e



T	min L	△
20	186 m	2°52'
15	139.5 m	3°49'

Notes:

(1) See Figure 940-10 for <u>deceleration</u> lane length L_D.

(2) Point A is the PC of the first curve designed at the ramp design speed.

(3) For striping, see the Standard Plans.

Collector Distributor (Off-Connections)

Figure 940-13b

1010 Auxiliary Lanes

1010.01 General

Auxiliary lanes are used to comply with capacity requirements; to maintain lane balance; to accommodate speedx change, weaving, and maneuvering for entering and exiting traffic; or to encourage carpools, vanpools, and the use of transit.

See the Traffic Manual and the MUTCD for signing of auxiliary lanes.

Although slow vehicle turnouts, shoulder driving for slow vehicles, and chain-up areas are not auxiliary lanes they are covered in this chapter because they perform a similar function.

See the following chapters for additional information:

Chapter	Subject
910	Turn lanes
910	Speed change lanes at intersections
940	Speed change lanes at interchanges
940	Collector distributor roads
940	Weaving lanes
1050	High occupancy vehicle lanes

1010.02 References

Revised Code of Washington (RCW) 46.61, Rules of the Road.

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, M 24-01. WSDOT

Traffic Manual, M 51-02, WSDOT.

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

Emergency Escape Ramps for Runaway Heavy Vehicles, FHWA-T5-79-201, March 1978

Highway Capacity Manual (Special Report 209), Transportation Research Board

NCHRP Synthesis 178, *Truck Escape Ramps*, Transportation Research Board

1010.03 Definitions

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

climbing lane An auxiliary lane used for the diversion of slow traffic from the through lane.

emergency escape ramp A roadway leaving the main roadway designed for the purpose of slowing and stopping out-of-control vehicles away from the main traffic stream.

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

lateral clearance The distance from the edge of traveled way to a roadside object.

posted speed The maximum legal speed as posted on a section of highway using regulatory signs.

passing lane An auxiliary lane on a two-lane highway used to provide the desired frequency of safe passing zones.

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

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

slow moving vehicle turnouts A widened shoulder area to provide room for a slow moving vehicle to pull safely out of the through traffic, allow vehicles following to pass, and return to the through lane.

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

1010.04 Climbing Lanes

(1) General

Normally, climbing lanes are associated with truck traffic, but they may also be considered in recreational or other areas that are subject to slow moving traffic. Climbing lanes are designed independently for each direction of travel.

Generally, climbing lanes are provided when the requirements of two warrants - speed reduction and level of service - are exceeded. The requirements of either warrant may be waived if, for example, slow moving traffic is demonstrably causing a high accident rate or congestion that could be corrected by the addition of a climbing lane. However, under most conditions climbing lanes are built when the requirements of both warrants are satisfied.

(2) Warrant No. 1 — Speed Reduction

Figure 1010-2a shows how the percent and length of grade affect vehicle speeds. The data is based on a typical heavy truck.

The maximum allowable entrance speed, as reflected on the graphs, is 55 mph. Note that this is the maximum value to be used regardless of the posted speed of the highway. When the posted speed is above 55 mph, use 55 mph in place of the posted speed. Examine the profile at least 0.4 km preceding the grade to obtain a reasonable approach speed.

If a vertical curve makes up part of the length of grade, approximate the equivalent uniform grade length.

Whenever the gradient causes a 15 mph speed reduction below the posted speed limit for typical heavy truck for either two-lane or multilane highways, the speed reduction warrant is satisfied (see Figure 1010-2b for an example).

(3) Warrant No. 2 — Level of Service (LOS)

The level of service warrant for two-lane highways is fulfilled when the up-grade traffic volume exceeds 200 VPH and the up-grade truck volume exceeds 20 VPH. On multilane highways, use Figure 1010-3.

(4) Design

When a climbing lane is justified, design it in accordance with Figure 1010-4. Provide signing and delineation to identify the presence of the auxiliary lane. Begin climbing lanes at the point where the speed reduction warrant is met and end them where the warrant ends for multilane and 90 m beyond for 2-lane highways. Consider extending the auxiliary lane over the crest to improve vehicle acceleration and the sight distance.

Design climbing lane width equal to that of the adjoining through lane and at the same cross slope as the adjoining lanes. When ever possible, maintain the shoulders at standard width for the class of highway. However, on two-way two-lane highways, the shoulder may be reduced to 1.2 m with justification.

1010.05 Passing Lanes

(1) General

Passing lanes are desirable where a sufficient number and length of safe passing zones do not exist and the speed reduction warrant for a climbing lane is not satisfied. Figure 1010-5 may be used to determine if a passing lane is recommended.

(2) Design

When a passing lane is justified, design it in accordance with Figure 1010-6. Make the lane long enough to permit several vehicles to pass. Passing lanes longer than 3 km can cause the driver to lose the sense that the highway is basically a two-lane facility.

Passing lanes are preferably four-lane sections.

A three-lane section may be used, however. Alternate the direction of the passing lane at short intervals to ensure passing opportunities for both directions and to discourage illegal actions of frustrated drivers.

Make the passing lane width equal to the adjoining through lane and at the same cross slope. Full-width shoulders for the highway class are preferred; however, with justification, the shoulders may be reduced to 1.2 m. Provide adequate signing and delineation to identify the presence of an auxiliary lane.

1010.06 Slow Moving Vehicle Turnouts

(1) General

On a two-lane highway where passing is unsafe, a slow moving vehicle is required, by RCW 46.61.427, to turn off the through lane wherever a safe turnout exists, in order to permit the following vehicles to proceed. A slow moving vehicle is one that is traveling at a speed less than the normal flow of traffic, behind which five or more vehicles are formed in a line.

A slow moving vehicle turnout is not an auxiliary lane. Its purpose is to provide sufficient room for a slow moving vehicle to safely pull out of through traffic and stop if necessary, allow vehicles following to pass, then return to the through lane. Generally, a slow moving vehicle turnout is provided on existing roadways where passing opportunities are limited, where slow moving vehicles such as trucks and recreational vehicles are predominant, and where the cost to provide a full auxiliary lane would be prohibitive.

(2) Design

Base the design of a slow moving vehicle turnout primarily on sound engineering judgment and Figure 1010-7. Design may vary from one location to another. A minimum length of 30 m provides adequate storage, since additional storage is provided within the tapers and shoulders. The maximum length is 0.5 km including tapers. Surface turnouts with a stable unyielding material such as BST or ACP with adequate structural strength to support the heavier traffic.

Locate slow vehicle turnouts where at least Design Stopping Sight Distance (Chapter 650) is available, decision sight distance is preferred, so that vehicles can safely reenter the through traffic. Sign slow moving vehicle turnouts to identify their presence.

When a slow moving vehicle turnout is to be built, document the location and why it was selected.

1010.07 Shoulder Driving for Slow Vehicles

(1) General

For projects where climbing or passing lanes are justified, but are not within the scope of the project, or where meeting the warrants for these lanes are borderline, the use of a shoulder driving section is an alternative.

Review the following when considering a shoulder driving section:

- Horizontal and vertical alignment
- Character of traffic
- Presence of bicycles
- Clear zone (Chapter 700)

(2) Design

When designing a shoulder for shoulder driving, use a minimum length of 180 m. The minimum shoulder width is 2.4 m with 3.0 m preferred. When barrier is present, the minimum width is 3.0 m with 3.6 m preferred. Adequate structural strength for the anticipated traffic is necessary and may require reconstruction. Select locations where the side slope meets the requirements of Chapter 640 for new construction and Chapter 430 for existing roadways. When a transition is required at the end of a shoulder driving section, use a 50:1 taper.

Signing for shoulder driving is required. Install guideposts when shoulder driving is to be permitted at night.

Document the need for shoulder driving and why a lane is not being built.

1010.08 Emergency Escape Ramps

(1) General

Consider an emergency escape ramp whenever long steep down grades are encountered. In this situation the possibility exists of a truck losing its brakes and going out of control at a high speed. Consult local maintenance personnel and check traffic accident records to determine if an escape ramp is justified.

(2) Design

(a) **Type.** Escape ramps are one of the following types:

- Gravity escape ramps are ascending grade ramps paralleling the traveled way. They are commonly built on old roadways. Their long length and steep grade can present the driver with control problems, not only in stopping, but with rollback after stopping. Gravity escape ramps are the least desirable design.
- Sand pile escape ramps are piles of loose, dry sand dumped at the ramp site, usually not more than 120 m in length. The deceleration is usually high and the sand can be affected by weather conditions; therefore, they are less desirable than arrester beds. However, where space is limited they may be suitable.
- Arrester beds are parallel ramps filled with a smooth, coarse, free-draining gravel. They stop the out-of-control vehicle by increasing the rolling resistance. Arrester beds are commonly built on an up grade to add the benefits of gravity to the rolling resistance. However, successful arrester beds have been built on a level or descending grade.

(b) **Location.** The location of an escape ramp will vary depending on terrain, length of grade, and roadway geometrics. The best locations include in advance of a critical curve, near the bottom of grade, or before a stop. It is desirable that the ramp leave the roadway on a tangent at least 5 km from the beginning of the down-grade.

(c) **Length.** Lengths will vary depending on speed, grade, and type of design used. The minimum length is 60 m. Calculate the stopping length using the following equation:

$$L = \frac{V^2}{0.98(R \pm G)}$$

Where:

L = stopping distance (m)
V = entering speed (mph)
R = rolling resistance (see Figure 1010-1)
G = grade of the escape ramp (%)

Speeds of out-of control trucks rarely exceed 90 mph; therefore, an entering speed of 90 mph is preferred. Other entry speeds may be used when justification and the method used to determine the speed is documented.

Material	R
Roadway	1
Loose crushed aggregate	5
Loose noncrushed gravel	10
Sand	15
Pea gravel	25

Rolling Resistance (R)
Figure 1010-1

(d) **Width.** The width of each escape ramp will vary depending on the needs of the individual situation. It is desirable for the ramp to be wide enough to accommodate more than one vehicle. The desirable width of an escape ramp to accommodate two out-of-control vehicles is 12 m and the minimum width is 8 m.

(e) The following items are additional considerations in the design of emergency escape ramps:

- If possible, at or near the summit, provide a pull-off brake-check area. Also, include informative signing about the upcoming escape ramp in this area.
- A free draining, smooth, noncrushed gravel is preferred for an arrester bed. To assist in smooth deceleration of the vehicle, taper the depth of the bed from 75 mm at the entry to a full depth of 600 to 750 mm in not less than 30 m.
- Mark and sign in advance of the ramp. Discourage normal traffic from using or parking in the ramp. Sign escape ramps in accordance with the guidance contained in the MUTCD for runaway truck ramps.

- Provide drainage adequate to prevent the bed from freezing or compacting.
- Consider including an impact attenuator at the end of the ramp if space is limited.
- A surfaced service road adjacent to the arrester bed is needed for wreckers and maintenance vehicles to remove vehicles and make repairs to the arrester bed. Anchors are desirable at 90 m intervals to secure the wrecker when removing vehicles from the bed.

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

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

1010.09 Chain-Up Area

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

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

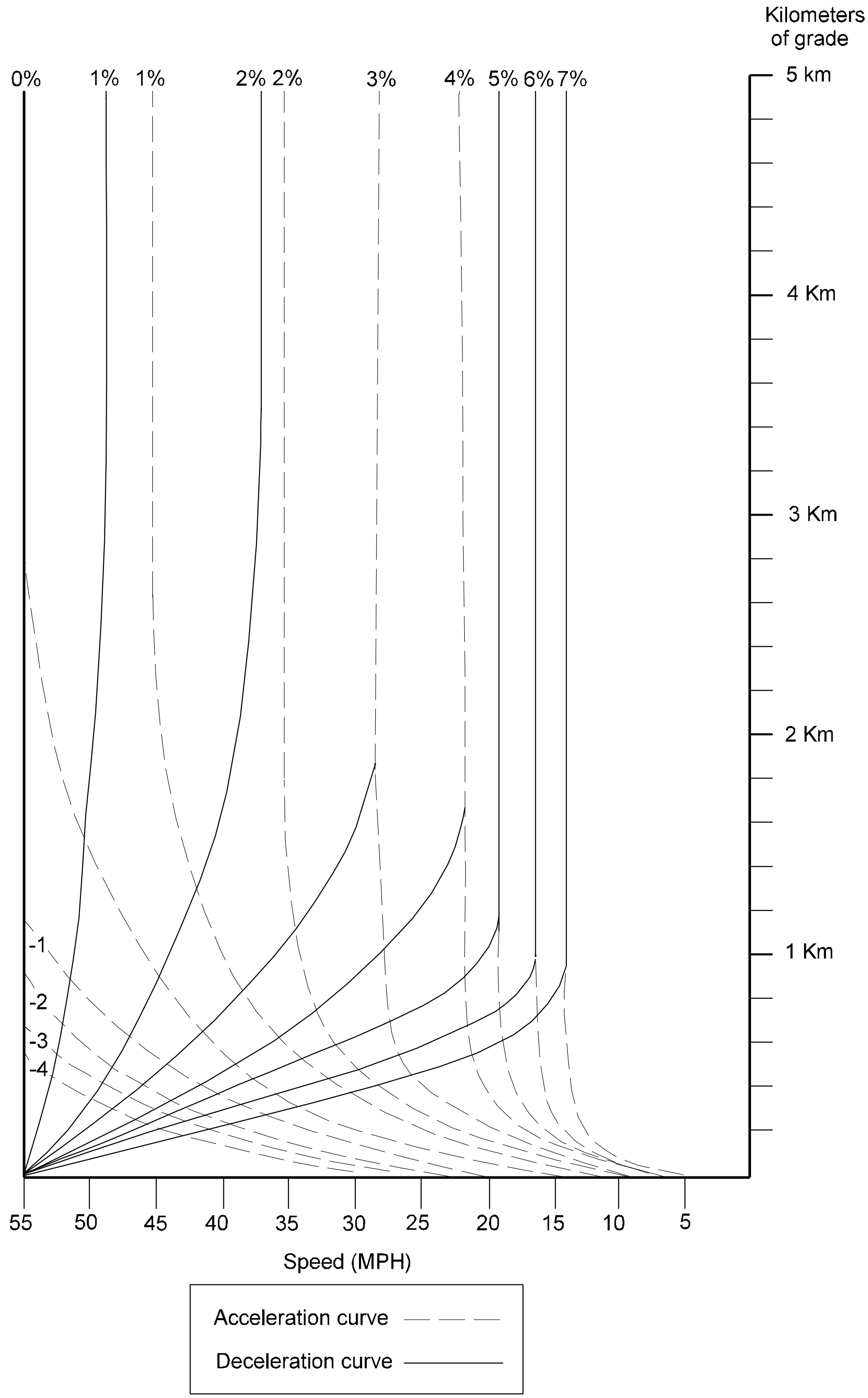
Consider illumination for chain-up and chain-off areas on multilane highways. When deciding whether or not to install illumination, consider traffic volumes during the hours of darkness and the availability of power.

1010.10 Documentation

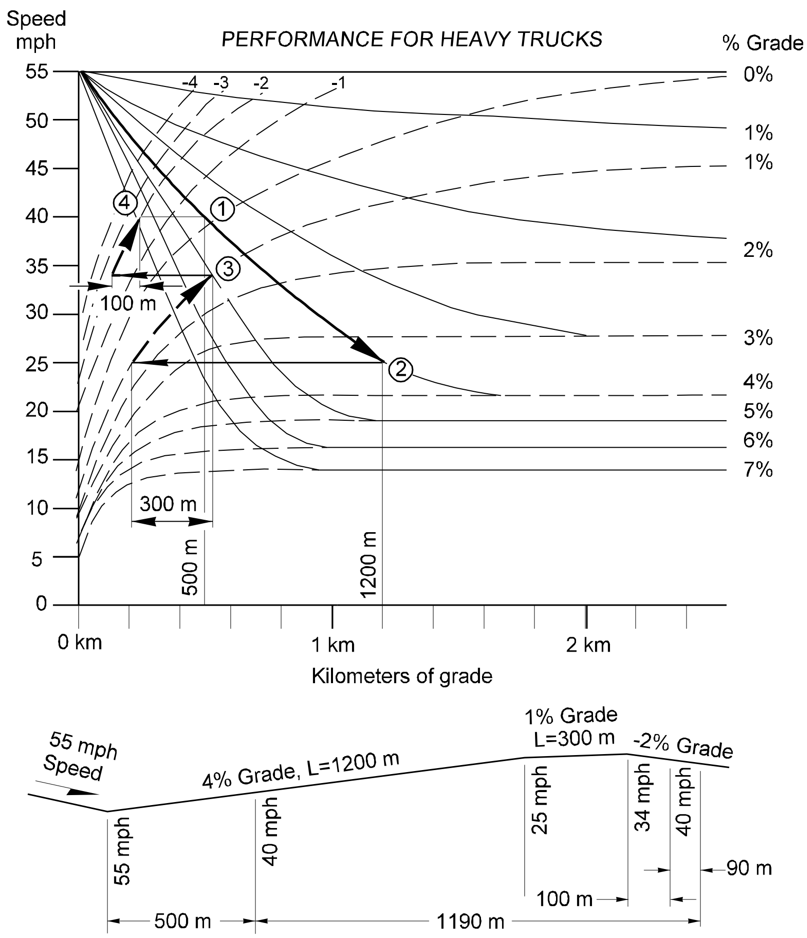
The following documents are to be preserved in the project file. See Chapter 330.

- ☐ Documentation that climbing lane warrant 1 has been met
- ☐ Documentation that climbing lane warrant 2 has been met
- ☐ Justification for waiving climbing lane warrant 1 or 2
- ☐ Justification for passing lanes
- ☐ Slow moving vehicle turnout documentation
- ☐ Emergency escape ramp documentation

P65:DP/DMM



Performance For Heavy Truck
Figure 1010-2a



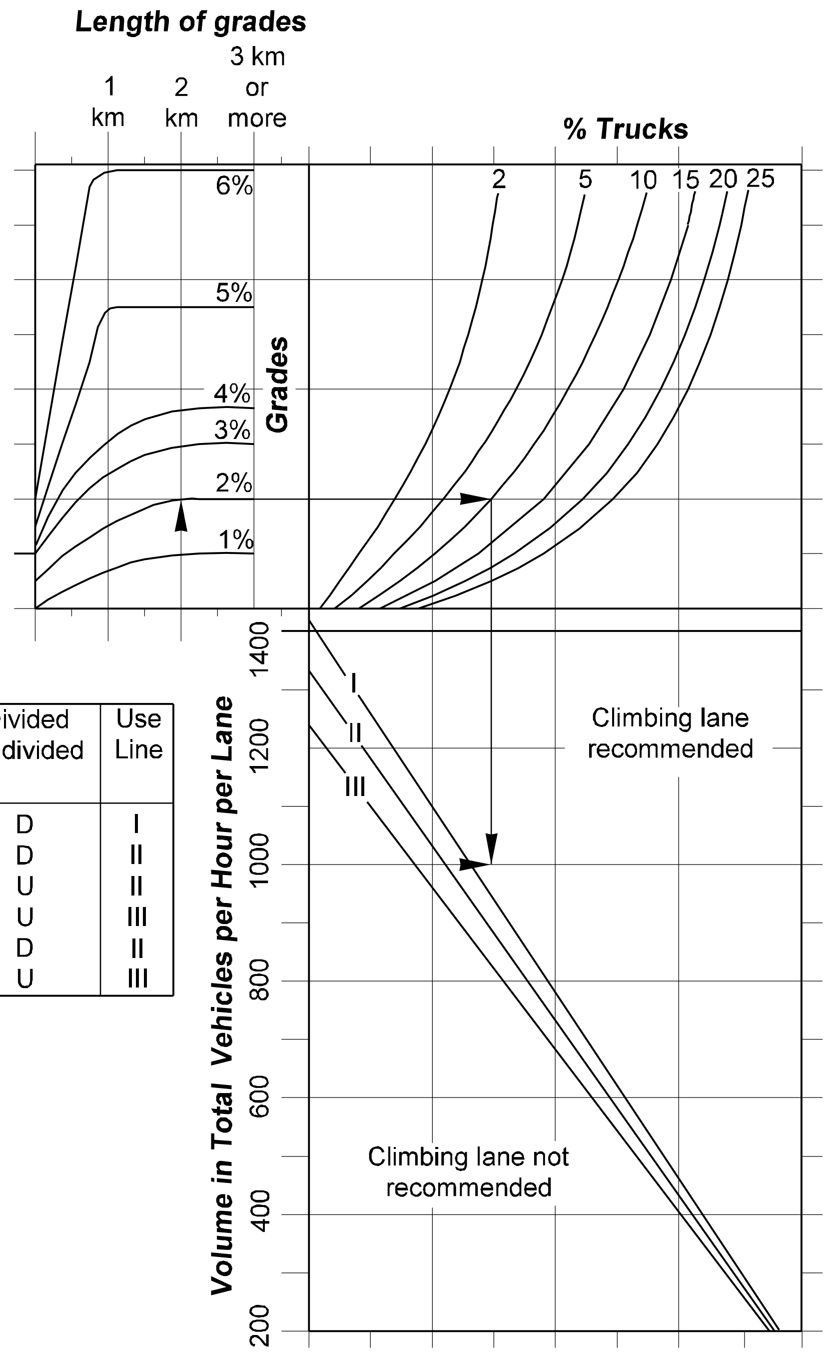
Given: A 2-lane highway meeting the level of service warrant, with the above profile, and a 55 mph posted speed.

Determine: Is the climbing lane warranted and, if so, how long?

Solution:

1. Follow the 4% grade deceleration curve from a speed of 55 mph to a speed of 40 mph at 500 m. The speed reduction warrant is met and a climbing lane is needed.
2. Continue on the 4% grade deceleration curve to 1200 m. Note that the speed at the end of the 4% grade is 25 mph.
3. Follow the 1% grade acceleration curve from a speed of 25 mph for 300 m. Note that the speed at the end of the 1% grade is 34 mph.
4. Follow the -2% grade acceleration curve from a speed of 34 mph to a speed of 40 mph, ending the speed reduction warrant. Note the distance required is 100 m.
5. The total auxiliary lane length is (1200-500)+300+100+90=1190 m. 90 m is added to the speed reduction warrant for a 2-lane highway, see the text and Figure 1010-4.

Speed Reduction Example
Figure 1010-2b

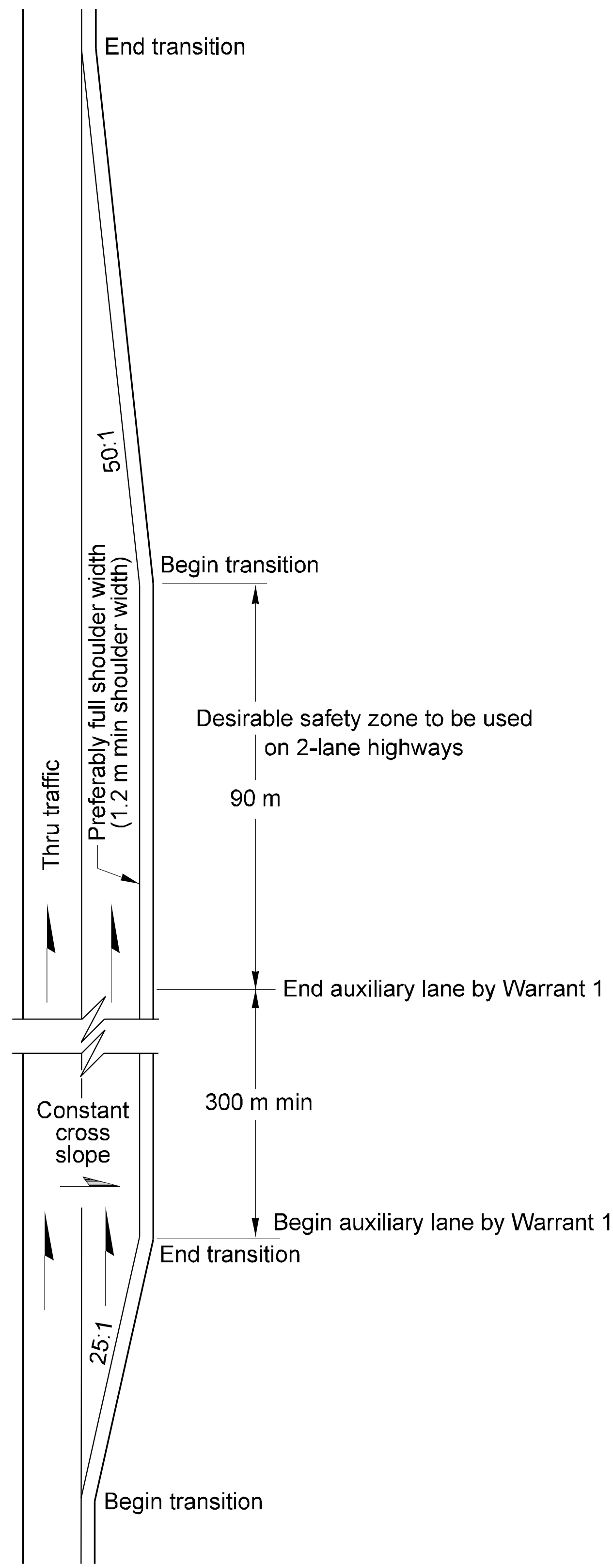


Lane Width (m)	Lateral Clearance (m)	Divided Undivided	Use Line
3.6	≥ 1.8	D	I
3.6	< 1.8	D	II
3.6	≤ 1.8	U	II
3.6	< 1.8	U	III
3.3	All	D	II
3.3	All	U	III

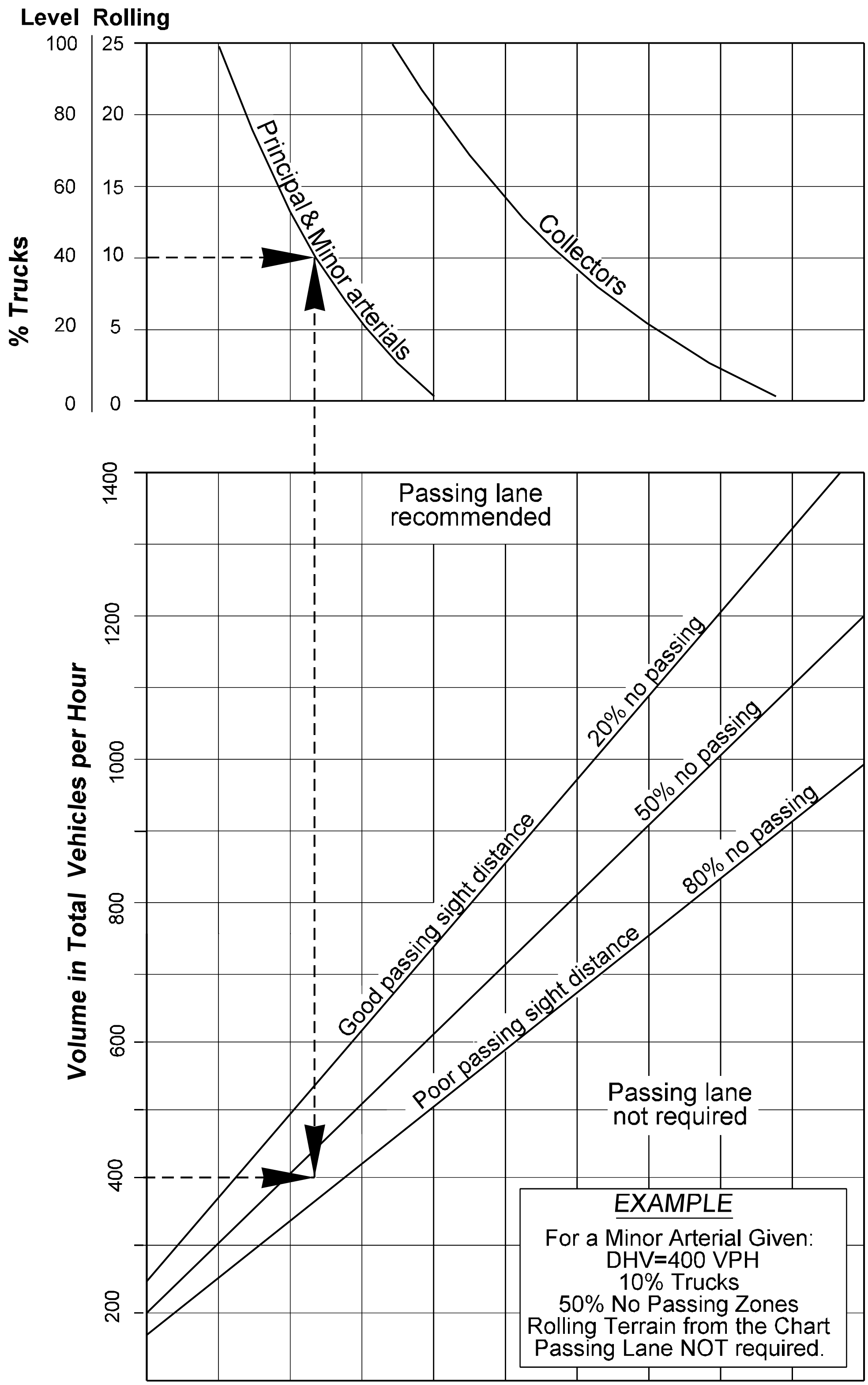
Example

2% grade for 2 km
10% trucks
3.6 m lanes
lateral clearance
≥ 1.8
4 lane, divided
DDHV = 2000
From the chart, climbing lane is recommended.

Level of Service — Multilane
Figure 1010-3

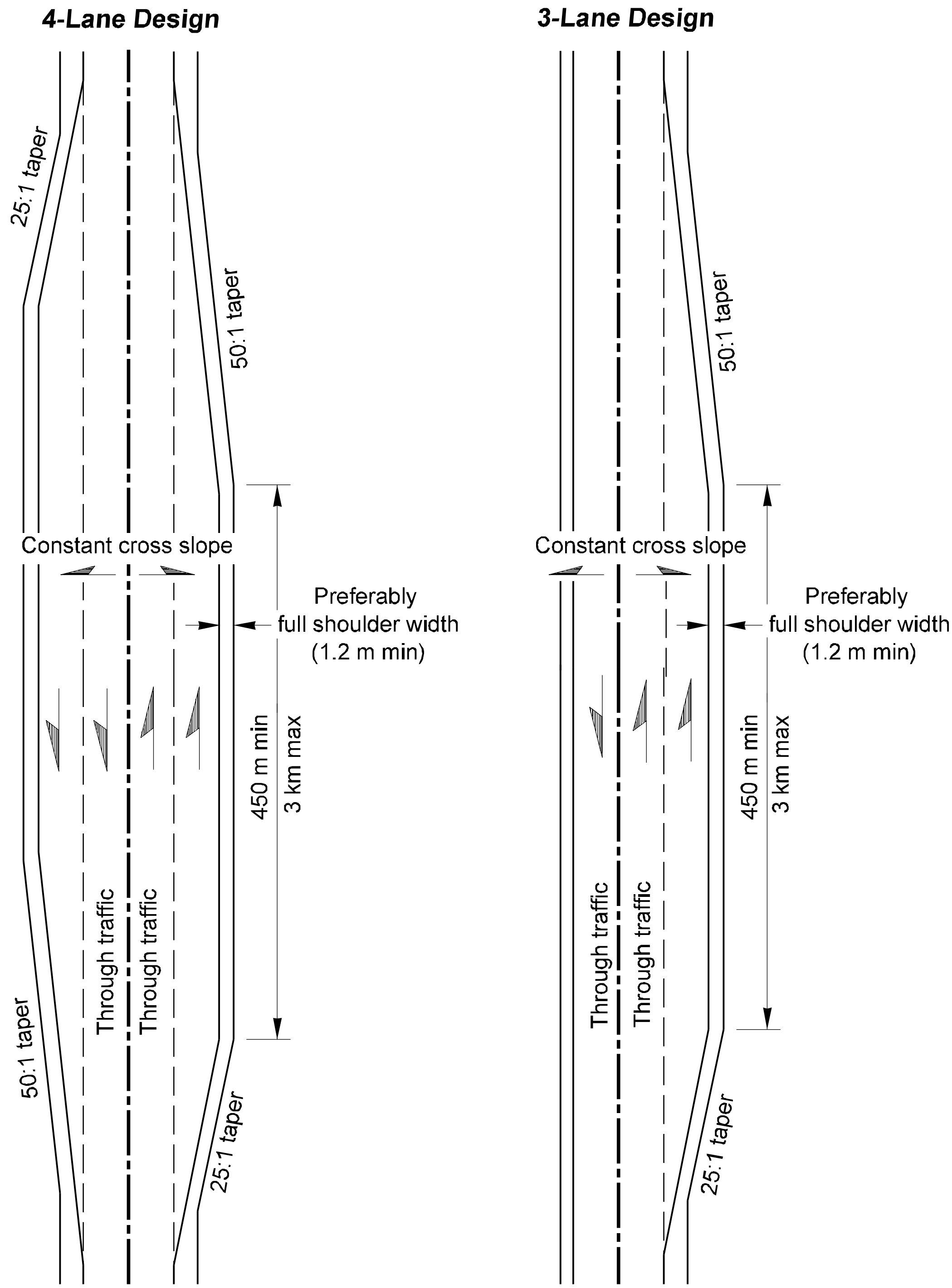


Auxiliary Climbing Lane
Figure 1010-4

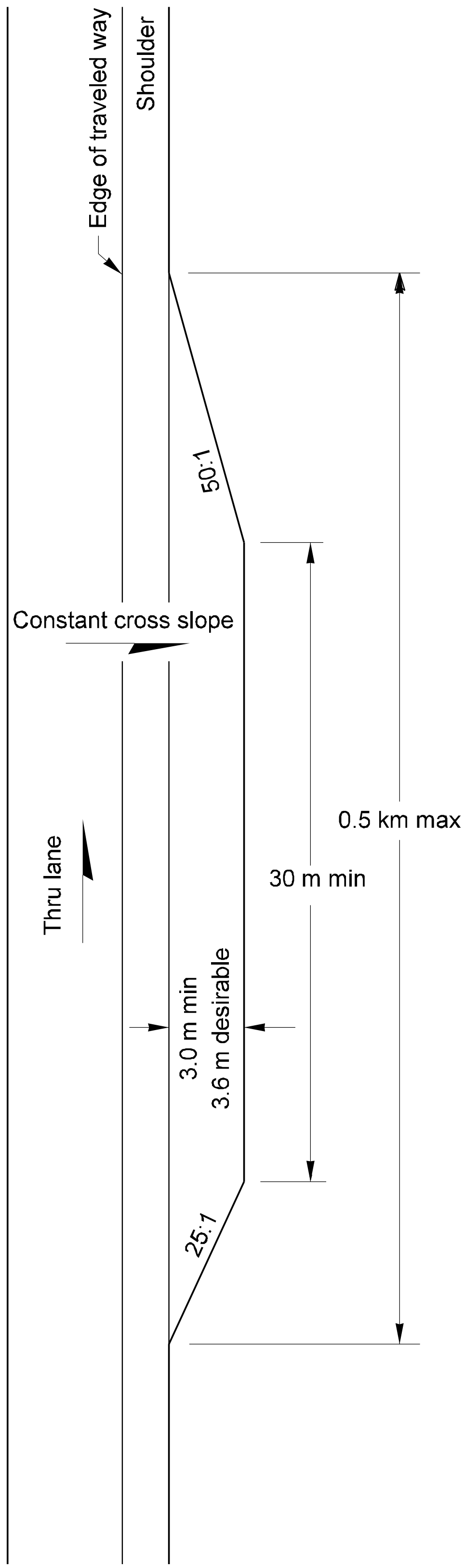


Warrant For Passing Lanes

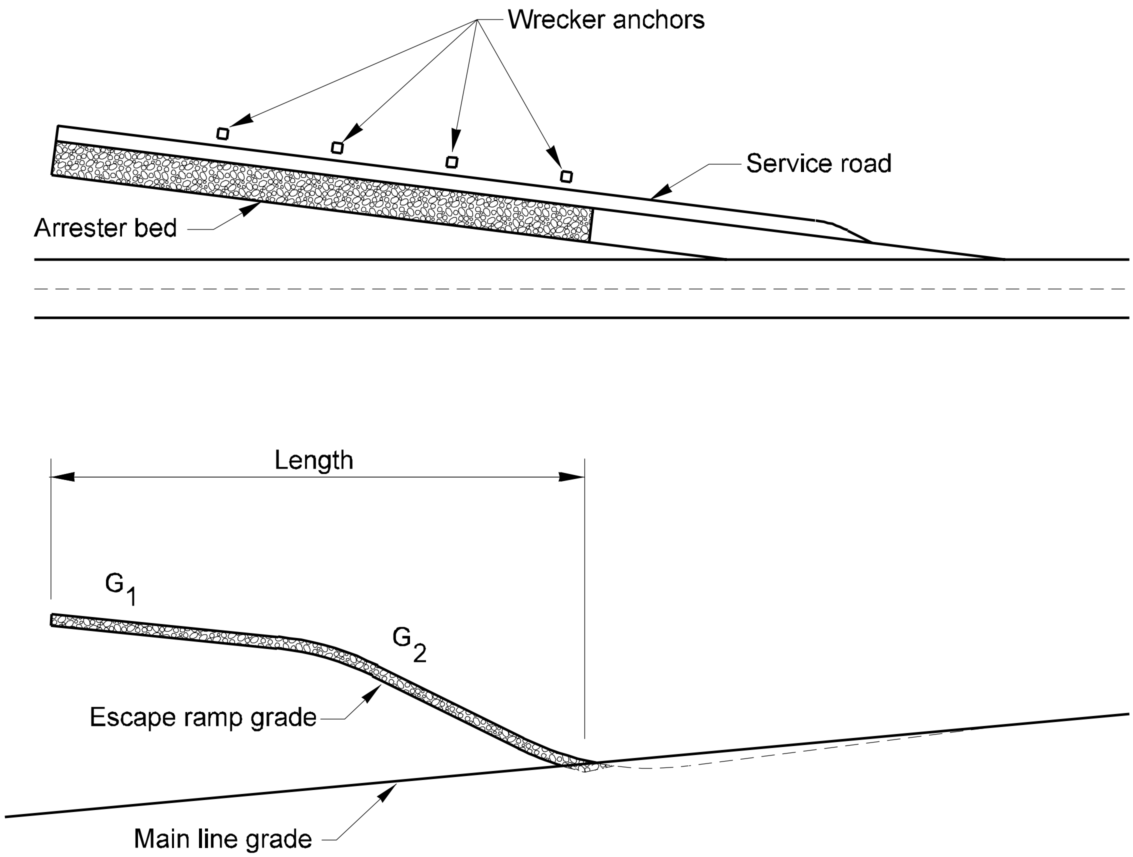
Figure 1010-5



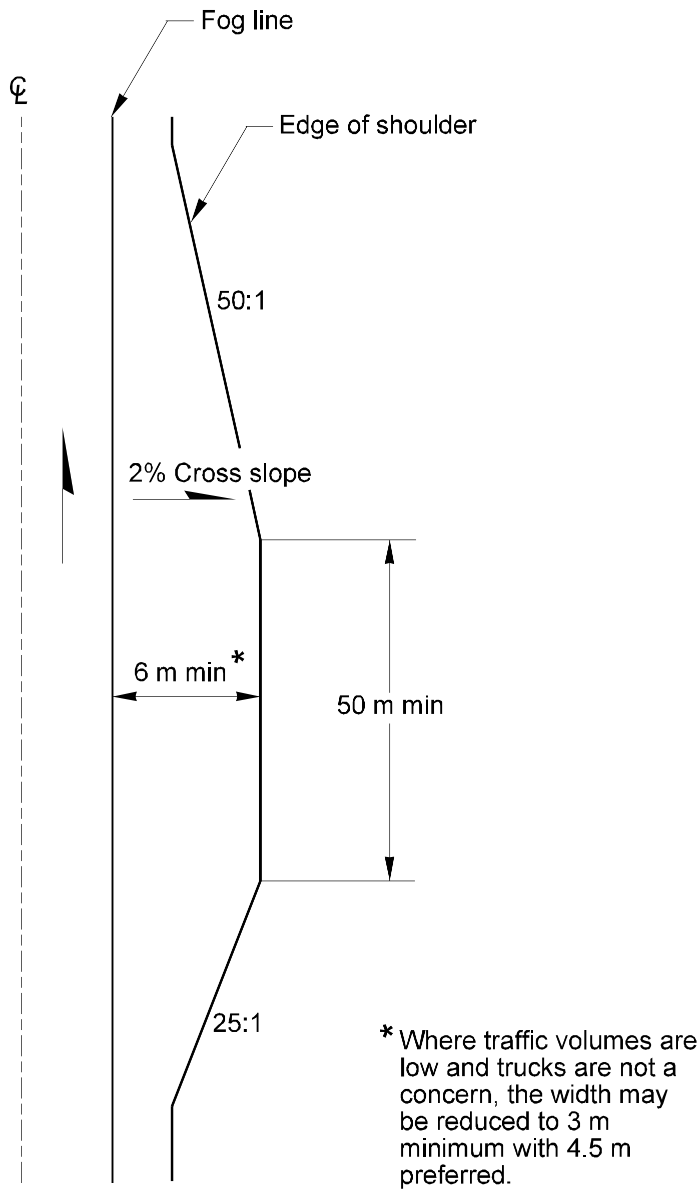
Auxiliary Passing Lane
Figure 1010-6



Slow Moving Vehicle Turnout
Figure 1010-7

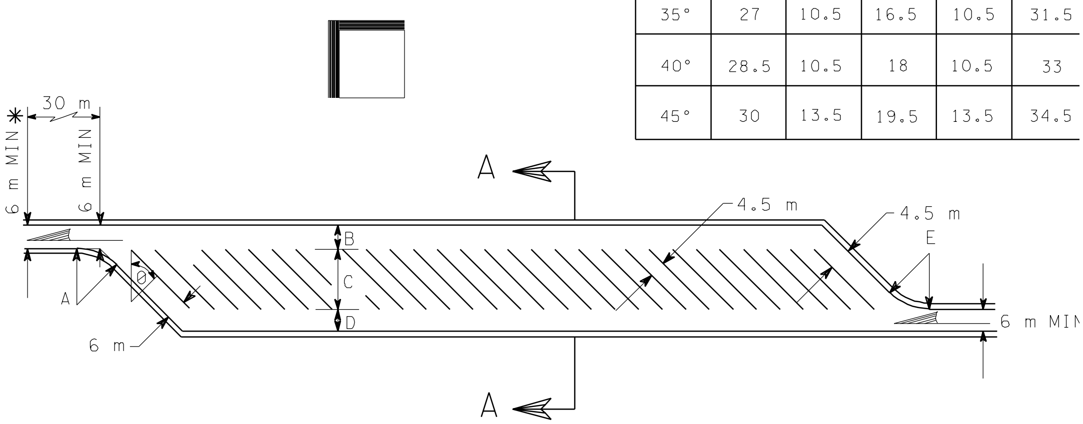


Typical Emergency Escape Ramp
Figure 1010-8

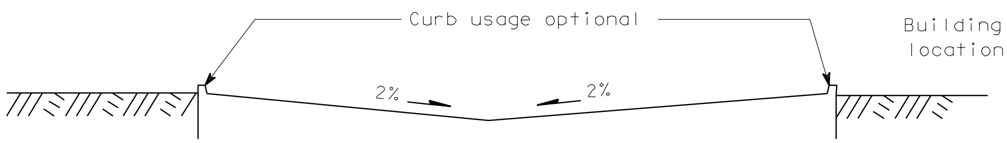


Chain-Up/Chain-Off Area
Figure 1010-9

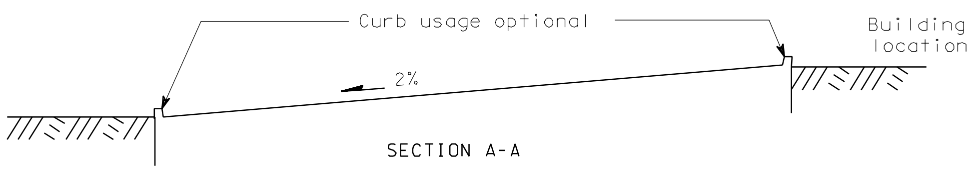
Ø	VARIABLES (meters) A	B	C	D	E
30°	25.5	9	15	9	30
35°	27	10.5	16.5	10.5	31.5
40°	28.5	10.5	18	10.5	33
45°	30	13.5	19.5	13.5	34.5



✳ Note: If exit ramp is tangent or has curve radii greater than 300 m, this width may be reduced to 4.2 m.

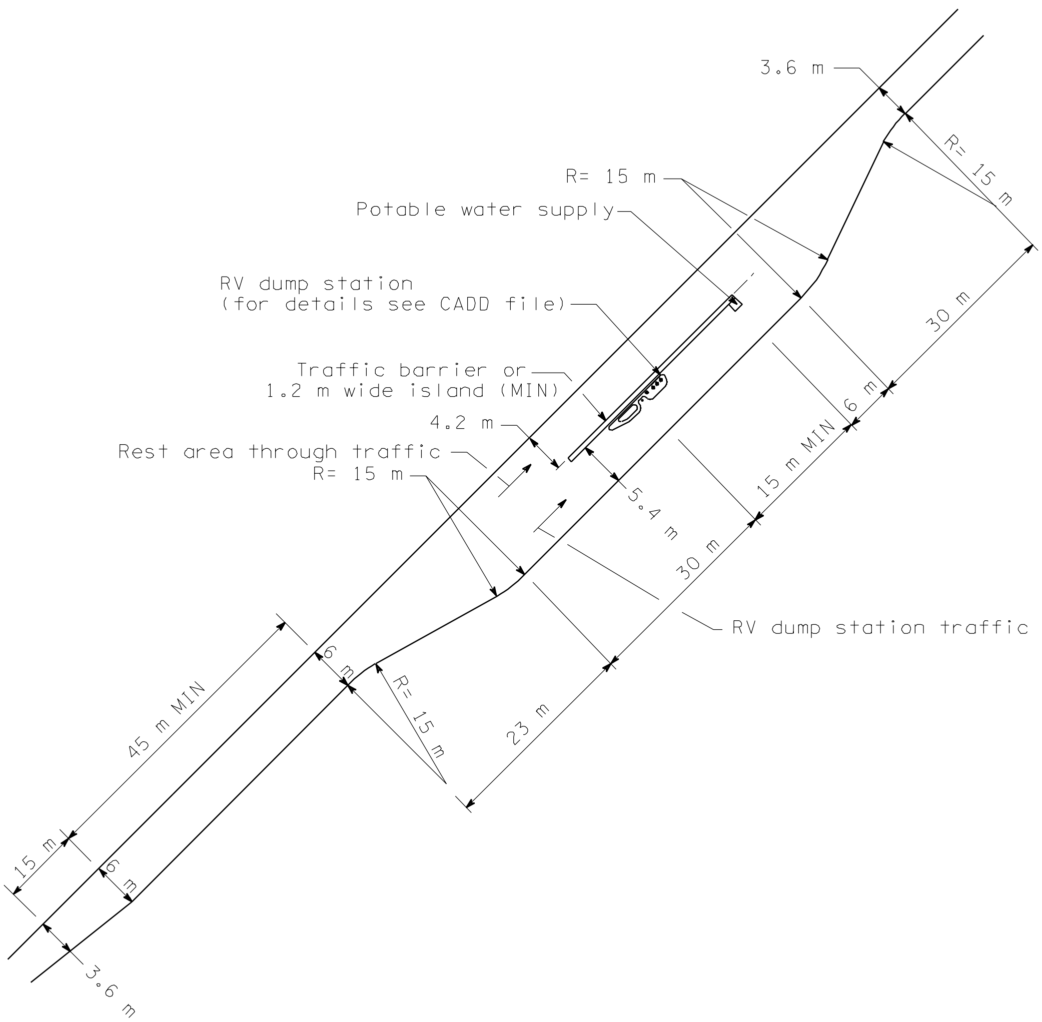


SECTION A-A

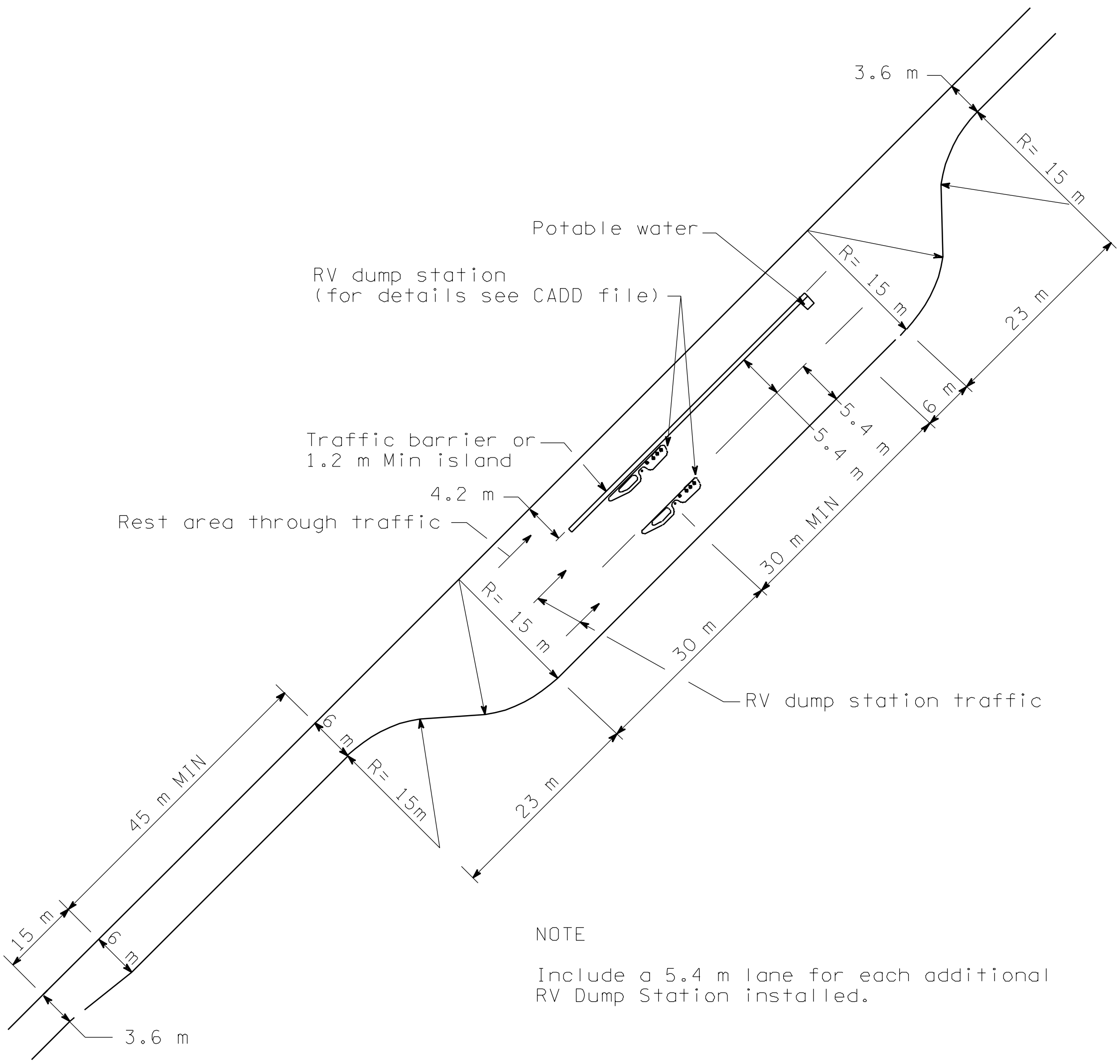


SECTION A-A
Alternate

Typical Truck Storage
Figure 1030-1



Typical Single RV Dump Station Layout
Figure 1030-2



NOTE

Include a 5.4 m lane for each additional RV Dump Station installed.

Typical Two RV Dump Station Layout
Figure 1030-3

(c) **Section**

- Show cross sections of the waterway. The extent will be determined by the OSC Hydraulics Branch.

The requirements for waterway profile and cross sections may be less stringent if the Hydraulics Branch has sufficient documentation (FEMA reports, for example) to make a determination. Contact the Hydraulics Branch to verify the extent of the information needed. Coordinate any rechannelization of the waterway with the Hydraulics Branch.

Many waterway crossings require a permit from the U.S. Coast Guard. (See Chapter 240.) Generally, ocean tide influenced waterways and waterways used for commercial navigation require a Coast Guard permit. These structures require the following additional information:

- Names and addresses of the landowners adjacent to the bridge site.
- Quantity of new embankment material within the floodway. This quantity denotes, in cubic meters, the material below normal high water and the material above normal high water.

Some waterways may qualify for an exemption from Coast Guard permit requirements if certain conditions are met. See the *Bridge Design Manual*. If the waterway crossing appears to satisfy these conditions, then submit a statement explaining why this project is exempt from a Coast Guard permit. Attach this exemption statement to the Environmental Classification Summary prepared for the project and submit it to the OSC Project Development Branch for processing to FHWA.

The region is responsible for coordination with the Bridge and Structures Office, U. S. Army Corps of Engineers, and U. S. Coast Guard for waterways that may qualify for a permit exemption. The Bridge and Structures Office is responsible for coordination with the U.S. Coast Guard for waterways that require a permit.

1110.05 Additional Data for Grade Separations

(1) Highway-Railroad Separation

Supplement bridge site data for structures involving railroads with the following:

(a) **Plan**

- Alignment of all existing and proposed railroad tracks.
- Center-to-center spacing of all tracks.
- Angle, station, and coordinates of all intersections between the highway alignment and each track.
- Location of railroad right of way lines.
- Horizontal curve data. Include coordinates for all circular and spiral curve control points.

(b) **Profile**

- For proposed railroad tracks; profile, vertical curve, and superelevation data for each track.
- For existing railroad tracks, elevations accurate to 3 mm taken at intervals of 2.5 to 3 m along the top of the highest rail of each track. Provide elevations to 15 m beyond the extreme outside limits of the existing or proposed structure. Tabulate elevations in a format acceptable to the Bridge and Structures Office.

(2) Highway-Highway Separation

Supplement bridge site data for structures involving other highways by the following:

(a) **Plan**

- Alignment of all existing and proposed highways, streets, and roads.
- Angle, station, and coordinates of all intersections between all crossing alignments.
- Horizontal curve data. Include coordinates for all curve control points.

(b) **Profile**

- For proposed highways; profile, vertical curve, and superelevation data for each.

- For existing highways; elevations accurate to 3 mm taken at intervals of 2.5 to 3 m along the center line or crown line and each edge of shoulder, for each alignment, to define the existing roadway cross slopes. Provide elevations to 15 m beyond the extreme outside limits of the existing or proposed structure. Tabulate elevations in a format acceptable to the Bridge and Structures Office format.

(c) **Section**

- Roadway sections of each undercrossing roadway indicating the lane and shoulder widths, cross slopes and side slopes, ditch dimensions, and traffic barrier requirements.
- Falsework or construction opening requirements. Specify minimum vertical clearances, lane widths, and shy distances.

1110.06 Additional Data for Widenings

Bridge rehabilitations and modifications that require new substructure are defined as bridge widenings.

Supplement bridge site data for structures involving bridge widenings by the following:

- Submit DOT Form 235-002A, "Supplemental Bridge Site Data-Rehabilitation/ Modification."

(a) **Plan**

- Stations for existing back of pavement seats, expansion joints, and pier center lines based on field measurement along the survey line and each curb line.
- Locations of existing bridge drains. Indicate whether these drains are to remain in use or be plugged.

(b) **Profile**

- Elevations accurate to 3 mm taken at intervals of 2.5 to 3 m along the curb line of the side of the structure being widened. Pair these elevations with corresponding elevations (same station) taken along the crown line or an offset distance (minimum of 3 m from the curb line). This information will be used to establish the cross slope of the existing bridge. Tabulate elevations in a format acceptable to the Bridge and Structures Office.

Take these elevations at the level of the concrete roadway deck. For bridges with latex modified or microsilica modified concrete overlay, elevations at the top of the overlay will be sufficient. For bridges with a nonstructural overlay, such as an asphalt concrete overlay, take elevations at the level of the concrete roadway deck. For skewed bridges, take elevations along the crown line or at an offset distance (3 m minimum from the curb line) on the approach roadway for a sufficient distance to enable a cross slope to be established for the skewed corners of the bridge.

1110.07 Documentation

The following documents are to be preserved in the project file. See Chapter 330.

- ☐ DOT Form 235-002, "Bridge Site Data - General"
- ☐ DOT Form 235-001, Bridge Site Data for Stream Crossings"
- ☐ DOT Form 235-002A, "Supplemental Bridge Site Data - Rehabilitation/ Modification"
- ☐ United States Coast Guard permit
- ☐ Environmental Classification Summary

P65:DP/DM11

Review Chapter 1110 of the *Design Manual*
for further information and description of the items listed below.

PLAN (In CAD file.)
______ Survey Lines and Station Ticks
______ Survey Line Intersection Angles
______ Survey Line Intersection Stations
______ Survey Line Bearings
______ Roadway and Median Widths
______ Lane and Shoulder Widths
______ Sidewalk Width
______ Connection/Widening for Traffic Barrier
______ Profile Grade and Pivot Point
______ Roadway Superelevation Rate (if constant)
______ Lane Taper and Channelization Data
______ Traffic Arrows
______ Mileage to Towns Along Main Line
______ Existing Drainage Structures
______ Existing Utilities — Type/Size/Location
______ New Utilities — Type/Size/Location
______ Light standards, Junction boxes, Conduits
______ Bridge Mounted Signs and Supports
______ Contours
______ Bottom of Ditches
______ Test Holes (if available)
______ Riprap Limits
______ Stream Flow Arrow
______ R/W Lines and/or Easement Lines
______ Exist. Bridge No. (to be removed, widened)
______ Section, Township, Range
______ City or Town
______ North Arrow
______ SR Number
______ Scale

TABLES (In tabular format in CAD file.)
______ Curb Line Elevations. at Top of Exist. Br. Deck
______ Undercrossing Roadway Existing Elevations
______ Undercrossing Railroad Existing Elevations
______ Curve Data

OTHER SITE DATA (May be in CAD or may be on supplemental sheets or drawings.)
______ Superelevation Diagrams
______ End Slope Rate
______ Profile Grade Vertical Curves
______ Coast Guard Permit Status
______ Railroad Agreement Status
______ Highway Classification
______ Design Speed
______ ADT, DHV, and % T

FORMS (Information noted on the form or attached on supplemental sheets or drawings.)

Bridge Site Data General
______ Slope Protection
______ Pedestrian Barrier/Pedestrian Rail Height Requirements
______ Construction/Falsework Openings
______ Stage Construction Channelization Plans
______ Bridge (before/with/after) Approach Fills
______ Datum
______ Video of Site
______ Photographs of Site
______ Control Section
______ Project Number
______ Region Number
______ Highway Section

Bridge Site Data for Stream Crossings
______ Water Surface Elevations and Flow Data
______ Riprap Cross Section Detail

Supplemental Bridge Site Data-Rehabilitation/Modification

BRIDGE, CROSSROAD, AND APPROACH ROADWAY CROSS SECTIONS
(May be in CAD or separate drawings.)
______ Bridge Roadway Width
______ Lane and Shoulder Widths
______ Profile Grade and Pivot Point
______ Superelevation Rate
______ Survey Line
______ PB/Pedestrian Rail Dimensions
______ Stage Construction Lane Orientations
______ Locations of Temporary Barrier
______ Conduits/Utilities in Bridge
______ Location and Depth of Ditches
______ Shoulder Widening for Barrier
______ Side Slope Rate

Bridge Site Data Check List
Figure 1110-1

1130 Retaining Walls and Steep Reinforced Slopes

113.01 References

Bridge Design Manual, M 23-50, WSDOT

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

Plans Preparation Manual, M 22-31, WSDOT

Roadside Manual, M 25-39, WSDOT

1130.02 General

The function of a retaining wall is to form a nearly vertical face through confinement and/or strengthening of a mass of earth or other bulk material. Likewise, the function of a reinforced slope is to strengthen the mass of earth or other bulk material such that a steep (up to 2V:1H) slope can be formed. In both cases, the purpose of constructing such structures is to make maximum use of limited right of way. The difference between the two is that a wall uses a structural facing whereas a steep reinforced slope does not require a structural facing. Reinforced slopes typically use a permanent erosion control matting with low vegetation as a slope cover to prevent erosion. See the *Roadside Manual* for more information.

To lay out and design a retaining wall or reinforced slope, consider the following items:

- Functional classification
- Highway geometry
- Design Clear Zone requirements (Chapter 700)
- The amount of excavation required
- Traffic characteristics
- Constructibility
- Impact to any adjacent environmentally sensitive areas
- Impact to adjacent structures
- Potential added lanes
- Length and height of wall
- Material to be retained
- Foundation support and potential for differential settlement
- Ground water
- Earthquake loads
- Right of way costs
- Need for construction easements
- Risk
- Overall cost
- Visual appearance

If the wall or toe of a reinforced slope is to be located adjacent to the right of way line, consider the space needed in front of the wall/slope to construct it.

(1) Retaining Wall Classifications

Retaining walls are generally classified as gravity, semigravity, nongravity cantilever, or anchored. Examples of the various types of walls are provided in Figures 1130-1a through 1c.

Gravity walls derive their capacity to resist lateral soil loads through a combination of dead weight and sliding resistance. Gravity walls can be further subdivided into rigid gravity walls, prefabricated modular gravity walls, and Mechanically Stabilized Earth (MSE) gravity walls.

Rigid gravity walls consist of a solid mass of concrete or mortared rubble and use the weight of the wall itself to resist lateral loads.

Once the detailed wall plans and designs are available as shop drawings after contract award, the Bridge and Structures Office will review and approve the wall shop drawings and calculations, with the exception of geosynthetic walls which are reviewed and approved by the Geotechnical Services Branch.

(c) Nonpreapproved Proprietary Walls. Final design approval authority for nonpreapproved proprietary walls is the same as for preapproved proprietary walls. The region initiates the design effort for all nonpreapproved wall systems by submitting wall plan, profile, cross-section, and other information for the proposed wall to the Bridge and Structures Office, with copies to the Geotechnical Services Branch and the Principal Architect. The Bridge and Structures Office coordinates the wall design effort.

Once the geotechnical and architectural assessments have been completed and the desired wall types selected, the Bridge and Structures Office contacts suppliers of the nonpreapproved wall systems selected to obtain and review detailed wall designs and plans to be included in the contract PS&E.

To ensure fair competition between all wall alternatives included in the PS&E, the wall face quantities for those wall systems subject to the same face embedment requirements should be identical.

The Bridge and Structures Office develops the special provisions and cost estimates for the nonpreapproved proprietary walls and sends the wall PS&E to the region for inclusion in the final PS&E in accordance with the *Plans Preparation Manual*.

(d) Nonstandard Nonproprietary Walls. With the exception of rockeries over 1.5 m high, nonproprietary geosynthetic walls and reinforced slopes, and soil nail walls, the Bridge and Structures Office coordinates with the Geotechnical Services Branch and the Principal Architect to carry out the design of all nonstandard, nonproprietary walls. In this case, the Bridge and Structures Office develops the wall preliminary plan from site data provided by the region, completes the wall design, and develops the nonstandard nonproprietary wall PS&E package for inclusion in the contract.

For rockeries over 1.5 m high, nonproprietary geosynthetic walls and reinforced slopes, and soil nail walls, the region develops wall/slope profiles, plans, and cross-sections and submits them to the Geotechnical Services Branch to complete a detailed wall/slope design.

For geosynthetic walls and slopes, and for rockeries, the region provides overall coordination of the wall/slope design effort, including coordination with the Principal Architect regarding aesthetics and finishes, and the Region or OSC Landscape Architect if the wall uses vegetation on the face. The Geotechnical Services Branch has overall design approval authority. Once the wall design has been completed, the Geotechnical Services Branch, and in some cases the Bridge and Structures Office, provides geotechnical and structural plan details to be included in the region plan sheets and special provisions for the PS&E. The region then completes the PS&E package.

For soil nail walls, once the Geotechnical Services Branch has performed the geotechnical design, the Bridge and Structures Office, in cooperation with the Geotechnical Services Branch, coordinates the design effort and completes the PS&E package.

(3) Guidelines for Wall/Slope Data Submission for Design

(a) Standard Walls, Proprietary Walls, Geosynthetic Walls/Slopes, and Soil Nail Walls. Where OSC involvement in retaining wall/slope design is required (as for standard walls and preapproved proprietary walls over 3 m in height, gabions over 2 m in height, rockeries over 1.5 m in height, all nonpreapproved proprietary walls, geosynthetic walls/slopes, and all soil nail walls), the region submits the following information to the Geotechnical Services Branch or Bridge and Structures Office as appropriate:

- Wall/slope plans.
- Profiles showing the existing and final grades in front of and behind the wall.

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