ODOT Highway Design Manual

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March 2022 Review

Oregon Department of Transportation

ODOT Highway Design Manual

Delivery & Operations Division | Engineering & Technical Services Branch

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Section 101 Introduction

This section provides background information on design standard policies, processes, and design standard identification. Information is presented on the appropriate design standards relevant to the project work type. Work types are defined to assist the designer in applying the proper standards.

General information is provided concerning design processes and different design strategies, such as ODOT's Blueprint for Urban Design (BUD), where six urban contexts have been established to provide design flexibility.   Originally developed in 2020 as a standalone document, the BUD has now been incorporated into the Highway Design Manual (HDM). Intended for most urban context areas, the six urban context design criteria are not to be used for interstates or limited-access freeways (expressways) with interchanges. Additional design guidance is provided for ODOT urban and rural freeways (including interstate highways), rural expressways, and rural arterials, collectors, and local routes.

Other parts of the HDM are broken down into specific design guidance such as geometric design, cross section elements, elements of design, pedestrian design, bicycle design, etc. The parts are separated to address the various transportation modes that serve different types of users, such as pedestrians or bicycles, and discuss the standards that apply when designing these facilities. This format allows the HDM to be more flexible to incorporate future changes into the standards. Future additions might include subjects such as autonomous vehicles or robotic delivery services on sidewalks.

Text within some parts of this manual is presented in specific fonts that show the required documentation and/or approval if the design does not meet the requirements shown.

Table 100-1: Font Key

Font Key Term	Font	Deviations	Approver
Standard	**Bold text**	Design Exceptions	State Traffic-Roadway Engineer (STRE) and for some projects, FHWA
Guideline	***Bold Italics tex***t	Design Decisions Document	Region with Tech Expert input
Option	*Italics Text*	Document decisions	EOR

General Text	Not bold or italics	N/A	N/A

Standard - A statement of required, mandatory, or specifically prohibitive practice regarding a roadway geometric feature or appurtenance. All Standard statements appear in bold type in design parameters. The verb "provide" is typically used. The adjective "required" is typically used in figures to illustrate Standard statements. The verbs "should" and "may" are not used in Standard statements. The adjectives "recommended" and "optional" are only used in Standard statements to describe recommended or optional design features as they relate to required design features. Standard statements are sometimes modified by Options. A design exception is required to modify a Standard. The State Traffic-Roadway Engineer (STRE) gives formal approval, and FHWA approves as required.

Guideline - A statement of recommended practice in typical situations. All Guideline statements appear in bold italicized type in design parameters. The verb "should" is typically used. The adjective "recommended" is typically used in figures to illustrate Guideline statements. The verbs "provide" and "may" are not used in Guideline statements. The adjectives "required" and "optional" are only used in Guideline statements to describe required or optional design features as they relate to recommended design features. Guideline statements are sometimes modified by Options. While a formal design exception is not required, documentation of the decisions made by the Engineer of Record in the Design Decision documentation or other engineering reports is required. Region approval, with input from Technical Experts, is formally recorded via the Urban Design Concurrence Document in the Design Decision portion. The Urban Design Concurrence document is located on the Highway Design Manual website.

Option - A statement of practice that is a permissive condition and carries no requirement or recommendation. Option statements sometimes contain allowable ranges within a Standard or Guideline statement. All Option statements appear in italic type in design parameters sections. The verb "may" is typically used. The adjective "optional" is typically used in figures to illustrate Option statements. The verbs "shall" and "should" are not used in Option statements. The adjectives "required" and "recommended" are only used in Option statements to describe required or recommended design features as they relate to optional design features. While a formal design exception is not required, documentation of the decisions made by the Engineer of Record in the Design Decision documentation or other engineering reports is best practice.

General Text - Any informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. The remaining text in the manual is general text and may include supporting information, background discussion, commentary, explanations, information about design process or procedures, description of methods, or potential considerations and all other general discussion. General text statements do not include any special text formatting. General text may be used to inform and support design exception requests, particularly where narrative explanations show best practices or methods of design that support the requested design exception.

Section 102 Definitions

The following are definitions of words and phrases used in the HDM. Other definitions may be in the individual parts to which they apply. These definitions do not necessarily apply outside the context of the HDM. The Oregon Standard Specifications for Construction along with ODOT manuals and guidance may also provide definitions for terms used in the HDM, but those definition do not necessarily apply to the HDM. Definitions provided in the HDM are applicable to the HDM.

Unless otherwise defined in this document, the terms used in the HDM are defined according to American Association of State Highway Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets (7th edition; 2018) which ODOT has adopted and incorporated into the HDM. Oregon Administrative Rules (OAR) and Oregon Revised Statutes (ORS) have specific definitions for legal regulations that are specific to Oregon Law and may not be in alignment with the HDM definitions.

These definitions are used to identify the ODOT applicable standards and sections for the design and construction on right of way. Construction of these facilities can be funded with various specialized funding programs with terms that are not synonymous with these definitions. Eligibility for funding is determined by the program definitions, rules and manager.

1R/3R Record of Decision - Documentation to determine whether the 1R or 3R standard applies to a paving project.

AASHTO Green Book - Formally titled *A Policy on Geometric Design of Highways and Streets, 2018* is a publication for the new construction of facilities. Adjustments to the guidance for preservation type projects is not considered in this publication.

Context Sensitive Solutions (CSS) - A planning and design approach to advance programs and projects in a collaborative manner and in a way that fits into the community and environment.

Blueprint for Urban Design (BUD) - Formerly an interim and companion document to the HDM and other ODOT design manuals to provide updated urban design guidance until the related design manuals are updated. The policies of the BUD are incorporated into this manual.

Design Exception - Approval authorized by the State Traffic-Roadway Engineer to deviate from a design criteria standard. Design Exceptions are submitted on the Design Exception Request Form (see HDM Part 1000).**New Construction** - Projects with improvements that construct facilities where no previous public right of way existed (i.e. virgin horizontal alignments and 4R projects).

"On or along the State Highway" - Facilities for public use that are adjacent to the state highway road system regardless of who has public ownership, public easements, or intergovernmental agreements of the underlying property where the facility resides.

Performance-Based Practical Design - A design approach grounded in performance management using appropriate performance-analysis tools considering both short and long term project and system goals while addressing current project purpose and need. Engineering judgement is used to build improvements from existing conditions to meet project and system objectives.

Practical Design - A systematic approach to deliver the broadest benefits to the transportation system, within existing resources, by establishing appropriate project scopes to deliver specific results.

Reconstruction - Fully rebuilt projects on established and existing public right of way with alterations to the facility.

Relocation - Project that replaces a segment of the existing highway facility with a newly constructed facility in a different location. A temporary detour is not considered relocation.

Urban Design Concurrence Form - Form to determine project context, define project design criteria, and document project design decisions for projects.

Urban - Relating to, or characteristic of a town or city

Urban Context - Relates to all nearby built and natural features, as well as social, economic and environmental factors impacting a location. Urban context is based on existing and future land use characteristics, development patterns, and roadway connectivity in an area. For purposes related to the Highway Design Manual, urban context is not limited to places within the current Urban Growth Boundary (UGB).

Urban Design - For the HDM, the term applies to urban contexts relating to land uses that broadly identify the various built environments along ODOT roadways.

Section 103 Acronyms

1R - Resurfacing

1R(+) - 1R project with additional work items added by other funding

3R - Resurfacing, Restoration, Rehabilitation

4R - Reconstruction, Resurfacing, Restoration, Rehabilitation

AASHTO - American Association of State Highway and Transportation Officials

ADA - American with Disabilities Act

APM - Analysis Procedure Manual

BDM – Bridge Design Manual

BUD - Blueprint for Urban Design

CC - Commercial Center

CFR - Code of Federal Regulations

CLPA - Certified Local Public Agency

DAP - Design Acceptance Package

DSL - Department of State Lands (Oregon)

ETSB - Engineering and Technical Services Branch (ODOT)

EOR - Engineer of Record (see also POR)

FACS - Features, Attributes, and Condition Survey

FHWA - Federal Highway Administration

GIS - Geographic Information System

HCM - Highway Capacity Manual (TRB)

HDM - ODOT Highway Design Manual

HSM - Highway Safety Manual (AASHTO)

IAMP - Interchange Area Management Plan

IMR - Interchange Modification Request

ITE - Institute of Transportation Engineers

LAG - Local Agency Guidelines

LCDC - Land Conservation Development Commission

LPA - Local Public Agency

MASH - Manual for Assessing Safety Hardware (AASHTO)

MUTCD - Manual of Uniform Traffic Control Devices

NACTO - National Association of City Transportation Officials

NCHRP - National Cooperative Highway Research Program

OAR - Oregon Administrative Rule

ODOT - Oregon Department of Transportation

OHP - Oregon Highway Plan

ORS - Oregon Revised Statute

OTP - Oregon Transportation Plan

OTTCH - Oregon Transportation Traffic Control Handbook

POR - Professional of Record (see also EOR)

PBPD - Performance-Based, Practical Design

PROWAG - Public Right of Way Accessibility Guidelines

ROW - Right of Way

S.C.O.P.E. Values - Safety, Corridor Context, Optimize the System, Public Support, Efficient Cost

SF - Single Function

SHPO - State Historic Preservation Office

STA - Special Transportation Area

STIP - State Transportation Improvement Plan

STRE - State Traffic-Roadway Engineer

SUE - Subsurface Utility Exploration

TPR - Transportation Planning Rule

TRB - Transportation Research Board

TSP - Transportation System Plan

UBA - Urban Business Area

UDC - Urban Design Concurrence

UGB - Urban Growth Boundary

V/C - Volume to Capacity

Section 104 Design Guidance

104.1 Blueprint for Urban Design (BUD)

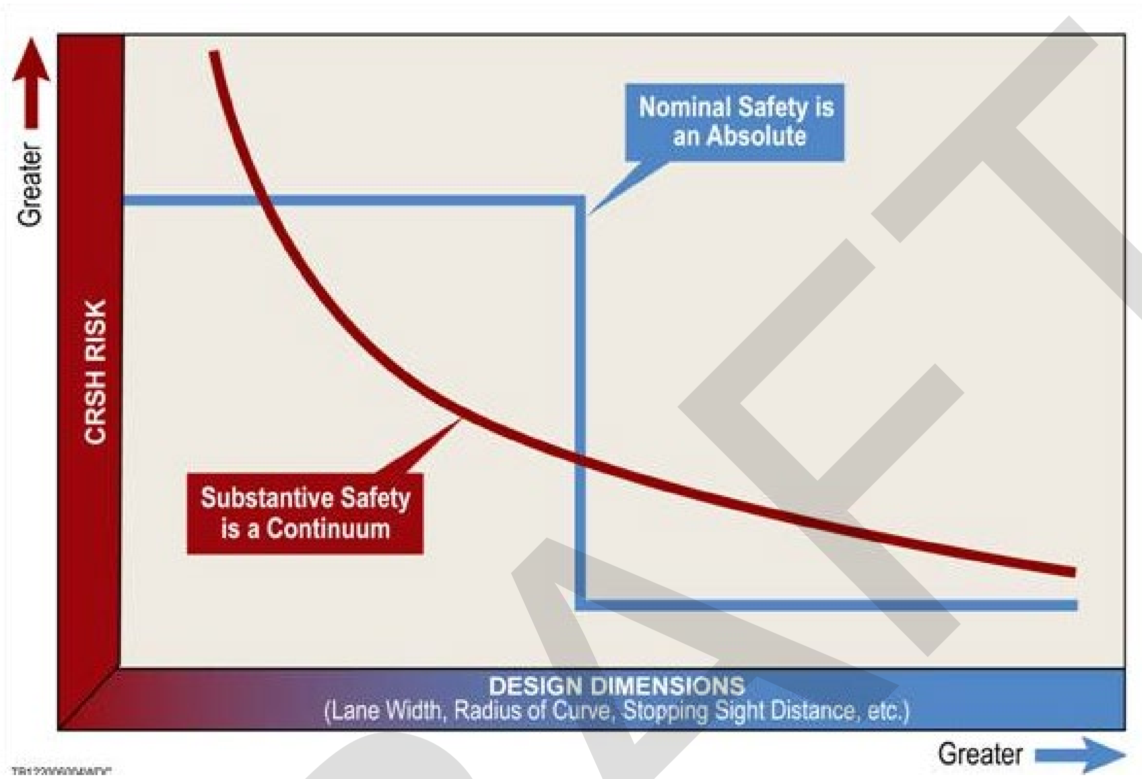
In addition to ODOT's Practical Design philosophy and multi-modal transportation design, the BUD and its context and majority of content was an interim document bridging the gap between its inception and the update of the HDM. The BUD content is incorporated into this HDM update.

The BUD content now included in the HDM applies to urban land use contexts that broadly identify the various built environments on or along the state highway. The key concepts introduced by the BUD are that urban design:

1. Includes urban context in addition to the existing highway classification.
2. Highlights and provides flexibility.
3. Introduces Performance based design.
4. Starts at the highest level of protection for pedestrians, bicyclists, and other users of the pedestrian and transition realms.
5. Provides a focused design documentation process.

Urban contexts defined in the HDM are based on existing and future land use characteristics, development patterns, roadway classification and connectivity, along with overall community goals and aspirations of an area. Urban context is not limited to places within the current Urban Growth Boundary (UGB) nor are they confined to city or town limits. Urban context is also not defined by federal limitations on population density determinations of what is considered as an urban area. With the exception of interstates and limited-access freeways (expressways) with interchanges, the urban planning principles, design principles, and guidance focus on all roadways within the HDM defined urban contexts. While the HDM urban design guidance does not apply to the main line or ramps of a limited access interstate highway, freeway or expressway with interchanges, it does apply along the crossroad between, and leading up to, the ramp terminals and urban contextual design criteria can be applied to complete the local network. For design consistency, the crossroad between the interstate or freeway ramp terminals and depending on channelization operations, sometimes a distance further, whether state owned or part of the local network, is considered part of the interchange. As such, continuity of the local network and context needs to be maintained in relationship to the operational needs of the main highway. Although the crossroad of an interstate or limited access freeway (expressway) may be located in an urban context, the intended mobility and high-level operation of the interstate or limited access freeway (expressway) has priority. Ramp traffic affected by operation of the crossroad cannot backup onto the main line of the interstate, freeway or expressway and cause a potential safety issue.

Figure 100-1: Comparing Nominal and Substantive Safety



(Source: NCHRP Report 480 – TRB 2002)

Figure 100-1 depicts nominal safety (subjective safety) and substantive safety (objective safety) in relation to crash risk and design dimensions. Nominal safety is safety that relies on the perception of the user. This assessment will vary between observers and will depend on their perspectives. Substantive safety is safety that can be measured or quantified independent of the observer. Design guidance has evolved over the years to be more context sensitive and to integrate flexibility, but these features are often underutilized. Additionally, design guidance now considers the various modal needs of a transportation system. This evolution reflects the shift from nominal safety (subjective) to substantive safety (objective). Transportation professionals strive to use guidance and standards to support evolving needs and provide a safe and efficient network.

In an effort to incorporate updated guidance from national perspectives and tailor it to meet the needs of the Agency and local contexts, ODOT founded the Urban Design Initiative. The initiative provides principles and guidance that can be used for both planners and engineers in order to allow flexibility to meet the modal needs of the users in urban communities.

The ODOT Urban Design Initiative recognized that ODOT's earlier urban design needs and guidance were not strategically aligned. The Main Street Handbook (1999) informs planners but does not reflect the most recent evolution of modal guidance. Additionally, planners and designers needed consistent tools that supported the recently adopted modal plans, such as the Bicycle and Pedestrian Plan and Public Transportation Plan. A bridging document, the BUD met these identified needs and is incorporated into the HDM.

ODOT has taken a performance-based approach to project development and delivery that supports decision-making from planning through design. Identifying the desired project outcomes, while understanding the urban context and identifying the primary roadway users, can guide practitioners in determining appropriate performance measures to evaluate the trade-offs of various design decisions. Completing these steps early in the project flow can guide the planning phase and refine the range of alternatives considered. Reviewing and confirming project goals throughout planning, design, and construction validates that the chosen alternative, reflects the original project goals and serves the intended users.

> Performance-based design is an approach that emphasizes the outcomes of design decisions as the primary measure for design effectiveness.
> *NCHRP Report 785*

Understanding and executing a performance-based approach enables project teams to make informed decisions about the performance trade-offs of alternative solutions. This is especially helpful when developing solutions in fiscally and physically constrained environments. National activities and associated publications, such as FHWA Performance-Based Practical Design initiatives and NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets have resulted in a framework for how this approach can be executed within a project. As demonstrated in the AASHTO Green Book, this approach will continue to shape how practitioners deliver projects in a variety of contexts and stages of project flow.

Tort liability and risks are often seen as impediments to appropriately adapted flexible designs, given urban context. There is a misperception that "designing to standards" inherently improves safety performance and eliminates risks of lawsuits. Practitioners need to understand fundamental elements of tort liability to make informed decisions and learn how to manage risk by documenting the project evaluation and decision-making process. NCHRP Legal Digest 57 provides additional information on tort liability related to design guidance and standards.

Documenting the decision-making process when selecting the design for new or reconstructed roadways is an effective way to manage risk. This includes documenting design considerations and evaluated alternatives based on clearly outlined project goals. The guidance provided in the HDM allows for a diverse range of potential designs. Therefore, the discretionary decisions of project teams must be documented as part of ODOT's urban design concurrence documentation. The intent of the urban design concurrence documentation is to provide the justification and evidence necessary to manage tort liability. As previously noted, the Roadway designer is responsible for the final compilation of the Urban Design Concurrence document. The Urban Design Concurrence document is located on the Highway Design Manual website.

104.2 Emerging Framework for Geometric Design

The 2012 version of the HDM incorporated ODOT's Practical Design philosophy by establishing appropriate project scopes fitted to specific project purpose and need. The Practical Design S.C.O.P.E. Values (Safety, Corridor Context, Optimize the System, Public Support, and Efficient Cost) are still valid today for the current version of the HDM. In addition to ODOT's Practical Design philosophy and multi-modal transportation design, the BUD, and its context and majority of content, has been incorporated into the HDM. The HDM gathers the advancements of multi-modal designs that have been developed since the 2012 HDM and highlights the opportunities for continued flexibility in ODOT's current design criteria in an effort to produce effective outcomes for each facility based upon the urban context and design flexibility to accommodate community needs.

On a national level, FHWA is also looking at performance based design by modifying the controlling criteria from the thirteen controlling criteria established in 1985 to two controlling criteria for low speed roadways (< 50 mph design speed) and ten controlling criteria for high speed roadways (>=50 mph design speed). FHWA determined that all the criteria contained in the design standards are important, but that not all the criteria affect safety and operation to the same degree. FHWA noted that State DOT's can determine their own level of documentation needed based upon laws and practices. Additional information on controlling criteria can be found in Part 1000, Design Exceptions.

104.3 National Guidance Policies and Documents

ODOT regularly evaluates planning and design guidance from other national associations and organizations for incorporation into the information provided in the HDM. Practitioners follow the direction contained within the HDM and recommend changes to be considered from the following sources as needed:

- American Association of State Highway Transportation Officials (AASHTO)
- Federal Highway Administration (FHWA)
- Institute of Transportation Engineers (ITE)
- National Association of City Transportation Officials (NACTO)
- National Cooperative Highway Research Program (NCHRP)
- U.S. Access Board

Section 105 How ODOT Uses National Guidance

Federal law dictates the role of national standards for highway facilities in https://www.ecfr.gov/current/title-23. Title 23 CFR Part 625 requires that each state have standards for new construction (4R) and preservation (3R) of highways that account for applicable federal requirements including design exceptions. It identifies the AASHTO Green Book as the national design standard for NHS highways unless FHWA approves a substitution. The ODOT HDM is approved by FHWA for use in Oregon as the standard for ODOT highways and transportation facilities. The following are examples of how ODOT stays up to date with and incorporates national design guidance.

♦ Design Flexibility

In addition to 23 CFR Part 625, section 1404 of the FAST Act, which amends 23 United States Code (USC) section 109, provides requirements as well as direction for flexibility and access for other modes of transportation in the design process. The revised requirements for flexibility and other modes from 23 USC 109 under section c (1) have been or will be incorporated into 23 CFR Part 625 with the next update to the CFR.

Title 23 CFR Part 655 requires that every state follow a national standard for uniformity in the use of traffic control devices and identifies the Manual on Uniform Traffic Control Devices (MUTCD) as the FHWA approved source. Oregon adopted the federal manual with a state-specific supplement to the MUTCD. Similar federal requirements exist where a national standard manual is recommended and a state-specific substitute manual is optional. Some examples of these include standards for bridge and illumination design.

23 CFR Part 658 establishes the National Freight Network and provides guidance to states for freight vehicle size and weight allowed to utilize the national network without special permits. It also provides guidance on what can and cannot be restricted concerning freight vehicles operating on the national freight network. Appendices A, B, and C of 23 CFR Part 658 should also be evaluated along with the ODOT Freight Mobility Manual when determining modal priorities for a project.

The United States Department of Transportation (USDOT), led by Congressional action, developed federal policy and directives for states to take action on flexibility in design and addressing flexibility on the core National Highway System (NHS) routes. Additionally, the Fixing America's Surface Transportation (FAST) Act requires designs for projects on the NHS to consider all factors in 23 USC 109(c)(1), including cost savings that can be achieved by using flexibility in current design guidance. Based on this support for improved pedestrian and bicycle facilities and flexibility within current design standards, numerous national organizations produced innovative design guides and resources intended to supplement the adopted standards. ODOT issued a letter of support that encourages engineers, planners and designers to reference the growing library of resources that help "…provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians…" and "…to be at the forefront of the integration of sustainable intermodal transportation…to help form sustainable solutions to today's ever-increasing intermodal transportation challenges…". The design resources referenced in ODOT's letter were those produced by AASHTO, NACTO, and ITE. Since these memoranda, the FHWA grew its library of publications that help encourage and support walking and bicycle use for all ages and abilities. A list of these publications can be found on the FHWA website.

♦ Innovative Concepts

In order to solve urban transportation issues through innovation, some concepts may conflict with requirements in the adopted highway standards. There is a process outlined by FHWA to enable innovation by experimenting with new ideas. Through the experimentation process, design standards can evolve, or new standards can be created. When innovative practices are acceptable to ODOT, standards and manuals to support these practices can be updated. FHWA provides a design deviation approach that provides further flexibility with the reduction in number of controlling criteria. However, approval for design deviations or concurrence is still processed at the state level. Federal regulation sets required criteria for design, but still provides flexibility for state jurisdictions to apply their own criteria as well and ODOT uses federal guidance when applying both federal regulations and specific state criteria.

♦ Use of the Highway Safety Manual

In 2015, the Fixing America's Surface Transportation (FAST) act was passed to authorize federal funds for Federal-aid highways, highway safety programs, and public transit programs. It endorsed the use of federal funds for design flexibility outlined in Section 1404. Section 1404(a) of the FAST Act also required the Secretary of Transportation, when developing design criteria for the NHS, to consider the Highway Safety Manual (HSM), published by AASHTO. The HSM is not a design standard, but it presents a variety of methods for quantitatively estimating crash frequency or severity at various locations. It is a foundational manual in the long-term effort to improve the state of the practice for safety prediction tools. The HSM is a key safety reference influencing the development of national design policy. Additionally, the increased use of improved safety production tools in the planning and design process allow improved analysis of safety performance among design alternatives.

♦ Americans With Disbalites Act

Another example of national requirements and guidance that ODOT uses are regulations concerning the Americans with Disabilities Act. 28 CFR Part 35 prohibits discrimination on the basis of a disability under the Americans with Disabilities Act of 1990 in state and local government services. The ADA Amendments Act of 2008 broadened the scope of protection under the ADA in the definition of what a disability is, such that extensive analysis is not required. Various resources exist that provide guidance and best practices for implementing accessible pedestrian facilities, but these resources are not uniform in how they interpret the draft accessibility guidelines (PROWAG). Due to the potential liability associated with varying interpretations of accessibility requirements, ODOT has its own standards that incorporate national guidance and best practices that may exceed minimal requirements under the ADA to optimize and provide better access for individuals. State and local governments are required to make transportation facilities and services accessible, even when explicit standards for ADA design criteria on transportation infrastructure are still emerging and evolving. In order to ensure that the standards are current, an Accessibility Consultant with national expertise reviews all of ODOT's ADA policies for accessibility and concurs as part of a federal agreement, which settled a lawsuit regarding ADA facilities for pedestrians.

♦ Participation in National Research, Committees and Organizations

While there are fundamental underlying physics and engineering principles that form the foundation for roadway design, it is an ever-evolving practice. There are often innovation and creative ideas, concepts, and techniques emerging for solutions to evolving challenges. ODOT stays up-to-date with the changing trends through participation in research projects at both the state and national level, with staff participating on AASHTO and NCHRP technical panels providing review and input. Participation on these panels provides access to current national and international practices. New publications, documentation, and information are reviewed for applicability to Oregon. Publications vetted through AASHTO and included in the Federal Register are generally adopted for use. Other national publications may be considered, when appropriate, as supplemental reference guidance to ODOT and AASHTO design criteria.

Section 106 Approval Processes

106.1 Design Standards

ODOT's Chief Engineer, through delegated authority from the Oregon Transportation Commission (OTC) is responsible for the approval of design standards.

106.2 Design Exceptions

The Chief Engineer has sub-delegated the approval of exceptions to design standards to the State Traffic-Roadway Engineer. Most design exceptions require signature by both the Engineer of Record (EOR) and State Traffic-Roadway Engineer as this is an Engineering Report. Design exceptions may also require approval by FHWA. Design exceptions and the design exception process are addressed in Part 1000 of the HDM.

106.3 Urban Design Concurrence Document

The BUD established the Urban Design Concurrence document form to determine project context, define design criteria, and document design decisions. Authority for approval of the Urban Design Concurrence Document (UDC) will reside in the Region Technical Center. The Region Technical Center Manager provides final approval of urban design concurrence with collaborative input from Region planning, traffic, roadway, and maintenance. Generally, the designer for roadway geometrics is responsible for the final compilation of the UDC. However, the Region Technical Center Manager may assign document compilation to another design team member if deemed more appropriate for a project. The document is a collaborative effort of the scoping and project development teams. The intent is for the form to be more of a living document throughout the planning, scoping and project development stages that aids in creating project business cases, project charters, scoping concepts and project narratives. It is important to maintain the UDC with project documentation through the various stages of a project. If a UDC is initiated with planning activities it should be included with documentation of those studies or plans (TSP, Facility Plans, etc.) and is provided for inclusion of project business cases and project charters and scoping activities. Not all planning activities will initiate a UDC. In this case, a UDC is initiated at project scoping. A "draft" UDC is included as part of the final scoping documents to document scoping decisions that led to the concept design.

The Context and Modal Integration sections of the document can be started in the region planning section prior to scoping. However, final determination is a collaborative effort of the scoping and project development teams when creating the draft and final UDC. Pertinent background information from Transportation System Plans, Corridor Studies or other planning documents is included to aid the scoping team in defining project concepts. At the end of project scoping, the draft or concept Design Decisions portion of the Urban Design Concurrence Document is filled out identifying the scoping concept design for the project.

At project initiation, the project development team will utilize the draft or concept UDC for understanding of project goals and as a starting point for the final design. The project development team verifies that the concept UDC still covers the project goals and design needs in the event there have been significant changes in the project area since the scoping team finished the concept design. If changes have occurred, the UDC is updated to reflect those changes to ensure project goals and outcomes defined in scoping are met. Or, if the original goals and outcomes can no longer be met, the form is used to document why. Once the scoping concept design decisions are verified or modified as needed, the project team can move forward with project development and finalize the Urban Design Concurrence Document to be submitted with the Design Acceptance Package. The UDC establishes the design cross-section. Any deviations for the allowable design ranges will still need a Design Exception.

By ODOT directive and with the exception of interstate roadways, freeways or designated expressways with interchanges, every urban project requires a design concurrence document. The project category will determine the amount and extent of the information provided in the final concurrence document. Projects with limited scope like 1R or 3R paving projects, targeted safety projects or Single Function projects, etc. will have limitations when filling out some portions of the Urban Design Concurrence Document. However, even on these limited scope projects, project teams need to identify and include opportunities to upgrade and improve existing conditions for all users of the roadway system. When initially determining project scope within the limits of a project category, it is a good idea to start by answering the question, “What is an appropriate design for this roadway section and project?”, rather than the more typical and limiting question, “What do we have to do?"

Although an Urban Design Concurrence Document is required by policy on all urban projects, realistically there may be some projects of such limited scope that do not affect the roadway cross-section where completing the Urban Design Concurrence Document has no effect on project outcomes. In these cases, the Urban Design Concurrence Document is superfluous to the project and adds no significant value for documentation. In these rare instances, an Urban Design Concurrence Exemption Request can be submitted for potential approval by the State Traffic-Roadway Engineer. The request form, Urban Design Documentation Exemption Memo, is available on the Highway Design Manual website. It is provided as a template that can be added to region letterhead, filled out and submitted to the Statewide Project Delivery Branch, Technical Services, Traffic-Roadway Section. If approved by the State Traffic-Roadway Engineer, the exemption memo is submitted with the Design Acceptance Package in lieu of the Urban Design Concurrence document.

There is a minimal number of project types where the Urban Design Documentation Exemption Memo would apply. Examples of project types that could apply include ITS projects, bridge preservation category projects, bridge rail screening projects or other project types that have limited, specific scope and do not affect the roadway cross-section. For more information on the applicability of the Urban Design Documentation Exemption Memo, contact the Senior Urban Design Engineer in the Statewide Project Delivery Branch, Technical Services, Traffic-Roadway Section.

106.4 1R/3R Record of Decisions Documentation

The 1R/3R Record of Decisions Documentation form (ODOT form number 734-5244) is used as part of a formal process for determining whether a paving preservation project will be designated 1R or 3R. This document is filled out at project scoping and reviewed and validated at project initiation. The 1R/3R Record of Decision Documentation Form is approved by the Pavements Manager, the Region Traffic Manager, and the Region Roadway Manager. For more information, see 119.1 1R/3R Record of Decisions Documentation.

106.5 FHWA Emergency Relief Program - Betterments

The FHWA Emergency Relief (ER) program is intended to assist the States and local agencies in repairing disaster damaged highway facilities and returning them to their pre-disaster condition. In-kind restoration is the predominate type of repair. Emergency relief fund and betterments for assisting States in repairing damaged highway facilities require approval from FHWA. Approval requires detailed justification. Section 120 provides additional information on emergency relief and betterments. For more information, see Section 120 Emergency Relief Program-Betterments.

106.6 Record Retention

All project design documents are subject to ODOT record retention policies and schedules. For more information regarding these policies, see the [Department of Transportation Highway Division Record Retention Schedules].

106.7 EOR Requirements for Projects

ODOT requires all plans, Professional of Record (POR) sheets, and design exceptions be in electronic (PDF) format. Requirements for the Engineer of Record are established by Oregon

State Board of Examiner for Engineering and Land Surveying (OSBEELS) and are to be followed by engineers serving in this role on ODOT public work projects. ODOT uses digital seals and signatures for electronic documents as allowed by administrative rule OAR 820-025-0001. ODOT Engineering and Technical Services Directive TSB21-01(D) provides ODOT requirements for use of digital seals and signatures on technical documents. See Figure 100-2, Figure 100-3, and Figure 100-4 for digital seal format according to OAR 820-025-0001. See Figure 100-5 for an example of a digitally signed engineering seal, provided by OSBEELS.

Figure 100-2: Engineering Seals from OAR 820-025-0005

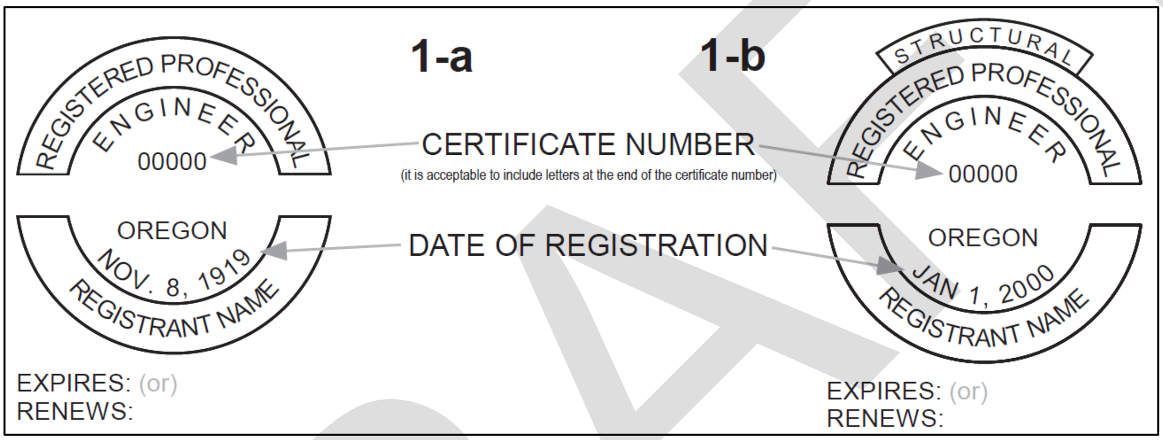


Figure 100-3: Land Surveyor and Photogrammetrist Seals from OAR 820-025-0005

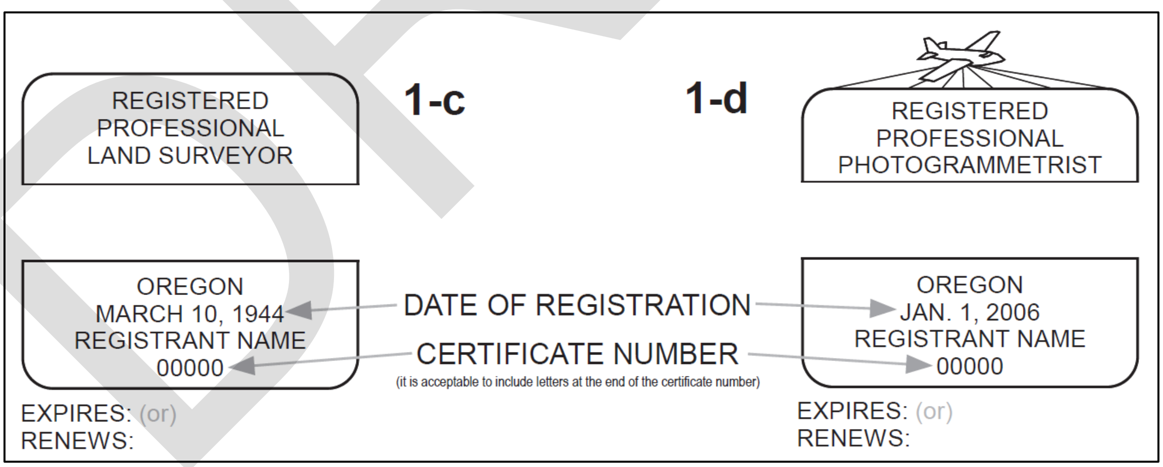


Figure 100-4: Water Right Examiner and Traffic Engineer Seals from OAR 820-025-0005

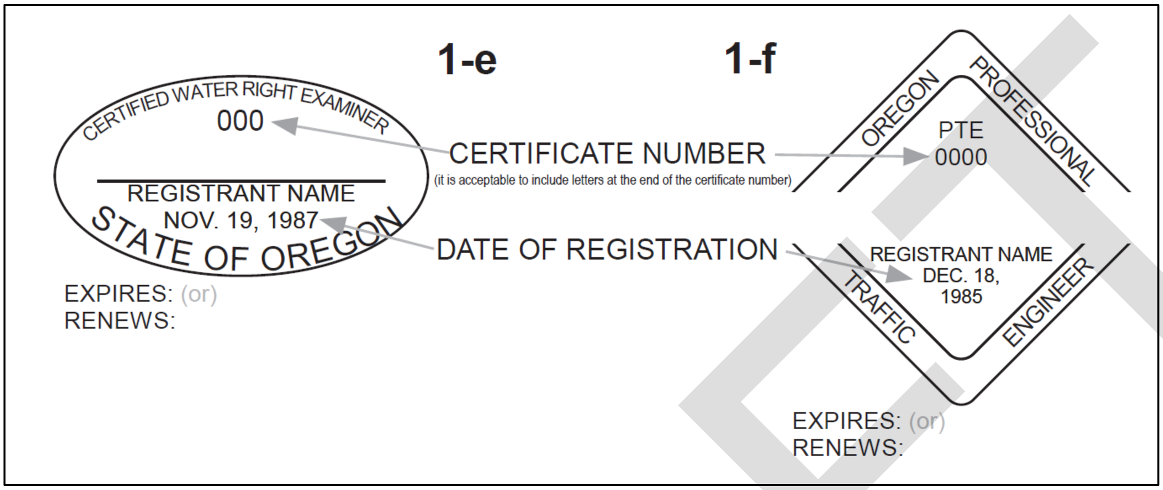
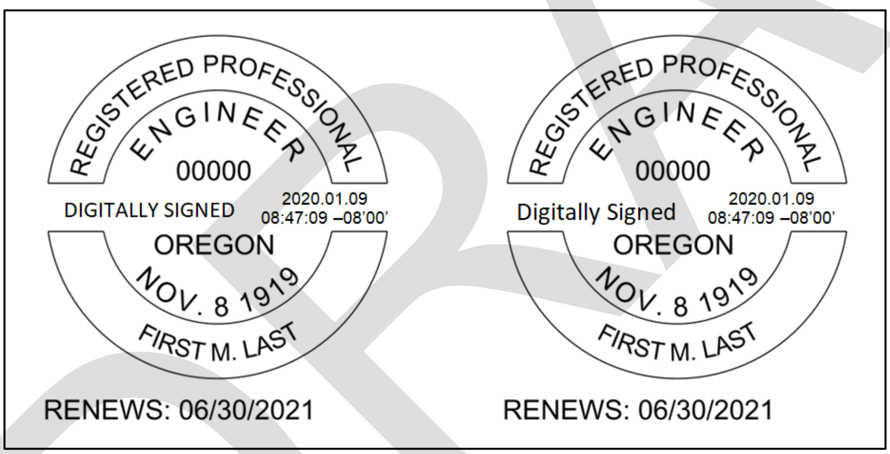


Figure 100-5: OSBEELS Digital Seal Examples



Section 107 Design Flexibility

107.1 Introduction

While there are fundamental underlying physics and engineering principles that form the foundation for roadway design, it is an ever-evolving practice. Innovation and creative ideas, concepts, and techniques continually emerge for solutions to evolving challenges. To foster collaboration and provide inclusion and local insights into project development from roadway users, ODOT established what was called Stakeholder Involvement in the early 1990s. In the mid-1990s, ODOT embraced context sensitive solutions (CSS) design, which later became context sensitive and sustainable solutions (CSSS or CS3). The 1999 Oregon Highway Plan (OHP) (including amendments) established roadway segment designations to differentiate contexts in urban locations. The official segment designations include Special Transportation Area (STA), Urban Business Area (UBA), and Commercial Centers (CC). The 2003 HDM created an urban design chapter to specifically address design for the roadway segment designations described in the 1999 OHP as well as for non-designated context segments that include Urban Suburban Fringe, Developed Areas, and Traditional Downtown/Central Business Districts. In addition to the segment designations, the 1999 OHP also categorized roadway sections into state-determined classifications. These classifications include Interstate Highways, Statewide Highways, Regional Highways, and District Highways.

In 2010, ODOT established its Practical Design strategy. That strategy provided a foundation for thought and processes to achieve more focused improvements at a lower cost. Practical Design was, at that time, the next logical step in the evolution of ODOT's approach to program and project development and delivery. It provided a platform to be more deliberate in our efforts to provide the underlying goal of developing the "Right Projects, at the Right Time, at the Right Cost, and in the Right Way.

Performance-Based Practical Design is the next step in the evolution of roadway design from a contextual basis. Performance-Based Practical Design takes the concepts and principles of Practical Design and incorporates performance information to emphasize outcomes of design decisions as the primary measure for design effectiveness. Understanding and executing a performance-based approach enables project teams to make informed decisions about the performance trade-offs of alternative solutions. This is especially helpful when developing solutions in fiscally and physically constrained environments. ODOTs approach to Performance-Based Practical Design fits with national design trends. National activities and associated publications, such as FHWA Performance-Based Practical Design initiatives and NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets have resulted in a framework for how this approach can be executed within a project. In addition, the AASHTO Green Book is moving toward FHWA backed Performance-Based Practical Design principles. ODOT is on the leading edge of this transition with the development of the Blueprint for Urban Design and the subsequent inclusion of that information into the 2022 HDM.

Practical Design and its evolution to Performance-Based Practical Design afford the design flexibility to creatively design solutions to meet project needs and goals by focusing on outcomes. Engineering judgement is a key component when applying flexibility to designs to achieve appropriate solutions. Guidance throughout the HDM is intended to aid designers in making choices where trade-off decisions inherent to flexible design need to be made. An important aspect to decision making required in Performance-based Practical design is utilizing multi-disciplinary teams that provide varied viewpoints and information to the project. The multi-disciplinary teams should include not only engineers, but also planners, landscape architects, active transportation staff and others pertinent to decisions that will affect project goals and outcomes.

When applying the Performance-Based Practical Design principles and determining appropriate trade-offs across a project cross-section, having a methodology to evaluate impacts to design elements is important. Dividing the cross-section into areas based on element functionality within those areas is one way to analyze potential individual element impacts caused by trade-off decisions in relation to the cross-section as a whole. As such, the "realm" concept was established. These realms include the following and are shown in Figure 100-6:

- Land Use Realm
- Pedestrian Realm
- Transition Realm
- Travelway Realm

Figure 100-6: Example of Cross-Section Realm

Context is a key factor in roadway design. Context includes the adjacent land use context as well as the context of the road itself. The highway has an intended function that is also integral to its context. The federal functional classifications as well as the ODOT classifications and the OHP segment designations all provide input in evaluating the roadway context. The overall context to be considered in the project design process includes the land use context and the determined roadway context, both from the perspectives of existing land uses as well as future planned land uses. Municipal and local community input is important in the context discussion as well. The Blueprint for Urban Design established six contexts for design that are listed below:

- Traditional Downtown/Central Business District
- Urban Mix
- Commercial Corridor

- Residential Corridor
- Suburban Fringe
- Rural Community

107.2 Practical Design

The 2012 version of the HDM incorporated ODOT's Practical Design philosophy by establishing appropriate project scopes fitted to specific project purpose and need. There are five key values that help form the foundation of Practical Design. These values support ODOT's mission of providing a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians. These "S.C.O.P.E." values provide a basis to be kept in mind when working through the project development and design process.

1. **Safety** - Overall system safety will not be compromised. The goal is to make the system as safe as practical. This does not mean settling for a lower level of safety, but instead, continue to make choices about safety and use sound engineering judgment when making safety decisions (i.e., look for high value add-ins with minimal cost). Individual projects may look different. But, every project will either make the facility safer or will maintain the existing safety level for that facility.

2. **Corridor Context** - Practical Design takes the concept across a system, down to a corridor level, and apply it to each project. A corridor approach should be used in establishing or evaluating design criteria, and then be applied consistently throughout the corridor. Roadways should respect the character of the community, include the current and planned land uses, and work within the intended corridor use. The unique features of the project and how this "fix" fits with other parts of the corridor and with the natural and surrounding built environment should be considered.

3. **Optimize the System** - Adopting more of an asset management approach to managing pavements, bridges and roadway safety features allows the assessment of the current state of an individual infrastructure asset, and then to develop specific maintenance, repair, rehabilitation and replacement strategies that optimize the life-cycle investment in that particular asset. This, in turn, can allow available funding to be allocated on a priority basis to those assets and/or combination of assets that ensure that the entire highway system is optimized for safety, mobility and financial investment. This optimization for safety, mobility, and financial investment will involve balancing the trade-offs between these competing goals.

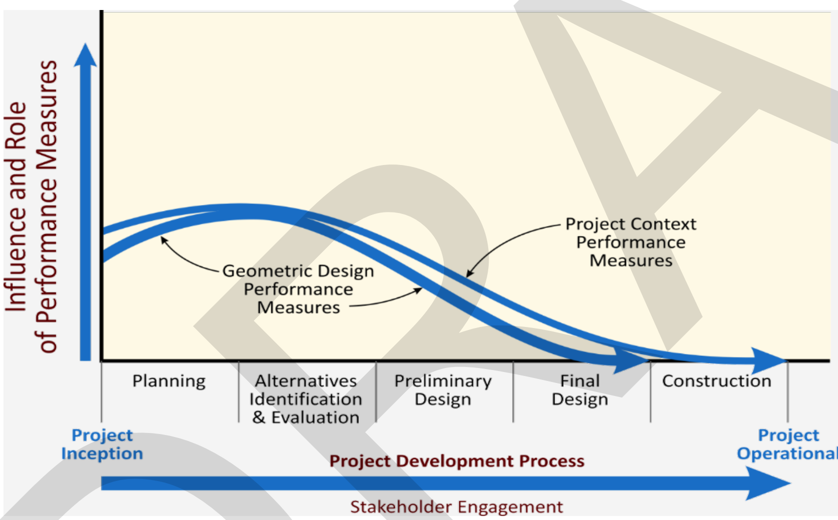
4. **Public Support** - ODOT recognizes that public trust is a cornerstone of success and strives to work in partnership with the local communities in making system improvements visible to the traveling public. Working with locals provides opportunities for the community to shape the chosen solution, and consider the needs for pedestrians, bicyclists, public transit users, freight and mobility. When working with community interests, it is essential to have

clarity about the project purpose, need and alignment of the proposed project with the overall plan for Oregon's transportation system.

5. **Efficient Cost** - ODOT has limited funds to apply to projects and strives to stretch these funds as much as possible and to develop projects that meet the desired purpose, but is open to considering incremental improvements. Practical Design requires applying the appropriate standards to the critical elements in order to meet the project specific purpose and need. This allows for a redistribution of funds that were previously used on other items that may not have been as high of a priority on one project, to be used where they will produce the most benefit to the system. Practical Design stresses making the best strategic decisions that benefit the overall system.

107.3 Performance-Based Practical Design

Figure 100-7: Role of Performance Measures within the Project Delivery Process



Source: NCHRP Report 785

Performance-Based Practical Design builds on the 2010 Practical Design Strategy utilizing the five base S.C.O.P.E. principles outlined previously in conjunction with performance metrics established for project outcomes. Aligning the two strategies emphasizes delivering projects that benefit the transportation system utilizing existing resources to establish appropriate project scopes that include different perspectives and discuss pertinent project information early in the project development flow to establish clear project objectives and problem statements that focus on both short term and long term desired outcomes. More information about the use of context and performance-based design can be found in subsequent parts and chapters of this document.

107.4 Context and Roadway Classification

> Performance-based design is an approach that emphasizes the outcomes of design decisions as the primary measure for design effectiveness.
> *NCHRP Report 785*

There are many definitions of urban and rural. For this document and for ODOT urban project design, the focus is on land use context in relation to determined roadway context and classification. Urban design practices have been an evolving process. The 2012 ODOT HDM melded the Context Sensitive design principles of the 1990s with the 2010 ODOT Practical Design strategy of S.C.O.P.E. It prescribed design requirements categorized by the context of the highway. The 2012 HDM mirrored the design guidance in the AASHTO Green Book chapters for urban and rural. The next step in the progression of urban roadway design is performance-based design. National design guidance, including the eighth edition of the AASHTO Green Book, is moving toward integrating performance-based design that encompasses a focused approach to determine appropriate design with flexibility that better aligns roadway function and user needs based on the context. Performance-based design provides a framework for evaluating trade-offs and creating designs that meet the desired outcomes of a project to address all roadway user concerns. This type of approach is being adopted in many other states as well. Through the development of the Blueprint for Urban Design, ODOT is incorporating performance-based design into HDM criteria and accepted practices with this document. Performance-Based, Practical Design is a refinement to, and the next step, of ODOT's continued practice of Context Sensitive Practical Design.

Depending on the decided context of a highway, the ODOT criteria for various design elements is different. Design elements potentially affected by context include the width of travel lanes, turn lanes, shoulders and medians, superelevation rates, maximum degree of curvature, maximum grade, bicycle facility and pedestrian facility type and size, presence of on-street parking, and vertical clearance.

When determining the context of a roadway section, roadway federal functional classification, state classification, adjacent land use, roadside context, roadway segment designation, and to some extent, traffic volume and number of lanes is considered. Traffic volume, speed, and lane configuration along with classification are indicators of how a roadway section is being used and sets expectations for road users, as well as expectations for adjacent businesses – both existing and future.

With the increasing emphasis on active and public transportation, social equity, and climate impacts, defining context is even more important for urban design. Therefore, more differentiation within the previously established context categories was needed. As an example, the context defined in the OHP and 2012 HDM as "Urban/Suburban Fringe" covers a variety of cross-section types and potentially various land use or roadside context configurations. Creating greater differentiation in contexts based on more specific parameters along a section of roadway that affect its use can provide flexibility. It also helps prioritize design elements to better address user and community needs, rather than a "one-size-fits-all" approach. This is the basis for performance-based design, which focuses on the outcomes of the design decisions as the primary measure of design effectiveness.

107.5 Design Standard Policy

The HDM represents ODOT interpretation of federal guidance, including the AASHTO Green Book and NCHRP and TRB research documents. ODOT uses three sets of design criteria: ODOT4R/New, ODOT 3R, and ODOT 1R.

The standards selected for design of all projects are presented, with some modifications, from the following references:

2022 ODOT Highway Design Manual

2014 ODOT Hydraulics Manual

A Policy on Geometric Design of Highways and Streets - 2018 (AASHTO Green Book)

Roadside Design Guide (AASHTO, 2011)

A Policy on Design Standards - Interstate System. (AASHTO 2016).

Guide for the Development of Bicycle Facilities (AASHTO 2012)

Guidelines for Geometric Design of Low-Volume Roads (AASHTO 2019)

Guide for the Planning, Design, and Operation of Pedestrian Facilities (AASHTO 2021)

2010 Americans with Disabilities Act (ADA) Standards for Accessible Design

Public Rights-of-Way Accessibility Guidelines (with supplements)

Highway Drainage Guidelines (AASHTO 2007)

The applicable ODOT standards are defined in Table 100-3 Design Standards Selection Matrix.

Section 108 Local Agency Guidelines

Some projects under ODOT roadway jurisdiction traverse across local agency boundaries. Some local public agencies (LPA) have adopted design standards and guidelines that may differ from ODOT design standards. Although the appropriate ODOT design standards are to be applied on ODOT roadway jurisdiction facilities, the designer should be aware of the local agency publications and design practices, which can provide additional guidance, concepts, and strategies for design.

The Local Agency Guidelines (LAG) manual for Certified Local Public Agencies (CLPAs) outlines guidance in delivering federal-aid projects including ADA requirements. Certified Local Public Agencies are agencies that have undergone a process to become certified to deliver projects utilizing federal funds. These agencies when certified have established processes that have been reviewed by ODOT's local program manager in coordination with FHWA to deliver projects with federal funding. CLPAs submit design exceptions and concurrences for projects on or along the state highway through the ODOT established process. LPAs have three options in delivering projects with federal-aid funding including:

1. A CLPA delivers its own project through the certification program;
2. An LPA contracts with a Certified LPA to deliver the project; or
3. An LPA contracts with ODOT to deliver the project.

As noted above, any projects on the state highway system shall follow the standards and guidance in the HDM. Local agencies may have more stringent requirements that must be adhered when project overlap jurisdictions. Both agencies requirements need to be met. In addition to the Design Standards Matrix in Table 100-3 Design Standards Selection Matrix, the LAG manual provides additional guidance on appropriate standards.

The LAG manual addresses projects where local agencies deliver projects on ODOT facilities. Local projects funded through ODOT-managed selection processes may be led by local agencies and are expected to be designed and constructed to reflect the original project proposal. ODOT retains decision-making authority for projects on state-owned roadways, including those projects led by local agencies. For local-led projects, ODOT's funding agreements require local agencies to submit final cost, as-constructed drawings, and other documents to confirm the project selected was what was ultimately constructed. Local agency projects on ODOT's system may only be led by certified agencies with ODOT approval to lead delivery. For projects not on ODOT's system or delivered by ODOT, the local agency is responsible for design decisions, but ODOT can aid the local agency in decision-making as an interested partner.

Section 109 Plans, Programs, and Policies

109.1 Introduction

The authority and need to develop projects is established through various plans, programs and policies that outline the primary responsibility of ODOT to provide a safe, efficient, and integrated multi-modal transportation system for the mobility and accessibility of people and goods. In meeting these plans, programs and policies, ODOT shall consider appropriate alternatives for meeting statewide needs. For every project, a number of alternatives, including the no-build alternative, will be evaluated in arriving at the appropriate solution. This section only provides an overview of the project selection and development process. For more detailed information on project development, refer to ODOT's project delivery guidance, operational notices, bulletins, and directives.

109.2 Planning and Project Development

ODOT project development and delivery are organized by ODOT project delivery guidance, which includes both program and project development elements. Transportation planning (part of program development) includes development of the Oregon Transportation Plan and modal/topic plans that provide Oregon's strategic transportation vision and policies. Statewide policy plans also provide guidance and direction for developing more refined transportation system plans.

City and county Transportation System Plans (TSPs), which include the state system within their boundaries, describe existing conditions, identify roadway classification and transportation needs over a 20-year period, and develop priorities for transportation system improvements within a defined geographic area. Generally completed by local cities or counties, TSPs evaluate needs across all modes of transportation and may include portions of whole transportation corridors. Program Managers may consider projects identified in TSPs for inclusion in a future Statewide Transportation Improvement Program (STIP) and should refer to transportation planning documents to help with context and objectives for transportation improvements.

Transportation Policy Planning is high level and includes:

1. Oregon Transportation Plan
2. Oregon Highway Plan and other modal/topic plans
3. Strategic vision, high level policy planning
4. A framework to help prioritize investments for all modes of transportation
5. Identification of strategic objectives and outcomes from management and investment decisions

Transportation System Planning includes:

1. City and/or county TSPs
2. ODOT facility plans such as Interchange Area Management Plans (IAMPs), refinement plans, access management plans, scenic byway plans, etc.
3. An assessment of future transportation system needs and recommended solutions

4. Prioritized investment strategies and projects
5. Transportation Management systems used to evaluate highway assets and assist in the selection of projects
6. Planning work and documents for all modes of transportation, including pedestrians, bicyclists, micro-mobility users, ride-share participants and public transit riders
7. Projects that are prioritized for inclusion in the STIP

The Transportation Planning Section is responsible for managing the statewide policy planning process and the Regional Planning Units are responsible for managing or informing the system planning process. Local Transportation System Plans (TSPs) must follow state statutes when addressing the state highway system within their communities. OAR 366.215 dealing with freight mobility on the state highway system and ORS 374.329 dealing with transfer of state freight routes to local jurisdiction need to be incorporated when writing TSPs. The Federal Register 23 CFR Part 658 would also apply to National Freight Network roadways within a local TSP.

The following are key policies, rules, and statutes that uniquely inform urban design and will be highlighted in later portions of this document:

1. Bicycle and Pedestrian Bill (ORS 366.514)
2. Freight Reduction in Carrying Capacity Review (ORS 366.215) (OAR 731-012)
3. Transportation Planning Rule (TPR) (OAR 660-012-0060), including Section 8 and Section 10 related to Multimodal Mixed-Use Areas (MMA)
4. Oregon Highway Plan mobility standards/targets
5. Oregon Highway Plan, Policy 1A – Classification
6. Highway segment designations (OHP Policy 1B)
7. Special Transportation Areas (STA), Urban Business Areas (UBA), Commercial Centers (CC)
8. Practical Design Strategy (Appendix D of the HDM)
9. Applicable Oregon Land Use Law and rules (ORS 197, OAR 660, Division 12, 24, 22)

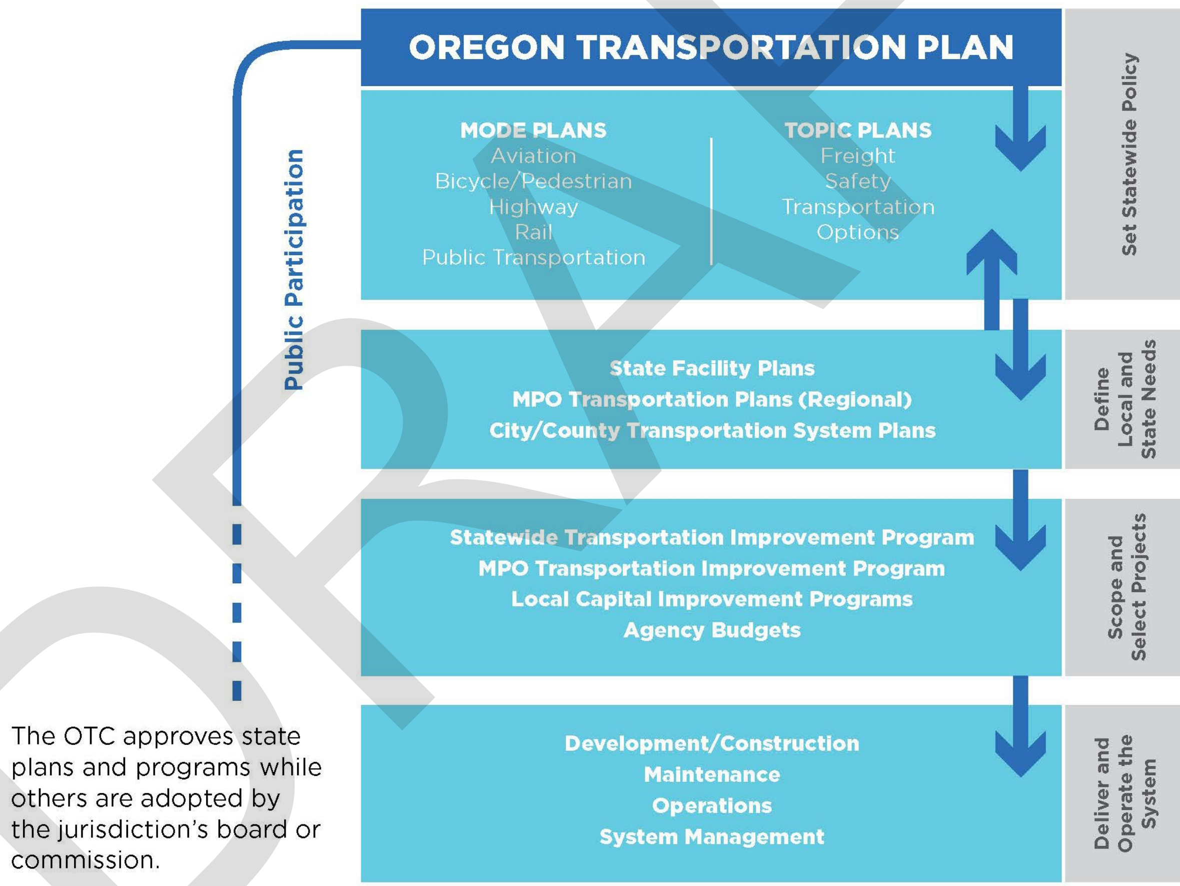
ODOT has the following statewide planning documents that have been adopted by the OTC and provide basis for project development:

1. Oregon Transportation Plan
2. Oregon Highway Plan
3. Oregon Bicycle and Pedestrian Plan
4. Oregon Freight Plan

5. Oregon Rail Plan
6. Oregon Transportation Options Plan
7. Oregon Public Transportation Plan
8. Oregon Transportation Safety Action Plan
9. Oregon Aviation Plan
10. Statewide Transportation Strategy

Figure 100-8 provides an overview of ODOT integrated transportation planning.

Figure 100-8: ODOT Integrated Transportation planning



109.3 Oregon Transportation Plan

The State Transportation System Plan is composed of the Oregon Transportation Plan (OTP), mode and topic plans, and facility plans. Oregon's statewide policy plans articulate the transportation system and focus ODOT's investments to maintain and improve that system, often by informing system management, project selection, and subsequent planning and design guidance. Oregon's transportation planning documents ultimately derive from and implement the goals and policies of the OTP. It establishes a vision and policy foundation to guide transportation system development and investment. The OTP and its mode and topic plans guide decisions by ODOT and other transportation agencies statewide, and are reflected in the policies and decisions explained in local and regional plans. The OTP's influence on project delivery is primarily from its investment scenarios, which inform how Oregon should prioritize transportation investments across all modes that implement OTP goals in response to current and future funding levels. Most modal and topic plans have similar scenarios and investment guidelines to help inform project investment decisions.

109.4 Mode and Topic Plans

ODOT uses two categories of statewide plans to implement the OTP: mode and topic plans. Policies and strategies in these plans often lead to further mode or topic studies, planning and design guidance, and guidance for project selection. ODOT's modal plans reflect four distinct transportation systems: highway, bicycle and pedestrian, rail, and public transit. The Bicycle and Pedestrian Plan (OBPP), for example, guides the state through efforts such as prioritizing projects, developing design guidance, collecting important data and other activities that support walking and biking in Oregon. Similarly, the Oregon Highway Plan (OHP) defines the state highway system and establishes policies for managing and enhancing that system. Both plans inform project delivery primarily by structuring how ODOT prioritizes investments in that mode, and by informing further planning and technical guidance developed by ODOT.

ODOT's topic plans recognize that some challenges and opportunities apply to all modes and require coordinated action outside of any one modal plan. For example, the Transportation Safety Action Plan (TSAP) prioritizes a set of actions to produce a safer transportation system across all modes. The TSAP evaluates safety in planning and design considerations while also informing how ODOT structures its safety project selection process. Similarly, the Oregon Freight Plan's (OFP) policies and strategies improve freight connections to local, state, tribal, regional, national, and international markets. The OFP is a resource designed to guide freight-related operation, maintenance, and investment decisions across all modes. Topic plans inform and focus ODOT's investment priorities (like modal plans) but do so with respect to Oregon's entire transportation system rather than for specific modes. ODOT's topic plans include the Oregon Statewide Transportation Strategy (which includes a 2050 vision for greenhouse gas emission reduction), Transportation Options, as well as the TSAP and OFP.

109.5 Local Plans

Mode and topic plans are statewide plans that are part of the OTP. These plans refine and apply OTP policy to specific modes or topics and guide state, regional, and local investment decisions for the parts of the transportation system that they address. Like the OTP, the goals, policies, and strategies of mode and topic plans are further refined in other regional and local plans such as facility plans, local transportation system plans, and other documents.

ODOT planners participate in ODOT scoping and project delivery teams and are responsible for communicating expectations from local plans for projects in urban areas. On development-funded projects, developers are expected to construct projects and frontages consistent with local TSPs and ODOT standards. Local plans include:

- Transportation System Plans (TSPs)
- Local Streets Plans
- Transit Development Plans (Transit Master Plans)
- Safe Routes to School Action Plans
- Facility Plans
- Streetscape Plans
- Active Transportation Plans (ATPs)

ODOT's multiple plans and programs help to identify transportation needs and determine which transportation projects will be developed and constructed. These plans and programs in concert with the Regions and Area Commissions on Transportation (ACTs) help guide the setting of priorities for the Statewide Transportation Improvement Program (STIP).

109.6 Statewide Transportation Improvement Program

The Statewide Transportation Improvement Program (STIP) is the Oregon Department of Transportation's capital improvement program for state and federally-funded projects. The STIP is developed in coordination between ODOT, Federal and local governments, Area Commissions on Transportation, Metropolitan Planning Organizations (MPO), Tribal governments, and the public. The STIP is adopted by the Oregon Transportation Commission (OTC) and approved by FHWA and Federal Transit Administration (FTA) as required.

The STIP is a staged, multi-year program of multimodal transportation projects. It is consistent with the statewide transportation plan and planning processes as well as metropolitan plans and transportation improvement programs (TIPs). STIP cycles currently renew every three years. Typical project types include Safety, Operations, Bridge, Active Transportation, Pavement Preservation and Modernization STIP projects.

The STIP lists projects that are funded by different programs. Typical funding programs through the STIP include the following: (The following list is not all-inclusive. Check the STIP website for complete list.)

1. Fix-It Program - Includes all the capital funding categories that maintain or fix ODOT's portion of the transportations system. Fix-It needs are derived from a statewide asset management system. Projects that are eligible for Fix-It include: State-owned bridges; highway pavement; culverts; seismic mitigation; salmon (fish passage); bicycle and pedestrian facilities on state highways; and site mitigation and repair.
2. Enhance Highway Program - Enhance Highway programs enhance or expand the transportation system. This includes improving interchanges, new bridges on new alignments, and adding lanes on highways
3. Safety Program - Safety program projects reduce deaths and injuries on Oregon roads. This includes the All Roads Transportation Safety Program (ARTS), which selects projects that will make roads safer for all transportation modes using the roadway.
4. Public and Active Transportation Program (Non-Highway Program) - Program provide direction on three sub-categories on non-highway funding including: Public Transportation; State Highway Fund bicycle and pedestrian; and non-highway discretionary such as ADA curb ramps, active transportation , passenger rail, community paths, safe routes to school, and other transportation options.
5. Local Programs - Local program direct funding to local governments so they can fund priority projects including: Metropolitan planning; Transportation Management Areas; Congestion mitigation and air quality; Surface transportation block grant program; Immediate Opportunity Fund; and Transportation and growth management.
6. Other Functions Program - Includes allocations for workforce development, statewide planning and data collection, and administrative programs provided for by federal resources.

While all STIP project should follow a decision making process, it is imperative that urban design projects have a documented decision framework. The following is a general decision making framework for the performance-based design approach to developing urban STIP projects.

1. Review previous corridor studies or project plans to understand the urban context and modal expectations.
2. To the extent possible when no prior applicable plans and studies are available, establish project goals and document the urban context and modal expectations.

Collaboration through a multidisciplinary project team can help support these activities.

3. Verify during the scoping process that the conceptual design meets project goals and desired outcomes and fits the urban context.
4. Confirm during the final design stage that the design decisions align with the project goals, urban context and expected user needs.
5. Prior to construction, confirm that the final design meets the original project goals and desired outcomes. Include clear documentation of design decisions, particularly if they do not align with the guidance for the identified urban context.
6. Establish an approach for monitoring the project.

Any changes to prior decisions are evaluated against the original intent of the project, and justification is provided for evaluation by a multidisciplinary project team.

Section 110 Design Standards Identification and Selection

ODOT recognizes the following roadway project types along with the requisite design criteria and standards:

- 1R - Resurfacing
- 3R - Resurfacing, Restoration, and Rehabilitation
- 4R - Resurfacing, Restoration, Rehabilitation, and Reconstruction
- AASHTO

The following sections provide a brief description of each of the sources of design standards currently in use by ODOT. These standards give design criteria for both state and local jurisdiction roadways. These standards are dependent on the highway's functional classification (See Appendix A) and the work type.

It is important to note that in addition to the standards described below, considerable reference information is available in other publications. A listing of these references is given in this chapter in Section 121 and is considered to be supplemental to the design criteria given elsewhere in this manual. Procedures for deviating from these standards and guidelines are outlined in Part 1000, Design Exceptions.

With a design flexibility approach to projects, the different funding sources available, and bundling of funding sources, it is possible to have projects that involve several types of design standard requirements.

For example, a grind and inlay preservation project that includes new multimodal design elements such as a new separated multi-use path. In this specific instance, preservation standards such as 1R or 3R would be used for the preservation grind and inlay portion of the project and 4R standards for the separated multi-use path. The designer will need to work with the project team to determine the project elements and then select the appropriate standard.

110.1 Work Types

The standards used to develop roadway geometric and non-geometric details generally have a major effect on the overall project cost. The type of work, location of the project, and type of roadway facility are all factors that must be taken into consideration when making that selection.

When determining the appropriate design standard for use in project development, work types can be divided into the categories listed below. Funding may come from a number of funding programs such as Fix-It, Enhance, Safety, Local Programs or a combination of funding programs. It is the type of work that determines the design standard to use and not the funding type. It is possible to have a preservation project that the base funding is “Fix-It” and “Public and Active Transportation” program funding is included to install bicycle features such as a buffered bike lane. In this case 1R or 3R standards would be used for the preservation aspect of the project and 4R standards would be used as the base standard for the buffered bicycle lane. The project context and existing features may provide justification for using existing non-standard design features when it is determined to be an appropriate design through the design exception process. Further discussion of the specific categories are included in subsequent sections.

ODOT recognizes the following general highway work types:

1. Modernization [New Construction/Reconstruction]
2. Preservation
    a. Resurfacing
    b. Interstate Maintenance
    c. Resurfacing, Restoration, and Rehabilitation
3. Safety Improvements
4. Operations
5. Maintenance
6. Miscellaneous/Special Programs
    a. ADA Curb Ramp Only

    b. Grant Project
    c. Property Development Permit Projects
    d. Emergency/Natural Disaster

7. Local Programs (AASHTO)

Work types can fall under a variety of design standards. See Table 100-2 for potential design standards that typically apply to each work type.

Other disciplines utilize other design standards that must also be determined during project development. Coordination with all disciplines involved with a project is critical to overall project success.

Table 100-2: Applicable Design Standards

Work Type	Potential Applicable Design Standards			
	1R	3R	4R	AASHTO
Modernization			✓	
Preservation				
Resurfacing	✓	✓		
Interstate Maintenance	✓	✓		
Safety Improvements		✓	✓	
Operations		✓	✓	
Maintenance	✓	✓	✓	
Misc./Special Programs				
ADA Curb Ramp Only				
Grant Project			✓	✓
Property Development Permit Projects		✓	✓	
Emergency/Natural Disaster		✓*		
Local Programs				✓

✓* - Emergency/Natural Disaster projects may not be required to comply with all 3R design standards, as the main goal of these projects is to reopen compromised sections of highway, and projects are often designed to, at a minimum, meet design standards of the pre-emergency condition.

Section 111 ODOT 1R Standard

With agreement from FHWA, the ODOT 1R standard is intended to preserve the highway paving with single lift overlays or inlays that are considered non-structural. As such, these projects meet the FHWA definition of "alterations". Generally, no specific pavement design life is considered, but it is intended to provide at least 8-years. Since these are considered alterations and not reconstruction projects, the Oregon stature ORS 366.514 (Bike Bill) requirements are not triggered. However, shoulder widening and other bicycle related design items can be added to 1R projects if other funding alternatives are used and the addition of the design items does not delay the project.

In addition to bicycle design elements, the replacement of safety items such as guardrail, guardrail terminals, concrete barrier, impact attenuators, and signs may also be included in the 1R project if funding other than Preservation funds are used and the added work will not delay the scheduled bid date. Any existing safety features that are impacted by the proposed resurfacing must be adjusted or replaced by the 1R project. 1R projects may also be able to take advantage of restriping options to allow reconfiguration of cross-section elements to provide upgraded bicycle facilities at little to no additional project cost. As noted below in the project requirements, section 111.6, all projects that include resurfacing (except for chip seals) are to install or upgrade curb ramps.

Where additional funds are available, additional work can be added to a project using the 1R design standard. In this case, the project is considered to be a 1R+ project. The additional work would generally use the 4R standard.

111.1 Scoping Requirements

In order to ensure the intent of the program is met in addressing pavement and safety needs, adequate advance information is needed to assure adequate statewide decisions are made with consistency. If additional funding sources are anticipated through scoping, they should be identified with the final scoping documents.

1. 1R/3R Record of Decisions Documentations Form
    a. This form steps the scoping team through the scoping process. Parts of the form are filled out by different sections including: Pavements, Traffic, and Roadway.
    b. Use of this form provides a statewide uniform approach to determining the project design standard – 1R vs 3R – that will be applied to a pavement preservation project.

111.2 Project Initiation Requirements

At project initiation, the 1R/3R Record of Decisions Documentation form must be reviewed and validated to ensure the project will be developed under the appropriate design standard.

111.3 Paving Criteria – 1R Projects

1. A paving project is initially designated 1R based on the appropriate paving treatment. 1R pavement treatments are defined as a single lift overlay or inlay and are considered as non-structural pavement preservation according to agreement with FHWA. (There is no formal requirement for pavement design life for an individual project; however, since the 1R treatment is location specific, it is expected that an 8 year pavement life will be the goal of the program).
2. Pavement Services is the final authority regarding the pavement design.
3. Where less than approximately 5% of a project (based on lane miles paved) includes more than a single lift non-structural overlay or inlay, the project may be designated 1R.
4. Where up to approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project may be designated 1R; however, this requires the approval of a design exception.
5. Where more than approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project must be designated 3R
6. As an exception to this rule, a grind and inlay plus an overlay may also be considered for development under the 1R standard; however, this would be uncommon and requires the approval of a design exception.
7. Where the appropriate course of action is not clear based on the percentages noted above, include Technical Services Roadway staff in the discussion.
8. Chip seals are 1R projects and subject to the requirements of the 1R standard. Chip seals do not require ADA curb ramp work.

111.4 Criteria for Unprotected and Unconnected Bridge Ends -1R Projects

1. On 1R paving projects, any bridge rail with unprotected ends or unconnected transitions exposed to traffic must be mitigated. Provide an end treatment meeting the current standard, or a design exception must be obtained. (Note: In very specific, one-way

roadway locations a protected bridge rail trailing end may not be required. Contact the Senior Roadway/Roadside Design Engineer in the Technical Services Traffic-Roadway Section for guidance.)

2. Unprotected ends – Where the end of the bridge rail is exposed with no end treatment such as a transition to guardrail or a crash cushion.
3. Unconnected transition – Where there is no crashworthy transition between the end of the bridge rail to the guardrail or other barrier.
4. For possible funding options, contact the Senior Roadway / Roadside Design Engineer in the Technical Services Traffic-Roadway Section.

111.5 Roadside Safety Hardware Requirements for 1R Projects

The FACS-STIP tool is used to access roadside safety hardware data and other inventory data used for scoping 1R projects.

ODOT has adopted the Manual for Assessing Safety Hardware (MASH 2016) as the standard criteria for assessing and crash testing roadside safety hardware. Existing safety hardware evaluated under the previous standard – NCHRP 350 is allowed to remain in service in most cases on 1R projects.

Pre-NCHRP 350 hardware may be upgraded if additional funding is available (1R+). Existing roadside safety hardware that is left in service must be adjusted as necessary to maintain functionality. See Part 400.

111.6 Curb Ramp Requirements for 1R Projects

All projects that include resurfacing (except for chip seals) shall install or upgrade curb ramps where applicable. Street crossings shall be evaluated for official actions required to document any closed crossings either pre-existing or for new closures requests.

111.7 Preservation (1R vs. 3R)

The term preservation is often used as a catch-all meaning. Improvements to extend the service life of existing facilities, and rehabilitative work on roadways are preservation types of projects. In general, preservation projects add useful life to the road without increasing the capacity, and may include:

1. Pavement inlays and/or overlays (including minor safety and bridge improvements)
2. Interstate Maintenance (IM) Program (pavement preservation projects on the Interstate system
3. Re-establishing an existing roadway
4. Resurfacing projects

The pavement preservation category of projects on state highways use the ODOT 3R Urban, Rural, Freeway, or 1R, standard depending upon the highway classification and location. Generally, preservation projects preserve and extend the service life of an existing highway typically by at least 8 years. 1R preservation projects are focused primarily on improving pavement condition and restriping markings. They are usually considered non-structural and a specific design life may not be intended. 3R Preservation projects may include small portions of modernization activities as part of the project such as affecting subgrade, re-basing, adding a turn lane, or minor curve modifications. As long as these elements do not account for over 50% of the project length, the appropriate ODOT 3R standard is to be used, otherwise the project is treated as modernization and the appropriate ODOT 4R/New standard shall be used. As discussed earlier, the different funding sources may allow a combination of design standards to be used with the appropriate design standard being use of the specific work type. The ODOT Roadway Engineering Unit can assist regarding the appropriate standards use for projects that involve multiple work types.

There are cases where the designer needs to be aware of funding limitations as they relate to preservation type projects and safety features. This information is more fully discussed later in this section.

111.8 Preventive Maintenance

Preventive Maintenance is a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without significantly increasing the structural capacity. An example of Preventative Maintenance is a chip seal project.

Preventive maintenance projects are often done through maintenance forces and they preserve and extend the service life of existing highways and structures. Preventive maintenance projects are subject to ODOT 1R design standards, and generally, existing widths of lanes and shoulders have been maintained in the past. However, even these projects can evaluate the existing cross-section and with restriping, can reconfigure the cross-section to make improvements for multimodal considerations.

Section 112 ODOT 3R Design Standards

The 3R standard is intended to preserve and extend the service life of existing highways and enhance safety using cost-effective solutions. Service life is extended with structural rehabilitation without complete reconstruction.

ODOT 3R Design Standards are found in different Parts of the HDM, Parts 200 and 300, which contain information dealing with pavement widths, horizontal curvature, superelevation, and other references specific to this type of work. The 3R requirements are similar to TRB Special Report #214, but with additional guidance in respect to context, performance base design, and design flexibility. Guidance from other research such as NCHRP Report 876, Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects is incorporated. ODOT 3R standards have been developed for both Urban and Rural areas and are arranged according to functional class. 3R type projects located on designated expressways are to use the appropriate urban or rural arterial 3R standard.

112.1 Preservation (Resurfacing, Restoration, and Rehabilitation)

As stated above, 3R are projects that preserve and extend the service life of existing highways and enhance safety using cost-effective solutions. Improvements include extending pavement life by at least 8 years, safety enhancements, minor widening (minor widening considered to be widening at spot locations, widening at curves, etc.), improvements in vertical and horizontal alignment, improvement in superelevation, flattening of side slopes and removal of roadside hazards. The scope is influenced by factors such as roadside conditions, funding constraints, environmental concerns, changing traffic and land use patterns, surfacing deterioration and crash type and rate. 3R projects are not constructed with the intent of improving highway mobility; however it is sometimes an automatic incidental benefit as a result of improving the riding surface and improving safety.

This category includes, but is not limited to the following types of work: overlay projects with or without minor widening to shoulders or travel lanes, Latex Modified Concrete (LMC) overlays, widening for curb, and extending tapers. Also included in this class are projects with site specific vertical or horizontal curve corrections, and left turn channelizations, when included in an overlay project for safety purposes. Scarifying existing surfacing, rebasing and repaving is considered as 3R if the scope of the job does not require the original subgrade to be altered. All project widening in this category is limited to less than a full lane width except when channelization is incorporated.

Due to the variance in projects scopes, the application of 3R standards will typically involve substantial engineering judgement compared to 4R projects where, in general, design elements are being brought up to current standard. Project scope of work, purpose and need, and alternative analysis and trade-offs in respect to 3R projects must be included in the decision process of determining which design elements are affected. All projects shall strive to meet all of the 3R design requirements, but with the primary focus of 3R projects preserving and extending the pavement life, and the associated ADA triggers such as curb ramps, not all projects are able to improve all project elements. In respect to engineering judgement, the use of design exceptions with appropriate justification may be an appropriate tool in designing 3R projects.

When preservation projects are being considered for 1R, the 1R/3R Record of Decisions Documentation process will be used to determine if the preservation project will be a 1R project, a 1R+ project, or a 3R project. Once this determination has been made the appropriate design standards are to be used.

As discussed above, engineering judgement will be involved in some preservation projects as it is possible for 3R projects to have some 4R design elements, such as vertical and horizontal curve correction, adding a bike lane, or sidewalk and curb ramps. Those 4R elements are to meet the 4R standards. Depending on the project specifics, it may be more appropriate from a design flexibility and context perspective to request a design exception to the 4R requirements.

Section 113 ODOT 4R/New Design Standard

The ODOT 4R/New standard is intended to either reconstruct or newly construct infrastructure. Reconstruction involves removal of base material, and may involve changes to vertical or horizontal geometry of the highway.

Generally these standards are found in the HDM, starting in this Part and running through the remaining document. The ODOT 4R/New standards give specific values for use in all areas of design. It is intended that all design values given in the ODOT 4R/New standards are to be within the values or ranges given in the AASHTO Green Book. That publication is to be referenced, when a particular design detail is not covered in the ODOT 4R/New standards. ODOT 4R/New standards have been developed for both Urban and Rural areas of the state and are further defined by freeways, expressways, and arterial standards.

The ODOT 4R/New standards also contain the following specific requirements which are not included within the AASHTO Green Book:

1. ODOT requires use of spirals. Use spiral lengths given in the HDM, as appropriate.
2. Superelevation runoffs match the ODOT spiral length.
3. ODOT requires construction minimum vertical clearances.

4. For vertical clearance on Local Agency jurisdiction roadways, see Part 300
5. Use ODOT specific design speeds. See Section 207.10 Speed, Context, and Design
6. Use a performance based and context design approach to ODOT's six urban contexts.

The ODOT 4R/New standard is applicable to projects that are considered either new construction or reconstruction.

New construction projects are projects constructed in a new location, new alignments, major additions such as interchanges and safety rest areas, or rebuilding an existing facility with major vertical or horizontal alignment changes. Other modal new construction project include multi-use paths and off road bicycle facility options. Very little of ODOT's work is new construction as most of the highway infrastructure is in place. ODOT primarily maintains, preserves, and enhances existing highway corridors. New construction projects generally improve transportation safety, address gaps and deficiencies in the multimodal transportation network, add capacity to the highway system to facilitate existing traffic and/or accommodate projected traffic growth thereby enhancing the corridor. New construction projects can also include new construction activities such as construction of a new segment of highway on new alignment. Other modal projects on state highways and bridges such as light-rail, bus-rapid transit, streetcar, and alike can be considered new construction or reconstruction projects. New construction projects typically achieve a 20 year service life for pavements.

Reconstruction projects upgrade the facility to acceptable geometric standards and as a result, often provide a greater roadway width. The improvements may be in the form of additional lanes and/or wider shoulders and produce an improvement in the highway's mobility. Reconstruction projects normally include, but are not limited to, the following types of work:

1. Altering the original subgrade
2. New, or replacement of, Structures or bridges, and similar projects.
3. Addition of Lanes including:
    a. Through Lanes
    b. Passing and Climbing Lanes
    c. Turn Lanes
    d. Acceleration and Deceleration Lanes
    e. High Occupancy Vehicle (HOV) lanes
    f. Reconfiguring cross section with striping or managed lanes (4R only when adding lanes, striping reconfiguration can also be achieved with 1R and 3R projects.)
4. New alignments and/or new facilities
5. Highway reconstruction with major alignment improvements or major widening

6. Grade separations and Interchanges
7. Widening of bridges to add travel lanes
8. New safety rest areas and viewpoints
9. Parking lot, park-n-ride, transit center/hub, and similar projects
10. Port of entry and weigh station facilities
11. Vehicle charging stations
12. Truck escape ramps
13. Median crossovers
14. Tolling infrastructure and facilities
15. New multi-use/shared use path

When the 4R requirements cannot be achieved, a design exception is required (see 106.2 and Part 1000).

113.1 Single Function Projects (4R)

Single Function projects are 4R projects with a limited scope of work. Single function projects do not require non-related substandard features of the roadway to be addressed. For example, if a guardrail upgrade qualifies as a Single Function project, it will not be necessary to address other substandard features on the roadway, such as lane and shoulder width, horizontal and vertical alignment, etc.

Design exceptions are only required on the element or component that is modified or altered within the 4R single function project. See specific or applicable sections throughout the HDM relating to each element or component. See Part 1000 for the design exception request process.

Single Function 4R projects include projects that do not permanently impact the travel lanes or shoulders of the highway (boundaries of the roadway realm). Generally, projects that only include work outside the edge of pavement will qualify for as a 4R single function project. For example curb ramp only projects are outside the edge of pavement. Culvert replacement projects may involve work within the roadway, however will not permanently impact the travel lanes, and can be single function projects. These projects address a specific need. Another example of a single function project with work within the roadway is a rockfall mitigation project that also involves work to reopen the roadway, as long as the work within the roadway is restoring pre-slide conditions. The scope of work is limited to features that are directly impacted as a result of addressing the specific need. For example, a signal upgrade at an urban intersection may impact the sidewalk and trigger the need to provide necessary ADA upgrades. In no case shall safety, operations, pedestrian and/or bicycle conditions be degraded as a result of a single function project. Each feature constructed in a single function project must be built to the applicable standard for new construction. Resurfacing projects are not single function projects, see Section 111.

Section 114 AASHTO Design Standards

These standards are contained in the AASHTO Green Book. AASHTO standards are specifically for use in the design of new construction and reconstruction projects, when the project is located on routes under local jurisdiction. As stated in the preface of the book, the AASHTO Green Book is not intended as a policy for 3R projects, traffic engineering, safety, and preventive maintenance-type projects that include very minor or no roadway work. The reader is referred to NCHRP Report 876 and related references, for guidance in the design of 3R projects. However, for local agency urban preservation type projects utilizing federal funding, the local agency has the choice of using the ODOT 3R standard or AASHTO's Green Book.

AASHTO's Green Book policy is organized in a system so the roadway's functional classification and volume determines which part of the policy applies to that roadway. The AASHTO policy includes chapters in which general design controls and elements are discussed as they apply to all types of functional classifications and provide groundwork to understanding basic design concepts. These chapters cover highway functions, design controls and criteria, elements of design, and cross section elements. The policy also gives specific design information for at-grade intersections, grade separations and interchanges.

Chapter 1 of the 2018 AASHTO Green Book continues to embrace design flexibility and performance-based design for projects as part of the project development process, and introduces definitions of the following work types:

1. New construction
2. Reconstruction
3. Projects on existing roads

The "projects on existing road" definition addresses projects "that do not change the basic roadway". Although not defined , these types of projects are very similar to 3R projects in respect to maintaining the existing roadway if the roadway in question is performing well or make improvement in these project to address crashes, operational improvement needs, or design improvements that would be expected to reduce crashes and are cost effective. The next update of the AASHTO Green Book will fully incorporate this concept in the remaining chapters of the AASHTO Green Book.

Chapter 1 of the 2018 Green Book also introduced a context classification system that characterizes roadways by their surrounding environment and how the roadway fits into the community. This is very similar to the approach ODOT has taken, initially in the 2003 Highway

Design Manual (OHP Highway Segment Designations) and further developed in the Blueprint for Urban Design (BUD).

The remainder of AASHTO's Green Book policy covers design details as they relate to specific functional classifications. AASHTO Green Book policy provides design direction for the following classifications:

1. Rural and Urban Freeways
2. Rural and Urban Arterials
3. Rural & Urban Collector Roads and Streets
4. Local Roads and Streets including Special Purpose Roads

It is imperative that any user of AASHTO's Green Book study and understand the concept of functional classification. The AASHTO's Green Book gives an explanation of this in Chapter 1 (Highway Functions) and the above mentioned discussion on roadway context. Part 1200 of this manual outlines additional information dealing with traffic studies and functional class in urban areas and how it relates to design. There may be occasions, due to functional class definitions, that an urban setting may have a rural functional classification. In these situations the designer should consult with the Region Roadway Manager.

Functional Classifications have been established for all state highways by the ODOT Transportation Development Branch. Appendix A contains a list of resources for determining route functional classification. The functional classification should also be checked against the functional classification contained in a local TSP. Design specifics cannot be accurately selected from AASHTO's Green Book without the correct functional class being known.

Section 115 Design Standards for Special Cases

Depending on the work to be done that doesn't fall within one of the above design standards, the design standard for the project needs to be decided as a special case for that project. That decision should be made by the project development team and approved by the State Traffic-Roadway Engineer.

115.1 Combined Projects Standards or Types

A project may have more than one design standard applied to different segments where it is appropriate and fits the purpose and need of the project scope. A project scope may include intersection improvements, while other portions may be limited to preservation paving. Many times, projects are combined for programmatic, scheduling, contracting or efficiency purposes, while still maintaining separate design standards.

115.2 Routine Maintenance

Routine Maintenance consists of work that is planned and performed on a routine basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service. Routine maintenance activities are typically performed by the district maintenance offices.

115.3 Bridge

Bridge design categories determine the design criteria and requirements for projects on bridges. These categories include: Modernization, Retrofit, Preservation, or Maintenance. These categories and related design criteria and requirements are defined for bridge projects and found in the Bridge Design Manual (BDM).

These categories operate independently from the roadway design standards identified in Section 110 and Section 113. A project involving bridges will have both a roadway design standard and at least one bridge design category. For projects initiating outside of Bridge Program, the bridge design category may be based on the work required by the roadway design standard; however the bridge design category must still be determined.

Roadway design standards and other agreements govern work outside of the bridge footprint, including approach slabs, drainage features and bridge rail transitions.

115.4 Safety

Safety projects address the statewide prioritized high crash locations and corridors, including the Interstate system, in order to reduce the number of fatal and serious injury crashes. The All Roads Transportation Safety (ARTS) Program has been developed to address the safety needs on all public roads in Oregon. The ARTS Program is data and safety driven to achieve the greatest benefits in crash reduction and is blind to jurisdiction.

Safety projects typically fall into two categories, systemic and hot spots. Systemic projects are those that typically use low-cost safety measures that have been proven to reduce fatal and serious injury crashes. Systemic projects focus on intersections, roadway departures, and bicycle and pedestrian.

Examples of systemic projects include:

1. Installation of curve warning signs
2. Reflective backplates on signals
3. Delineation
4. Rumble strips
5. Countdown pedestrian timers
6. Bicycle and Pedestrian projects such as pedestrian lighting and bicycle lanes.

Hot spot projects are those that have been identified as having a higher than normal crash occurrences. Typical hot spot project locations are segments of roadways or intersections. Examples of hot spot projects include:

1. Left turn channelization
2. Installation of climbing lanes or passing lanes
3. Curve realignments
4. Installation of traffic signals
5. Installation of roundabouts
6. Conversion of a signal to a roundabout

With the Department's limited resources and performance-based, practical design approach, safety projects focus on providing solutions in a prioritized manner to solve the highest level issues first. For example the primary intent of a left turn channelization project may install the left turn channelization to reduce rear-end crashes but may not address non-standard shoulder and lane widths or install a right turn lane where right turn criteria has been met. These safety projects are focused on a specific improvement that require mitigation but do not require addressing other non-standard features that are unrelated to the specific safety issue identified in the project scope. Limited safety funding is not intended to be used to upgrade features where there is no identified safety issue.

As with all projects, the Practical Design Goals and SCOPE Values are applied to safety projects. As outlined by Practical Design Goal #3 (design projects that make the system better, address changing needs, and/or maintain current functionality by meeting, but not necessarily exceeding, the defined project purpose and need and project goals) safety projects may focus on specific prioritized safety issues, providing an incremental improvement while improving and/or maintaining safety. As with all projects, engineering judgment and the use of the design exception process are a vital element of the development of safety projects and help efficiently focus specific funding to projects where it is needed.

The design standard selection on a safety project will be determined on a case by case evaluation from discussion between region traffic and roadway staff and Technical Services

Traffic-Roadway staff based on project context and location specifics. Generally, safety projects use 4R standards for the elements affected. However, because safety projects are focused on particular concerns at high crash sites, engineering judgment is necessary when evaluating roadway cross-section elements and safety treatments for proposed improvements. Table 100-2 lists applicable standards for project types.

In order to provide the greatest improvement in relation to the limited funding available, roadway elements that are directly related to the scope and focus of the safety issue being addressed will be improved. It may be acceptable to leave in place existing non-standard roadway elements that do not directly affect the project focus, providing that doing so does not degrade the roadway section or create additional safety concerns. For safety projects that involve channelization, Figure: 500-19 Left-Turn Channelization provides alternative guidance on shoulder width. Safety projects that are considered Single Function 4R include traffic signals, illumination, signing, delineation, pavement marking, removal of fixed objects, pedestrian crossing improvements and continuous rumble strip projects that do not include significant additional pavement. Regardless of which standard is selected, design exceptions may be necessary to meet the project scope values and should be evaluated early in project scoping.

115.5 Operations

Operations projects increase the efficiency of the highway system, leading to safer traffic operations and greater system reliability. These types of projects include:

1. ITS: Intelligent Transportation System (includes ramp metering, variable message signing, incident management, emergency response, traffic management operation centers, and mountain pass and urban traffic cameras)
2. TDM: Transportation Demand Management (includes rideshare, vanpool, and park and ride programs)
3. Rockfalls and Slides (chronic rockfall areas and slides; not emergency repair work)
4. Signals, signs, channelization, and other operational improvements such as restriping and minor widening.

Many of the operational work type projects involve installation of system management equipment and operation improvement items such as ramp meters, response equipment or signs and signals. These installations would all use standard equipment. Operational projects such as rockfall and slide projects would use the Single function category, which includes 4R standards as this type of project is intended for safety enhancements and not an improvement in roadway width or highway mobility. Operational projects that include channelization,, or widening will also use 4R standards.

115.6 Development Review and Permitted Projects (Non-STIP)

Development review projects are those land development projects with associated traffic that may impact the safety and operations of state transportation facilities. Development review projects may impact traffic, mobility, ODOT facilities, access to the state system, local street network, safety, ADA, rail, etc. Development review projects may result in improvements on state highway frontage, such as sidewalks, bike lanes, right and left turn channelization, intersection traffic control such as roundabouts or signals/signal modifications as part of the mitigation alternatives.

Integrating new development into and along the existing infrastructure and transportation system creates the need for continuous collaboration. This type of project requires the development review team to review existing plans, prior studies, and/or other information about the project location to verify that the improvements associated with the development meet the code requirements and long-term needs for the area. ODOT staff reviewing development related projects should review the TSP and corridor plan, if available, to understand the urban context, goals and desired outcomes for the project area, and future right-of-way needs.In most cases, it will not be feasible to conduct a planning process as part of the development review, but project teams will be able to follow the decision-making framework in this chapter to document assumptions and decisions. Development review projects shall use the 4R Standard. Development Review projects do not require the design life V/C requirements (Table 1200-1; old Table 10-2) to be met as the project mitigation will determine the needed improvements on the state highway system. In many development review instances, there will be limitations on developer requirements for cross-section improvements. These limitations often restrict work to half-street improvements and improvements only along the developer's available frontage in order to meet permitting requirements. If the selected design does not align with adopted plans or current standards for the urban context, ODOT staff should document design decisions and seek agreement from the multidisciplinary project team.

115.7 Miscellaneous/Special Programs

These are projects funded through special programs such as grants that do not easily fit into other work types. The design standard selection on these projects will be determined on a case by case evaluation based on project context and location specifics. There are times when 3R standards or Single Function 4R guidelines are appropriate. Projects that provide greater roadway width, add capacity, affect curb placement, or improve the level of mobility are to use 4R standards. Examples of these special programs may include: bicycle and pedestrian grants, fish passage and culvert improvements, and immediate opportunity funds.

Section 116 Design Standard Selection

The following matrix shows which design standards are applicable for certain projects based on work type, and if the project involves a state route or local agency road.

Table 100-3 Design Standards Selection Matrix

Work Type	Roadway Jurisdiction				
	State Highways			Local Agency Roads [1]	
	Interstate	Urban State Highways	Rural State Highways	Urban	Rural
Modernization/	ODOT 4R/New [2] Freeway	ODOT 4R/New [2] Urban	ODOT 4R/New [2] Rural	AASHTO	
Preservation/	ODOT 3R Freeway	ODOT 3R Urban	ODOT 3R Rural	AASHTO [3]	ODOT 3R Rural [4]
Preventive Maintenance [5]	1R	1R	1R	NA	NA
Safety-Operations-Miscellaneous/ Special Programs	ODOT Freeway [6]	ODOT Urban [6]	ODOT Rural [6]	AASHTO	ODOT 3R Rural

1. For projects on a local jurisdiction route, the local authority may, at its option, use either the appropriate AASHTO Green Book standard or select a standard of their own choice. This discretion is given by ORS 368.036. (ORS 368.036 applies to counties only, not cities.). AASHTO standards shall be used for all local agency jurisdiction roadway projects on the National Highway System (NHS).
2. Limited scope modernization projects may use Single Function 4R standards – determined on a case-by-case basis.
3. The local agency has the choice to use the AASHTO Green Book or ODOT 3R Urban design standards. Local Agencies may use AASHTO for Vertical Clearance requirements on Local Agency Jurisdiction Roads.

4. Federally funded Preventive Maintenance work, which includes Chip Seals and Thin Overlays, will be required to follow 1R standards. Preventive Maintenance projects and/or 1R Projects are not applicable to LPA Preservation Projects unless on the State Highway System.

5. The appropriate ODOT 3R standard may be used for some projects. Selection is case by case. Designer to confirm appropriate standard with Region Roadway Manager.

Section 117 Project Delivery Process

The ODOT Project Management Office (PMO) provides guidance material that outlines the program development and project development processes that are part of the project delivery process. The guidance material provides program development information such as system management, business case development, scoping teams, practical design, and draft and final STIP development. It also provides information on the project development milestones including; project initiation, design acceptance, advanced plans, final plans and PS&E submittal.

ODOT's Project Delivery Life-Cycle model provides a project path that designers and project teams can continually use to re-enforce the project purpose and need. There are multiple milestones and documentation points that ensure the project purpose and need, as well as project goals and objectives are being met. The milestones are also used to document project decisions such as design criteria, finalizing the project charter, the DAP (Design Acceptance Package), change management requests, and S.C.O.P.E. integration elements. Designers should use the milestones as an opportunity to ensure that the project design is in line with the project purpose and need.

One of the more critical project delivery milestones is the DAP. DAP occurs at the end of the initial design phase where the different disciplines review the project. Some of the deliverables at DAP include Environmental documentation, Design Acceptance Plans, design narrative, access management documentation, and project footprint.

There are benefits in design staff understanding the program development and project delivery processes. Information regarding these processes are available from PMO.

There are opportunities within each stage of the ODOT Transportation System Lifecycle to apply a performance-based design approach and identify opportunities for tailoring this overall framework to align with the goals and objectives of projects. Within each stage of the Transportation System Lifecycle, evaluating the trade-offs between design, operations, and safety can help confirm that the project solutions align with the intent of the context and identified users.

A multidisciplinary project team established at the early stages of the project can provide continuity through project completion. In ODOT's Transportation System Lifecycle, this team (which may vary by project phase) will help verify that planning decisions are considered at the next stage of alternatives evaluation and preliminary design. During Program Development, this team is the Project Scoping Team, and during Project Development, this team is the Project Delivery Team. These multidisciplinary project teams will create documentation, maintain project continuity, and verify that design decisions are aligning with the original project goals. The performance-based approach establishes a framework that can guide this team throughout the project flow.

117.1 Design Flexibility in Project Delivery

ODOT's Performance-Based, Practical Design (PBPD) strategy is an integral part of project development, and specifically, the design process. PBPD requires sound engineering judgment and making informed decisions based on a specific project scope, purpose and need. PBPD will typically require more information during project development allowing for proper decision making when weighing and determining the design elements for a specific project. In addition to ODOT's PBPD strategy the Department continues to promote design flexibility and multi-modal design within project development.

Integrating a performance-based approach and a multidisciplinary project team into the four stages of ODOT's System Lifecycle can help establish appropriate desired project outcomes and effectively evaluate trade-offs during decision making. This approach can also be a guide for creating an iterative process that allows for flexibility in the design, continuous verification of desired project outcomes, and documenting of design decisions throughout each stage of the process. Figure 100-9 illustrates how a performance-based approach may be integrated into the System Lifecycle stages and highlights key locations for input and documentation.

Figure 100-9 A Performance-Based Approach to ODOT Project Flow

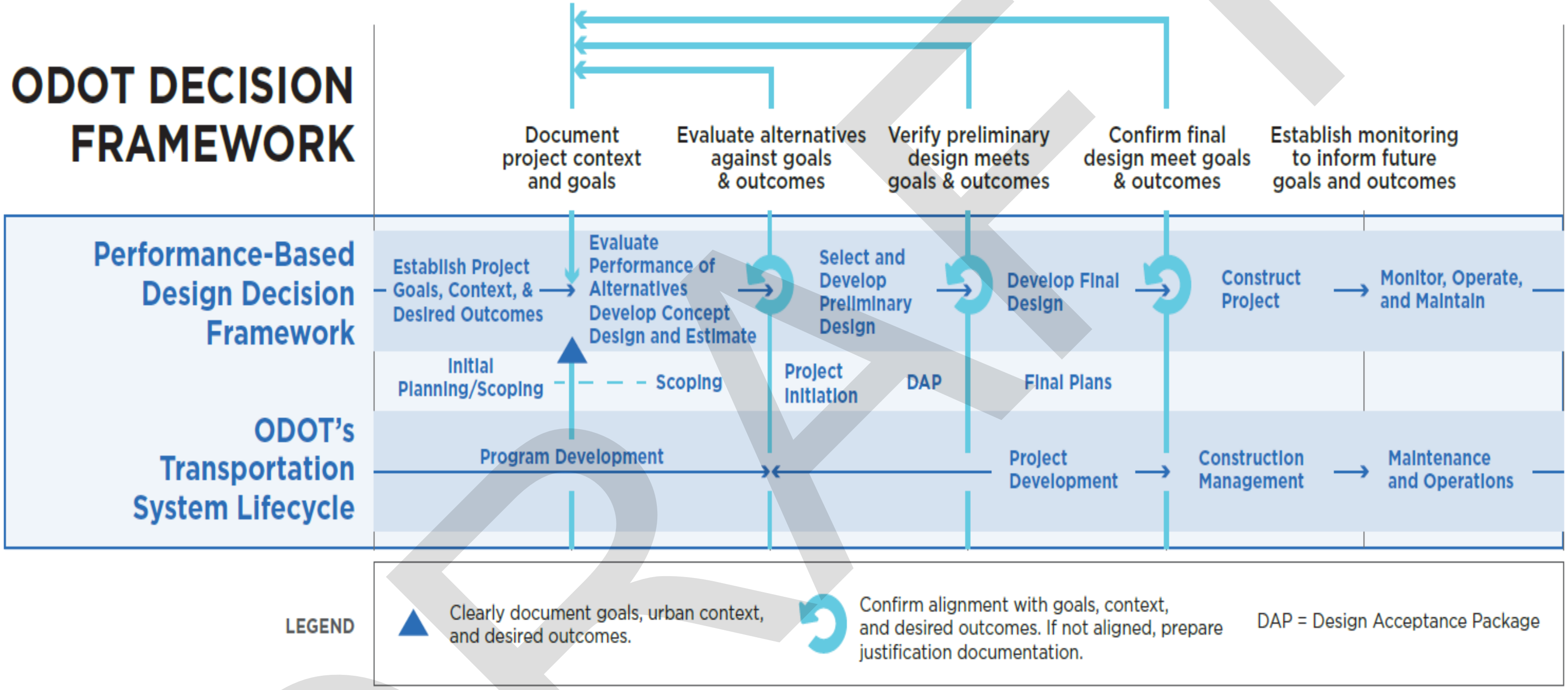


Figure 100-9 provides a multimodal decision-making framework and shows how this approach may become iterative at specific stages of the project. The decision-making framework includes the following six stages:

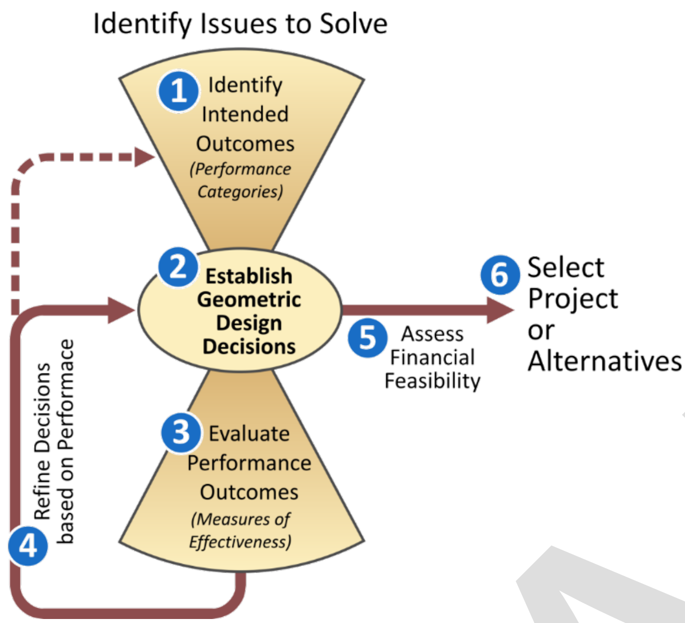
- Establish Project Goals, Context, and Desired Outcomes
- Evaluate Performance of Alternatives
- Select and Develop Preliminary Design
- Develop Final Design
- Construct Project
- Monitor, Operate, and Maintain

The circular arrow symbols in Figure 100-9 highlight milestones within the decision framework where the project goals and desired project outcomes should be revisited to verify that the planning and design decisions, alternatives development, and designs align with the original intent of the project and serve the needs of the users. These are also milestones in which design documentation of planning and design decisions is important. If design decisions, project team discussions, and alternative evaluations have led to any changes in the performance measures or project goals, this information and the project team decisions should be clearly documented. This process will need to follow guidance established in the ODOT Directive PD-02 and meet requirements and policies established through the ODOT Statewide Project Delivery Branch. Changes should be justified through ODOT Urban Design Concurrence documentation for urban projects and through the designer narrative for projects outside urban locations, reviewed, and then approved or rejected by a multidisciplinary team. As noted previously, engaging the multidisciplinary project team early in the project can help identify constraints, project context considerations, and evaluate trade-offs for various design decisions. The blue circular arrow symbols represent logical milestones for engaging this team to ensure that input is received early, often, and continuously throughout the project. Changes will need to be justified through ODOT design documentation, reviewed, and then approved/rejected by the team. If the change is approved by the team and it is deemed a scope change, a Change Management Request (CMR) may be needed.

♦ Design Flexibility - Applying a Performance-Based Approach within Project Development

Clear documentation of a performance-based approach can encourage effective problem-solving, collaborative decision making, and an overall greater return on infrastructure investments. NCHRP Report 785 presents a performance-based model based on desired project outcomes and applies the concepts at various project levels as shown in Figure 100-10.

Figure 100-10 Performance-Based Approach



Source: NCHRP Report 785)

1. Identifying desired project outcomes and performance metrics
2. Establishing design decisions based on the desired outcomes
3. Evaluating the performance of the design
4. Iterating and refining the design to align solutions with the desired outcomes
5. Assessing the financial feasibility of the alternatives
6. Selecting a preferred alternative that aligns with the desired outcomes or re-assessing desired outcomes if no acceptable solution is identified

The performance-based approach aligns with ODOT's Practical Design Strategy which calls for delivering projects that benefit the transportation system within existing resources by establishing appropriate scopes to deliver specific results. The ODOT Practical Design Strategy emphasizes the need to utilize different perspectives and discuss pertinent project information early in the project flow to establish clear project objectives and problem statements. This strategy describes the need to evaluate a specific project with the overall transportation system in mind and highlights that "the system context will shape the design".

The ODOT Performance-Based, Practical Design Strategy identifies the benefits of a multidisciplinary project team and outlines the values associated with this strategy. The values, described by the acronym "S.C.O.P.E.," are compatible with ODOT's mission and assist decision-makers in their role in managing the state's transportation system. The "S.C.O.P.E." values previously discussed in 107.2 are shown below:

- Safety
- Corridor Context
- Optimize the System
- Public Support
- Efficient Cost

Understanding how to integrate practical design strategies and a performance-based approach into the project flow can help guide practitioners in setting up project teams, documenting decisions, and identifying solutions that serve the intent of the urban context and users within that context.

Integrating practical design strategies and a performance-based approach is most effective when applied at the earlier stages of the project development. Design influences are identified, outlined, discussed, and evaluated before the actual design of a project begins. Early project scoping and alternatives, identification and evaluation efforts have a major influence. As a project moves from preliminary to final design, it becomes much more difficult to affect overall project outcomes.

117.2 Programs to Fund Projects

Projects are funded from a variety of sources. Urban projects are typically more difficult to fund due to competing interests. Figure 100-11 through Figure 100-13 show the primary ODOT programs to fund and deliver transportation projects.

1 Figure 100-11: Primary ODOT Programs to Fund and Deliver Transportation Improvements

Program Type	Program Focus	How Are Projects Selected	Design Opportunities[1]	Who Develops Project?
Fix-It Programs	Fix or preserve existing facilities (bridges, pavement, culverts, signals, etc.)	Data-driven, condition of assets	Consider low cost opportunities to address needs through innovative design (e.g. lane reconfiguration when repaving) Leverage other funding programs to address other needs in project area	ODOT or Certified Local Agency
Enhance Programs	Enhance or expand transportation facilities	Legislature, ACTs, and ODOT staff recommend priority investments from state and local plans (can be competitive grants or discretionary).	Most flexible to address design issues across modes and disciplines Leverage other projects to address multiple needs in project area Can fund stand-alone projects (grants and legislative discretionary projects)	ODOT or Certified Local Agency
Safety Programs	Reduce deaths and injuries on Oregon's roads	Data-driven, maximize safety impact (cost-benefit)	Approved safety countermeasures list provides multiple options to encourage context appropriate design solutions	ODOT or Certified Local Agency

Public and Active Transportation	Improve non-single occupancy vehicle (non-SOV) transportation options (e.g., pedestrian and bicycle, public transportation, ADA, transportation options/demand management)	Legislature, ACTs, and ODOT staff recommend priority investments from state and local plans (can be competitive grants or discretionary).	Very flexible to address design issues across modes and disciplines Can leverage other projects to address multimodal needs in project area or fund standalone projects	ODOT or Certified Local Agency

Figure 100-12: Primary ODOT Programs to Fund and Deliver Transportation Improvements, Continued

Program Type	Program Focus	How Are Projects Selected	Design Opportunities[1]	Who Develops Project?
Local Government Programs	Direct funding to local governments	Local governments identify priority investments.	Very flexible to address local priority design issues across modes and disciplines	MPO or Local Agency (if state funds) ODOT or Certified Local Agency (if federalized)
State-Funded Programs	Preserve and/or enhance transportation system (generally smaller projects than STIP Fix-It or Enhance) Examples: Safe Routes to School, Connect Oregon, State Pedestrian/Bicycle Program	Program-specific objectives (e.g., improve safety on school routes, promote economic growth)	Very flexible to address design issues across modes and disciplines Most flexible timeline (e.g., “Quick Fix” Safety or Pedestrian/Bicycle funds can be used for immediate improvements) Not subject to Federal requirements or required to be in STIP Can leverage other projects to address multimodal needs in project area or fund stand-alone projects	ODOT or Local Agency

Figure 100-13: Primary ODOT Programs to Fund and Deliver Transportation Improvements, Continued

Program Type	Program Focus	How Are Projects Selected	Design Opportunities[1]	Who Develops Project?
Development-Related Projects	Serve demand generated when property develops or redevelops	Part of land use permitting process. ODOT works with local agency (land use authority) and developer to identify needed improvements.	Consider opportunities to incrementally implement improvements in adopted plan and/or dedicate right-of-way for future improvements Not subject to Federal requirements or required to be in STIP Consider opportunities to address needs through innovative design and/or to leverage developer funded improvements	Developer and Local Agency (Land Use Authority)
Local Agency Projects	Locally funded projects	Local governments identify priority investments	Consider opportunities to address needs through innovative design and/or to leverage locally funded improvements	Local Agency

[1]All projects that receive state and federal funds are required to include at least the minimum bicycle and pedestrian facilities (per ORS 355.514) and ADA accommodation within the project budget. Some funds can be used for stand-alone bicycle, pedestrian and ADA projects or enhanced bicycle and pedestrian facilities within another project.

117.3 Refined Decision-Making Framework

This section provides information on establishing project goals and desired outcomes to inform the performance-based decision making throughout the project flow. Information is provided to help practitioners identify and select performance measures that relate to the project goals and how to evaluate alternatives throughout the project flow described previously.

♦ Establishing Project Goals and Desired Outcomes

Project goals and desired outcomes are identified early in the project flow. Projects will have specific goals based on funding categories as in 1R Paving, 3R Preservation, 4R Enhance/Modernization or Safety focused projects. Additional project goals are considered through a brief list of succinct points that speak to what a community thinks are important as it relates to a multimodal transportation vision and the associated land use goals of the study area. The multi-disciplinary project team (Project Scoping Team) identifies the final project goals and desired outcomes for consideration with the scoping phase. ODOT planning and active transportation members of the scoping team provide background information and direction for discussion of potential inclusion of additional project goals. Goals discussed may be visionary, future focused and aspirational as well as goals to achieve immediate needs. Not all projects can address all goals that may be discussed, but this process provides at least a minimum opportunity for project teams to include items with projects that make incremental improvements and build toward long-term objectives. As an example, even a minimal scope 1R paving project with funding category goals of simply paving and striping may be able to provide incremental improvements to a roadway section. Restriping a typical four or five lane section to include a lane reduction or "road diet" to gain operational and safety benefits of a median left turn lane or the addition of a buffered bicycle facility are initial steps to possible long-range goals and aspirations for the local community with little to no additional cost to the project.

♦ Project Goals to Consider

Vision of place: The vision will incorporate the existing context and may relate to a desired future land use pattern and nature of future growth (e.g., remain a Rural Community context, increase mix of uses to become an Urban Mix context). The role of the place in the region (e.g., employment center, residential enclave, neighborhood retail, regional shopping area, etc.) and other community values, such as safety, economic development, community character, as well as environmental and cost impacts are considered. The identified future vision of place is documented in a local implementation-oriented plan (e.g., small area plans) and vetted with area stakeholders.

Desired role of the facility: The desired role of the facility will draw heavily from the transportation characteristics as well as regional and local vision and goals for the study area, vetted with stakeholders. A facility could function as a regional commuting facility with longer-distance trips or a local-serving roadway with mostly short distance trips.

Major users of the facility: The context and the role of the facility will inform who the users are. Based on observations of existing and future transportation and land use conditions, the project team can define who the major users of the facility are now and in the future. These users may include pedestrians, bicyclists, public transit users, freight traffic, motorists, etc., and includes user demographic groups (e.g., elderly, school children, tourists, retailers, employees, disadvantaged communities, etc.) from major land uses around the facility as well.

The project goals should be determined at the start of the project with scoping and confirmed at key milestones in the multimodal decision-making framework. This will help verify that the alternatives and design decisions align with the original intent of the project and serve the needs of the identified users.

♦ Performance Measures, Evaluating Alternatives

Project-level performance measures allow practitioners to develop and evaluate alternatives based on the project goals and desired outcomes. For each project, performance measures are tailored to evaluate an alternative's ability to respond to the specific needs of the users and should relate directly to the project's documented goals. Therefore, performance measures are identified after defining the project's goals and desired outcomes, and before alternatives are developed. The measures chosen for a project are discussed, understood, vetted, and agreed upon with a multidisciplinary project team and when necessary, with key stakeholders.

In general, project-level performance measures:

- **Reflect Project Goals and Desired Outcomes:** Balanced measures of success account for project goals and how these goals fit into the larger transportation network (i.e., local versus commuter oriented). An effective set of measures describes the experience of each anticipated user and provides a way to assess the likelihood of achieving desired outcomes. Projects typically have a wide range of goals and, therefore, no individual measure should be used to determine the complete solution to a problem. For instance, a community may want to implement bicycle lanes on an ODOT arterial while minimally impacting traffic mobility. Measures such as bicycle level of traffic stress (LTS) or multimodal level-of-service (MMLOS) could be used to measure impacts to bicyclists, while the traditional vehicle volume-to-capacity (v/c) ratio would still be considered for traffic mobility.

- **Are Understandable and Easy to Communicate:** With competing interests developing potential transportation projects, measures of success need to communicate to all of those involved. Evaluation criteria need to be readily measurable using available data and explained in a way that can be understood by non-technical stakeholders and members of the public. While some measures require relatively complex calculations (such as v/c ratio), other simpler measures can still produce a good deal of understanding with minimum analysis. For instance, measures that describe the pedestrian environment can be as simple as determining the number of crosswalks per mile, the type of pedestrian signals provided, and the presence of Americans with Disabilities Act (ADA) compliant ramps. While it may seem that having more data and conducting more analysis would lead to the "correct" result, a simple and easy to understand set of evaluation criteria that truly reflect the context and project goals may lead to better stakeholder buy-in and the ultimate success of the project.
- **Are Consistent and Objectively Measurable:** To effectively support decision making, each measure needs to be objectively measurable for all alternatives. For example, a measure specific to traffic signal performance would not be consistently measurable for both alternatives when comparing a signalized corridor to a roundabout corridor. In another example, "forecast bicycle volumes" could be consistently and objectively measurable if the agency has a travel demand model for bicycle travel and takes infrastructure into account when predicting behavior. When selecting measures, it is important to agree on a consistent, objective methodology for evaluating the measure. Even more qualitative measures, such as "level of community support," can be measured using a consistent, objective method.
- **Help Differentiate Between Alternatives:** In aggregate, the selected set of measures needs to help differentiate performance among the alternatives to inform decision making. Each individual measure does not necessarily need to differentiate between all goals. In some cases, all alternatives under consideration will fulfill a goal (and related measure) to the same degree. However, within the set of measures, one or more must be measurably different between the various alternatives.
- **Need to be Specific to the Plan:** Effective measures of success need to be developed for specific plans and studies and not simply "copied and pasted" from previous studies with similar attributes. For example, while v/c ratio is generally used for many traffic-related roadway considerations, a study exploring ways to improve pedestrian safety on a corridor may focus on the number and spacing of pedestrian crossings instead. The v/c ratio may be a secondary evaluation element when determining a balance between the number of pedestrian crossings, corridor operations and the projected success in meeting the goal of pedestrian safety.

Appendix E in Volume 2 of the Blueprint for Urban Design provides a menu of potential project-level performance measures that could be considered for each mode and an example of linking performance measures to a project's goals and desired outcomes. This list is not intended to be an exhaustive list or to be prescriptive. The list draws from industry best practices, including latest guidance and research from FHWA, such as the FHWA Guidebook for Developing Pedestrian and Bicycle Performance, the Environmental Protection Agency (EPA) Guide to Sustainable Transportation Performance Measures, the Oregon Analysis Procedures Manual, and the Oregon Safety Action Plan. ODOT also has a set of system wide monitoring Key Performance Measures (KPMs); while these cannot all be applied at the project level to evaluate alternatives, they can help to inform the types of measures to be used. For example, one KPM is, "Number of serious traffic injuries per 100 million vehicle miles traveled (VMT) in Oregon." A corresponding project-level measure could be "predicted safety performance" for each alternative.

As discussed earlier in this section, establishing and applying performance measures has the greatest influence on project outcomes when they are incorporated early in project scoping and alternatives identification. The iterative nature of the project flow helps practitioners align solutions with the original desired outcomes.

♦ Selecting and Developing the Preliminary Design

The context informs the types of users and the intensity of uses within each context. For almost every project, the needs of users can be addressed in multiple ways. The alternatives developed to respond to these needs should explore a variety of methods and means for meeting them.

Sometimes, due to limited right-of-way, difficult choices must be made for how to serve different users along a roadway. Where it is not possible to provide a high-quality facility for each mode along all ODOT roadways, it may be necessary to rely upon parallel networks to provide additional travel options that serve all users.

In many cases, there may not be one clear-cut alternative that equally serves all users at the same level. Selecting a well-vetted set of performance measures will frame a discussion and provide information for ODOT, the public, and local officials to understand the trade-offs among the alternatives.

> **Example:** In a higher intensity area, such as a Traditional Downtown/Central Business District, local business owners may want to prioritize on-street parking over a dedicated bicycle facility, if they believe the on-street parking is critical to their customers. There are a variety of ways to address such a case. One solution would be to create a shared lane (vehicles and bicycles) with speeds that are 25 mph or lower to allow for a basic level of bicycle access. In this case, since not all bicyclists are comfortable sharing a lane with vehicle traffic, the project team can also look beyond the roadway in question and consider the larger network in developing alternatives by including parallel routes. When balancing modal needs, in–depth analysis is required to determine potential unintended consequences in trade-offs.

The example above is focused on an urban location, but it provides an exercise in trade-off analysis that can be generalized to all projects. The important point to emphasize is the need to evaluate trade-offs in depth to determine and understand any unintended consequences that may arise and to balance the positive and negative effects to overall goals for all users and the surrounding community.

Some potential ways to help evaluate the trade-offs for this example between on-street parking and a bicycle facility may include:

- Number of people served by each facility. This may need additional data. (e.g., parking spaces on a block used by 50 customers per day; bicycle lane used by 200 people per day);
- Availability of alternative facilities to serve each use (e.g., whether there is a nearby low-stress route for bicyclists or whether there is available parking on side streets or parking lots);
- Understanding the trade-offs between impacts on safety, comfort, and convenience of users (e.g., asking motorists to park and walk an extra block to access destinations, versus asking bicyclists to ride in mixed traffic or out of direction on an alternate route);
- Economic impact (e.g., understanding potential economic impacts of convenient on-street parking space versus bicycle facility to adjacent businesses); and
- How each alternative supports community goals.

If design decisions, project team discussions, and alternative evaluations lead to any changes in the performance measures or project goals, this information and the project team decisions are clearly documented (potentially as part of ODOT design documentation) and justified for review by the project team who would either confirm the decisions or would provide alternate direction on how to proceed. The alternate direction could include:

- Additional or further modification to the project team revisions;
- Rejection of the revisions and return to original project goals; or
- Decision to change the scope of the project and reinitiate the process of goals development.

This is a similar approach to what the scoping team uses on ODOT STIP projects. After consensus has been reached, the preliminary design decisions and trade-offs should be well documented, with stakeholder support as necessary. In some cases, this documentation will take the form of a “corridor plan” with a concept. In other cases, the documentation may be more informal and internal to ODOT to document the process and outcome to pass on to the final design project team.

♦ Program and STIP Development

The program development phase is the process where projects are created through the transportation planning process to the approval of the Oregon Transportation Commission and into the STIP. There are five major milestones in this process including (See the Project Delivery Guidebook for detail on the milestones):

1. Transportation Planning
2. Management Systems Analysis
3. Identify Potential Projects
4. Draft Scope, Schedule, Cost Estimate (Draft STIP)
5. Project Selection (Final STIP)

As part of this process, designers will be part of scoping teams, develop purpose and need statements, and provide potential solutions to identified problem statements. The end result of this phase is the development of the draft STIP and projects selected for the final STIP. There are several key documents created during the program development and the final STIP development and project initiation. These include, the Business Case, the Project Charter, the Project Management Plan and the Practical Design Scope Integration Form. The Urban Design Concurrence Document that focuses on the context, modal integration and project design decisions can be used to aid in the development of the Business Case and the Project Charter as well as being a basis for Project Management Plan and the Project Narrative as development continues to DAP and final plans.

One useful tool during scoping and programming is the Features, Attributes and Conditions Survey - Statewide Transportation Improvement Program (FACS-STIP) tool. It is a web-based geographic information system (GIS) application developed to provide easy access to transportation asset data. The tool consists of the Map tool, Data to Go, Asset Reporting and the Comment tool. It has continued to evolve over the years based on business needs and customer requests and will continue to respond to ODOT's evolving data needs.

117.4 Project Business Case

The Business Case is used to clearly define the problem, need, benefit, and value of projects. Business cases consider modal involvement, connections to basic assumptions, commitments for funding and the project's original funding program goals early in the project's lifecycle and ensure these elements are not lost in the project development process. Funding program managers typically develop the initial needs business case. They are responsible for managing the funding program portfolio and meeting funding program goals. Active scoping begins once project sponsors complete the business case. Post scoping, funding program managers work with project sponsors and designers to finalize the business case before project selection. The business case will include identification of accessible transportation elements being included in the project or a description why there are no accessible elements required.

117.5 Project Charters

A Project Charter serves as the agreement for the scope, schedule, budget, approach, and risks of the project. The Project Charter is used to provide direction to the project team and baselines the project scope, schedule, and budget. A Project Charter is required for every STIP Project on the State system that is delivered by the ODOT. A Project Charter is first drafted after the project is scoped for STIP programming purposes.

The Project Charter is completed during the Project Initiation Phase of project development. The Project Leader is responsible for developing the Project Charter in collaboration with the Area Manager and program manager(s). The Project Leader should ensure that the project charter is consistent with information in the final Business Case. For more information regarding the project charters, see the Project Charter Guidance from the ODOT Project Management Office.

117.6 Project Management Plan

Project management plans document how a project is to be managed, executed and controlled, and is continuously updated throughout the life of the project. Project management plans may not be needed on projects where standard operating procedures are used. On projects without standard operating procedures, project management plans document the process the team is going to use to develop the project.

Section 118 Design Procedures

The purpose of this section is to provide the designer with a general outline of design procedures from STIP development to the production of Plans, Specifications, and Estimates (PS&E). This section provides a design procedure for determining whether a project uses 1R, 3R, or 4R design guidance. Single Function project will typically use 4R design guidance. As such, Single Function projects are not discussed in detail in this section. Single Function projects will not be required to use the 1R/3R record of decision documentation procedures discussed later is this section. This section also provides roadside inventory procedures for 1R, 3R, and 4R projects.

This section is not all inclusive of all design features but will provide the designer with a general basis on how projects are designed through the project development process, including final STIP project selection. The ODOT Project Management Office (PMO) provides guidance material that outlines the program development and project development processes that are part of the project delivery process.

118.1 Project Development Process

The project development phase begins with the assignment of a project from the approved STIP to the preparation and readying of the project for bid letting. There are seven major phases of the project development lifecycle in which designers participate. The seven phases include:

1. Project Initiation - Tasks include the establishment of the project team and the review and confirmation of the project scope. During this task, the designer may need to provide conceptual designs that address the project problem, purpose and need statement, and scope as addressed in the project prospectus. All disciplines need to collaborate and integrate design needs as initial design parameters are established from scoping information.
2. Survey, Maps, Engineering and Environmental Reports - Depending on the type of project, the designer may need to participate in determining the type of survey information required for the project. Other task work involved may include: Hazardous Materials Corridor study; the Environmental Baseline report; Area of Potential Impact maps; Work Zone Traffic issues; Pavement design; and Traffic Counts and Preliminary Traffic Analysis.
3. Design Acceptance Phase- The design acceptance package (DAP) milestone is a critical decision point for the designer as the project geometry boundaries are set to enable other activities such as right of way, environmental permitting, and construction contract work to begin. The designer will typically deliver the roadway design, stage construction design, design narrative, and potentially the traffic control plans and interchange layout sheet during this task. The design narrative should provide a summary of the alternative analysis. Some of the deliverables for the designer at DAP may include:
    a) Preliminary horizontal and vertical geometry alignments
    b) Typical sections
    c) Superelevation
    d) Cut and Fill Slopes, Materials, and Earthwork
    e) Guardrail, Concrete Barrier, Cable Barrier
    f) Preliminary Drainage, Erosion Control, and Stage Construction design

g) Preliminary Quantity and Cost Estimate
h) Completion of the Roadside Inventory
i) Design Exception requests
j) Design Narrative
k) Design Maps, Profiles, Cross-Sections, and other deliverables
l) ADA Curb Ramp Footprint
m) Urban Design Concurrence Document

The designer should also be aware of the coordination with other disciplines, including but not limited to:

a) Utilities
b) Right of Way
c) Bridge
d) Geotechnical Engineering
e) Geology
f) /Environmental Services
g) Traffic Control
h) Pavements
i) Traffic
j) Transportation Analysis
k) Active Transportation Liaison
l) Region Transit Coordinator
m) Office of Project Letting (OPL)
n) Rail
o) Aeronautics
p) Access Management
q) Commerce and Compliance Division
r) Climate Change Office
s) Office of Civil Rights
t) Federal, State, and Local Agencies and other Stakeholders

4. Right of Way and Permits - During this stage, a number of right of way and permit functions are performed. Some of the tasks at this stage include; final right of way map and property descriptions; right of way acquisition; railroad encroachment map; right of way certification. Other tasks include obtaining required permits involving wetlands, fish passage, utilities, railroad, airport clearance, and others.

5. Plans Review Phase - The main purpose of this stage is additional technical and construction refinement of the project plans at the Preliminary Plans and Advance Plans milestones. Other tasks conducted in this phase include: update of the communication plan; noise mitigation; access management procedures; revision of estimates; and preliminary special provisions.

6. Final Plans and Special Provisions for Construction - This stage include the work conducted after the Advance Plans-Plans in Hand meeting. It is the last opportunity for technical review before the PS&E milestone. Final plans, cost estimate, construction schedule, and special provisions are deliverables during this stage.

7. Plans, Specifications, and Estimates for Construction - This stage involves the process where the project is considered complete and ready for bid advertisement through Project Controls Office and OPO – Construction Contracts.

Section 119 1R/3R/4R Design Procedures

This section provides information on the process used to determine if a project uses 1R, (1R+), or 3R standards. The initial design criteria determination is based on the project being either preservation or modernization. In respect to modernization projects, all modernization projects use 4R design guidance and are addressed in other Parts of the HDM. Some projects, due to funding and project elements, may consist of a combination of preservation and modernization projects. In those cases, 4R standards are to be used for the modernization portion of the project. For example a paving preservation project includes enhance funding to install a bike lane or a separate bike path. The bicycle design element of the preservation project will use the 4R standard.

The following guidance applies to all freeway, expressway, rural arterial, and urban arterial state highway projects. Once the design standard has been determined, subsequent parts of the HDM provide the design standards. As discussed earlier in this section, Single Function projects use 4R design criteria and are not required to use the 1R/3R record of decisions documentation procedures outlined below.

119.1 1R/3R Record of Decisions Documentation

The 1R/3R Record of Decisions Documentation document is used to determine what standard will be used to develop a preservation project. It is populated at project scoping and verified at project initiation. The form is turned in at DAP for all 1R projects. If a combination project has both preservation and modernization elements over the same section of roadway, and over 50% of the project length is determined to be modernization, the project is considered to be a 4R project. If a combination project has both preservation and modernization elements, but those elements are on separate segments of the project, both standards can be applied to the project. The record of decisions document provides both a pavement assessment and safety assessment to determine if a project uses the 1R, 1R+, or 3R standards. The form is completed by multiple disciplines including; Pavements, Traffic, and Roadway. A 1R project is typically a pave only project with some specific design elements that must be upgraded to current standards. These mandatory upgrades include items such as unprotected and unconnected bridge ends and installing or upgrading curb ramps. Any asset information that needs review is addressed in the document and is noted in the roadside inventory requirements discussed later in this Section. A 1R+ project is a 1R project that includes additional work that is not required for a 1R project. The additional work, or "+" element of the preservation project may look to upgrade other project assets and will typically use other asset funding sources to add additional elements to the project. These elements may be other safety elements or improvements such as bike lanes or channelization. Since 1R projects include paving, restriping will be needed as a 1R cost. Assessing the existing striping and the possibility of restriping to improve access for alternative modes is often a no cost inclusion to the project and is recommended. It is advantageous to utilize project resources to make incremental improvements where it is feasible, providing the inclusion is cost neutral and does not delay the project. The 1R standards are located in Section 111.

As discussed above, the procedures of the Record of Decisions Documentation document will determine if the preservation projects will use the 1R, or 3R standards. The decision document is to be filled out at project scoping and then revisited again at project initiation and becomes part of the permanent documentation for all 1R projects only. There may be occasion where, due to either pavement assessment, safety assessment changes, or other project impacts, the project may change from a 1R to a 3R and the designer will need to use the appropriate standard. For all urban projects, including preservation, the Urban Design Concurrence document is to be filled out after the Record of Decisions Documentation document and is addressed below.

119.2 1R/3R Record of Decision and Urban Design Concurrence Document for Urban Projects

For all urban projects, including preservation projects, the Design Concurrence document is filled out after the 1R/3R Record of Decisions Documentation document. The Urban Design Concurrence Document is also filled out at both the project scoping phase and again at the project initiation phase. As both documents include a section addressing the design criteria or category to use, consistency can be maintained in respect to which standards are to be used on a specific project. The Urban Design Concurrence document contains planning summary, general project information, project context information and results in a specific design standard to use. In respect to this section, completing the design concurrence document determines if the project will use the 1R or 3R preservation design standards or other design standards, such as 4R or 4R/Single Function.

Both the 1R/3R Record of Decisions Documentation and Urban Design Concurrence Document documents are to be consistent in the selected project design standard. If the project uses the 1R standard, the design guidance for 1R standards are addressed in Section 111. If the project is determined to use 3R standards, the following roadside inventory requirements are to be followed. As discussed earlier in this Section, projects that use the 4R standards are to use the roadside inventory requirements below.

119.3 Roadside Inventory - General

For all projects whether using 1R, 1R+, 3R, or 4R standards, some form of a roadside inventory shall be made of roadside features. The inventory is performed to determine asset condition, to inventory existing features, to assist in bid item background, and to also determine those features that do not conform to AASHTO's "Roadside Design Guide - 2011" and/or the AASHTO Green Book geometric design standards or non-geometric design standards (such as structural strength, safety features and traffic control, etc.). The inventory of roadside safety hardware is maintained by Technical Services staff. The FACS-STIP tool is used to access roadside safety hardware and other asset inventory data that can be accessed for scoping projects. The designer, along with assistance of the Project Team, should determine the level of detail needed for the project roadside inventory. Besides the mandatory use of the FACS-STIP tool, the roadside inventory can take many different forms, including but not limited to:

- A formal survey of the project;
- Use of the ODOT digital video log;
- Use of ODOT's TransGIS and multiple level data information;
- Use of other web mapping tools; or

- Different levels and intensity of project site visits.

The level of detail of the roadside inventory will vary between projects. This section provides direction on roadside inventory guidance for projects using 1R, 3R, or 4R standards. Preservation projects using 1R standards require minimal asset inventory work compared to projects using 4R (New Construction or Reconstruction) standards. Roadside inventory for projects using 3R standards will vary depending upon the project scope and purpose. This section should help the roadway, traffic, and other designers in providing the level of survey detail required to the Project Team.

The FACS-STIP Tool and associated user guides provide additional information to assist developing a roadside inventory for all projects. The FACS-STIP Tool provides data on highway features or attributes, such as freight routes, vertical clearance routes, state highway classification, functional classification, ORS 366.215 routes, etc. The FACS-STIP Tool allows the Department to maintain an up-to-date database system. The FACS-STIP Tool is required to be used on all projects in an effort to maintain an accurate and up to date asset inventory.

The 2011 AASHTO "Roadside Design Guide" provides information and operating practices related to roadside safety. A design exception process (Part 1000) has been developed for those project-specific non-standard roadside features that are identified in the roadside inventory. Design exceptions are required for any non-standard equipment or non-standard clear zone feature that will not be corrected as part of the project. As discussed in Part 1000, 4R clear zone design exceptions are approved by the State Traffic- Roadway Engineer while 3R clear zone design is the responsibility of the Region Technical Center.

119.4 Additional Roadside Inventory for 3R Projects

If it is determined that the 1R/3R Record of Decision Documentation results in the preservation project being 3R, additional roadside inventory features may be needed. As discussed previously, the scoping team should determine the level of effort that will be required, use the FACS-STIP tool for asset inventory, and use Region Scoping forms to assist project teams in capturing the appropriate level of roadside inventory. Very definite parameters should be set as to which roadside obstacles need to be inventoried. The intent is that projects using 3R standards are not inventoried to the level of a project using 4R standards. Not every object near the roadway that may constitute a substantial hazard should be inventoried. Continuous runs of utility poles or trees at the R/W line generally don't need to be inventoried.

Other than roadside features, the field work on these projects should be limited to the amount needed for quantity calculations. In general, field work should focus on addressing 3R requirements, including leveling for crown and super correction, lane and shoulder widths, bridge widths, existing rumble strips, and pavement detection loops. By their nature, urban projects may require some additional work, but every effort should be made to limit the survey work to the minimum needed for the particular project. By their nature, preservation projects on sections of highway having low crash history place special emphasis on pavement preservation even while recognizing that certain cost effective safety improvements may be necessary and desirable. The following guidance discusses additional 3R inventory requirements for freeways and other state highways.

♦ ODOT 3R Freeway Projects

If it is determined that the freeway preservation project is a 3R project, there are other assets and roadside inventory features that should be considered for identification to address other design requirements such as Interstate Maintenance Design Features. The FACS-STIP tool can be used to capture additional assets.

1. Interchange Ramp Surfacing
2. Other roadside obstacles not addressed above in the 1R/3R decisions document
3. Delineators
4. Fencing
5. Signing, Illumination, and Signal Loops
6. Rumble Strips
7. Striping
8. Drainage

♦ ODOT 3R Urban and Rural Highways

If it is determined that the urban or rural non-freeway preservation project is a 3R project, there are other assets and roadside inventory features that should be considered for identification to address other design requirements. In addition to the features listed below, the designer should be aware of other 3R design requirements that may impact the roadside inventory such as Mandatory 3R Design Features and the Urban Preservation Strategy.

1. Roadside Obstacles Within Clear Zone or R/W
    a) Trees
    b) Luminaires
    c) Utility Poles
    d) Misc. Fixed Objects (mail boxes, fire hydrants, railroad crossing warning devices, etc.)

2. Existing Guardrail, Cable Rail, and Concrete Barrier, including Bridge Rail Connections
3. Public Road Intersections with Stopping Sight Distance Less Than ODOT New Construction Standards
4. Horizontal Curves More Than 15 mph below project design speed, and the current year ADT is 2000 or greater.
5. Vertical Curves More Than 20 mph below the project design speed (Current year ADT greater than 2000), Hiding Intersections, Sharp Horizontal Curves, or Narrow Bridges
6. ADA Deficiencies

Following is a further explanation of the above inventory items and some thoughts on appropriate mitigation measures that may be incorporated on this type of project.

1. Roadside Obstacles - With the emphasis on pavement preservation, the inventory of roadside obstacles is limited under most circumstances to R/W or clear zone, whichever is less. Inventories wider than clear zone are not considered a good expenditure of engineering budgets as only under unusual circumstances will substantial widening or realignment be included in the project. The designer should rely on the scoping report from the project team and the project development team for guidance on the level of effort to be expended on the inventory of roadside obstacles.

2. Existing Guardrail - All existing guardrail including bridge connections and end treatments should be inventoried. Guardrail terminals rated as passing NCHRP Report 350 criteria can remain in place. Bridge connections shall consist of positive bridge connection, transition guardrail, and current standard terminal. During the inventory/analysis process, the project team should also be looking for opportunities to modify existing installations that do not adequately protect obstacles either by extending or burying ends in cuts, or considering new runs based on existing obstacles. Once any portion of the guardrail installation is modified, even for height, the entire run must be brought to new construction standards or a design exception must be obtained from the State Traffic-Roadway Engineer.

3. Intersection Sight Distance - Most of this analysis can be done in the office from As-Constructed Plans. Many times those intersections with deficient sight distance will also show up during the crash analysis. These intersections will probably have opportunities to incorporate low cost mitigation elements with the project to diminish crash potential. Deficient intersections should be reviewed on-site with the Region Traffic Engineer to aid in identifying mitigation measures.

4. Horizontal Alignment - Horizontal curve deficiencies can best be identified by a review of As-Constructed plans, but superelevation rates need to be measured in the field. As a minimum, superelevation should be corrected as close as reasonably possible to the new construction standard with the project. Additional mitigation (delineation, signing, etc.) may also be appropriate due to site-specific conditions. Again, the Region Traffic Engineer should be consulted for input.

5. Vertical Alignment - As-Constructed Plans should be used as a starting point for identifying vertical alignment deficiencies. Field verification is needed to determine if major driveways or intersections are hidden by the vertical curves. If a crash history exists at these locations or horizontal curve locations, it may be appropriate to include major safety improvements with the project. This need should be identified early, during project scoping, so funding can be procured.

6. Americans with Disabilities Act - ADA deficiencies are predominantly limited to urban preservation projects. ADA accommodation is more than a standard; it is a legal requirement. Intersection accommodation by installation of sidewalk ramp upgrades is an absolute minimum regardless of jurisdictional ownership of the sidewalks. Driveways, gaps deficiencies or obstacles in the sidewalk should be carefully reviewed for candidate improvements and may provide good opportunities to partner with local jurisdictions or ODOT Public and Active Transportation Program for a better overall facility. In rural area, shoulders often serve as a pedestrian facility. Shoulder widening may be considered as an incremental improvement to accessibility where pedestrian traffic is present.

119.5 Roadside Inventory for 4R Projects

The purpose of the inventory is to identify all objects and configurations that do not conform to the 2011 AASHTO "Roadside Design Guide" and the AASHTO Green Book geometric design standards and non-geometric standards (non-geometric standards relate to structural strength, safety features and traffic control). 4R projects shall have a full roadside inventory completed and should be brought up to full standards, including sight distance, horizontal and vertical alignment, ORS 366.514 (Bike Bill) requisites, and ADA requirements. In addition, safety projects identified through the All Roads Transportation Safety (ARTS) Program shall have a full roadside inventory completed.

The clear zone concept is discussed in the 2011 AASHTO "Roadside Design Guide". This guide provides an excellent elaboration on the clear zone concept and is a valuable working tool.

♦ Guidelines

Region scoping forms and the FACS-STIP Tool were developed to assist project teams in the scoping effort. The Region scoping forms and/or the FACS-STIP Tool should be used to provide an inventory of conforming and nonconforming objects and provide appropriate details to be used in the development of the project.

An inventory of non-conforming items should include, but not be limited to the following list of items:

1. Trees
2. Rock Outcrops
3. Steep Cut or Fill Slopes (1:3 or steeper)
4. Barriers (Guardrail, Cable Rail, and Concrete Barrier)
5. Impact Attenuators
6. Bridge Rails
7. Signs
8. Luminaires
9. Drainage Facilities
10. ADA Ramps
11. Bicycle Facilities
12. Sidewalks
13. Bridges
14. Utilities
15. Public Transit Stops/Facilities
16. Other:
    a. Roadway Surfaces and Dimensions
    b. Sight Distances
    c. Driveways
    d. Mailboxes
    e. Structure Columns
    f. Signals, ATR and ITS structures
    g. Drop-offs at Pavement Edge

h. Cattle and/or Equipment Pass Headwalls

The following is a further explanation of the above inventory items.

1. Trees present some interesting problems. The easy recommendation is to remove them if they are within clear zone, but in many cases the public sentiment is to save them at almost any cost. Some trees may be entitled to specific protection because of historic or ecological significance. In addition, the recently passed federal legislation titled, Infrastructure Investment and Jobs Act (IIJA), encourages adding street trees to address urban heat islands to help mitigate urban conditions. Reasonable protection, such as extending a barrier required for another obstacle, may be more expensive but also more acceptable to the public. Careful analysis of crash history at the site, evidence of the tree being hit, location (such as near outer edge of clear zone on inside of a curve), and public attitude (particularly in urban areas), may indicate an exception should be requested to allow the tree to remain. See Part 400 regarding street and median trees.

2. Rock outcrops in cut slopes can sometimes be removed, but large outcrops or solid rock cuts may need guardrail or barrier protection. These are easily overlooked as they have seldom been considered for protection. Decisions on the proper protection of slopes must be made only after considering the magnitude of the problem and the costs involved.

3. Cut or fill slopes steeper than 1:3 require protection. While slope flattening is the desirable action, primarily 3R projects, and at times, 4R projects seldom have adequate material available and R/W is frequently inadequate. Flattening may not be feasible due to streams or wetlands at the toe of the fill. Provision of barrier, guardrail, or cable rail is the usual solution. While vehicles can traverse a 1:3 slope, they cannot recover and the large clear zone required (over 120 feet at 70 mph) frequently cannot be provided within the R/W.

   Cut slopes steeper than 1:3 within the clear zone should be flattened or considered for protection. Provide a 1:3 or 1:4 "safety slope" area at the bottom of steeper cuts if possible. Decisions on the proper protection of slopes must be made only after considering the magnitude of the problem and the costs involved.

4. Barriers include guardrail, cable rail, and concrete barriers. Barrier that does not meet NCHRP-Report 350 criteria must be replaced. Guardrail must be checked against current standards for type of rail, height, flare rates, anchors, bridge connectors, terminals, lap direction, miscellaneous hardware, etc. If the terminal can be buried in the backslope it should be considered even though only a flare may be required. Concrete barrier sloped ends are allowable only when design speed is less than 45 mph or the sloped end is outside the clear zone.

   Concrete barrier shall meet current standards for size and shape. Consider the effect of overlays, past or present. At the base of the barrier the finished surface of the overlay must not be higher than the top of the vertical 3 inch portion of the barrier for proper functioning. Flare rates and terminal treatments (buried end, etc.) must conform with current standards. Narrow base barrier must be supported with embankment behind it.

Guardrail protecting fixed objects needs approximately 6.5 feet from face of rail to object to provide space for adequate deflection. If deflection room cannot be provided, contact the Senior Roadside Design Engineer for possible solutions. Exposed guardrail and barrier ends that cannot be properly flared or buried, such as in exit ramp gores, should be protected with an impact attenuator.

Contact the Senior Roadside Design Engineer in the Technical Services, Traffic-Roadway unit for guidance if there are questions concerning these items.

5. Existing impact attenuators must meet NCHRP-Report 350 230 criteria and be properly maintained with no modifications that are not approved by the manufacturer. Provide careful inspection by experienced personnel using the manufacturer's specification book. The District Manager, Senior Roadside Design Engineer, or manufacturer's representative may be appropriate sources of expert assistance. If a bridge or other significant structure is affected, include Bridge Engineering in the discussion.

6. The 2011 AASHTO Roadside Design Guide identifies acceptable bridge rail shapes. If in doubt as to acceptability of a particular rail type, consult Bridge Engineering. The concrete "safety shape" should be used on freeways. Guardrail connections to bridge rail are a critical area. Chapter 7 of the “Roadside Design Guide”, Bridge Railings and Transitions provides an excellent guidance.

7. Signs must be mounted on breakaway posts if within the clear zone. The need for a multidirectional breakaway base should be considered. The slope on unidirectional single-support breakaway bases must be in the correct direction.

   Breakaways must not be in the ditch and should be at or above the ground surface, but not over 4 inches above the surface. Proper bolts, washers, slip plates, etc., must be in place with no modifications, such as welding, that may alter the function of the breakaway.

   The hinge mechanism must also have all hardware in place. No auxiliary sign panels should span the hinge in such a way as to alter its function. The hinge mechanism should be a minimum of 7 feet, above the ground. On fills the nearest sign post should be at least 30 feet outside the edge of the traveled way (fog line) so the vehicle will not be airborne when it strikes the sign. Signs mounted on wood posts must not have concrete foundation collars or support plates. Wood post installations must comply with the Oregon Standard Drawings.

8. Luminaires must have frangible or slip bases if within the clear zone. Some older frangible bases may not function properly with the newer small cars. Consult the Traffic Structures Engineer for acceptability of specific frangible bases. If luminaires cannot be

readily relocated or protected, a study of the need for them should be considered. Eliminating them may be less hazardous than retaining them.

9. Drainage facilities should be studied carefully. Many transverse or longitudinal culverts may need stabilization, rehabilitation, or replacement. The structural integrity of each drainage facility should be evaluated prior to considering extending the culvert for widening a roadway. Contact the Highway Maintenance Supervisor for the project area for information pertaining to the existing culvert when the structure is less than 48 inches in diameter. If the culvert 48 inches in diameter or larger contact the Geo/Hydro Unit or the Region Hydraulics Engineer for assistance. If inadequate information is available, a thorough culvert inspection should be performed per Drainage Facilities Management System (DFMS) procedures.

   Many cross culverts can be lengthened to eliminate open ends, outlet ditches, etc., within the clear zone. Even though paved end slopes exist, they may not provide a safe end, since many of the 1:3 paved ends are inletted into 1:4 or 1:6 slopes, creating a ditch across the clear zone. Paved end slope installations must be constructed as shown in the Oregon Standard Drawings, with particular attention to warping or contouring the slope as shown.

   Metal end sections on culvert pipes require appropriate end treatments. Safety end sections should be considered on larger pipes (See Oregon Standard Drawings). Recontouring around some existing paved end slopes must be considered if erosion and settlement have allowed the upper end of some paved end slopes to project more than 6 inches above the ground.

   Longitudinal drainage ditches must be uniform and not eroded. Pipes under driveways and crossroads are to be reviewed to determine compliance with the Roadside Design Guide so that vehicles hitting them are not stopped abruptly or launched into the air. Type "M-E" or "M-O" inlets or modifications of them, may be required to accomplish these flatter end slopes. Pay particular attention to crash history when evaluating these features.

10. Most inventories for preservation and 4R projects are in conjunction with overlay or paving projects so correction of poor pavement conditions is an integral part of the project. Drop-offs, roughness, raveling joints, etc., must be analyzed if repaving is not already part of the proposed project.

Certain design elements can best be analyzed in the office using "As Constructed" plans. These include horizontal and vertical alignment and typical sections. Elements such as sight distance for merges, lane drops, road approaches, and intersections should also be analyzed in the field so the interaction of all elements can be better evaluated.

A broad viewpoint must be maintained so that possible hazards that don't fit conveniently in the categories already mentioned are not overlooked. Utilities (poles, valves, etc.) slope breaks that can launch a car or stop it as solidly as a barrier, cattle and equipment passes hidden by vegetation, erosion around culvert ends hidden by weed growth, etc., are easily overlooked. Shoulders on structures should be full width, according to current standards.

A working knowledge of the 2011 AASHTO "Roadside Design Guide", the Project Delivery Guidebook, the HDM, and the AASHTO Green Book will assist in project scoping and data information collection. A good understanding of how the clear zone requirement is determined by considering design speed, side slope, ADT, and curvature is needed. All nonconforming items are to be inventoried, even though it may appear to be difficult to bring them into conformance with the appropriate standard. ODOT's Practical Design Strategy document provides guidance in respect to project scope, economics and practicality of upgrading nonconforming elements.

The implementation of the 1R Preventative Maintenance Paving Program along with the 1R Safety Features Upgrade Program mark a fundamental change in ODOT's approach to maintaining the highway system while systematically improving safety.

119.6 Project Scoping

As discussed above, the 1R/1R+/3R design procedures and using the 1R/3R Record of Decisions Documentation determines if a project uses 1R, 1R+, or 3R standards. This 1R/3R Record of Decisions documentation is populated during the project scoping phase. Scoping assists in providing; definition of project context, asset condition, initial budget, identified risks, and opportunities. Scoping teams should consist of members from a variety of disciplines with a broad knowledge base. Each team will vary depending on the needs of the particular project. Each Region is responsible for the scoping of projects. 1R/3R projects may not require as many team members as a 4R project. Besides the Project Leader or Consultant Project Manager, representatives (not exclusive) may include: Roadway, Bridge, Traffic, Maintenance, Construction, Environmental, Pavements, Utilities, Survey, Geo/Hydro, Access Management, Right of Way, and Local Agency.

The intent of the Scoping Team is to identify the parameters of the project, clearly identify the problem, identify a range of solutions, determine a general schedule in respect to urgency and timeframe, and develop cost of the project based on general project elements and other funding opportunities. These may include some low cost mitigation measures or safety enhancements if funding is available.

To assist in the analysis and scoping trip, a large amount of asset should be completed by the different scoping team members prior to the site visit. The asset information can then be reviewed on site by the team and compared with the crash history.

The scoping team should determine the level of effort that will be required by the survey crew during project development phases. Very definite parameters should be set as to which roadside obstacles need to be inventoried. The intent of the inventory is not to survey every fixed object or culvert throughout the project. Only those objects near the roadway that constitute a substantial hazard should be inventoried. Continuous runs of utility poles or trees at the R/W line generally don't need to be inventoried. However, if there is a location with a number of run-off-the-road crashes (i.e. on the outside of a curve), then the effort and the area covered in the inventory should be increased. The ODOT Roadway Departure Safety program can be used to identify locations of high roadway departure locations and proposed countermeasures.

Other than roadside features, the field work should be limited to the amount needed for quantity calculations, in particular leveling for crown and super correction. By their nature, urban projects may require some additional work but every effort should be made to limit the survey work to the minimum needed for the particular project.

During scoping, the need for exceptions from design standards, or for new traffic control devices, should be identified. Design exception requests shall be submitted as early as possible in the project development process. This will minimize the need for redesign should the exception request be denied. Both the 1R/3R Record of Decisions Documentation and Urban Design Concurrence documents discuss design exceptions in respect to project scoping.

♦ Asset Inventory- 1R/3R Preservation Projects

The 1R/3R Record of Decisions Documentation will determine if a project is either 1R, 1R+, or 3R. The 1R/3R asset inventory and roadside inventory requirements of the Record of Decisions Documentation include the following features:

1. Pavement Condition
2. Roadway Departure Safety Plans
3. Intersection Safety Plans
4. Bicycle/Pedestrian Safety Plans
5. Safety Plans
    a. Review of Safety Priority Index System (SPIS)
6. Review of Crash History
7. ADA Features
8. Bicycle Facilities
9. Bridges/Structures- Vertical Clearance
10. Bridges/Structures- Bridge Rail
11. Sidewalks

12. Signs
13. Traffic Barriers
14. Traffic Signals
15. Public Transit Stops
16. Other Infrastructure Assets such as Geometry

Section 120 FHWA Emergency Relief Program-Betterments

120.1 General

The FHWA Emergency Relief (ER) program is intended to assist the States and local agencies in repairing highway facilities damaged by disaster, and returning those facilities to pre-disaster condition. In-kind restoration is the predominate type of repair. The purpose of this section is to define betterments, explain the Federal Highway Administration (FHWA) policy on betterments, give examples of betterments and provide guidance on the submittal of betterment requests for FHWA approval.

120.2 Definition

A betterment is defined as (1) an additional feature or upgrading, or (2) a change in capacity, function or character of the facility from its pre-disaster condition. Betterment requests during the last several years have been limited to the first category, with no proposals to change the capacity, function or character of a facility.

120.3 Policy

FHWA policy permits the approval of ER funding for upgrading or additional features to protect the highway from future disaster damage. To receive such approval, it must be shown that the ER expenditure is cost-effective in terms of reducing probable future recurring repair costs to the ER program. It is also FHWA policy that betterments to correct pre-existing conditions, particularly at landslides, will be subjected to a stricture test and it will be considerably more difficult to justify the expenditure of ER funds at such sites.

In general, betterments that change the capacity, function or character of a facility are not eligible for ER funding. Examples of this category of betterment include:

1. Adding lanes
2. Upgrading surfaces, such as from gravel to paved
3. Improving access control
4. Adding grade separation
5. Changing from rural to urban cross-section

One exception is that under special circumstances, ER funding can be used for a replacement bridge that can accommodate traffic volumes over the design life of the bridge, thus potentially allowing ER funding for added lane(s) on the structure.

120.4 Examples of Betterments

The following are examples of upgrading or additional features that are considered betterments. Specific FHWA approval is required before ER funds can be used for the following:

1. Stabilizing slide areas (e.g., internal dewatering systems, retaining structures, etc.)
2. Stabilizing slopes
3. Raising roadway grades
4. Relocating roadways to higher ground or away from slide prone areas
5. Installing riprap
6. Lengthening or raising bridges to increase waterway openings
7. Deepening channels
8. Increasing the size or number of drainage structures
9. Replacing culverts with bridges
10. Installing seismic retrofits on bridges
11. Adding scour protection at bridges
12. Adding spur dikes

There will be cases where one of the above features can be added with only a relatively minor expenditure of ER funds. These may include, for example, short and low height retaining structures, small areas of rock inlays for slope stabilization or installation of small amounts of riprap incidental to other repair work. The decision whether this work will be considered a betterment will be decided on a case-by-case basis.

The following are examples of upgrading or additional features that are not considered betterments:

1. Replacement of older features or facilities with new ones,
2. Incorporation of current design standards, and
3. Additional features resulting from the environmental process required as a condition of permit approval or environmental commitment.

120.5 Approval Requests

To request approval of a betterment, it will be necessary to provide detailed justification. It is important that the request contain information regarding conditions at the site prior to the disaster (including a brief summary of previous problems) and the current conditions at the site. The "do nothing" alternative must be discussed and it is expected that most proposals would include at least two "build" alternatives. Estimated costs for each alternative are needed. The appropriate ODOT unit must review and endorse betterment requests prepared by consultants.

The same basic rules will apply to betterment requests on local agency facilities. These proposals must be reviewed and endorsed by the appropriate ODOT unit and the request to use ER funds for such betterments must be made by ODOT in order to be considered.

As previously noted, if ER funds are to be approved, the betterment must be economically justified based on an analysis of the cost of the betterment versus projected savings in costs to the ER program should future disasters occur. This cost/benefit analysis must focus solely on benefits resulting from estimated savings in future recurring repair costs under the ER program. The analysis cannot include other factors typically included in highway benefit/cost evaluations such as traffic delay costs, added user costs, motorist safety, economic impacts, etc.

If FHWA is unable to provide ER funding for betterment, ODOT or the local agency has the option to include the work in either the ER repair project or a separate project, and fund it with other Federal-aid, State or local funds.

Section 121 References

121.1 AASHTO References

The following policies are helpful when developing transportation projects, and are currently available by order from AASHTO:

- *A Policy on Geometric Design of Highways and Streets – 2018 (AASHTO Green Book)*
- *Roadside Design Guide - 2011*
- *A Policy on Design Standards - Interstate System - 2016*
- *Guide for Development of New Bicycle Facilities – 2012*

121.2 Other References

The following list of references is not all-inclusive:

- Federal Aviation Regulations, Part 77 (D.O.T., F.A.A.)
- Oregon Standard Drawings
- Oregon Standard Specifications for Highway Construction 2021
- Contract Plans and Development Guide
- Manual on Uniform Traffic Control Devices and Oregon Supplementals
- ODOT Traffic Volume Tables
- Highway Capacity Manual,
- The 1999 Oregon Highway Plan
- State of Oregon, Bicycle and Pedestrian Plan - 2016
- Oregon Bicycle and Pedestrian Design Guide - 2011, ODOT
- TRB Special Report #214, Practices for Resurfacing, Restoration and Rehabilitation
- ODOT Soil and Rock Classification Manual,
- ODOT Bridge Design Manual and CAD Manual
- ODOT Geotechnical Design Manual
- ODOT Hydraulics Manual
- ODOT Traffic Manual
- ODOT Traffic Control Plans Design Manual
- ODOT Right of Way Manual
- ODOT Survey Manual
- ODOT Project Delivery Guidebook
- ODOT Access Management Manual
- ODOT Analysis Procedures Manual (APM)

- ODOT Traffic Signal Policy and Guidelines
- ODOT Traffic Signal Design Manual
- ODOT Highway Safety Program Guide
- ODOT Construction Manual
- Local Agency Guidelines Manual

Part 200 Geometric Design and Context

Section 201 Introduction

This section presents the primary design controls and criteria that are integral to the development of any highway project. Standards are presented for design speed, horizontal and vertical alignment, superelevation, sight distance, and grades. Understanding the traffic characteristics, providing for all transportation modes, selecting the appropriate design vehicle and design speed, and determining the access management strategy are all key to successfully delivering a project that meets the goals and values of practical design and design flexibility. Each of these design controls and criteria are discussed separately in the following sections for the different roadway functional classifications, both urban and rural; however, the intent is that all these considerations should be taken holistically for the best possible outcome. As with any project, the practical application of these standards will depend on the purpose, need, context, and unique constraints of the project.

This section also discusses the context of a roadway in relationship to roadway functional classification and the state highway classification, the flexibility in design depending on the context, while keeping in mind and collaborating with other areas of the Department such as operations, maintenance, and safety resulting in a design that provides a long service life.

With the incorporation of the Blueprint for Urban Design (BUD) into the HDM, there are six urban contexts that are similar to the past HDM Oregon Highway Plan segment designations. These different contexts and their relationship to each other are discussed in Section 203 through Section 207.

Because of the multiple urban contexts and their integration with design, a large portion of Part 200 is dedicated to describing the urban context, flexibility, and trade-offs within the urban environment. This does not distract from the importance of rural design and rural geometric design. Design controls and criteria are equally important in a rural environment as well, where design speeds are generally higher.

201.1 Definitions

Design Speed - The selected speed used to determine the various geometric design features of the roadway.

Target Speed - The speed set as a project goal. The intended operating speed.

> **Target Speed (ITE Definition)** - The highest operating speed at which vehicles should ideally operate on a roadway in a specific context.
>
> **Target Speed (AASHTO Working Definition)** - The operating speed that the designer intends for drivers to use.

Operating Speed - The speed at which vehicles are observed operating during free flow conditions

Running Speed - A vehicle's speed determined by dividing the distance traveled by the time duration, excluding delays.

85th Percentile Speed - The speed at or below which 85 percent of the drivers operate their vehicles, based from a speed study.

Green Book - AASHTO publication "A Policy on Geometric Design of Highways and Streets".

201.2 Acronyms

AASHTO - American Association of State Highway and Transportation Officials

FHWA - Federal Highway Administration

MCTD - Motor Carrier Transportation Division

PODI - Projects of Division Interest

Section 202 Approval Processes

202.1 Design Exceptions

Any deviation from any design standard requires a design exception approved by the State Traffic-Roadway Engineer. A design exception requires signatures from both the Engineer of Record (EOR) and State Traffic-Roadway Engineer. Design exceptions and the design exception process are addressed in Part 1000 of the HDM. Design exceptions may also require approval by the Federal Highway Administration (FHWA) for projects of interest they choose to review. Currently, these projects are called Risked Based Involvement Projects (RBIP). Previously, these projects were classified by FHWA as Projects of Division Interest or PODI.

202.2 Design Concurrence Document

The Blueprint for Urban Design (BUD), which has been incorporated into the HDM, established the urban design concurrence document form to determine project context, define design criteria, and document design decisions. Authority for approval of the urban design concurrence document will reside in the Region Technical Center. The Region Technical Center Manager shall provide final approval of design concurrence with collaborative input from region planning, traffic, roadway, and maintenance sections.

Section 203 Context and Classification

203.1 Urban Context and Roadway Classifications

This section describes the ODOT Urban Context system to differentiate the variety of urban areas and unincorporated communities in Oregon. The urban context of a roadway, together with its transportation characteristics, will provide information about the types of users expected along the roadway, regional and local travel demand of the roadway, and the challenges and opportunities of each roadway user. The urban context and transportation characteristics of a roadway will determine key design guidance and criteria for state roadways in urban areas, excluding interstates, limited-access freeways, and expressways with interchanges. The crossroad or cross street between ramp terminals of an interstate or limited access freeway (expressway) is not considered part of the interstate or freeway, but rather part of the urban network. Although the crossroad of an interstate or limited access freeway (expressway) may be located in an urban context, the intended mobility and high level operation of the interstate or limited access freeway (expressway) needs to be maintained. This section describes how to determine the urban context of an ODOT roadway and what additional transportation characteristics are considered when planning and designing a roadway. This will expand ODOT's context-sensitive approach for planning, design, and operations of projects in urban areas that serve all users.

> The urban context and transportation characteristics of a roadway will determine key design guidance and criteria for state roadways in urban areas, excluding interstates, limited-access freeways and expressways.

203.2 Design Flexibility in Urban Contexts

ODOT'S Performance-based, Practical Design aligns with national design trends and is set to follow FHWA direction as well as future updates to the AASHTO Green Book. The Performance-based, Practical Design process builds on ODOT's Practical Design strategy developed in 2010 and provides additional guidance for practitioners to use design flexibility to implement designs that are appropriate within each urban context described in Section 207 and Section 208. The process includes guidance to help practitioners identify and evaluate the final design, while considering operations, safety, and maintenance as well when determining criteria for urban projects. While the Highway Design Manual is a primary source for project design, inter-disciplinary scoping and project development teams need to utilize all ODOT resources and tools for evaluating design, operation, maintenance, and safety to balance trade-offs in order to integrate the needs of each modal group and develop solutions that meet the desired outcomes of a project. Part 300, Section 303 introduces the cross section realms and provides specific considerations to the design elements within each realm as it relates to urban projects. In addition, the summary tables within Part 300, Section 304 provide design guidance recommendations for ODOT urban projects. The Urban Design Concurrence document provides documentation of the project decision process and provides reasoning for the proposed project design, along with background information that pertains to the established project goals and outcomes.

203.3 Integrating Design, Operations, Maintenance, and Safety

Designing multimodal transportation facilities in urban areas is inherently complex. While past design trends have emphasized adherence to strict design standards, current urban design strategies highlight flexibility in design and emphasize the need to identify project goals and performance measures that align with the intended project outcomes. Project teams involved with urban design projects are tasked with balancing the needs and priorities of a variety of roadway users while integrating design principles, operations, maintenance tasks, and safety. Understanding and executing a performance-based approach within each stage of the project development process enables project teams to make informed decisions about the performance trade-offs. This is especially helpful when developing solutions in fiscally and physically constrained environments. National activities and associated publications, such as the FHWA Performance-Based Practical Design initiatives and the NCHRP Report 785: *Performance-Based Analysis of Geometric Design of Highways and Streets*, have resulted in a framework for how to integrate design, operations, and safety by evaluating the overall performance of a project.

Balancing the trade-offs by integrating design, operations, maintenance tasks, and safety for all modal groups involves using relevant, objective data to support the design decisions. This will require an awareness of the resources available to quantify specific performance measures or qualitatively describe the anticipated effect of a given roadway or intersection. Evaluating the trade-offs within a constrained roadway environment and balancing the needs of various modal users can be particularly challenging in an urban area. Along with federal design publications, the ODOT HDM is the primary resource for detailed design guidance providing flexibility in urban highway design in relation to land use and community-based decision processes. While in the past the primary project focus was motor vehicle operations, there are now resources and tools to guide practitioners in multimodal analysis and evaluating the needs for each user from an operational perspective. Both FHWA and ODOT recognize information found in resources outside federal or Oregon DOT publications. Some of these include, publications from other state DOTs, guides developed by national organizations like the National Association of City Transportation Officials (NACTO), the Institute of Transportation Engineers (ITE), and the American Society of Civil Engineers (ASCE), as well as information provided by many other transportation engineering resources. While outside resources may be utilized for information purposes, the Oregon Highway Design Manual is the deciding factor for design of highways, roads and streets on the Oregon state highway system.

Whether or not safety is the catalyst for a project, conducting safety analysis can help identify areas for improving the roadway for various modal users. ODOT seeks to provide safe transportation to each roadway user and continues to work towards reducing fatal and severe injury crashes on state facilities. Therefore, using safety performance measures or qualitative assessment of safety is often a focus when evaluating project alternatives and assessing project trade-offs. Practitioners can reference the Oregon Pedestrian and Bicycle Safety Implementation Plan for additional guidance and resources. In addition to modal, safety and operational needs, the Maintenance role in a facility's life cycle is an important one. Designing and constructing a facility that is difficult to maintain will not provide adequate long-term service and can degrade modal safety and operations over time.

Urban roadway facilities are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. The design team evaluates the difference between "accommodating" versus "designing for" a given mode and applies consistent principles within the project context. Multimodal design considerations depend on the intended function of the corridor, as well as balancing trade-offs and objectives from local plans. For example, consider a roadway designed primarily for mobility for motorized vehicles. The design is required to "accommodate" other users, such as pedestrians and bicycles, but it will not attract a wide range of vulnerable users. A roadway intended to serve and attract non-auto users, however, is "designed for" multimodal users. This means mobility for motorized vehicles takes a lower design priority and is "accommodated", possibly allowing increased congestion as the trade-off.

With an understanding of the overall project performance, including maintenance needs, a project team can begin to evaluate the design element application based on the integration of design, operations, and safety. Subsequent sections of Part 300 provide guidance for integrating design, safety and operations in conjunction with maintenance needs and provide potential tools for measuring and evaluating the considerations and trade-offs between design elements. Sections 205 and 206 provide information and recommendations for each ODOT Urban Context. In conjunction with Sections 303 and 304, they provide design guidance for roadway cross-sections within the various contexts and provide the next level of detail by discussing the range of considerations for design elements within the roadway cross-section, which are organized into "cross-section realms".

203.4 Resources for Design, Operations, and Safety

Specific safety calibration factors developed for the State of Oregon can help practitioners better apply the predictive safety methods in the Highway Safety Manual to address project safety outcomes.

Balancing the trade-offs by integrating design, operations, maintenance tasks, and safety for all modal groups involves using relevant, objective data to support the design decisions. This will require an awareness of the resources available to quantify specific performance measures or qualitatively describe the anticipated effect of a given roadway or intersection. Long term maintenance tasks must also be considered in the final design. The Maintenance Section plays a significant role in making sure ODOT's facilities function as they were designed. The Maintenance role in a facility's life cycle is an important one. Designing and constructing a facility that is difficult to maintain will not provide adequate long-term service. Other recently published research, such as NCHRP Report 880: *Design Guide for Low-Speed Multimodal Roadways*, also provides a useful resource for considering design trade-offs in an urban environment.

Whether or not safety is the catalyst for a project, conducting safety analysis can help identify areas for improving the roadway for various modal users. ODOT seeks to provide safe transportation to each roadway user and continues to work towards reducing fatal and severe injury crashes on state facilities. Therefore, using safety performance measures or qualitative assessment of safety is often a focus when evaluating project alternatives and assessing project trade-offs. There are limitations in the bicycle and pedestrian crash data available at ODOT. Practitioners can reference the Oregon Pedestrian and Bicycle Safety Implementation Plan for additional guidance and resources.

Evaluating the trade-offs within a constrained roadway environment and balancing the needs of various modal users can be particularly challenging in an urban area. The ODOT HDM is the primary resource for detailed design guidance and discusses the flexibility in highway design in relation to land use and community-based decision processes. While in the past the primary project focus was motor vehicle operations, there are now resources and tools to guide practitioners in multimodal analysis and evaluating the needs for each user from an operational perspective.

Section 204 Roadway Classification

The following guidance in this section discuss the different types of roadway classifications and contexts including; the federal functional classification, ODOTs state highway classification, the OHP highway segment designations and non-designated segments, other roadway designations such as freight routes and reduction review routes, and most recently, ODOT's six urban contexts.

The classification and context guidance needs to be considered holistically by the designer as the Highway Design Manual has developed the design standards based upon the federal functional classifications including: freeways; expressways; rural arterials, collectors and local routes; and urban arterials, collectors, and local routes. ODOT has further developed the urban functional classification into the following six urban contexts: traditional downtown/central business district; urban mix; commercial corridor; residential corridor; suburban fringe; and rural community. The six urban contexts are not necessarily based on being in the urban growth boundary, but the surrounding context of the roadway in question. These six urban context and design guidance are not to be used in the design of interstates and limited-access freeways (expressways) with interchanges. In respect to interchanges and depending on the style of interchange, the appropriate design context will need to be determined for the crossroad between the ramp terminals.

204.1 Oregon Highway Plan Classifications

ODOT currently uses a highway classification system that divides state highways into five primary categories: Interstate, Statewide, Regional, District, and Local Interest Roads. Table 200-1 shows ODOT's definitions and objectives for these classifications. ODOT uses the state highway classification system to guide management and investment decisions regarding state roadway facilities. The state highway classifications provide information on the role of roadways related to mobility and access, as well as limited guidance regarding the prioritization of roadway users.

> When planning in urban areas, the urban context is the primary basis of planning and design decisions. The state roadway designation would be a secondary basis of planning and design decisions.

Table 200-1 State Highway Classifications (OHP)

State Highway Classification	Primary Function	Secondary Function	Objective
Interstate Highways	Provide connections to major cities, regions of the state, and other states.	Provide connections for regional trips within metropolitan areas	Provide for safe and efficient high-speed continuous-flow operation in urban and rural areas. Includes managed access.
Statewide Highways	Provide inter-urban and inter-regional mobility and connections to larger urban	Provide connections for	Provide safe and efficient, high-speed, continuous-flow operations

State Highway Classification	Primary Function	Secondary Function	Objective
	areas, ports, and major recreation areas	intra-urban and intra-regional trips	
Regional Highways	Provide connections and links to regional centers, Statewide or Interstate Highways, or economic or activity centers of regional significance	Serve land uses in the vicinity of these highways	Provide safe and efficient, moderate to high-speed operations
District Highways	Provide connections and links between small urbanized areas, rural centers and urban hubs[1], and serve local access and traffic	N/A	Provide for safe and efficient, moderate to high-speed continuous-flow operation in rural areas[2] and moderate to low-speed operation in urban and urbanizing areas[1] for traffic flow and for pedestrian and bicycle movements
Local Interest Roads	Local streets or arterials serving little or no purpose for through traffic mobility	N/A	Provide for safe and efficient, low to moderate speed traffic flow and for pedestrian and bicycle movements.

Source: 1999 Oregon Highway Plan

[1] *Small urbanized areas, rural centers, and urban hubs described in the OHP are all considered urban. Their urban context would be classified based on the characteristics described in Section 207.*

[2] *Adding flexibility to the Statewide and Regional Highway classifications allows for low to moderate speeds in urban contexts and to further support safe movement of bicyclists and pedestrians. Currently, District Highways have different objectives in urban and rural areas; context and design flexibility provides the same opportunity for Statewide and Regional Highways.*

A subset of the five OHP classifications outlined above are roadways designated by the Oregon Transportation Commission as expressways. The OHP defines expressways as complete routes or segments of existing two-lane and multi-lane highways and planned multi-lane highways that provide for safe and efficient high speed and high volume traffic movements. Their primary function is to provide for interurban travel and connections to ports and major recreation areas with minimal interruptions. A secondary function is to provide for long distance intra-urban travel in metropolitan areas. In urban areas, speeds are moderate to high. In rural areas, speeds are high.

204.2 Other Roadway Designations or Characteristics

While context and OHP roadway classification can provide general guidelines for the type and activity level of different users, there are other roadway designations or characteristics that impact planning and design of roadways in urban areas. Table 200-2 summarizes some of these additional factors and the design criteria they can potentially affect. Section 207 provides more details related to how specific design elements are impacted by these designations or characteristics.

Table 200-2 Designations/Characteristics Impacting Design Decisions

Factors	Data Sources	Affected Design Criteria
Reduction Review Route	ODOT designation – defined and stipulated by statute; OAR 731-012 and ORS 366.215	Anything that constitutes a permanent change to overall roadway horizontal and vertical clearance
Level of Access Management[1]	Driveway density Intersection density[2]	Median type Median opening spacing Signal spacing Intersection spacing Frequency of pedestrian crossings Bicycle facility design Target speed
Freight Activity	Percent and volume of heavy vehicles Need for loading/unloading zones	Design vehicle Lane width Intersection curb-return radii Bicycle facility design
Transit Activity	Presence of transit routes/stops Transit ridership Local transit plans – Transit Development Plan, Transit Master Plan or Coordinated Plan	Lane width and use restrictions Sidewalk and bicycle connections Frequency of pedestrian crossings Bicycle facility design Transit stop location and layout
Seismic Lifeline Route / Tsunami Evacuation Route	Oregon designation	Lane width Shoulder width
Scenic Byways	Oregon designation	Consideration of natural and historic resources along the corridor

[1] *ODOT standards are defined and stipulated by statute OAR 734-051 and PD-03 Access Management*

[2] *Driveway density and intersection density are directly related to ODOT State Highway Designations*

The Oregon Highway Plan identifies three special overlay designations for the state freight network, Lifeline/Evacuation Routes (Seismic/Tsunami/Flood/Wildfire), and Scenic Byways. Designs on these designated routes have special considerations.

- **State Highway Freight System -** The primary purpose of the State Highway Freight System is to facilitate efficient and reliable interstate, intrastate, and regional truck movement through a designated freight system. This system includes routes on the National Highway System (NHS) as well as routes designated from legislative action ORS 366.215 and OAR 731, Division 12 that encompass the Reduction Review Route network.
- **Lifeline/Evacuation Routes -** Earthquakes, flooding, landslides, wild fires, and other natural and man-made disasters may destroy or block key access routes to emergency facilities and create episodic demand for highway routes into and out of a stricken area. ODOT's investment strategy should recognize the critical role that some highway facilities, particularly bridges, play in emergency response and evacuation. It is the policy of the State of Oregon to provide a secure lifeline network of streets, highways, and bridges to facilitate emergency services response and to support rapid economic recovery after a disaster.
- **Scenic Byways -** While every state highway has certain scenic attributes, the Oregon Transportation Commission has designated Scenic Byways throughout the state on federal, state, and local roads which have exceptional scenic value. It is the policy of the State of Oregon to preserve and enhance designated Scenic Byways, and to consider design elements for natural conditions and aesthetics in conjunction with safety and performance considerations on designated Byways.

Section 205 Documenting Context and Classification

This section describes how land use has been integrated into transportation planning, operations, and design in recent years. It outlines six urban land use contexts developed for state-owned roadways, and provides guidance to determine the urban context of a state-owned roadway.

Although rural contexts do not have as wide of variety as the urban contexts, rural contexts and the associated cross sectional elements need to be tied to their intended functional classification providing for a level of operation and safety. Rural contexts vary from full access controlled interstates to rural local routes that run through populated locations.

Context and other roadway characteristics/designations must be documented early in the project development process, ideally prior to project scoping, in order to use the appropriate context-based design criteria. Documentation becomes part of ODOT design concurrence to provide background for design decisions based on the context.

Context is initially documented in a local agency's long-range plan and/or an ODOT facility plan. In some cases, the context may be different for the existing condition and the future planned land use. Future context must be supported by other planning and regulatory documents establishing requirements for desired future land use development in terms of zoning allowances, property dedication stipulations, building setback limitations or any other state or local development requirements that direct property redevelopment towards the future contextual goals.

If the context is documented in an existing long-range or facility plan, planners should review and coordinate with local planners to confirm the context at the start of a project. For projects that are not included in a long-range or facility plan, in collaboration with local planners, ODOT determines the context at the start of the project, prior to scoping or design. ODOT will have the final determination of the context.

ODOT staff determine the applicable designations and characteristics for the roadway in question (Section 204, Table 200-1 and Table 200-2). These designations/characteristics are documented through Design Documentation, including a brief description of their impact on the design. This documentation becomes part of ODOT project design documentation to provide background for design decisions based on the context, classifications, designations, and characteristics.

The urban context and roadway characteristics/designations documented at the start of the project are reviewed and updated as needed at the start of every project phase to consider current data and recent local planning efforts and becoming part of the overall ODOT design documentation.

205.1 Urban Context and Land Use

Oregon has been at the forefront of linking land use and transportation planning for several decades. Policy 1B in the 1999 OHP recognizes that state-owned roadways can be the main streets of many communities. The policy strives to maintain a balance between serving those main streets and the through traveler. Policy 1B sets up three categories to designate highway segments, which were later adopted into the ODOT HDM in 2003:

- **Special Transportation Areas (STA):** Designated districts of compact development located on a state-owned roadway within an urban growth boundary in which the need for appropriate local access outweighs the considerations of highway mobility except on designated OHP Freight Routes where through highway mobility has greater importance.

- **Urban Business Areas (UBA):** Existing areas of commercial activity or future nodes and various types of centers of commercial activity within urban growth boundaries or urban unincorporated community boundaries on District, Regional or Statewide Highways where vehicular accessibility is important to continued economic viability.
- **Commercial Centers (CC):** Large, regional centers or nodes with limited access to the state highway. Commercial Centers are to locate in a community that is the population center for the region and where the majority of the average daily trips to the center originate.

Nationally, a similar direction focusing on land use context as a driver for transportation planning and design has been taking place. "Transect" is a term from biology, where it describes the range of different habitats in nature. As with organisms who prefer to live in or thrive in different habitats, personal preferences, opportunities, constraints, and needs can determine the type of environment in which community members live or work, from a rural place to a city center, and everywhere in between. Land development patterns tend to follow a transect as they transition from rural to urban. Within each transect zone, a predominance of specific types of land uses are expected. For instance, higher density housing and mixed-use buildings are typical in the more urban transect zones. Figure 200-1 illustrates the transect and transect zone concept.

Figure 200-1 A typical Rural to Urban Transect and Transect Zones

This prototypical development pattern was first codified in the SmartCode in 2003. (Grow Smart RI, www.growsmartri.org)

Since then, various agencies have adopted their own versions to help understand the users in each transect zone and the needs of roadway users in each zone. Recent efforts include the land use contexts found in the Pennsylvania and New Jersey Departments of Transportation *Smart Transportation Guidebook*; the Florida Department of Transportation's *Context Classification* system; and most recently, the National Cooperative Highway Research Program (NCHRP) Report 855: *An Expanded Functional Classification System for Highways and Streets.*

NCHRP Report 855 provides a general starting point for agencies to adopt their own classification of contexts and defines the following five land use contexts:

Rural: Areas with lowest density of development, few houses or structures (widely dispersed or no residential, commercial, and industrial uses), and usually large setbacks.

Rural Town: Areas with low-density development but diverse land uses with commercial main street character, potential for on-street parking and sidewalks, and small setbacks.

Suburban: Areas with medium-density development, mixed land uses within and among structures (including mixed-use town centers, commercial corridors, and residential areas), and varied setbacks. Appropriate roadway designs require an understanding of the function of the roadway within its current and planned future contexts and the needs of the existing and potential roadway users.

Urban: Areas with high-density development, mixed land uses and prominent destinations, potential for some on-street parking and sidewalks, and buildings with varying setbacks from the roadway.

Urban Core: Areas with highest density of development, mixed land uses within and among predominately high-rise structures, and small setbacks of buildings from the roadway.

205.2 ODOT Urban Context

In developing a context-sensitive approach to planning and designing roadways in urban areas, ODOT has created a set of six urban land use contexts to describe the variety of urban areas and unincorporated communities in Oregon. As defined previously, the term "urban," as used throughout this document, is a broad use of the word and is not limited to places within an Urban Growth Boundary (UGB), nor is it limited to the federal classification of urban being determined by a population density of 5,000 or more. Based on the Rural Community context, unincorporated cities and towns are considered as urban for the purposes of this document. However, to meet the Rural Community context there needs to be a recognition of, or semblance to, a city or town proper. Merely having a collection of houses or buildings adjacent to the highway does not fit the intended definition of a Rural Community context as it is used in this document. There needs to be a central community aspect like a post office or store in conjunction with a collection of residences to meet the intent of the Rural Community context.

The six ODOT Urban Contexts build off the NCHRP Report 855, with a few changes to reflect Oregon-specific conditions. The suburban context was split into two contexts to distinguish between commercial and residential-focused areas. The Suburban Fringe context was added to draw attention to areas transitioning from rural to a more urban context. The ODOT Urban Contexts and their relationship with the NCHRP Report 855 contexts are shown in Table 200-3.

Table 200-3 ODOT Urban Contexts in Relation to NCHRP 855 Contexts

ODOT Urban Context	NCHRP Report 855 Context
Traditional Downtown/ Central Business District (CBD)	Urban Core/Rural Town
Urban Mix	Urban
Commercial Corridor	Urban/Suburban
Residential Corridor	Urban/Suburban
Suburban Fringe	Suburban/Rural
Rural Community	Rural Town

The six ODOT Urban Contexts shown in Table 200-3 are general and may not fit every project location specifically. Planning activities or project teams determine the appropriate context based on predominant land use, modal goals, roadway function, or other major considerations such as anticipation of future planned land use and community aspirations. Figure 200-2 illustrates the NCHRP Report 855 contexts compared to the ODOT Urban Contexts.

Figure 200-2 NCHRP Report 855 and ODOT Urban Land Uses

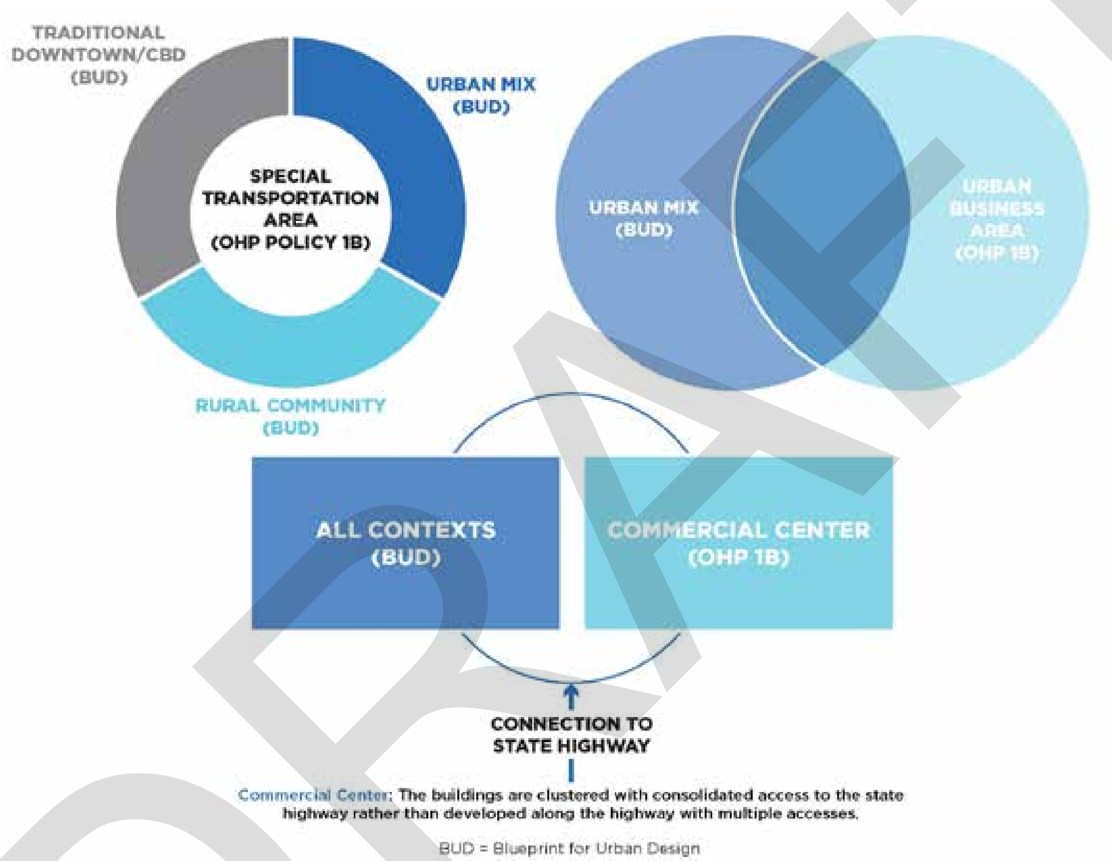
NCHRP Report 855 suggests a Suburban context. When developing the ODOT urban contexts, it was felt that a more nuanced approach to the suburban area was needed. As a result, the ODOT suburban context is separated into Commercial Corridor, Residential Corridor and Suburban Fringe contexts.

205.3 Urban Context and the Oregon Highway Plan

There is overlap between the Oregon Highway Plan Policy 1B highway segment designations of Special Transportation Area (STA), Urban Business Area (UBA), and Commercial Center (CC) and the urban contexts defined in the HDM. Figure 200-3 shows how STAs, UBAs, and CCs relate to the ODOT Urban Contexts. A Traditional Downtown/Central Business District(CBD) is generally STA like; however, a CBD is not always classified as an STA. Nor is an STA always a

Traditional Downtown/CBD. An STA can be located in a Traditional Downtown/CBD, but it can also be located in an Urban Mix context or a Rural Community context. A UBA can be located within an Urban Mix context; however, Urban Mix is not always classified as a UBA. Depending on adjacent land uses and characteristics, a CC may be located in any of the urban contexts.

Figure 200-3 Oregon Highway Plan Segment Designations of Urban Contexts



205.4 Determining Urban Context

Table 200-4 presents a framework of general characteristics to determine the urban context along state roadways. The definitions and descriptions in Section 205.2 give a broad overview of the land use types and street patterns found within each context. The measures in Table 200-4 provide more detailed assessments of the existing or planned conditions along the roadway. These measures are evaluated through a combination of a field visit, internet-based aerial and street view imagery, map analysis, consultation with the local jurisdiction, and a review of land use plans including Transportation System Plans (TSP) as well as other planning studies or activities. Oregon Highway Plan segment designations are policy driven and as such, they apply to all context evaluations. While they are not specific to any single urban context, segment designations assigned to a roadway section do play a part in the final design criteria of a determined urban context. The OHP segment designations are part of the final evaluation as needed, but the urban context is not solely dependent on a highway segment designation. For example, an ODOT roadway does not need to be designated as an STA to be considered a Traditional Downtown/CBD context; however, if a roadway section is determined to be an Urban Mix and it is also designated as an STA, then the final design needs to include appropriate STA criteria.

Projects with a relatively short design horizon, such as resurfacing projects, may only need to consider existing conditions in the determination of the urban context. However, it is beneficial for practitioners to look for opportunities to support future land use expectations and address gaps in the bicycle and pedestrian network, where feasible. Proposed developments with approved permits are considered part of the existing conditions. For projects with a longer design life that consider future transportation demand projections, documented future land use plans are considered in determining the urban context.

In some cases, the urban context may differ on each side of the roadway (e.g., commercial corridor across from residential corridor). Where characteristics differ on each side of the roadway, appropriate context determination is focused on predominant land use, modal balance/needs, roadway function, or other major considerations. Generally, there is enough flexibility within the design matrices for the determined context to provide a consistent cross-section when contexts overlap.

1 Table 200-4 ODOT Urban Context Matrix

Land Use Context	Setbacks **Distance from the building to the property line**	Building Orientation **Buildings with front doors that can be accessed from the sidewalks along a pedestrian path**	Land Use **Existing or future mix of land uses**	Building Coverage **Percent of area adjacent to right-of-way with buildings, as opposed to parking, landscape, or other uses**	Parking **Location of parking in relation to the buildings along the right-of-way**	Block Size **Average size of blocks adjacent to the right-of-way**
Traditional Downtown/ CBD	Shallow/ None	Yes	Mixed (Residential, Commercial, Park/Recreation)	High	On-street/ garage/ shared in back	Small, consistent block structure
Urban Mix	Shallow	Some	Commercial fronting, residential behind or above	Medium	Mostly off-street/Single row in front/ In back/ On side	Small to medium blocks
Commercial Corridor	Medium to Large	Sparse	Commercial, Institutional, Industrial	Low	Off-street/In front	Large blocks, not well defined
Residential Corridor	Shallow	Some	Residential	Medium	Varies	Small to medium blocks
Suburban Fringe	Varies	Varies	Varied, interspersed development	Low	Varies	Large blocks, not well defined
Rural Community	Shallow/ None	Some	Mixed (Residential, Commercial, Institutional, Park/Recreation)	Medium	Single row in front/ In back/ On side	Small to medium blocks

2

205.5 Urban Context and Multimodal Users

The ODOT Urban Contexts can also help planners and engineers understand the types of users and the intensity of use expected within each urban context. For example, in a Traditional Downtown/CBD, practitioners would expect a higher number of pedestrians, bicyclists, and transit users than in a Suburban Fringe context. Therefore, slower speeds, shorter signal spacing, shorter crossing distances, and other design elements such as bicycle facilities, on-street parking, and wide sidewalks are considered as strategies to improve safety and comfort of the anticipated users (bicyclists, pedestrians, and transit riders). However, freight movements and delivery of goods to business within a Traditional Downtown/CBD must also be accommodated.

In a Suburban Fringe area, designers would expect a predominance of vehicles and freight; however, bicyclists and pedestrians are also likely to be present and enhanced facilities are considered for safety and comfort. A roadway in the Suburban Fringe context would typically have higher speeds, and lower levels of traffic delay, but the design elements for the facility will change as it transitions into different urban contexts.

When determining the roadway typical section proposed for a project, designers use the urban context to better understand the anticipated users and identify appropriate consideration for each of them. Table 200-5 shows a representation of the relative need of each user type to drive planning and design decisions in the different urban contexts. This table is a starting point and not a final determination of modal considerations. Specific modal integration is determined on a project-by-project basis; however, modes with lower consideration must still be accommodated. For example, there will be freight needs to deliver products to businesses in a CBD. Even if freight is a lower consideration compared to bicyclists and pedestrians, project-level needs incorporate how freight will access the area. In this example, it may mean the design vehicle is a single-unit (SU) and a tractor-trailer combination WB-67 is "accommodated". However, on Reduction Review Routes, ORS 366.215 and OAR 731-012 requirements must also be considered in these decisions. The following parts and sections will contain more guidance on criteria to be used for each urban context. Guidance for bicycle facility selection and its relation to modal integration is located in Part 900, Bikeway Design.

Table 200-5 General Modal Considerations in Different Urban Contexts

Land Use Context	Motorist	Freight	Transit	Bicyclist	Pedestrian
Traditional Downtown/CBD	Low	Low	High	High	High
Urban Mix	Medium	Low	High	High	High
Commercial Corridor	High	High	High	Medium	Medium
Residential Corridor	Medium	Medium	Low	Medium	Medium
Suburban Fringe	High	High	Varies	Low	Low
Rural Community	Medium	Medium	Varies	High	High

High: Highest level facility should be considered and prioritized with other modal treatments.

Medium: Design elements should be considered; trade-offs may exist based on desired outcomes and user needs.

Low: Incorporate design elements as space permits.

Section 206 Examples of ODOT Urban Contexts

206.1 Traditional Downtown / Central Business District

Thinking of the Traditional Downtown/Central Business District context, the major sections of downtown Portland, Salem, Eugene, Bend, Medford or Grants Pass come to mind. However, smaller towns and cities like Tillamook, Astoria, Coos Bay, Bandon, Hood River, Baker City, Lakeview and Burns to name a few also have great downtown areas and are considered in the Traditional Downtown/Central Business District context. Small block sizes characteristic to the Traditional Downtown/Central Business District encourage walking, biking and transit modes for access to properties, business and activities.

General Characteristics of the Traditional Downtown/Central Business District context: Buildings are generally at the back of walk or with small setbacks. Access to buildings is from the sidewalk or pedestrian pathway. Land use is mostly commercial and retail with some mixed residential, park space or small recreation areas. Buildings cover large portions of the right-of-way and block sizes are small with on-street parking or shared parking in back of buildings along with a developed grid system of streets.

Figure 200-4 Aerial - Baker City, Downtown Grid (US30/OR7)

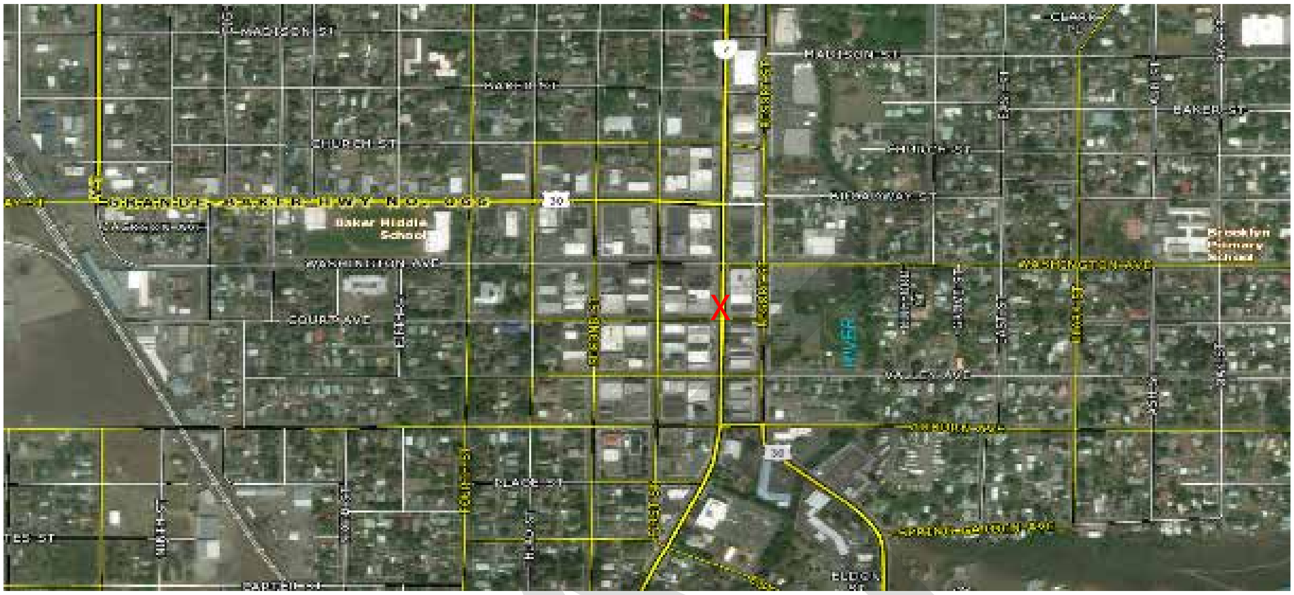
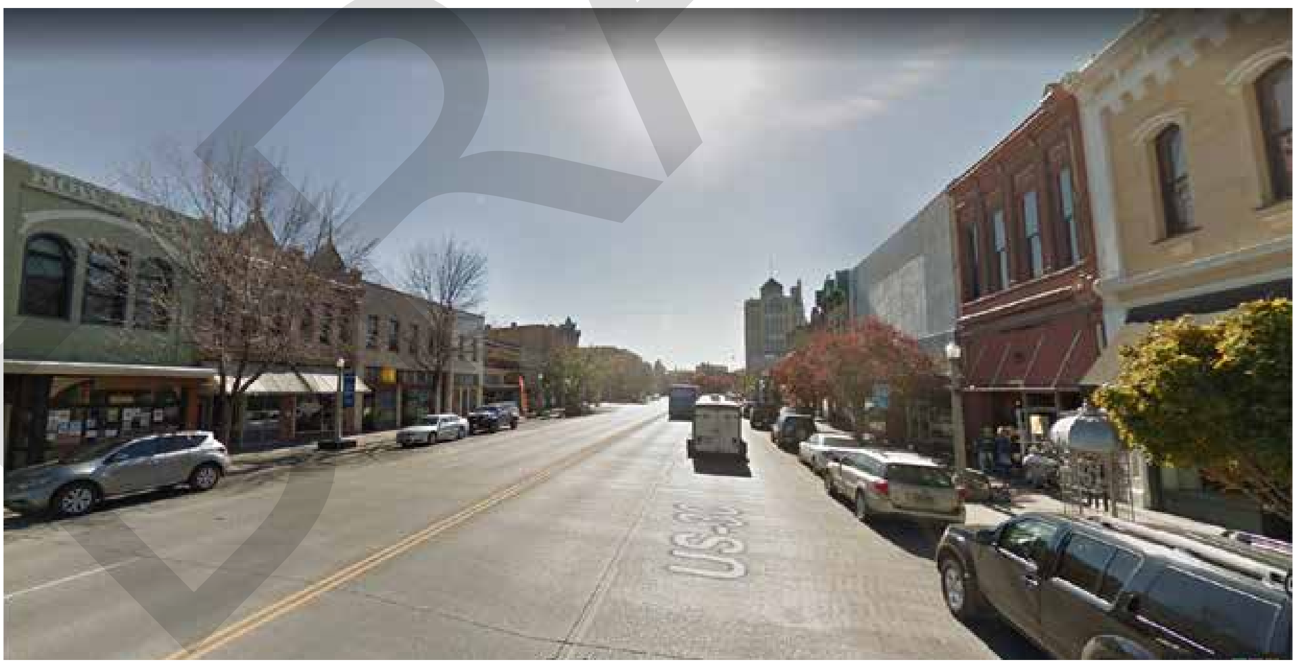


Figure 200-5 Baker City Downtown (US30)



206.2 Urban Mix

The Urban Mix context generally is the area adjacent as a roadway moves outward from the central downtown area. It is often established as businesses move outward into older residential areas and properties redevelop or repurpose. There may be no defining line between a Traditional Downtown/Central Business District and an Urban Mix. The two contexts may morph into one another. Smaller block sizes are conducive to walking, biking and transit for access to properties.

General Characteristics of the Urban Mix Context: Building setbacks are generally shallow with a mix of buildings tight with the sidewalk and some with a small frontage to the sidewalk and pedestrian pathway. Land use is commercial, retail or professional offices fronting the property and may have residential on upper floors or in back. In conjunction with the business properties, there may be older residential mixed in with the more recent property redevelopments. Building coverage is generally medium in relation to property sizes with some on-street parking, but parking is mainly off-street, single row parking in front, in back or on side. The street network is in a connected grid pattern with blocks small to medium in size.

Figure 200-6 Aerial - Urban Mix Portland: US26, Powell Blvd. West of I-205 (Inner Powell)

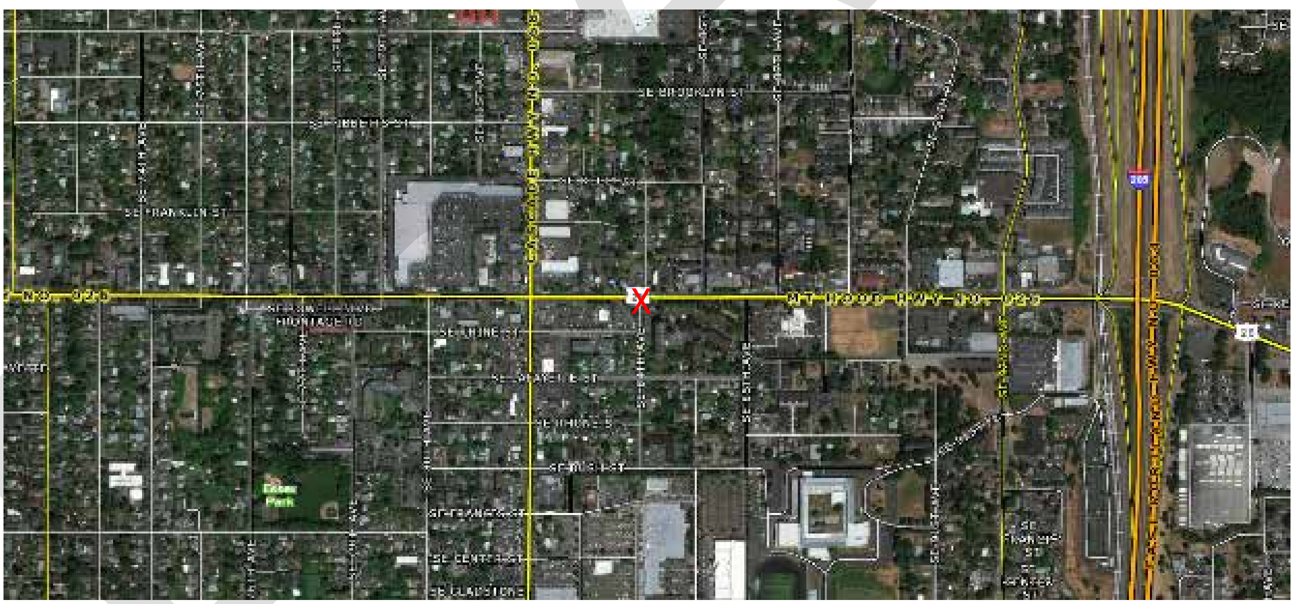


Figure 200-7 Urban Mix - Portland US26, Powell Blvd.

206.3 Commercial Corridor

A Commercial Corridor context is readily identifiable and consists primarily of large commercial, retail or industrial properties along major, higher speed arterials. As a result, access to properties along a Commercial Corridor has traditionally been focused on motorized vehicles with some transit access. A connected street network grid is not usually present as many of the properties in this context developed on large tracts of land that were originally at the edge of communities and subsequent characteristic development followed as the rest of the corridor was established. Special attention is needed when designing bicycle and pedestrian facilities for this context.

General Characteristics of the Commercial Corridor Context: Building setbacks are medium to large with off-street parking area between the sidewalk and building entrances. Building coverage on the properties is small in relation to the total right-of-way. Land uses encompass commercial, retail or industrial businesses that include large parking areas for customers and employees.

Figure 200-8 Aerial - Commercial Corridor, US97 South Redmond

Figure 200-9 Commercial Corridor - US97 South Redmond

206.4 Residential Corridor

The Residential Corridor context differs from the Commercial Corridor with its higher density of residential properties. It may be along a higher speed arterial as is a Commercial Corridor, but greater potential for pedestrian, bicycle and transit access from residential properties will be a design focus along Residential Corridors. This context has a more connected street grid network and may have mixed commercial, retail and light industrial activities to support the residential nature. Access to the highway is primarily through public street connections, although some properties with higher densities of residents or higher trip generations may have some direct access.

General Characteristics: Building setbacks are generally shallow with some buildings at the back of walk. Land use is varied with commercial and retail in relation to the high density of residential properties. Building coverage on residential right-of-way varies from single family homes to higher density, multi-family housing. Block sizes are small to medium with parking options that vary with posted speeds from on-street for some roadway types to off-street in most cases, due to the general location of this context along major arterials.

Figure 200-10 Aerial - Residential Corridor, OR221 Wallace Road, West Salem

Figure 200-11 Residential Corridor - OR 221, West Salem (Parkway Concept)

206.5 Suburban Fringe

The Suburban Fringe context is generally the transition area from higher speed rural roadways to the lower speed urban section entering communities. The design focus for this context is speed control and communicating to drivers they are entering an urban area or rural community.

General Characteristics of the Suburban Fringe Context: Building setbacks vary with no specific distance, but are generally large. Few buildings are at the roadway or right-of-way edge. Properties are generally larger with buildings taking up minimal space leaving large open areas. Land use is varied. Development is interspersed with residential, farming, commercial, retail and industrial. Block sizes are large and not well defined. Parking is primarily off-street, although depending on the adjacent urban context, some on-street parking could be present.

Figure 200-12 Aerial - Suburban Fringe, OR 212 Damascus

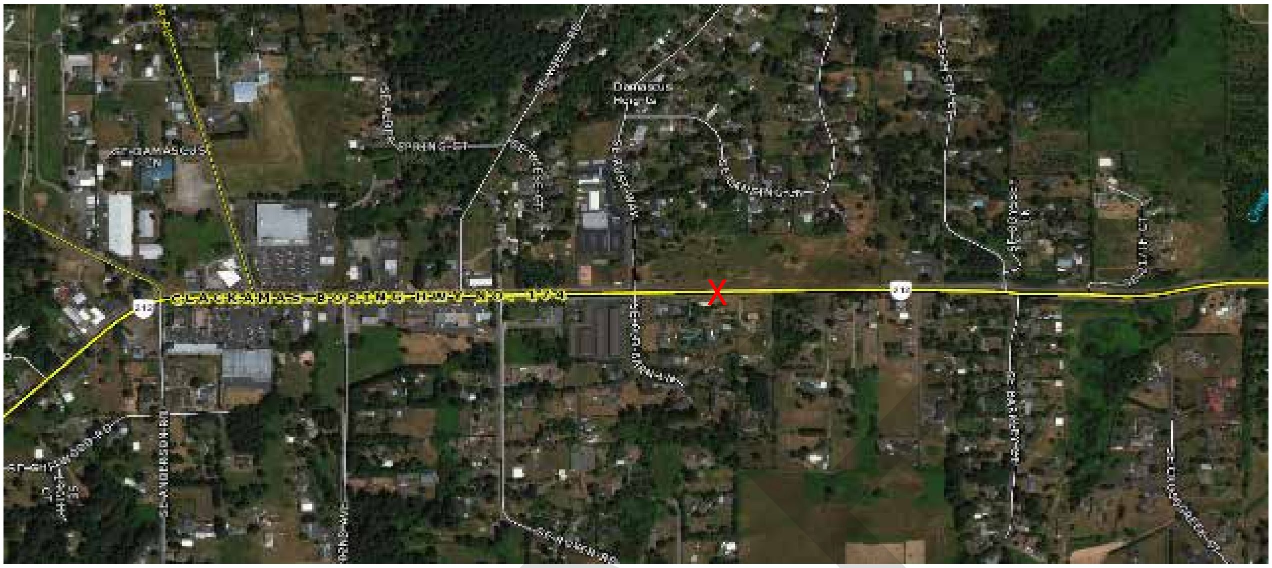


Figure 200-13 Suburban Fringe - OR 212 Damascus

206.6 Rural Community

The Rural Community context was established for small, unincorporated communities that encompass concentrated areas of development surrounded by undeveloped areas with the highway running through main street. The design focus in this context is on speed control and connectivity. Safe access across the highway for residents of these communities is paramount for community activities. Students getting to school, people accessing mail at the post office or shopping for groceries are daily activities that can be done through walking and biking for many residents, rather than driving short distances. Providing designs that control the speed of through traffic and provides facilities to enhance safe walking and biking can improve the quality of life for these communities. It is important to strike a balance between through traffic needs and local community needs.

General Characteristics of the Rural Community Context: Building Setbacks are shallow to none with open frontages and a single row of parking along the edge of the highway. Land use is varied with some residential mixed with mostly small businesses, small retail or light industrial. Post offices, general stores, parks and recreation facilities are common. Block size is generally small and often not well defined.

Figure 200-14 Aerial - Rural Community, OR 22 Gates

Figure 200-15 Rural Community, OR 22 Gates

Section 207 Designing Based on Context and Classification

The purpose of this section is to outline how the contexts, modal expectations, and roadway characteristics described earlier in this part can be applied together, with the design approach described for each context. Table 200-6 provides general guidance on design direction for various elements of the roadway design. More specific guidance for design elements within each land use context is included in Part 300. The design guidance tables and cross section figures in Part 300 also provide more detail on considering different roadway characteristics.

207.1 Urban and Rural Freeways (Including Interstates)

Speeds for these roadways range from 50 to 70 mph. These access controlled facilities focus on the vehicular mode, mobility over access, and need to accommodate the heavy and large loads that use urban and rural freeways, including the interstate system. Both the urban and rural contexts have similar modal expectations and roadway contexts, although the urban freeways traverse through the different urban environments.

207.2 Urban and Rural Expressways

Similar to urban and rural freeways, urban and rural expressways mainly focus on vehicle mobility, although expressways may or may not have the high level of access control as freeways. Because expressways may consist of grade separated or at-grade intersections, the level of modal accommodation will vary. Speeds are relatively high ranging from 45 to 70 mph depending on urban or rural environments. Urban expressways with grade separated accesses do not fit the six urban contexts defined in the HDM and are generally designed using Urban freeway criteria. However, urban expressways with at-grade intersections do fit with the six ODOT urban contexts and are subject to the appropriate design criteria for the selected context.

As with any urban roadway, right of way, cost, terrain, and other constraints may necessitate designing expressways below the standards described for them. The appropriate design exception must be obtained to reduce any design element below standard criteria. Justification for exceptions from expressway design standards must be substantial. Due to the mobility needs of expressways, they are held to a high standard and therefore exceptions should be minimized. For more information on the design exception process, refer to Part 1000.

207.3 Rural Arterials, Collectors, and Local Routes

Rural arterials, collectors, and local routes serve most uses related to vehicular traffic moving through rural arterials, but also a wide range of modes due to the rural arterial functional classification making up a large percentage of rural facilities ranging from rural arterials to rural local routes. Speed ranges also vary in the range of 45 to 70 mph.

207.4 Traditional Downtown / Central Business District

To best serve all users, vehicle speeds are generally 25 mph or below, and higher levels of congestion are expected. Transit stops are placed at frequent intervals, and transit priority treatments can help with transit mobility, even in congested conditions. Preferred bicycle and pedestrian facilities are relatively wide and comfortable to serve users of all ages and abilities. Curbside uses are important and may include transit and freight loading/unloading needs, parking (vehicles, bicycles, etc.), and other uses. Landscaping and street tree installation follows ODOT placement and spacing guidelines and are appropriate in this context.

207.5 Urban Mix

To best serve all users, vehicle speeds are typically 25 to 30 mph, and higher levels of congestion are acceptable. Transit stops are placed in proximity to origins and destinations. Preferred bicycle and pedestrian facilities are relatively wide and comfortable to serve users of all ages and abilities. Where low speeds cannot be achieved, practitioners must consider a buffer between travel lanes and bicycle and pedestrian facilities. Curbside uses are important and may include transit and freight loading/unloading, parking (vehicles, bicycles, etc.), and other uses.

Landscaping and street trees, following ODOT placement and spacing guidelines, are appropriate in this context.

207.6 Commercial Corridor

Multimodal access to destinations must be balanced with vehicle and freight throughput. Vehicle speeds are typically 30 to 35 mph, depending on the roadway function. Medians facilitate access to commercial destinations. Demand for transit service is moderate to high due to the prevalence of commercial land use. Bicycle and pedestrian connections to transit are emphasized as part of the bicycle network. Boarding and alighting occur at the curbside. Preferred bicycle and pedestrian facilities are separated from travel lanes by a buffer.

207.7 Residential Corridor

On state-owned roadways, these streets are likely to see use from a variety of modes, with most uses related to vehicular traffic moving through the area. Vehicle speeds are typically 30 to 35 mph, depending on the roadway function. The single-use nature of this context limits the multimodal activity; however, providing bicycle and pedestrian facilities is preferred for residents. Facilities separated from travel lanes by a buffer are preferred. Consider local pedestrian/bicycle plans when designing for the Residential Corridor context. Providing appropriate enhanced crossings where desired by local communities can benefit pedestrian movement along and across the highway.

207.8 Suburban Fringe

Pay special attention to the expected future context of the roadway when determining the level of consideration paid to each mode. Speeds will generally be higher on these roadways with a range of 35 to 40 mph. Therefore, evaluate bicycle and pedestrian facilities to meet existing and future needs. Although not always possible, facilities separated from travel lanes by a buffer provide safer and more comfortable experiences for users and are the preferred choice. This context often separates rural areas from more urban contexts. A primary goal of projects in this context is to lower operating speeds through appropriate transition zones as vehicles enter more urbanized areas.

207.9 Rural Community

In this context, streets are likely to see use from a variety of modes, with most uses related to either vehicular traffic moving through the town or local community members moving throughout the community via walking, bicycling, or driving. To best serve this mix of users, encourage vehicle speeds in the range of 25 to 35 mph entering the town, potentially through the use of speed transition zones. Other design features can help inform drivers they are entering a town, such as “gateway” intersections, street trees lining the street, or other local icons/art/signs visible from the street. Pedestrian crossings of the roadway in rural towns are relatively frequent to reduce the roadway’s impact as a barrier. Designs related to sidewalks, bicycle facilities, and curbside uses reflect the need of the local community.

1 Table 200-6 Designing based on context, considering roadway designations and activity of different modes

Context	Typical Speed Ranges (MPH)[4]	Travel Lanes[2]	Turn Lanes[1,2]	Shy Distance[1,3]	Median[1,2]	Bicycle Facility[1,2,5]	Sidewalk	Target Pedestrian Crossing Spacing Range (feet)[6]	On-street parking[1]
Urban and Rural Freeways (including interstates	50-70 mph	Start with standard	Not Applicable	Start with standard	Start with standard	Generally, Not Applicable (only in specific cases)	Not Applicable	Not Applicable	Not Applicable
Grade Separated Urban and Rural Expressways	45-70 mph	Start with standard	Not Applicable for Grade Separations/ Start with standard	Not Applicable for Grade Separations/ Start with standard	Start with standard	Generally, Not Applicable (only in specific cases)	Not Applicable	Not Applicable	Not Applicable
At-Grade Urban and Rural Expressways	45-70 mph	Urban - Use Context Rural - Start With Standard	Urban - Use Context Rural - Start With Standard	Urban - Use Context Rural - Start With Standard	Urban - Use Context Rural - Start With Standard	Urban - Use Context Rural - Start With Standard See Part 900	Urban - Use Context Rural - Start With Standard See Part 800, 900	Urban - Use Context Rural - Start With Standard	Urban - Use Context Rural - Start With Standard
Rural Arterials/ Collectors/ Local Route	45-70 mph	Start with standard	Start with standard	When applicable, Start with standard	Start with standard	Start with standard	When applicable, Start with standard	When applicable, Start with standard	When applicable, Start with standard

Traditional Downtown/ CBD	20-25	Start with minimum widths, wider by roadway characteristics	Minimize additional crossing width at intersections	Minimal	Optional, use as pedestrian crossing refuge	Start with separated bicycle facility	Ample space for sidewalk activity (e.g., sidewalk cafes, transit shelters)	250-550 (1-2 blocks)	Include on-street parking if possible
Urban Mix	25-30	Start with minimum widths, wider by roadway characteristics	Minimize additional crossing width at intersections	Minimal	Optional, use as pedestrian crossing refuge	Start with separated bicycle facility, consider roadway characteristics	Ample space for sidewalk activity (e.g., sidewalk cafes, transit shelters)	250-550 (1-2 blocks)	Consider on-street parking if space allows
Commercial Corridor	30-35	Start with minimum widths, wider by roadway characteristics	Balance crossing width and operations depending on desired use	Consider roadway characteristics, desired speeds	Typically used for safety/ operational management	Start with separated bicycle facility, consider roadway characteristics	Continuous and buffered sidewalks, with space for transit stations	500-1,000	Not Applicable
Residential Corridor	30-35	Start with minimum widths, wider by roadway characteristics	Balance crossing width and operations depending on desired use	Consider roadway characteristics, desired speeds	Optional, use as pedestrian crossing refuge	Start with separated bicycle facility, consider roadway characteristics	Continuous and buffered sidewalks	500-1,000	Generally Not Applicable, Consider roadway characteristics
Suburban Fringe	35-40	Start with minimum widths, wider by roadway characteristics	Balance crossing width and operations depending	Consider roadway characteristics, desired speeds	Optional, use as pedestrian crossing refuge	Start with separated bicycle facility, consider	Continuous and buffered sidewalks	750-1,500	Not typical

			on desired use			roadway characteristics			
Rural Community	25 - 35	Start with minimum widths, wider by roadway characteristics	Balance crossing width and operations depending on desired use	Consider roadway characteristic s, desired speeds	Optional, use as pedestrian crossing refuge	Start with separated bicycle facility, consider roadway characteristics	Continuous and buffered sidewalks, sized for desired use	250-750	Consider on-street parking if space allows

[1] Design decisions consider the presence and volumes of freight and transit activity. Follow the Reduction Review Route policy and process.

[2] Design decisions must consider the existing level of access management and/or the driveway density.

[3] Shy distance: the lateral distance from the edge of the travel way beyond which a roadside object will not be perceived as an immediate hazard by the typical driver.

[4] Section 207.10, Target Speed provides the approach and strategies associated with target speed.

[5] Section 306 Part 900 provide guidance to determine appropriate bicycle facility selection.

[6] Section 307 and Part 800 provide guidance for pedestrian crossing locations and pedestrian facilities.

207.10 Speed, Context, and Design

.. Design Speed

Design speed is a selected speed used to determine the various geometric design features of the roadway. The selected design speed is consistent with the speeds that drivers are likely to expect on a given highway. The design speed of a project may have a direct impact on the cost, safety, and quality of the finished project. With the exception of local streets, the chosen design speed in rural areas should be as high as practicable to attain a specified degree of safety, mobility, and efficiency while taking into consideration constraints of environmental quality, social and political impacts, economics, and aesthetics. In urban situations, the design speed is generally equal to or, where necessary, higher than the posted speed of the particular section of roadway. When establishing a project design speed, consider land use, pedestrian needs, safety, and community livability. Care must be taken to not confuse design speed with operating speed, posted speed, 85th percentile speed, target speed, or running speed. See AASHTO's *"Geometric Design of Highways and Streets - 2018"* for a detailed explanation of each of these different kinds of speeds.

The selection of a design speed for any given project is dependent on several factors. These factors include traffic volume, geographic characteristics of an area, functional classification of the roadway, number of travel lanes, 50th and 85th percentile speeds, roadway environment, adjacent land use, context, and type of project being designed. Design speeds are generally selected in increments of 5 mph.

When selecting an appropriate design speed, the roadway section in question as well as adjacent sections to the proposed project are considered. Within the project, the chosen design speed is applied consistently throughout the section keeping in mind the speed a driver is likely to expect. This is very important when dealing with horizontal and vertical alignments, superelevation rates, and spiral lengths. For example a project with a selected design speed of 55 mph may consist of multiple horizontal curves. All horizontal curves should be designed for 55 mph along with the appropriate superelevation and spiral length for the design speed. The proper use of design speed creates consistent roadways and expectations for the driver. Due to economical or environmental reasons all curves may not be able to achieve the desired design speed. In those cases it is important that the driver be advised of the lower speed condition ahead with the use of curve warning signs.

Finally, selecting the appropriate design speed for a particular section must consider transition areas from rural to urban environments. Providing a smooth and clear transition from high rural speed conditions to urban environments is critical in controlling drivers' perceptions of the areas they are entering. These transitions alert users of the changing environment, and control vehicular speeds as they enter various urban environments. The most common and effective transitions are those that establish a different roadway culture such as sidewalks, buffer strips, and raised medians. Another common technique for transition areas is visual narrowing of the roadway. This can be accomplished with raised islands, buffer strips, and landscaping.

Although this section will primarily focus on design speed for motor vehicles, the design speed selection process is also considered for other modes such as bicycles. Design speed guidance for bicycle facilities is located in Part 900.

Selecting Project Design Speed

For all projects on state highways, the design speed is selected by the Region Roadway Manager in cooperation with Technical Services Roadway Staff. This applies to private developments only if they include any construction on the highway, other than the access itself. Where mitigation impacts the cross-section or alignment of the highway, such as a channelization, widening or striping, the design speed must be approved by the Region Roadway Manager before any permit is issued.

Design speed is integral to many other design elements. As such, selection of design speed needs to be carefully considered to determine an appropriate value. For urban locations, it may be appropriate to utilize the posted speed as project design speed. For higher speed interstate highways, freeways and other roadways in open road locations, it may be advantageous to select a design speed higher than the posted to allow for driver variability. The selected design speed for non-freeway 3R and Single Function projects is the same as the posted speed in most cases and does not require an approval. However, there may be occasions where the Region's goals for a section of roadway would call for selecting a design speed that is higher than the posted speed. In no circumstances will a design speed be lower than the posted speed and in general, design exceptions are not granted for design speed. Rather, selection of an appropriate design speed is preferred.

Additional information on specific design speeds and target speeds based on specific cross sectional information and context can be found in PART 300- Cross Section Elements.

Target Speed

Target Speed is a term and concept developed in the 2010 Institute of Transportation Engineers (ITE) publication, Designing Walkable Urban Thoroughfares: A Context Sensitive Approach and is used primarily in urban locations. ITE defined target speed as the highest operating speed at which vehicles should ideally operate on a roadway in a specific context. AASHTO has a working definition of target speed that defines it as the operating speed that the designer intends for drivers to use. For ODOT purposes, target speed is the appropriate speed at which drivers should be operating a vehicle on a section of roadway based on context, classification and overall operations. Target speed differs from design speed in that it is often an aspirational goal of a project and may be the ultimate goal for speed reduction along a roadway segment. Design speed for a project can be set at the posted speed limit, but it is not set below the posted speed limit. Depending on context, roadway operations and characteristics, target speed may be established below the posted speed limit when appropriate speed reduction is a project goal. Target speeds need to be determined with realistic goals in mind. Target speed needs to fit with the context and operational needs of a location. Setting a target speed 15 mph below the posted speed on a major, urban arterial in a Commercial Corridor context may not be realistic when considering the design element options available to achieve that much of a speed reduction. Other than a roundabout, no single design treatment will afford significant speed reduction. Research has shown speed reductions of 5 mph and sometimes as high as 10 mph can be achieved when combinations of design treatments are utilized together.

Reducing vehicle operating speeds on highways within urban areas can encourage walking and bicycling and reduce fatal and serious injury crashes. Considering the target speed (desired operating speed) and identifying strategies to achieve the desired speed are key priorities for urban projects. Understanding the relationship between the target speed, design speed, and posted speed can help practitioners consider the trade-offs from a speed perspective and how speed may influence the characteristic of the roadway and its users.

Recommendations for Target Speed

In urban locations, the target speed, the posted speed and design speed should be the same, and a roadway should encourage an actual operating speed at the target speed. This is a concept that has become known as a “self-enforcing roadway”. Ideally, the target speed is intended to be used as the posted speed limit in urban locations. When the target speed is less than the posted speed limit, project design provides appropriate speed management treatments to encourage drivers to operate at the intended target speed. If the design treatments are successful in lowering operating speeds to the target speed, then the posted speed can also be lowered to match the target and operating speeds. Table 200-7 provides recommendations for target speed in each ODOT defined urban context. It also includes a list of suggested design treatments to incorporate in project designs to aid in achieving the desired target speed.

Table 200-7 Recommended ODOT Target Speed and Design Treatments for Urban Contexts

Urban Context	Target Speed (MPH)	Design Treatments

Traditional Downtown/CBD	20-25	Roundabouts, lane narrowing, speed feedback signs, on-street parking[1], street trees[2], median islands, curb extensions, chicanes[3], textured surface, coordinated signal timing, speed tables[3], road diets
Urban Mix	25-30	Roundabouts, lane narrowing, speed feedback signs, on-street parking[1], street trees[2], median islands, curb extensions, chicanes[3], textured surface, coordinated signal timing, road diets
Commercial Corridor	30-35	Roundabout, lane narrowing, speed feedback signs, landscaped median Islands, coordinated signal timing, road diets
Residential Corridor	30-35	Roundabout, lane narrowing, speed feedback signs, landscaped median Islands, coordinated signal timing, road diets
Suburban Fringe*	35-40	Roundabouts, transverse pavement markings, lane narrowing, speed feedback signs, road diets, entry treatments
Rural Community	25-35	Roundabouts, lane narrowing, speed feedback signs, on-street parking[1], street trees[2], median islands, curb extensions, chicanes[3], speed tables[3], road diets, entry treatment

* The suburban fringe context is typically suburban adjacent to rural areas at the edge of urban development, but often is in the process of developing. For projects in the suburban fringe context zone, practitioners should consider likely future development and consider applying designs for residential corridor, commercial corridor, or urban mix contexts if this type of development is likely to occur.

[1] If on-street parking is not well utilized, the additional pavement width may increase operating speeds.

[2] When used along roadways, street trees may not reduce speeds in a specific urban context to a point where it is appropriate to have a vertical element adjacent to the roadway.

[3] Speed tables and chicanes may not be appropriate on most state roadways but may be considered in special cases.

207.11 Posted Speed

Posted speed is the legally enforceable maximum speed drivers must follow. In Oregon, posted speed limits are set based on a number of factors, including the results of a speed study. Many factors are considered when making a recommendation for an appropriate posted speed. The speed data and crash history play an integral part in determining a recommended speed. The posted speed is heavily influenced by the existing conditions, including roadway geometry, the roadside culture and development, and Oregon statutes.

As with most state transportation departments, ODOT's traditional approach for setting speed depends on the 85th percentile speed as the key factor in determining the recommended speed. The basis for using 85th percentile speeds was originally safety, since research had shown that traveling at or near 85th percentile speed was the lowest risk of crash for drivers. Newer research indicates that drivers are primarily at higher risk when driving faster than the 85th percentile. Thus, the 85th percentile speeds seem to separate the acceptable behavior from the unsafe behavior. Newer strategies are being developed to determine appropriate posted speeds that augment the 85th percentile criteria. For more detailed and current information on how posted speeds are set, consult the ODOT Speed Zone Manual.

207.12 85th Percentile Speed

The 85th percentile speed is that speed at or below which 85 percent of the drivers operate their vehicles. The 85th percentile speed assists in determining the posted speed. However, the posted speed and the 85th percentile speed may not always be the same. In some instances, where statutory speeds have been applied, the posted speed may be set below the 85th percentile speed. All non-statutory posted speeds are determined by a speed study. The designer should check with the Technical Services Traffic-Roadway Section for speed study information when using 85th percentile and posted speeds in design. Measuring the 85th percentile speed in the field can provide additional information for consideration in selecting the appropriate design and target speeds and is strongly recommended.

Section 208 Urban Arterial Design

This section provides guidance for general design and standard selection for urban arterials. Specific geometric design criteria are located in the following sections: Section 216, Design Speed; Section 217, Sight Distance; Section 218, Horizontal Alignment; Section 219, Vertical Alignment; Section 220, Combined Horizontal and Vertical Alignment; and Section 221, Grades.

State highways through urban areas are part of the state highway network and provide connectivity to rural areas and adjacent communities and urban areas. In addition, they serve as arterials for the particular community where they reside and often are the major or principal arterial in that community. This section provides information on ODOT 3R Urban Arterial design guidance followed by the ODOT 4R Urban design guidance, and the ODOT Urban 1R and ODOT Urban Single Function design guidance. Section 203 through Section 207 cover context, context determination, general design by context, and design speed for urban locations. Horizontal alignment and superelevation, vertical curvature, grades, stopping sight distance, and cross sectional design criteria are addressed in later sections. The primary function of an urban arterial is to serve major through traffic movements with a high level of mobility and provide limited land access. Arterials carry the highest traffic volumes and serve as the conduit for longer internal and external trips as well as for intra-area travel between city centers. However, arterials often traverse major city centers such as traditional downtowns, central business districts or regional commercial centers. In addition, due to existing land use and development patterns, arterials often are adjacent to areas of intense auto oriented development. These different land use designations can significantly affect the design of a particular arterial highway. Issues such as pedestrian movement, transit accommodation, bicycle facilities, freight routes, through traffic capacity, as well as the type of land use designation must all be considered when determining appropriate context and design for urban arterials. In order to address conflicts that arise when designing arterial highways in these locations, ODOT developed the six urban contexts described in sections 205 and 206, creating areas along state highways where context sensitive designs and practical solutions are needed. These six urban contexts and associated design guidance consider the 1999 Oregon Highway Plan highway segment designations and non-designated segments. Prior criteria developed for the Special Transportation Area (STA), Urban Business Area (UBA), and Commercial Center (CC) OHP designations are policy driven. As such, these areas that exist on the state highway system by designation of the Oregon Transportation Commission (OTC) must be incorporated with current ODOT urban design contexts and design criteria when they coincide with the six HDM urban contexts along a highway corridor. Current HDM urban design criteria are similar and have been derived from earlier urban criteria for STAs, UBAs and CCs. Incorporating the policy driven OHP segment designated sections into the HDM contexts for a project final design is not difficult. The segment designations need to be identified and documented with the project UDC documentation to ensure appropriate design parameters coincide with OHP policy. Since there is much overlap between the OHP segment designations policy requirements and the six urban contexts listed in the HDM, this may seem redundant. However, designs must follow design criteria and policy. Identifying design compliance with policy is an important part of project documentation.

Since arterials can traverse many different types of areas within urban growth boundaries, speed is often a major concern. Transition, design and operating speed of an arterial as it enters an urban area on the fringe, moving to areas of normal urban density and then into compact town centers, is often a challenge for a designer. However, these transition areas are often the most critical design consideration for an urban arterial as it travels through an urban area. The designer is encouraged to utilize visual cues such as landscaping, roadside amenities, visual aesthetics, and design elements to help achieve the appropriate speed transitions for these areas and roadway sections.

Another important aspect to Urban Arterial design is determining the appropriate design speed and target speed. The selection of design speed and target speed is dependent on many factors that need to be carefully considered and evaluated. Section 207 provides information on selecting design speeds that should be reviewed prior to selection of a design speed for a particular project.

208.1 Rural to Urban Transitions

One of the most important elements of arterial urban highway design is the transition area. Transition areas occur when a rural highway enters an urban area, when urban expressways enter slower speed urban centers or between other different urban environments such as between a rural area and a suburban fringe. The types and treatments of transitions will vary depending upon the type of transition.

A very common type of transition is the transition from a rural high speed highway to an urban highway. In many small communities or rural communities, the length of transition is very short. The main emphasis for a designer in these areas is to try to change the look and feel of the highway segment. This often involves establishing urban design features such as sidewalks, buffer strips, marked crosswalks, landscaping, bike lanes, raised medians, and illumination. Generally these types of features will portray to the motorist that they are entering a changing environment that is urbanized and requires slower speeds and greater attention to pedestrians, bicyclists, and transit vehicles. Designing for the context of the roadway can also include designing for the intended operating speed of a roadway segment. Speed is part of the context of a roadway. In some of these transition areas, reducing the cross section width may be an appropriate option, but is only one of many ways to help transition speeds. Changing the roadway culture, including elements outside of the roadway section, can also help to create transition areas. Any modifications of the actual cross section elements should be consistent with the design criteria for a particular urban environment and context. Many of these standards are also applicable to transitioning from a high-to-moderate speed urban expressway to other urban environments. The key message to send to motorists is that the culture and function of the highway has changed.

Transitions to downtown/central business district type of environment are very important. These areas are often very low speed and controlling operating speeds is important to the success of these areas. A recommended approach to dealing with transitions into downtown environments is the use of a “Gateway” approach. A “Gateway” is essentially a special entry that sends a message to motorists that this is a downtown environment. Features such as curb extensions, on-street parking, wider sidewalks, pedestrian scale lighting, landscaping and/or other roadside features, are good visual cues and can be incorporated into a Gateway concept. Other tools include narrow cross sections utilizing reduced shoulder, median, shy distance, and/or lane widths. Gateways should include a vertical element that helps effect a visual narrowing. There are many different options to help achieve this result.

In summary, the goal of transition areas is to affect motorists’ perceptions of the area, establish speed expectations, establish the function of the highway, and make motorists aware that something has changed. Designing effective transition areas is not always easy. Resources are available to assist with design concepts and strategies for transition areas. These include staff resources from Technical Services including Roadway, Bicycle and Pedestrian Program, and

Traffic Management units, as well as written guidance from *Main Street… When a Highway Runs Through It: A Handbook for Oregon Communities*, *DLCD/ODOT; Oregon Roadway Design Concepts, ODOT; and Metro's Street Design Guide, Creating Livable Streets - Street Design Guidelines for 2040, the NACTO Urban Street Design Guide*, as well as others.

Section 209 ODOT 3R Urban Design Standards

This section discusses the appropriate design standards for urban non-freeway arterial highway projects and is applicable to arterials, collectors, and local streets. Specific geometric design criteria are located in the following sections: Section 216, Design Speed; Section 217, Sight Distance; Section 218, Horizontal Alignment; Section 219, Vertical Alignment; Section 220, Combined Horizontal and Vertical Alignment; and Section 221, Grades.

In general the intent of 3R projects is pavement preservation with additional focus on safety items. Some of those safety items include mandatory 3R design features such as ADA curb ramps and deficient guardrail, consideration of low-cost safety mitigation measures, and in the case of urban arterials, the corrective measures located in the 3R urban preservation strategy. The Urban Preservation Strategy adds design guidance which provides statewide consistency in the urban preservation program.

A design feature not meeting the standards as specifically noted in the following areas: roadway width; bridge width; horizontal curvature; vertical curvature and stopping sight distance; pavement cross slope; superelevation; vertical clearance; ADA; or pavement design life must be upgraded or a design exception must be documented and approved. For more information on these criteria and other safety-conscious design considerations, the designer should become acquainted with *"TRB Special Report #214"*, and NCHRP Report 876 "Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects"

Once the decision is made to upgrade a roadway feature, the designer uses the *ODOT Highway Design Manual*, the AASHTO publication *"A Policy on Geometric Design of Highways and Streets"* (Green Book), the AASHTO *"Roadside Design Guide"* or *"TRB Special Report #214"*, or NCHRP Report 876 "Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects", whichever gives guidance in the particular area of need. When evaluating intersections, consider turning radius to facilitate truck movements as well as intersection sight distance.

Section 210 ODOT 4R Urban Design Criteria

As discussed previously in this Part, ODOT has developed six urban contexts for urban arterials, which include: traditional downtown/commercial business district; urban mix;

commercial corridor; residential corridor; suburban fringe; and rural community. In addition to the design guidance in Part 200, cross section design criteria have been developed and are located in Part 300 (Cross Section Elements). Each of the different urban contexts come with a recommended range of design criteria. Selecting values within the ranges of recommended guidance does not require a design exception. Appropriate values are documented in the Urban Design Concurrence Document. Going below the minimum value in the recommended guidance does require a design exception and discussion with Technical Services, Roadway staff as early as possible in the project development process is encouraged.

Guidance for Specific geometric design criteria are located in the following sections: Section 216, Design Speed; Section 217, Sight Distance; Section 218, Horizontal Alignment; Section 219, Vertical Alignment; Section 220, Combined Horizontal and Vertical Alignment; and Section 221, Grades.

Section 211 ODOT 1R and Single Function Urban Design Standards

1R and Single Function applicable design criteria and requirement for urban roadways is located in Part 300 (Cross Section Elements) as the 1R projects are typically paving only projects. Single Function projects are to use the 4R standard.

Section 212 Role of Planning Documents and Design Criteria

Coordinating planning activities with project design is critical to ensure decisions and commitments made during the planning process are incorporated into final project designs. This is particularly important in urban locations where community desires of local jurisdictions have been included in long range planning documentation. Planning documents such as corridor plans, refinement plans, regional or local transportation system plans and facility plans including Interchange Area Management Plans (IAMPs) provide valuable guidance to designers. These documents have undergone extensive public involvement to select the type and level of infrastructure improvements that address the identified problems. The designer needs to be aware of and understand the context of the recommendations contained in these planning documents when preparing project designs. Contact the Region Planning Manager and staff to help identify and interpret the information in these plans. In the case of Interchange Area Management Plans (IAMP) and other types of planned facility designs the Chief Engineer’s approval is required.

The types of plans discussed above are all plans adopted by local jurisdictions and/or the Oregon Transportation Commission. Therefore, transportation improvement projects must be consistent with these adopted plans. Design elements and features on State Highways must meet ODOT Design Standards. The Department cannot construct, fund or permit design elements or features that do not meet standard criteria unless a Design Exception has been approved by the State Traffic-Roadway Engineer. Because pertinent information may not be available in these early planning processes, exceptions to design standards are typically processed during project development and are approved in writing at that time. Similarly, any traffic control changes such as traffic signals, signing, or striping must have the written approval of the State Traffic-Roadway Engineer.

However, since Transportation Plans commonly have design elements and features of State Highways discussed in them, there are times when deviations to design standards need to be addressed during planning to ensure they are incorporated in the final project development when the planning documents are actually implemented. These design elements and features may include roadway cross-sections, centerline alignments, interchange layout configurations, bike facilities, sidewalks, shoulders, and shared use paths.

Issues corresponding to interpretation can occur when the design elements and features shown in Transportation Plans differ from those in the Highway Design Manual. Since ODOT prepared, funded or reviewed the plan, local government or the public often think that the design elements and features shown have been approved by ODOT and that ODOT will construct or allow the construction of these elements and features according to the plan. Unless a Design Exception has been previously sought, future projects linked to an adopted plan may be required to follow ODOT standards regardless of the design elements or features that may have been identified in the plan.

To avoid this problem, planning studies should follow ODOT Design Standards or seek a Design Exception, Part 1000 of the Highway Design Manual describes the Design Exception process. Below are some guidelines for inclusion of design elements and features in planning documents that include State Highways:

1. Don’t show specific dimensions for any design elements.
2. If you do show dimensions, they should be to ODOT standards.
3. For planning studies that have non-standard design elements and features that may be constructed within five years, obtain a Design Exception before incorporation of dimensions into the final plan.
4. For planning studies that have non-standard design elements and features that may be constructed within five to ten years, submit a Draft Design Exception request and obtain a written indication or concurrence that a Design Exception is warranted and would probably be approved from the State Traffic-Roadway Engineer before incorporation of dimensions into the final plan.
5. Planning documents cannot select an alternative with non-standard elements or features as the preferred alternative unless a Design Exception has been obtained or

the State Traffic-Roadway Engineer has indicated that one would probably be approved.

6. In consideration of overall safety along a highway segment, proposed cross-sections with multiple non-standard design elements should be avoided. When avoidance is not possible, the cumulative effect on operations and safety of introducing multiple non-standard elements in the same cross-section must be considered and evaluated carefully.

Planning documents are often long range. Their use is for planning land use and infrastructure options over 15 and 20-year periods of time or more. These long-term plans designate future areas of development. Designers must ensure the safety of all users when designing projects that travel through these future areas of development. Consideration should be given to long range planning efforts and how those efforts impact the proposed roadway projects. The designer should work with the Project Team, Region Planning Manager, and/or Area Manager to gain a better understanding of the planning efforts and processes completed or underway for a particular area.

Section 213 Urban and Rural Freeway Design

This section provides guidance for standards on urban and rural freeways for 3R, 4R, 1R, and Single Function design projects. Specific geometric design criteria are located in the following sections: Section 216, Design Speed; Section 217, Sight Distance; Section 218, Horizontal Alignment; Section 219, Vertical Alignment; Section 220, Combined Horizontal and Vertical Alignment; and Section 221, Grades. Cross sectional design guidance is addressed in Part 300.

The designer must be aware of which standards apply and choose the appropriate standard when dealing with freeways. The practical design strategy and design flexibility plays a role in providing guidance for the designer in project design and development. Whether a freeway project is single function, 1R, 3R, or 4R, sound engineering judgment and decision making is required. The designer, working with the project, team should keep project scope, purpose and need, and the practical design "SCOPE" values in mind when making project design decisions.

Freeways are the highest form of arterials and have full access control. The full control of access is needed for prioritizing the need for through traffic over direct access. A freeway’s primary function is to provide mobility, high operating speed, and level of service, while land access is limited. Access connections, where deemed necessary, are provided through ramps at grade separated interchanges. The major advantages of access controlled freeways are high capacity, high operating speeds, operational efficiency, lower crash potential, and safety to all highway users.

The major differences between freeways and other arterials include the following elements: grade separations at cross roads and streets; the grade separated cross road connections between the freeway and crossroad are accomplished through exit and entrance ramps; and full control of access. Expressways can be designed with both freeway and non-freeway design elements. The use of jug handle style interchanges and use of right turn channelization is not considered freeway design, but can be used in expressway design. The long term corridor and planning goals should be part of the process in whether or not to design an expressway to freeway standards. (See Section 214 for additional information on expressways and the decision to design expressways as freeways).

The Freeway 3R Design Standards apply to both urban and rural freeway conditions for preservation or Interstate Maintenance projects. All new freeways or modernization of existing freeways are to use the 4R/New standards.

213.1 ODOT 3R Freeway Design Standards

When a project on the freeway system has been classified as 3R, the standards and guidance outlined in the following sections apply. The development of a freeway 3R project should also be responsive to the considerations concerning purpose, applicability, scope, determination, and design process. The 3R standards for those specific listed elements are based on the 2016 AASHTO publication, "A Policy on Design Standards-Interstate System", which provides guidelines for work on the Interstate system. The standards provided are considered as allowable minimums. For those design elements not specifically addressed, the guidelines in the AASHTO Green Book are to be followed. 3R projects that include specific horizontal and vertical curve corrections are to use ODOT 4R standards for those curve correction design elements. In addition to these standards, Interstate Maintenance Design Features in Part 300 are to be incorporated into all interstate freeway 3R projects. The "Have To" list is the recommended minimum treatment for the listed project elements. The "Like To" list includes treatments for elements which should be considered when economically feasible, i.e. minimal extra cost, or funds available from sources other than the Preservation Program.

Technical Resources have been identified for a number of the project elements. These resources should be utilized by the Project Team to aid in determining if a "Like To" measure is warranted, cost-effective and fundable or if a design exception should be sought to do less than the "Have To" requirements. Design exceptions should be identified as soon as possible (typically during project scoping) and the appropriate design exception request officially submitted for approval as soon as all pertinent information can be determined and analyzed. Design exceptions are covered in Part 1000.

213.2 ODOT 4R Freeway Design Standards

Urban freeways generally have more travel lanes and carry more traffic than rural freeways. Urban freeways can be either depressed, elevated, at ground level, or a combination of the above mentioned. Urban freeways usually have a narrower median than rural freeways due to the high cost of obtaining right-of-way. In addition, urban freeways tend to have more connections than rural freeways but complying with interchange spacing requirements is critical to maintaining a high level of long term freeway operations.

Rural freeways are generally similar in concept to urban freeways, except that the horizontal and vertical alignments are more generous in design. This level of design is normally associated with higher design speeds and greater accessibility to right of way. Due to the nature of the facility, right of way is typically more available and less expensive in a rural setting. This allows for a wider median which improves the safety of the facility. In addition to the increase in safety of a rural freeway, the higher design speeds in a rural setting allow for greater capacity, a higher level of mobility, and potentially a reduced need for multiple lanes. Rural freeways are normally more comfortable from a driver perspective, and generally have lower maintenance costs.

213.3 ODOT 1R and 4R Single Function Freeway Design Standards

1R and 4R Single Function applicable design criteria and requirement for freeways is located in Part 300 (Cross Section Elements). 1R projects are typically paving only projects. Single Function projects are 4R projects with a very limited scope of work.

Section 214 Urban and Rural Expressway Design

Section 214 will provide 3R, 4R, 1R and single function design guidance for urban and rural expressways. Specific geometric design criteria are located in the following sections: Section 216, Design Speed; Section 217, Sight Distance; Section 218, Horizontal Alignment; Section 219, Vertical Alignment; Section 220, Combined Horizontal and Vertical Alignment; and Section 221, Grades.

Urban and rural highways can take several forms: freeways, expressways, arterials, collectors, and sometimes, local roads. Similar to urban and rural freeways, urban and rural expressways are a designation identified in the Oregon Highway Plan and mainly focus on vehicle mobility, although expressways may or may not have the high level of access control as freeways. The following is from the Oregon Highway Plan:

> "Expressways are complete routes or segments of existing two-lane and multi-lane highways and planned multi-lane highways that provide for safe and efficient high speed and high volume traffic movements. Their primary function is to provide for interurban travel and connections to ports and major recreation areas with minimal interruptions. A secondary function is to provide for long distance intra-urban travel in metropolitan areas. In urban areas, speeds are moderate to high. In rural areas, speeds are high."

Because expressways may consists of grade separated or at-grade intersections, the level of modal accommodation will vary. Speeds are often relatively high ranging from 45 to 70 mph depending on urban or rural environments.

Designing urban and rural expressway highway projects presents designers with a variety of challenges. Designers must balance the needs of autos, trucks, transit, bicyclists, and pedestrians, while considering highway function, speed, safety, alignment, channelization, right of way, environmental impacts, land use impacts, and roadside culture. Part 200 address the design standards for design speed, horizontal alignment and superelevation, vertical curvature, grades, and stopping sight distance while cross sectional design criteria are addressed in Part 300. This section will discuss a variety of issues, concerns, and areas for consideration when designing urban and rural expressways.

One critical distinction when designing a project on an urban expressway is if the section has grade-separated intersections or if intersections are at-grade.

- If the expressway section has at-grade intersections, then the six urban contexts and their respective design criteria apply to determine appropriate design decisions and the Urban Design Concurrence document is used. (Section 202 – Section 207 and Part 300)
- If the expressway section has grade-separated intersections (interchanges), then design decisions are based on freeway and higher operating speed design criteria.

214.1 ODOT 3R Urban and Rural Expressway Design Standards

The 3R expressway design guidance for urban and rural expressways are generally the same as the 3R urban and rural arterial design guidance. Part 300, provides additional information for urban expressway 3R design. In general the intent of 3R projects is pavement preservation with additional focus on safety items. Some of those safety items include mandatory 3R design features such as ADA curb ramps and deficient guardrail, consideration of low-cost safety mitigation measures, and in the case of urban expressways, the corrective measures located in the 3R urban preservation strategy.

214.2 ODOT 4R Urban Expressway Design Standards

Urban expressways are generally high-speed, limited access facilities whose function is to move both inter-urban and intra-urban traffic. Mobility is a high priority. Expressways may often serve as major freight corridors as well as being designated as an OHP Freight Route. They are often part of the National Highway System (NHS). Private property access is discouraged in favor of through mobility importance. Access is normally restricted to at-grade signalized and unsignalized public road intersections or interchanges. At-grade signalized intersections may provide full access. However, at-grade, unsignalized intersections should be considered carefully and for safety reasons, it is desirable to limit them to a right-in, right-out condition. In areas where there is no other reasonable access, private approach roads may be allowed. Private approach road connections to expressways need to be considered and evaluated carefully in order to minimize safety risks and to address driver expectancy related to the context and roadside culture and should also be limited to a right-in, right-out condition. Expressways may have a mixture of at-grade intersections and interchanges. However, the mixing of at-grade intersections with grade separated interchanges in proximity to each other should be kept to a minimum. Drivers may become confused in their perception of expectations at the different connection styles causing undesirable actions on their part as they interact with other vehicles entering or leaving the roadway. Some expressways may become freeways in the future and therefore should be designed, operated, and managed at the highest level to ensure long-term operations. The transitioning of urban roadways to expressways should take into account the long-term plan for the roadway, which can impact the design of the facility.

214.3 ODOT 4R Rural Expressway Design Standards

Expressways are designated by the OTC. They are allowed on statewide, regional and district classified highways. Expressways are generally high speed, limited access facilities whose main function is to provide for safe and efficient high speed and high volume traffic movements. Expressway designation is not limited to multi-lane roadways. Rural two-lane highways can also be designated as expressways. The Dalles-California Highway (US 97) in Central Oregon is an example of a designated expressway that includes both multi-lane sections and two-lane sections. The primary function of rural expressways is to provide connections to larger urban areas, ports, and major recreational areas with minimal interruptions. Rural expressways may also serve as major freight corridors or may be located on Freight Routes. Private access is discouraged and public intersections are highly controlled. Rural expressways may utilize at-grade intersections or grade separated interchanges. However, the mixing of at-grade intersections with grade separated interchanges in proximity to each other should be kept to a minimum. Drivers may become confused in their perception of expectations at the different connection styles causing undesirable actions on their part as they interact with other vehicles entering or leaving the roadway. Some expressways may become freeways in the future and therefore should be designed, operated, and managed at the highest level to ensure long-term operations. The transitioning of rural roadways to expressways should take into account the long-term plan for the roadway, which can impact the design of the facility.

High level roadways, although classified as expressways, may operate more as a freeway. These expressways have grade separations in place of at-grade intersections and are fully access controlled. When high level expressways meet the operational definition of freeways, the expressway should be designed with freeway standards. This means many of the design elements such as left turn lanes, striped medians, and right turn lanes would not apply.

214.4 ODOT 1R and Single Function Urban and Rural Expressway Design Standards

1R and Single Function applicable design criteria and requirement for expressways is located in Part 300 (Cross Section Elements) as the 1R projects are typically paving only projects. Single Function projects are to use the 4R standard.

Section 215 Rural Arterial, Collector, and Local Route Design

This section provides guidance for general design of Rural Arterial, Collector, and Local Routes on 3R, 4R, 1R, and Single Function design projects. Specific geometric design criteria are located in the following sections: Section 216, Design Speed; Section 217, Sight Distance; Section 218, Horizontal Alignment; Section 219, Vertical Alignment; Section 220, Combined Horizontal and Vertical Alignment; and Section 221, Grades. Cross sectional design criteria are addressed in Part 300.

Rural highways make up a large percentage of the state highway mileage. Rural highways cover the widest range of geographical and topographical conditions. Rural highways connect all parts of the state to each other. Rural highway designs should provide the safest cost effective solutions. This chapter also discusses how to design highways that are Scenic Byways and highways that travel through the many rural communities located throughout the state.

The arterial road systems provide a high speed and high volume travel network between major points in urban and rural areas. Rural arterials consist of a wide range of roads, from multi-lane rural expressways to low volume, two lane roads. Most rural state highways in Oregon are functionally classified as arterials as they serve the greatest traffic volumes and provide critical connections to the larger urban areas, ports, multi-modal facilities, and recreational areas.

However, some state highways serve very low volumes of traffic and are classified as collectors or local roads. The design standards and guidelines contained in this chapter are only to be used for non-freeway rural highway design. Rural freeway design is covered in Part 600.

215.1 ODOT 3R Rural Arterial, Collector, and Local Route Design Standards

This section discusses the appropriate design standards for rural non-freeway highway projects and is applicable to arterials, collectors, and local streets. In general the intent of 3R projects is pavement preservation with additional focus on safety items. Some of those safety items include mandatory 3R design features such as ADA curb ramps and deficient guardrail, consideration of low-cost safety mitigation measures.

Non-freeway 3R projects should be developed in line with the SCOPE values of Practical Design presented in Part 100. A feature not meeting the standards as specifically noted for roadway width, bridge width, horizontal curvature, vertical curvature and stopping sight distance, pavement cross slope, superelevation, vertical clearance, ADA, or pavement design life must be upgraded or a design exception must be documented and approved. For more information on these criteria and other safety-conscious design considerations, the designer should become acquainted with TRB Special Report #214-"Designing Safer Roads-Practices for Resurfacing, Restoration, and Rehabilitation".

Once the decision is made to upgrade a roadway feature, the designer should use the ODOT Highway Design Manual, the AASHTO Green Book, TRB Special Report #214, or NCHRP Report 876 "Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects", whichever gives guidance in the particular area of need. When evaluating intersections within a 3R project, turning radius to facilitate truck movements should also be considered as well as intersection sight distance.

215.2 ODOT 4R Rural Arterial, Collector, and Local Route Design Standards

.. ODOT 4R Rural Arterial Design Standards

Most rural state highways are classified as arterial roadways. Appendix A contains a listing of the functional classification of all state highways. Corridor Plans, and county Transportation System Plans (TSPs) also need to be reviewed to ensure that the highway classification is correct. Where discrepancies exist between the tables in Appendix A and the classifications assigned by a Corridor Plan or TSP, the higher classification is used. The context must also be considered. Some rural highways with less than 5000 ADT are classified as rural arterials, yet go through small cities with a posted speed of 25 to 30 mph. In these locations, urban standards are appropriate and careful consideration must be given to the transition from a high to low speed environment. Section 216 through Section 221 provides ODOT 4R/New Rural design standards for the design of reconstruction and new construction projects on rural highways.

ODOT 4R Rural Collector Design Standards

Collectors serve two very important functions. First collectors provide mobility to and from the arterial streets. Second, collectors provide land access to abutting properties. Due to their dual purpose, collectors have mobility characteristics that are just below those of an arterial and just above those of a local street.

The design elements of collector roads are similar to the design elements of arterials, although typically the range of values is slightly less demanding. Design speeds are normally lower than those for arterials, steeper grades are allowed, and lane and shoulder widths are generally narrower.

The different design standards for rural collectors can be found in Section 216 through Section 221. Additional information on collectors can found in Chapter 6 of the AASHTO Green Book.

ODOT 4R / New Local Rural Route Design Standards

A rural local route's primary function is to provide access to rural areas. Local routes account for a very large proportion of the roadway mileage in the State. Local routes normally carry very low volumes; therefore, design standards for local routes are generally lower than those standards for collectors and arterials. Design speeds are lower, steeper grades are allowed, and travel lanes and shoulder widths are narrower.

Additional information on rural local routes can be found in Chapter 5 of the AASHTO Green Book.

215.3 ODOT 1R and Single Function Rural Arterial, Collector, and Local Route Design Standards

1R and Single Function applicable design criteria and requirement for rural arterials, collectors, and local routes is located in Part 300 (Cross Section Elements) as the 1R projects are typically paving only projects. Single Function projects are to use the 4R standard.

Section 216 Design Speed

216.1 ODOT 3R Urban and Rural Design Speed-All Highways

The design speed for 3R projects will generally be the posted speed, but consideration of context, environment and existing features resulting in the selection of other than the posted speed as the design speed should be given. The intent of a 3R project is to preserve the existing pavement by resurfacing or rehabilitating the roadway, extend the service life of the facility, and consider safety enhancements. General federal guidance notes that the geometric design should be consistent with speeds implied by the posted or regulatory speed. With the design speed being equal to the posted speed, drivers will be able to operate at the posted speed without exceeding the safe design speed of the facility. There may also be occasions where the Region's goals for a section of roadway would call for selecting a design speed that is higher than the posted speed.

216.2 ODOT 4R Urban and Rural Freeway Design Speed

In general, the design speed of freeways should be similar to the desired running speed during off peak hours, keeping in mind a reasonable and prudent speed. In some urban areas, with populations under 50,000, the posted freeway speed is 65 mph. In more densely populated urban areas (over 50,000), the posted speed is 55 or 60 mph, or in constrained areas, 50 mph. Because of the different posted speeds the design speed chosen may vary. In many urban areas the amount of available right of way can be restricted and achieving high design speeds can be very costly. In balancing the need for safety and providing a high speed facility with consideration for right of way costs, the design speed for urban freeways shall be a minimum of 50 mph. A 50 mph design speed may only be used in very constrained urban corridors or in mountainous terrain, and the design speed must be consistent with the corridor and meet driver expectancy. On most urban freeway corridors, a design speed of 60 mph can be provided with little additional cost. In situations where the corridor is relatively straight and the character of the roadway and location of interchanges permit a higher design speed, 70 mph should be used.

For rural freeways the design speed is 70 mph, except that in mountainous terrain, a design speed of 50 to 60 mph may be used. The design speed must be consistent with the corridor and meet driver expectancy.

Rural freeways outside of mountainous terrain generally have higher design speeds. Normally right of way is more available in rural locations allowing for more generous horizontal and vertical alignments. These higher design speeds allow for increased volumes and capacity while providing a safe facility and a more comfortable driving environment. Increased capacity leads to improvements to the level of mobility standards and a facility that will operate longer than a lower design speed urban freeway. For all freeway projects, the design speed is to be selected by the Region Roadway Manager in cooperation with Technical Services Roadway staff.

Other sections discuss design speed selection for the design of 3R, 1R, and Single Function projects. Table 200-8 provides suggested design speed values for various roadways.

216.3 ODOT 4R Urban Expressway Design Speed

The design speed of an expressway is a critical element for determining the appropriate standard to be applied to a given segment. Expressways are usually high-speed roadways and should be designed appropriately. Most urban expressways should be designed based upon a 55 mph design speed or higher. In more restrictive urban environments, a 50 mph design speed may be more appropriate. A 45 mph design speed may be considered only in highly constrained areas and retrofit situations. Several factors including planned operating speeds, amount of access control, use of at-grade intersections, use of grade separations and topography play major roles in determining the appropriate design speed. Some Urban Expressways may have the look and feel of a Freeway. In these instances, it is important to recognize the context and resultant driver expectation. Table 200-8 provides suggested design speed values for various roadways.

216.4 ODOT 4R Rural Expressway Design Speed

Rural expressways carry high speed and high volume traffic and should be designed accordingly with the function of the facility. Rural expressway design speeds should be designed for a minimum 50 mph design speed in mountainous areas, 60 mph in rolling terrain, and 60 or 70 mph in flat terrain. Expressways may in time evolve into freeways and the chosen design speed should allow for that facility type transition. Table 200-8 provides suggested design speed values for various roadways.

216.5 ODOT 4R Rural Arterial

Rural arterials have a wide range of design speed depending on the terrain, traffic volume, location of facility, and driver expectancy. Design speeds range from 45 mph in mountainous terrain and low volume to 60 or 70 mph on level terrain. A 60 mph design speed works well for most of Oregon’s rural two lane highways. In general design speeds on level terrain range from 60-70 mph; rolling terrain design speeds in rural areas range from 50-60 mph; and mountainous terrain design speeds range from 45-50 mph. A 45 mph design speed in mountainous terrain or a 50 mph design speed in rolling terrain would only apply where the traffic volumes are low. The design speed in rural communities will vary according to community characteristics. Rural arterials also traverse rural towns and communities. In these areas, determine design speed based on adjacent land use, community needs and overall operations. Table 200-8 provides suggested design speed values for various roadways.

216.6 ODOT 4R Rural Collector and Local Route Design Speed

The ODOT 4R Rural Collector and Local Route Design Speed requirements can be found in Table 200-8.

216.7 ODOT 4R Urban Arterial Design Speed

With the recent development of the Blueprint for Urban Design, ODOT developed a relationship between target speed, design speed, posted speed, and the operating speed of an urban roadway in an effort to provide direction for ODOT urban arterial design speeds. Design and speed management treatments were developed to help achieve the range of target speeds for the urban contexts. Table 200-8 below provides the guidance for design speeds for various roadway types and includes urban arterials. The goal is for the design speed, posted speed, and target speed to be the same in most urban locations, but in no case, can the design speed of urban arterials be less than the posted speed. As an aspirational goal, target speed may be shown below posted when speed reduction is defined as a project goal. Additional information on target speed and recommendations for design speed/target speed is discussed in Section 207.10, Speed, Context and Design. Table 200-8 below provides suggested design speed values for various roadways.

Table 200-8 Design Speed Selection

	DESIGN SPEED			
Terrain	**Flat**	**Rolling**	**Mountainous**	**Urban**
FUNCTIONAL CLASSIFICATION/CONTEXT				
Freeway	70	70	50-70	50-70
Urban Expressway	45-70			

Rural Expressway	50-70	
Rural Arterial	45-70	
Rural Collector	45-70	
Rural Local Route	45-50	
ODOT URBAN CONTEXTS	**DESIGN SPEED/TARGET SPEED**	
Traditional Downtown/CBD	20-25	Speeds shown for Urban Contexts are considered aspirational "target speeds" anticipated for each context. Actual selected project design speed shall not be less than posted speeds. In cases where desired target speed is less than posted speed, design speed is set at posted speed and design treatments are employed to reduce operating speed.
Urban Mix	25-30	
Commercial Corridor	30-35	
Residential Corridor	30-35	
Suburban Fringe	35-40	
Rural Community	25-35	

Section 217 Sight Distance

217.1 General

Sight distance is unobstructed distance of roadway ahead visible to the driver. There are multiple types of sight distance that include stopping sight distance, passing sight distance, decision sight distance and intersection sight distance. It is critical that sight distance issues be properly developed and applied to projects. Required stopping sight distance is shown in Table 200-9. Figure 200-16 indicates how sight distances are measured.

Check horizontal sight distance when designing slopes and retaining walls or where median barriers raised medians, center piers, structure screening or screen plantings are used. Combinations of slight horizontal curvature with crest vertical curves may seriously diminish sight distance where high curb or planting is used. Set slopes, walls and other side obstructions back from the pavement edge to provide at least minimum stopping sight distance for a driver in the traffic lane nearest the obstruction. Take into consideration the possibility of future conversion of shoulders or parking areas to driving lanes.

For intersections at grade, a vehicle entering the highway from a side street or access must be able to clearly see a vehicle throughout the sight triangle based on minimum stopping sight distance and preferably intersection sight distance for the design speed. It is desirable to provide sufficient sight distance so that the entering vehicle may cross or make a turn without significant slowing of the through traffic. On high speed, high volume roadway intersections, providing intersection sight distance, rather than the minimum stopping sight distance, will minimize operational and safety problems. Horizontal sight distance, as measured 2 feet above the centerline of the inside lane at the point of obstruction, must at least equal the stopping sight distance. This assumes there is little or no vertical curvature. When the normal cut bank reduces the horizontal sight distance below the stopping sight distance for the design speed, the cut bank is flattened or benched.

Vertical curves designed to the minimum stopping sight distance may need to be flattened to obtain intersection sight distance, passing sight distance, etc. All forms of sight distance must be checked and provided for as appropriate.

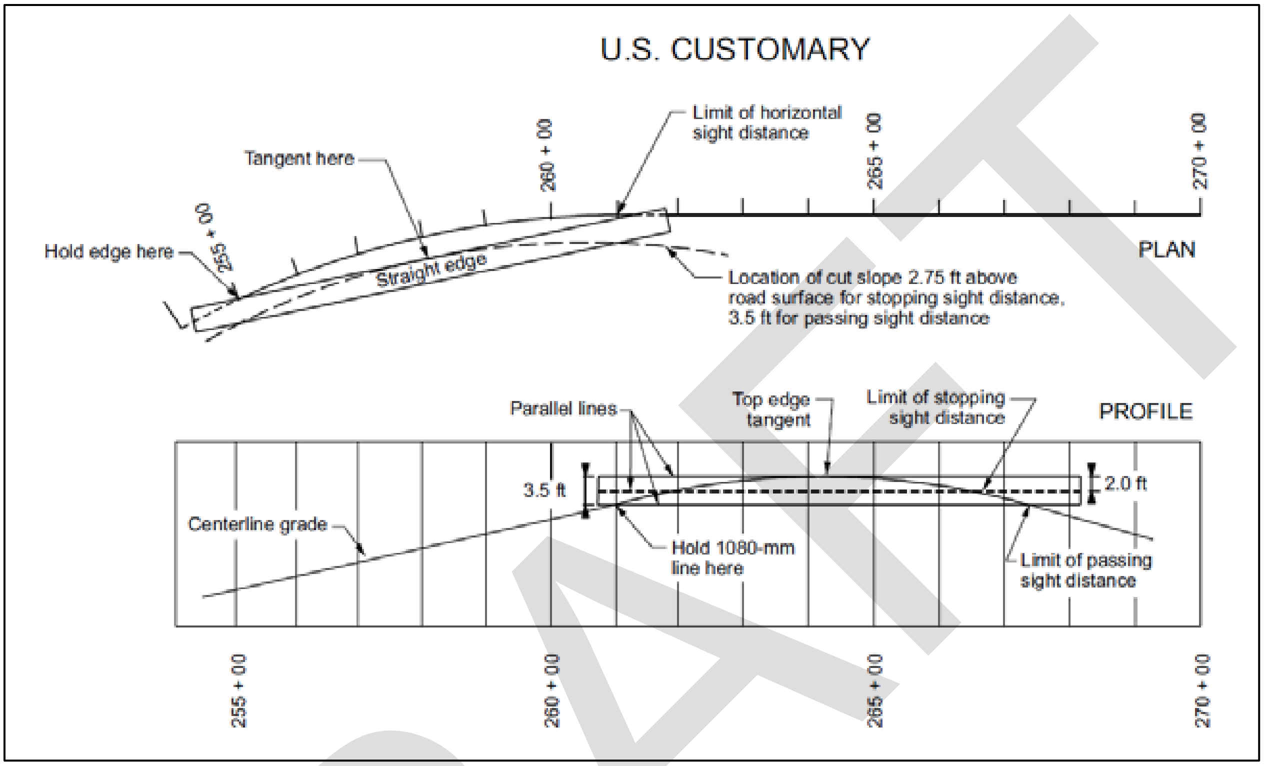
217.2 Stopping Sight Distance

Stopping sight distance is the minimum distance required for a vehicle traveling at a particular design speed to come to a complete stop after an obstacle on the road becomes visible. Stopping sight distance is normally sufficient to allow an alert and prudent driver to come to a hurried stop under normal circumstances. Stopping sight distance is measured from the driver's eye (assumed to be 3.5 feet above the roadway surface) to an object 2 feet above the roadway surface. Stopping sight distance is the summation of two distances: the distance traveled by a vehicle from the time the driver sees an object that requires a stop to the instant the brakes are applied, and the distance required to stop the vehicle from the time the brakes are applied. These two distances are called brake reaction distance and braking distance. Table 200-9 contains the stopping sight distance standards.

Stopping sight distance must, at a minimum, be obtained on all vertical and horizontal alignments. Figure 200-51 shows the minimum stopping sight distance requirements for crest and sag vertical curves (See Part 600, Table 600-4 for sight distance on ramps). Figure 200-17 indicates the minimum stopping sight distance for horizontal curves. Care must be taken to ensure that these minimum distances are obtained in project design. Roadside elements such as cut slopes, guardrail, tunnels, retaining walls, bridge rail, and barriers can obstruct the view of the driver and must be properly located to ensure that proper stopping sight distance is achieved. As noted previously, other types of sight distance may control in a design. For example, it would be desirable to flatten a crest vertical curve in order to provide full intersection sight distance from a side street.

Highway grades can have a significant effect on stopping sight distances. Refer to Figure 200-16 or Figure 3-1 on page 3-4 of the 2018 AASHTO Green Book, for more information about the effects of grades on stopping sight distances, See Table 3-2 on page 3-6 of the 2018 AASHTO Green Book.

Figure 200-16: Determining Stopping Sight Distance



Source: AASHTO 2018

Table 200-9: Stopping Sight Distance

Design Speed	Stopping Sight Distance
25 mph	155 ft.
30 mph	200 ft.
35 mph	250 ft.
40 mph	305 ft.
45 mph	360 ft.
50 mph	425 ft.
55 mph	495 ft.
60 mph	570 ft.
65 mph	645 ft.
70 mph	730 ft.

Source: 2018 AASHTO

217.3 Decision Sight Distance

Many times the elements of the roadway become complex and require additional distances for drivers to make the proper maneuver. Stopping sight distance may not be adequate when drivers must process complex roadway information in an instance or when the roadway information is difficult to decipher or unexpected. Endeavor to provide decision sight distance at locations where multiple information processing, decision making, and corrective actions are needed. Sample locations where decision sight distance is needed include unusual intersection or interchange configuration and lane drops. If site characteristics allow, locate these highway features where decision sight distance can be provided. If this is not practicable, use suitable traffic control devices and positive guidance to give advanced warning of the conditions. Work with the Region Traffic Engineer on the need for decision sight distance at certain locations - also if there is need for additional signing, illumination, etc. Decision sight distance is calculated using the 3.5 foot eye height and the 2 ft object height that is also used for stopping sight distance. Pages 3-7 thru 3-9 of the AASHTO Green Book provide more information on decision sight distance.

217.4 Intersection Sight Distance

Obtaining intersection sight distance is important in the design of intersections. Intersection sight distance is considered adequate when drivers at or approaching an intersection have an unobstructed view of the entire intersection and of sufficient lengths of the intersecting highways to permit the drivers to anticipate and avoid potential collisions. Sight distance must be unobstructed along both approaches at an intersection and across the corners to allow the vehicles simultaneously approaching, to see each other and react in time to prevent a collision. Intersection sight distance is determined by using a 3.5 foot eye height and a 3.5 foot height of object.

It is desirable to provide intersection sight distance at every road approach, whether it is a signalized intersection or private driveway. In no case is the sight distance to be lower than stopping sight distance. On high speed, high volume roadway intersections, providing intersection sight distance, rather than the minimum stopping sight distance, will minimize operational and safety problems.

When reviewing intersection sight distance, items such as building clearances, street appurtenances, potential sound walls, landscaping, on-street parking and other roadway elements must be taken into consideration in determining and obtaining the appropriate sight distance at intersections. Railroad and rail crossings are treated in the same manner as roadway intersections in determining intersection sight distance for the vehicle crossing the tracks. For placement of trees within the intersection sight distance triangle, see Part 300.

Pages 9-35 through 9-59 of the AASHTO Green Book indicate intersection sight distance for traffic turning left, crossing, or turning right onto a major highway. While it is desirable to obtain intersection sight distance at all intersections, in no case is the sight distance to be less than stopping sight distance.

217.5 Passing Sight Distance

Passing sight distance is the minimum distance required for a vehicle to safely and comfortably pass another vehicle. An assumption made for passing sight distance includes the passing vehicle accelerating to a speed of 10 mph above the vehicle being passed and the oncoming vehicle not reducing speed. A 3.5 foot height of eye of the passing vehicle and 3.5 foot height of object are used for measuring passing sight distance. If adequate passing sight distance opportunities cannot be accommodated in the project design, passing lanes or climbing lanes are desirable. Work with the Region Traffic Engineer on locations for passing opportunities, or passing or climbing lanes. Pages 3-10 thru 3-17 of the AASHTO Green Book provide more information on passing sight distance.

Section 218 Horizontal Alignment

218.1 General

The horizontal alignment of a highway affects vehicle operating speeds, sight distances, passing opportunities and highway capacities. Decisions on alignment also have a major impact on the cost of a project. To provide a consistent alignment, avoid sudden changes from tangents and gentle curves to sharp curves.

Check the combination of horizontal alignment and sight obstructions. Analyze horizontal curves through cut areas, through tunnels, and at intersections with minimum building set-backs to determine that stopping and intersection sight distances are met. Figure 200-17 provides design speed, stopping sight distance, and line of sight requirements for horizontal curves.

218.2 Urban Non-Freeway Horizontal Alignment

Controlling vehicle speed in urban corridors is important when balancing project design for all road users. The six ODOT urban contexts each have a defined target speed range appropriate for project design goals. One aspect in project design that aids in controlling vehicle speed is the roadway alignment. In new construction and to some degree in roadway reconstruction, the designer has control of potential alignment options and decisions that affect potential speed profiles. However, since much of ODOT's urban design work is along established corridors, alignments have already been established with existing built environments surrounding them. When corridor alignments were originally established, the areas may have been more rural in context, but over time, the adjacent properties redeveloped and the roadside context changed. In these locations, designers often have limited ability to make significant, if any, changes to the existing alignment and alternative methods of speed control are applied to achieve the desired target speed.

218.3 3R Freeway Horizontal Curvature and Superelevation

Horizontal alignment, superelvation, and superelevation transition shall meet the minimum standards outlined in the AASHTO Green Book. Existing non-spiraled alignments are allowed as long as AASTHO transition design control requirements (tangent-to-curve transition) are met. ODOT 4R standards are to be used for horizontal and vertical curve corrections.

Because of terrain and high design speeds, rural freeways should have very gentle horizontal and vertical alignments. In rural areas, the designer should be able to create a safe and efficient facility while taking into consideration the aesthetic potential of the freeway and surrounding terrain. Most freeways are constructed near ground level and the designer should take advantage of the existing topography to create not only a functional freeway, but also one that looks and drives well and fits into the existing topography.

218.4 3R Rural Arterial Horizontal Curvature and Superelevation

Alignment improvements to horizontal curvature and superelevation can be as cost effective as lane and shoulder width improvements. Evaluate reconstruction of the horizontal alignment when the speed inferred by the existing curvature is more than 15 mph below the project design speed, and the current year ADT is 2000 or greater. When reconstruction of the horizontal alignment is not justified, apply appropriate mitigation measures such as those listed in Part 300, Section 311. Correction of the superelevation should be applied if the comfort speed of the curve is lower than the project design speed. If the comfort speed exceeds the project design speed, maintain the superelevation unless there is a justifiable reason to change it.

218.5 3R Urban Arterial Horizontal Curvature and Superelevation

Each horizontal curve should be evaluated for design sufficiency compared to the ODOT Urban Standards. Deficient curves should be evaluated against criteria below to determine what level of corrective action, if any, is appropriate.

Evaluate reconstruction of horizontal curvature when the design speed of the existing curve is more than 15 mph below the project design speed, and the current year ADT is 2000 or greater. When curve reconstruction is not justified, appropriate mitigation measures such as those listed in Part 300, Section 312 should be applied. Correction of the superelevation should be applied if the comfort speed of the curve is lower than the project design speed. If the comfort speed exceeds the project design speed, the superelevation should be maintained unless there is a justifiable reason to change it.

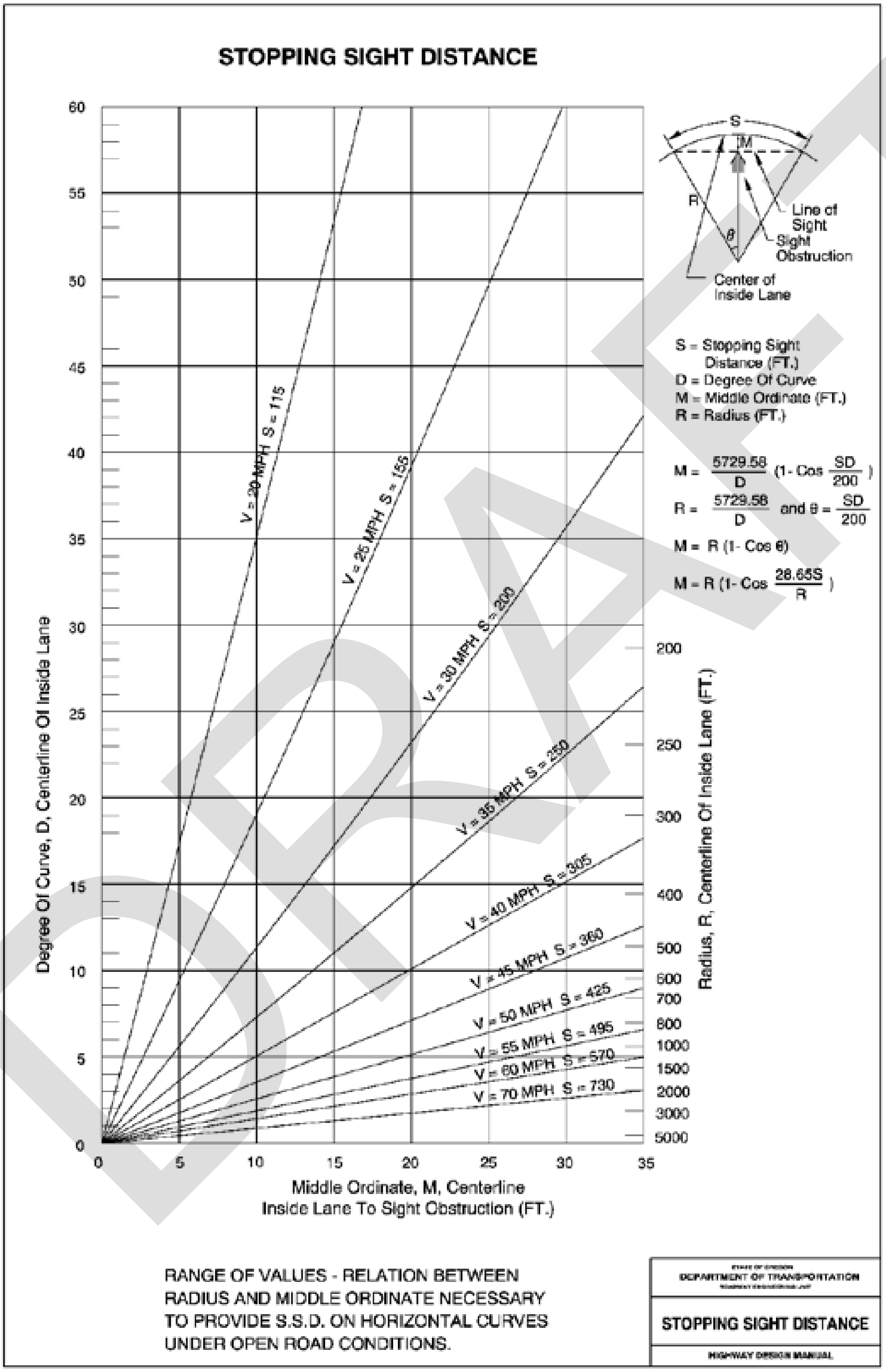
218.6 4R Horizontal Curvature (All Highways)

Curve calculations are based on the arc definition for a circular curve. Minimum degree of curvature can be found in Table 200-10 (Open Road), Table 200-11 (Urban) and Table 200-12 (Suburban). Sufficient curve length must be used to prevent the appearance of a "kink" in the alignment. For small deflection angles, a minimum arc length of 15 times the design speed is required. For larger deflection angles where spiral transitions are required, the minimum arc length of the simple curve is 50 ft. An angle point is considered a curve with an arc length of zero, and therefore, does not meet the minimum standard.

Compound curves are adjoining curves in the same direction with differing degrees of curvature. They may be used where necessary with an intermediate spiral segment. Design the spiral segment to provide an "a" value equal to or less than the standard spiral for the sharper curve. See Part 600 for spiral segments. The “a” value is a measure of the rate of change of the curvature. (Change in Degree of curve x 100 / length of spiral).

Broken back curves are curves in the same direction connected with a short segment of tangent. It is desirable to avoid the use of broken back curves. When the use of a broken back alignment cannot be avoided, design the tangent section so that all travel lanes slope in the same direction as the superelevation of the curves. This avoids the introduction of two flat spots on the travel lane toward the outside of the curves and prevents the development of a dip on the edge of the pavement that can affect driver comfort and drainage (See Figure 200-19). Generally this treatment is required when the length of the tangent is 500 feet or less.

Figure 200-17: SSD on Horizontal Curves



218.7 Spirals

Spirals provide a transition between tangents and curves and between circular curves of substantially different degrees of curve (spiral segment). The natural path of a vehicle entering a curve is to drive a spiral. Spirals also provide a location for developing superelevation. Standard spiral lengths are based on the number of lanes being rotated and the super rate for the curve. Apply spirals to all curves of 1° or sharper. This applies to secondary as well as to primary highways. Curves with a degree of curve flatter than 1° are not required to be spiraled. It is recommended that spirals be used for curves with a degree of curve flatter than 1° to assist in developing the superelevation runoff. When designing an unspiraled curve, refer to Figure 200-20. Longer spirals than the standard may be used wherever advantage in their use is apparent. Many existing alignments on the highway system include longer than standard spirals and operate very well. Consider using longer spirals appropriate for a section with additional lanes when future widening is anticipated. The standard spiral lengths for typical design speeds in open road, urban, and suburban settings are presented in Table 200-10, Table 200-11 and Table 200-12. The minimum spiral length for any curve not covered by these tables can be calculated using the three formulas also presented on Table 200-10, Table 200-11 and Table 200-12. Note that the spiral lengths presented in the tables are based on the formulas and then adjusted to provide a consistent progression in the “a” value. The “a” value is a measure of the rate of change of the curvature. (Change in Degree of curve x 100 / length of spiral). This results in a consistent feel for the driver. Spiral lengths are normally rounded up to the nearest 5 ft.

Design exceptions are required when using spirals that are less than standard. Using longer spirals than standard does not require an exception. Using unequal spiral lengths is not an exception if both meet or exceed standards. This arrangement is most commonly found on ramps. Designers always need to consider potential operational effects and the roadway context in making alignment decisions.

Prior versions of design standards were based on using inside edge super rotation. Current standards allow for using other rotation points when developing superelevation.

Ramp profile grades are typically carried at the ramp alignment and rotated about that point.

It's common for ramp alignments in the "terminal area" (where the ramp meets the crossroad) to have a spiral on one end only. The portion of the curve closest to the crossroad typically has to have reduced or no super in order to get intersection grades to work. A spiraled alignment in this situation isn't usually too beneficial. See Part 600 for additional information. An exception is not required for this situation.

The minimum length of the simple curve between spirals is 50 feet. At times it may be appropriate to install a spiral segment to transition from one central curve to another central curve. These are called compound curves. The spiral segment assists in providing a smooth transition between two curves in close proximity to each other. Back to back spirals between reversing curves are permissible.

The type and locations of the facility (urban or rural in nature) will dictate the proper combination of curve, spiral, and superelevation rate.

On some low speed non-superelevated roadways, the use of spirals may not be warranted. In addressing the six urban context for urban arterials, the lack of spirals and/or reduced superelevation rate or the use of a crown section may be warranted in these environments in providing designs flexibility and urban context. Designing such roadways without spirals and standard superelevation requires a design exception.

218.8 Superelevation and Methods for Developing Superelevation

The standard method of developing superelevation runoff is shown in Figure 200-20 and Figure 200-22. The standard method of superelevation development for ODOT is rotation around the profile grade. The profile grade is normally carried along the centerline or the low side edge of travel. Other options as shown in Figure 200-21 are also available. Where the grade is 4% or greater, the superelevation is developed according to Section 221. When the super is rotated about centerline, ensure the design doesn't create a low spot on the inside of the curve where ponding can occur. For flat curves with a degree of curve less than 0° 30' superelevation is typically not required. In the design of runoff, the use of multiple line profiles is suggested. Multiple line profiles are especially useful in situations where grade controls at road approaches, building elevations or interchange designs are encountered.

When a horizontal curve has less than 200 feet of main circular curve, the superelevation along the main curve is determined by joining the runoffs in the center of the curve and using a continuous vertical curve of a length equal to twice the length of the main curve, with a minimum vertical curve length of 200 feet.

On multi-lane divided highways, each direction may have an independent alignment. In these situations, the superelevation for one direction may be developed independent of the other to minimize run-out lengths. Each direction follows the superelevation rules contained in this section for the number of lanes on each alignment.

When the tangent distance between reversing curves is less than 400 feet, adjust the runoff of the superelevation so that the edges of pavement and the centerline fall on a uniform grade between the Point of Curve to Spiral (PCS) of the first curve and the Point of Spiral to Curve (PSC) of the second curve. (See Figure 200-20).

Standard superelevation applies on climbing lanes, when climatic conditions warrant it, a design exception for reduced superelevation may be granted for a climbing lane on the high side of a curve.

Use Table 200-10 to determine proper superelevation and spiral lengths for freeways and rural highways. For design speed other than shown, determine the superelevation by interpolation and calculate the spiral length. This table is also used for constrained rural mountainous locations.

Table 200-10 also applies to freeways and rural areas where snow and ice conditions prevail. Elevations over 3000 feet can be considered where snow and ice prevail. Other locations, such as the Columbia River Gorge may be considered for discussion as a snow and ice area. In these areas, avoid using a degree of curve that would normally be designed with a superelevation greater than 8%. For example, if the design speed is 70 mph, the maximum degree of curve where snow and ice prevail would be 3 degree. If a sharper curvature must be used, the superelevation may be held at 8% with the understanding that the curve would have a “comfort speed” lower than the design speed and may need to be posted with a speed rider. In this situation, the comfort speed table (Table 200-13) can be used to determine the comfort speed of any curve at 8% superelevation. Limiting the superelevation to 8% on roadways where snow and ice prevail requires a design exception. It is generally not appropriate to limit the superelevation to anything less than 8% on a rural highway as that may compromise safety and operations during warmer times of the year.

Use Table 200-11 for ODOT urban context locations where design speeds range from 25-40 mph and the maximum superelevation rate is 4%. Use the suburban superelevation and spiral lengths table (Table 200-12) for transition areas between urban/suburban and rural areas and design speeds range from 45-55 mph, with a maximum superelevation rate of 6%. This table may also be appropriate for the suburban fringe context and also rural community context where design speeds range from 45-55 mph.

Table 200-10: Open Road Superelevation & Spiral Lengths

		70 mph									60 MPH									50 MPH									
D	R	e	L1	L2	L3	L4	L5	L6	L7	L8	e	L1	L2	L3	L4	L5	L6	L7	L8	e	L1	L2	L3	L4	L5	L6	L7	L8	D
0°30'	11459.16	2.0	-	-	-	-	-	-	-	-	NC	-	-	-	-	-	-	-	-	NC	-	-	-	-	-	-	-	-	0°30'
0°35'	9822.13	2.0	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	NC	-	-	-	-	-	-	-	-	0°35'
0°40'	8594.37	2.5	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	NC	-	-	-	-	-	-	-	-	0°40'
0°45'	7639.44	3.0	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	NC	-	-	-	-	-	-	-	-	0°45'
0°50'	6875.49	3.0	-	-	-	-	-	-	-	-	2.5	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	0°50'
0°55'	6250.45	3.5	-	-	-	-	-	-	-	-	2.5	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	0°55'
1°00'	5729.58	3.5	205	310	410	515	615	720	820	925	3.0	175	265	350	440	525	615	700	790	2.0	145	220	290	365	435	510	580	655	1°00'
1°05'	5288.84	4.0	205	310	410	515	615	720	820	925	3.0	175	265	350	440	525	615	700	790	2.5	145	220	290	365	435	510	580	655	1°05'
1°10'	4911.07	4.0	205	310	410	515	615	720	820	925	3.5	175	265	350	440	525	615	700	790	2.5	145	220	290	365	435	510	580	655	1°10'
1°15'	4583.66	4.5	205	310	410	515	615	720	820	925	3.5	175	265	350	440	525	615	700	790	2.5	145	220	290	365	435	510	580	655	1°15'
1°20'	4297.18	4.5	205	310	410	515	615	720	820	925	4.0	175	265	350	440	525	615	700	790	3.0	145	220	290	365	435	510	580	655	1°20'
1°25'	4044.41	5.0	205	310	410	515	615	720	820	925	4.0	175	265	350	440	525	615	700	790	3.0	145	220	290	365	435	510	580	655	1°25'
1°30'	3819.72	5.0	205	310	410	515	615	720	820	925	4.0	175	265	350	440	525	615	700	790	3.0	145	220	290	365	435	510	580	655	1°30'
1°35'	3618.68	5.5	205	310	410	515	615	720	820	925	4.5	175	265	350	440	525	615	700	790	3.5	145	220	290	365	435	510	580	655	1°35'
1°40'	3437.75	5.5	205	310	410	515	615	720	820	925	4.5	175	265	350	440	525	615	700	790	3.5	145	220	290	365	435	510	580	655	1°40'
1°45'	3274.04	6.0	205	310	410	515	615	720	820	925	5.0	175	265	350	440	525	615	700	790	3.5	145	220	290	365	435	510	580	655	1°45'
1°50'	3125.22	6.0	205	310	410	515	615	720	820	925	5.0	175	265	350	440	525	615	700	790	4.0	145	220	290	365	435	510	580	655	1°50'
1°55'	2989.35	6.5	205	310	410	515	615	720	820	925	5.0	175	265	350	440	525	615	700	790	4.0	145	220	290	365	435	510	580	655	1°55'
2°00'	2864.79	6.5	205	310	410	515	615	720	820	925	5.5	175	265	350	440	525	615	700	790	4.0	145	220	290	365	435	510	580	655	2°00'
2°10'	2644.42	7.0	215	325	430	540	645	755	860	970	6.0	175	265	350	440	525	615	700	790	4.5	145	220	290	365	435	510	580	655	2°10'
2°15'	2546.48	7.0	220	330	440	550	660	770	880	990	6.0	175	265	350	440	525	615	700	790	4.5	145	220	290	365	435	510	580	655	2°15'
2°20'	2455.53	7.5	225	340	450	565	675	790	900	1015	6.0	175	265	350	440	525	615	700	790	4.5	145	220	290	365	435	510	580	655	2°20'
2°30'	2291.83	7.5	225	340	450	565	675	790	900	1015	6.5	175	265	350	440	525	615	700	790	5.0	150	225	300	375	450	525	600	675	2°30'
2°45'	2083.48	8.0	240	360	480	600	720	840	960	1080	7.0	190	285	380	475	570	665	760	855	5.5	165	250	330	415	495	580	660	745	2°45'
3°00'	1909.86	8.0	250	375	500	625	750	875	1000	1125	7.5	205	310	410	515	615	720	820	925	6.0	180	270	360	450	540	630	720	810	3°00'
3°15'	1762.95	8.5	255	385	510	640	765	895	1020	1150	8.0	220	330	440	550	660	770	880	990	6.0	195	295	390	490	585	685	780	880	3°15'
3°30'	1637.02	9.0	270	405	540	675	810	945	1080	1215	8.0	220	330	440	550	660	770	880	990	6.5	210	315	420	525	630	735	840	945	3°30'
3°45'	1527.89	9.0	285	430	570	715	855	1000	1140	1285	8.0	225	340	450	565	675	790	900	1015	7.0	210	315	420	525	630	735	840	945	3°45'
4°00'	1432.39	9.0	300	450	600	750	900	1050	1200	1350	8.5	230	345	460	575	690	805	920	1035	7.5	210	315	420	525	630	735	840	945	4°00'
4°15'	1348.14	9.5	300	450	600	750	900	1050	1200	1350	8.5	230	345	460	575	690	805	920	1035	7.5	215	325	430	540	645	755	860	970	4°15'
4°30'	1273.24	9.5	300	450	600	750	900	1050	1200	1350	9.0	240	360	480	600	720	840	960	1080	8.0	220	330	440	550	660	770	880	990	4°30'
4°45'	1206.23	9.5	300	450	600	750	900	1050	1200	1350	9.0	245	370	490	615	735	860	980	1105	8.0	220	330	440	550	660	770	880	990	4°45'
5°00'	1145.92	9.5	300	450	600	750	900	1050	1200	1350	9.5	255	385	510	640	765	895	1020	1150	8.5	230	345	460	575	690	805	920	1035	5°00'
5°15'	1091.35	10.0	300	450	600	750	900	1050	1200	1350	10.0	300	450	600	750	900	1050	1200	1350	8.5	230	345	460	575	690	805	920	1035	5°15'
5°30'	1041.74	10.0	300	450	600	750	900	1050	1200	1350	10.0	300	450	600	750	900	1050	1200	1350	8.5	230	345	460	575	690	805	920	1035	5°30'
5°45'	996.45	10.0	300	450	600	750	900	1050	1200	1350	10.0	300	450	600	750	900	1050	1200	1350	9.0	230	345	460	575	690	805	920	1035	5°45'
6°00'	954.93	10.0	300	450	600	750	900	1050	1200	1350	10.0	300	450	600	750	900	1050	1200	1350	9.0	240	360	480	600	720	840	960	1080	6°00'
6°15'	916.73	10.0	300	450	600	750	900	1050	1200	1350	10.0	300	450	600	750	900	1050	1200	1350	9.0	245	370	490	615	735	860	980	1105	6°15'
6°30'	881.47	10.0	300	450	600	750	900	1050	1200	1350	10.0	300	450	600	750	900	1050	1200	1350	9.5	250	375	500	625	750	875	1000	1125	6°30'
6°45'	848.83	10.5	285	430	570	715	855	1000	1140	1285	10.5	285	430	570	715	855	1000	1140	1285	9.5	255	385	510	640	765	895	1020	1150	6°45'
7°00'	818.51	10.5	285	430	570	715	855	1000	1140	1285	10.5	285	430	570	715	855	1000	1140	1285	9.5	260	390	520	650	780	910	1040	1170	7°00'
7°15'	790.29	10.5	285	430	570	715	855	1000	1140	1285	10.5	285	430	570	715	855	1000	1140	1285	10.0	265	400	530	665	795	930	1060	1195	7°15'
7°30'	763.94	10.5	285	430	570	715	855	1000	1140	1285	10.5	285	430	570	715	855	1000	1140	1285	10.0	270	405	540	675	810	945	1080	1215	7°30'
8°00'	716.20	10.5	285	430	570	715	855	1000	1140	1285	10.5	285	430	570	715	855	1000	1140	1285	10.5	280	420	560	700	840	980	1120	1260	8°00'
8°30'	674.07	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	8°30'
9°00'	636.62	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	9°00'
9°30'	603.11	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	9°30'
10°00'	572.96	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	10°00'
10°30'	545.67	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	11.0	265	400	530	665	795	930	1060	1195	10°30'
11°00'	520.87	11.5	250	375	500	625	750	875	1000	1125	11.5	250	375	500	625	750	875	1000	1125	11.5	250	375	500	625	750	875	1000	1125	11°00'
12°00'	477.46	11.5	250	375	500	625	750	875	1000	1125	11.5	250	375	500	625	750	875	1000	1125	11.5	250	375	500	625	750	875	1000	1125	12°00'
14°00'	409.26	11.5	250	375	500	625	750	875	1000	1125	11.5	250	375	500	625	750	875	1000	1125	11.5	250	375	500	625	750	875	1000	1125	14°00'
16°00'	358.10	12.0	235	355	470	590	705	825	940	1060	12.0	235	355	470	590	705	825	940	1060	12.0	235	355	470	590	705	825	940	1060	16°00'
18°00'	318.31	12.0	235	355	470	590	705	825	940	1060	12.0	235	355	470	590	705	825	940	1060	12.0	235	355	470	590	705	825	940	1060	18°00'
20°00'	286.48	12.0	220	330	440	550	660	770	880	990	12.0	220	330	440	550	660	770	880	990	12.0	220	330	440	550	660	770	880	990	20°00'
24°00'	238.73	12.0	220	330	440	550	660	770	880	990	12.0	220	330	440	550	660	770	880	990	12.0	220	330	440	550	660	770	880	990	24°00'
36°00'	159.15	12.0	205	310	410	515	615	720	820	925	12.0	205	310	410	515	615	720	820	925	12.0	205	310	410	515	615	720	820	925	36°00'

NOTES:

1 Select only one design speed that is appropriate to the corridor or section of highway.
DO NOT use more than one column in the design of a corridor or section of highway.

2 The shaded area represents degree of curvature that should only be used in constrained areas. These curves would need to be posted at a lower speed since the comfort speed is lower than the selected design speed. See Table 3-5 in this chapter.

3 For a degree of curve that falls between values listed use the super rate and spiral length for the next highest degree of curve listed.

4 For design speeds other than shown, the superelevation & spiral length can be interpolated from the table.

5 The formulas below can be used to determine the minimum spiral length for superelevation runoff, comfort and aesthetics: Use the longest spiral solution of the three and round up to the nearest 5 ft.

Superelevation Runoff
Ln= [(w * n * e) / s] * b; b=[1 + 0.5 * (n-1)] / n

Where: w=width of lane; typically 12 ft
Where: e=superelevation rate in percent
Where: n=number of lanes rotated
Where: b=adjustment factor
Where: s=relative slope in percent
s=0.70 @ 25 mph
s=0.66 @ 30 mph
s=0.62 @ 35 mph
s=0.58 @ 40 mph
s=0.54 @ 45 mph
s=0.50 @ 50 mph
s=0.47 @ 55 mph
s=0.45 @ 60 mph
s=0.43 @ 65 mph
s=0.40 @ 70 mph

Centrifugal Control: Ls= (D)(V^3/3638)
Where: V=velocity in mph and D= Degree of curv

Aesthetic Control: Ls=2.9V
Where: V=velocity in mph

LEGEND:

NC - Normal crown
D - Degree of curve
e - Superelevation in percent
Ln - Standard spiral length for n lanes rotated;

Table 200-11: Urban Superelevation & Spiral Lengths

D	40						35						30						25						D
	e	L1	L2	L3	L4	L5	e	L1	L2	L3	L4	L5	e	L1	L2	L3	L4	L5	e	L1	L2	L3	L4	L5	D
1°00'	NC	-	-	-	-	-	NC	-	-	-	-	-	NC	-	-	-	-	-	NC	-	-	-	-	-	1°00'
1°15'	NC	-	-	-	-	-	NC	-	-	-	-	-	NC	-	-	-	-	-	NC	-	-	-	-	-	1°15'
1°30'	2	120	180	240	300	360	NC	-	-	-	-	-	NC	-	-	-	-	-	NC	-	-	-	-	-	1°30'
1°45'	2	120	180	240	300	360	NC	-	-	-	-	-	NC	-	-	-	-	-	NC	-	-	-	-	-	1°45'
2°00'	2	120	180	240	300	360	2	105	160	210	265	315	NC	-	-	-	-	-	NC	-	-	-	-	-	2°00'
2°15'	2.5	120	180	240	300	360	2	105	160	210	265	315	NC	-	-	-	-	-	NC	-	-	-	-	-	2°15'
2°30'	2.5	130	195	260	325	390	2	105	160	210	265	315	NC	-	-	-	-	-	NC	-	-	-	-	-	2°30'
2°45'	2.5	140	210	280	350	420	2	105	160	210	265	315	NC	-	-	-	-	-	NC	-	-	-	-	-	2°45'
3°00'	2.5	120	180	240	300	360	2.5	105	160	210	265	315	2	90	135	180	225	270	NC	-	-	-	-	-	3°00'
3°15'	2.5	120	180	240	300	360	2.5	105	160	210	265	315	2	90	135	180	225	270	NC	-	-	-	-	-	3°15'
3°30'	2.5	120	180	240	300	360	2.5	105	160	210	265	315	2	90	135	180	225	270	2	75	115	150	190	225	3°30'
3°45'	2.5	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2	75	115	150	190	225	3°45'
4°00'	2.5	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2	75	115	150	190	225	4°00'
4°15'	3	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2	75	115	150	190	225	4°15'
4°30'	3	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2	75	115	150	190	225	4°30'
4°45'	3	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2	75	115	150	190	225	4°45'
5°00'	3	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2	75	115	150	190	225	5°00'
5°15'	3	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2	75	115	150	190	225	5°15'
5°30'	3	120	180	240	300	360	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2.5	75	115	150	190	225	5°30'
5°45'	3	125	190	250	315	375	2.5	105	160	210	265	315	2.5	90	135	180	225	270	2.5	75	115	150	190	225	5°45'
6°00'	3	130	195	260	325	390	3	105	160	210	265	315	2.5	90	135	180	225	270	2.5	75	115	150	190	225	6°00'
6°15'	3	135	205	270	340	405	3	105	160	210	265	315	2.5	90	135	180	225	270	2.5	75	115	150	190	225	6°15'
6°30'	3	140	210	280	350	420	3	105	160	210	265	315	2.5	90	135	180	225	270	2.5	75	115	150	190	225	6°30'
7°00'	3.5	140	210	280	350	420	3	105	160	210	265	315	2.5	90	135	180	225	270	2.5	75	115	150	190	225	7°00'
7°30'	3.5	150	225	300	375	450	3	105	160	210	265	315	2.5	90	135	180	225	270	2.5	75	115	150	190	225	7°30'
8°00'	3.5	160	240	320	400	480	3	105	160	210	265	315	2.5	90	135	180	225	270	2.5	80	120	160	200	240	8°00'
8°30'	3.5	165	250	330	415	495	3	110	165	220	275	330	3	90	135	180	225	270	2.5	85	130	170	215	255	8°30'
9°00'	4	170	255	340	425	510	3	115	175	230	290	345	3	90	135	180	225	270	2.5	90	135	180	225	270	9°00'
9°30'	4	175	265	350	440	525	3	120	180	240	300	360	3	95	145	190	240	285	2.5	95	145	190	240	285	9°30'
10°00'	4	180	270	360	450	540	3.5	125	190	250	315	375	3	100	150	200	250	300	2.5	100	150	200	250	300	10°00'
10°30'							3.5	130	195	260	325	390	3	105	160	210	265	315	2.5	105	160	210	265	315	10°30'
11°00'							3.5	135	205	270	340	405	3	105	160	210	265	315	2.5	105	160	210	265	315	11°00'
11°30'							3.5	140	210	280	350	420	3	110	165	220	275	330	2.5	105	160	210	265	315	11°30'
12°00'							3.5	145	220	290	365	435	3	110	165	220	275	330	2.5	105	160	210	265	315	12°00'
12°30'							3.5	150	225	300	375	450	3	115	175	230	290	345	2.5	105	160	210	265	315	12°30'
13°00'							3.5	155	235	310	390	465	3	115	175	230	290	345	2.5	105	160	210	265	315	13°00'
13°30'							3.5	160	240	320	400	480	3	120	180	240	300	360	2.5	105	160	210	265	315	13°30'
14°00'							4	165	250	330	415	495	3	120	180	240	300	360	3	105	160	210	265	315	14°00'
15°00'							4	175	265	350	440	525	3.5	125	190	250	315	375	3	105	160	210	265	315	15°00'
16°00'													3.5	130	195	260	325	390	3	105	160	210	265	315	16°00'
17°00'													3.5	135	205	270	340	405	3	105	160	210	265	315	17°00'
18°00'													3.5	140	210	280	350	420	3	105	160	210	265	315	18°00'
19°00'													3.5	145	220	290	365	435	3	105	160	210	265	315	19°00'
20°00'													3.5	150	225	300	375	450	3	105	160	210	265	315	20°00'
21°00'													4	160	240	320	400	480	3	105	160	210	265	315	21°00'
22°00'													4	165	250	330	415	495	3	110	165	220	275	330	22°00'
23°00'																			3	115	175	230	290	345	23°00'
24°00'																			3.5	120	180	240	300	360	24°00'
25°00'																			3.5	120	180	240	300	360	25°00'
26°00'																			3.5	120	180	240	300	360	26°00'
27°00'																			3.5	120	180	240	300	360	27°00'
28°00'																			3.5	120	180	240	300	360	28°00'
29°00'																			3.5	125	190	250	315	375	29°00'
30°00'																			3.5	130	195	260	325	390	30°00'
32°00'																			3.5	150	225	300	375	450	32°00'
34°00'																			4	155	235	310	390	465	34°00'
36°00'																			4	155	235	310	390	465	36°00'

When standard length spirals cannot be attained, use the formulas below for minimum spiral lengths by runoff, comfort, & aesthetics.
Use the longest spiral solution of the three and round to the nearest higher even 5 feet.

Superelevation Runoff
Ln= [(w * n * e) / s] * b; b=[1 + 0.5 * (n-1)] / n

Where: w=width of lane, typically 12 ft
Where: e=superelevation rate in percent
Where: n=number of lanes rotated
Where: b=adjustment factor
Where: s=relative slope in percent
s=0.70 @ 25 mph
s=0.66 @ 30 mph
s=0.62 @ 35 mph
s=0.58 @ 40 mph
s=0.54 @ 45 mph
s=0.50 @ 50 mph
s=0.47 @ 55 mph
s=0.45 @ 60 mph
s=0.43 @ 65 mph
s=0.40 @ 70 mph

Centrifugal Control: Ls= (D)(V^3/3538)
Where: V=velocity in mph and D= Degree of curve

Aesthetic Control: Ls=2.9V
Where: V=velocity in mph

LEGEND:

NC - Normal crown
D - Degree of curve
e - Superelevation in percent
Ln - Standard spiral length for n lanes rotated

Table 200-12: Suburban Superelevation & Spiral Lengths

	55						50						45						
D	e	L1	L2	L3	L4	L5	e	L1	L2	L3	L4	L5	e	L1	L2	L3	L4	L5	D
0°45'	2	160	240	320	400	480	NC	-	-	-	-	-	NC	-	-	-	-	-	0°45'
0°50'	2	160	240	320	400	480	NC	-	-	-	-	-	NC	-	-	-	-	-	0°50'
0°55'	2	160	240	320	400	480	2	145	220	290	365	435	NC	-	-	-	-	-	0°55'
1°00'	2.5	160	240	320	400	480	2	145	220	290	365	435	NC	-	-	-	-	-	1°00'
1°05'	2.5	160	240	320	400	480	2	145	220	290	365	435	2	135	205	270	340	405	1°05'
1°10'	2.5	160	240	320	400	480	2.5	145	220	290	365	435	2	135	205	270	340	405	1°10'
1°15'	3	160	240	320	400	480	2.5	145	220	290	365	435	2	135	205	270	340	405	1°15'
1°20'	3	160	240	320	400	480	2.5	145	220	290	365	435	2	135	205	270	340	405	1°20'
1°25'	3	160	240	320	400	480	2.5	145	220	290	365	435	2.5	135	205	270	340	405	1°25'
1°30'	3	160	240	320	400	480	3	145	220	290	365	435	2.5	135	205	270	340	405	1°30'
1°35'	3.5	160	240	320	400	480	3	145	220	290	365	435	2.5	135	205	270	340	405	1°35'
1°40'	3.5	160	240	320	400	480	3	145	220	290	365	435	2.5	135	205	270	340	405	1°40'
1°45'	3.5	160	240	320	400	480	3	145	220	290	365	435	2.5	135	205	270	340	405	1°45'
1°50'	3.5	160	240	320	400	480	3.5	145	220	290	365	435	3	135	205	270	340	405	1°50'
1°55'	4	160	240	320	400	480	3.5	145	220	290	365	435	3	135	205	270	340	405	1°55'
2°00'	4	160	240	320	400	480	3.5	145	220	290	365	435	3	135	205	270	340	405	2°00'
2°05'	4	160	240	320	400	480	3.5	145	220	290	365	435	3	135	205	270	340	405	2°05'
2°10'	4	160	240	320	400	480	3.5	145	220	290	365	435	3	135	205	270	340	405	2°10'
2°15'	4.5	160	240	320	400	480	4	145	220	290	365	435	3.5	135	205	270	340	405	2°15'
2°20'	4.5	160	240	320	400	480	4	145	220	290	365	435	3.5	135	205	270	340	405	2°20'
2°25'	4.5	160	240	320	400	480	4	145	220	290	365	435	3.5	135	205	270	340	405	2°25'
2°30'	4.5	160	240	320	400	480	4	145	220	290	365	435	3.5	135	205	270	340	405	2°30'
2°35'	4.5	160	240	320	400	480	4	145	220	290	365	435	3.5	135	205	270	340	405	2°35'
2°40'	4.5	160	240	320	400	480	4	145	220	290	365	435	3.5	135	205	270	340	405	2°40'
2°45'	4.5	160	240	320	400	480	4	145	220	290	365	435	3.5	135	205	270	340	405	2°45'
2°50'	4.5	160	240	320	400	480	4	145	220	290	365	435	4	135	205	270	340	405	2°50'
2°55'	4.5	160	240	320	400	480	4.5	145	220	290	365	435	4	135	205	270	340	405	2°55'
3°00'	4.5	160	240	320	400	480	4.5	145	220	290	365	435	4	135	205	270	340	405	3°00'
3°15'	5	165	250	330	415	495	4.5	145	220	290	365	435	4	135	205	270	340	405	3°15'
3°30'	5	170	255	340	425	510	4.5	145	220	290	365	435	4	135	205	270	340	405	3°30'
3°45'	5	180	270	360	450	540	4.5	150	225	300	375	450	4.5	135	205	270	340	405	3°45'
4°00'	5	190	285	380	475	570	4.5	160	240	320	400	480	4.5	135	205	270	340	405	4°00'
4°15'	5.5	200	300	400	500	600	5	170	255	340	425	510	4.5	135	205	270	340	405	4°15'
4°30'	5.5	210	315	420	525	630	5	180	270	360	450	540	4.5	135	205	270	340	405	4°30'
4°45'	5.5	220	330	440	550	660	5	190	285	380	475	570	4.5	135	205	270	340	405	4°45'
5°00'	6	230	345	460	575	690	5	195	295	390	490	585	4.5	140	210	280	350	420	5°00'
5°15'	6	240	360	480	600	720	5.5	200	300	400	500	600	5	145	220	290	365	435	5°15'
5°30'							5.5	205	310	410	515	615	5	150	225	300	375	450	5°30'
5°45'							5.5	210	315	420	525	630	5	155	235	310	390	465	5°45'
6°00'							5.5	215	325	430	540	645	5	160	240	320	400	480	6°00'
6°15'							5.5	220	330	440	550	660	5	165	250	330	415	495	6°15'
6°30'							6	225	340	450	565	675	5	170	255	340	425	510	6°30'
6°45'							6	230	345	460	575	690	5.5	175	265	350	440	525	6°45'
7°00'													5.5	180	270	360	450	540	7°00'
7°15'													5.5	185	280	370	465	555	7°15'
7°30'													5.5	190	285	380	475	570	7°30'
7°45'													5.5	195	295	390	490	585	7°45'
8°00'													6	200	300	400	500	600	8°00'

When standard length spirals cannot be attained,
use the formulas below for minimum spiral lengths by
runoff, comfort, & aesthetics.
Use the longest spiral solution of the three and
round to the nearest higher even 5 feet.

Superelevation Runoff:
Ln= [(w * n * e) / s] * b; b=[1 + 0.5 * (n-1)] / n

Where: w=width of lane; typically 12 ft
Where: e=superelevation rate in percent
Where: n=number of lanes rotated
Where: b=adjustment factor
Where: s=relative slope in percent
s=0.70 @ 25 mph
s=0.66 @ 30 mph
s=0.62 @ 35 mph
s=0.58 @ 40 mph
s=0.54 @ 45 mph
s=0.50 @ 50 mph
s=0.47 @ 55 mph
s=0.45 @ 60 mph
s=0.43 @ 65 mph
s=0.40 @ 70 mph

Centrifugal Control: Ls= (D)(V^2/3638)
Where: V=velocity in mph and D= Degree of curve

Aesthetic Control: Ls=2.9V
Where: V=velocity in mph

LEGEND:

NC - Normal crown
D - Degree of curve
e - Superelevation in percent
Ln - Standard spiral length for n lanes rotated;

Figure 200-18: Standard Superelevation

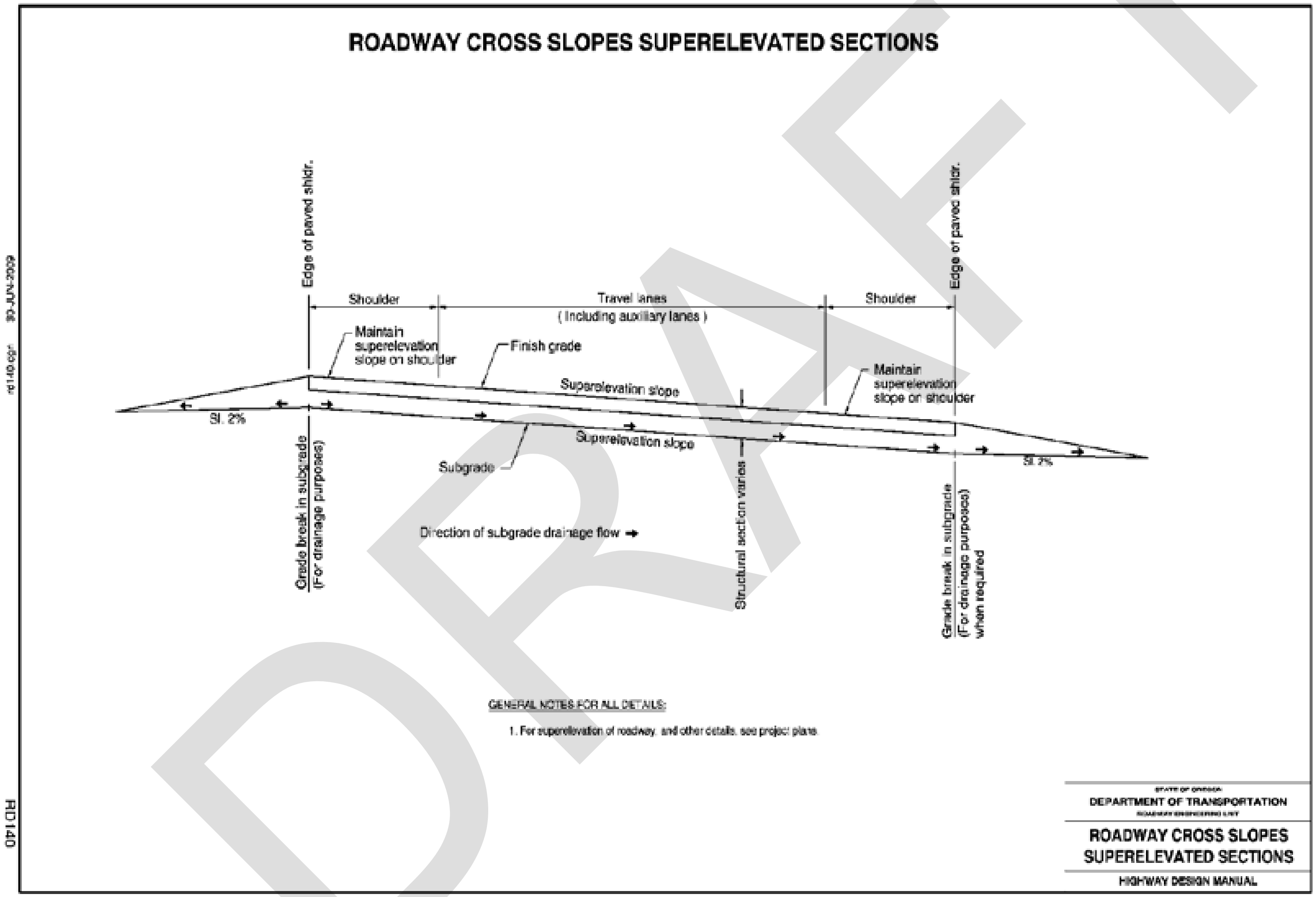
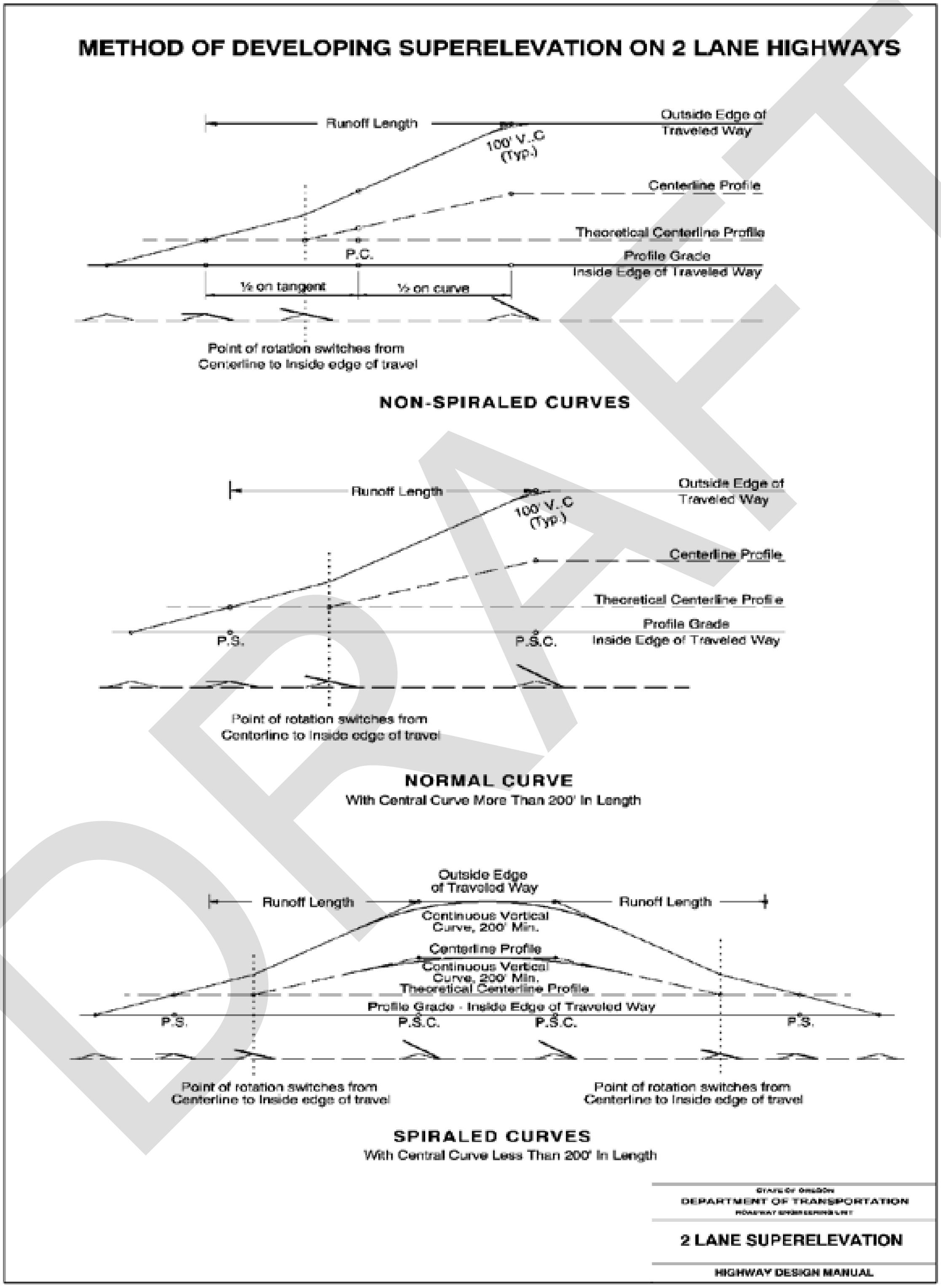


Figure 200-19: Developing Superelevation on 2-Lane Highways



1 Figure 200-20: Developing Superelevation on 2-Lane Highways (Cont'd)

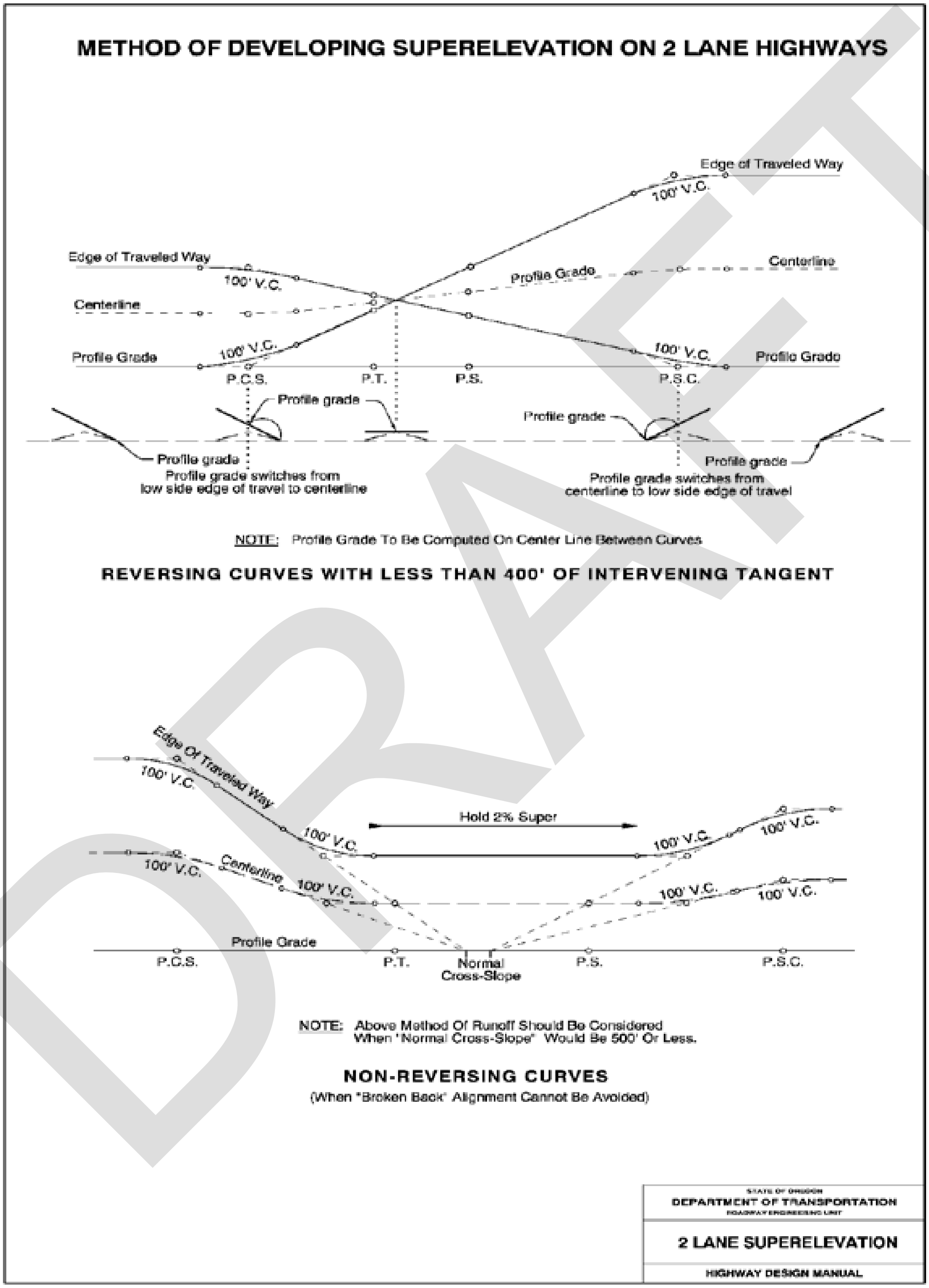
2 

Figure 200-21: Examples of Additional Methods for Developing Superelevation

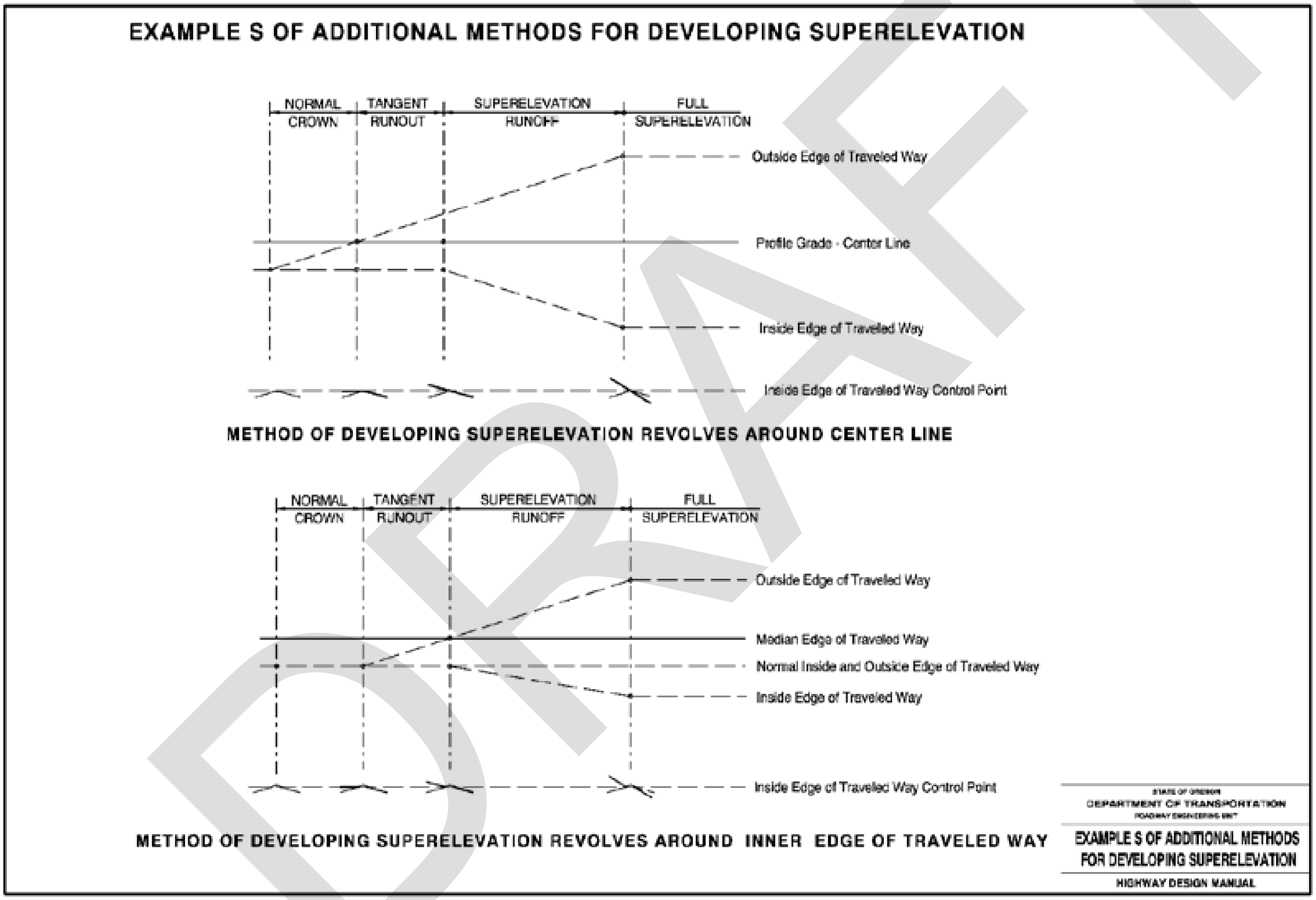
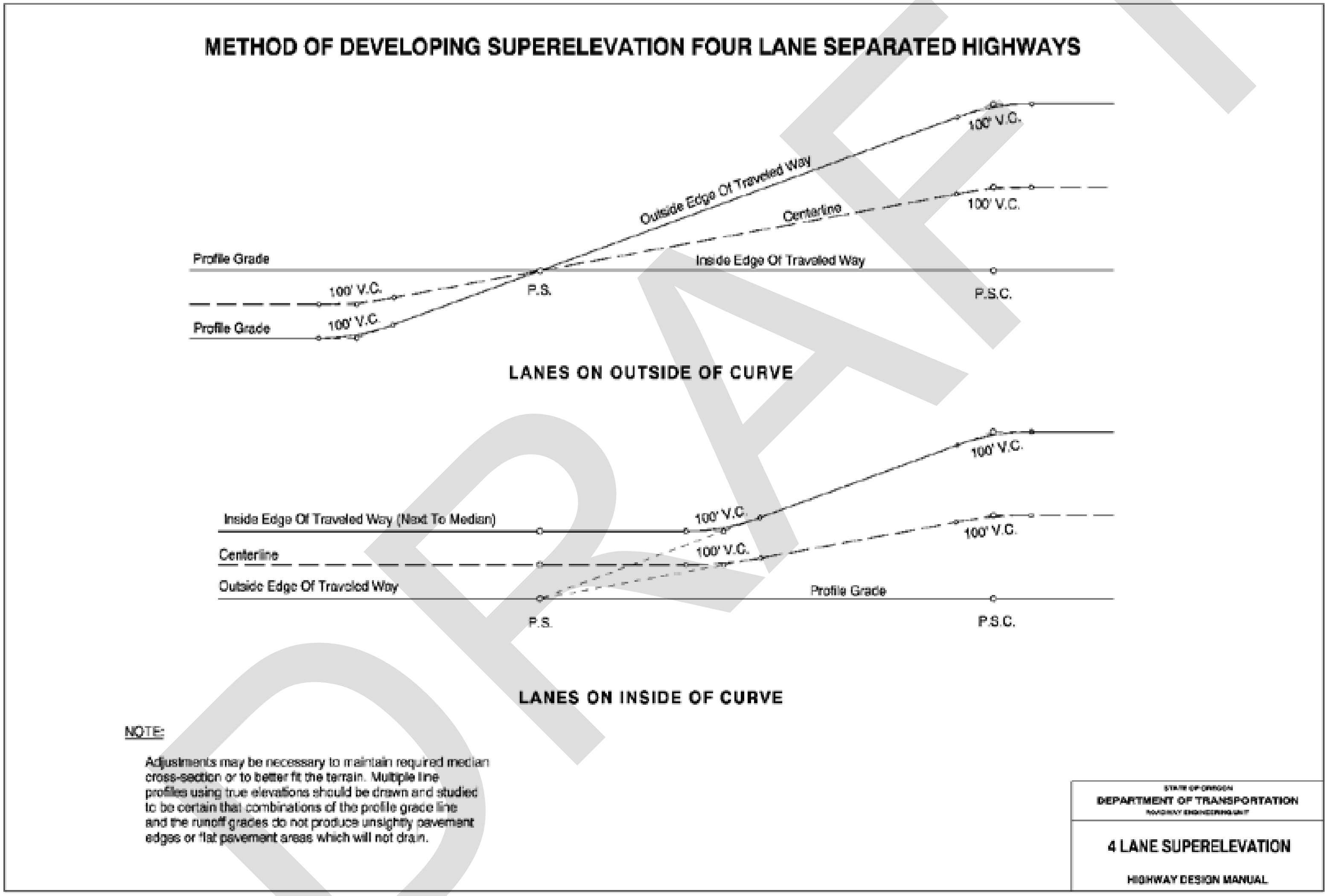


Figure 200-22: Developing Superelevation on 4-Lane Highways



218.9 Comfort Speed Chart

The Comfort Speed Chart shown in Table 200-13 represents the vehicle speed, degree of curvature and superelevation at the point where the driver begins to experience an unacceptable level of discomfort. The data in this chart does not represent a design standard. Design standards for superelevation are provided in Table 200-10, Table 200-11 and Table 200-12. This chart is provided as a tool to evaluate existing or proposed sections for safety and operation. It can also be used for supporting data as part of a design exception.

1 Table 200-13: Comfort Speed

Curve		Superelevation in Feet per Foot of Width																						
Degree	Radius (ft)	-0.020	0.000	0.020	0.025	0.030	0.035	0.040	0.045	0.050	0.055	0.060	0.065	0.070	0.075	0.080	0.085	0.090	0.095	0.100	0.105	0.110	0.115	0.120
0°30'	11459.16	87	94	100																				
0°45'	7639.44	81	86	92	93	95																		
1°00'	5729.58	76	81	86	87	88	90	91																
1°15'	4583.66	72	76	81	82	83	84	86	87	88														
1°30'	3819.72	68	73	77	78	79	80	81	82	83														
1°45'	3274.04	65	70	74	75	76	77	78	78	79	80	81	82											
2°00'	2864.79	63	67	71	72	72	73	74	75	76	77	78	79	80										
2°15'	2546.48	61	64	68	69	70	71	72	72	73	74	75	76	77	77	78								
2°30'	2291.83	59	62	66	67	67	68	69	70	71	72	72	73	74	75	75	76							
2°45'	2083.48	57	60	64	64	65	66	67	68	68	69	70	71	72	72	73	74							
3°00'	1909.86	55	59	62	63	63	64	65	66	66	67	68	69	69	70	71	72							
3°15'	1762.95	54	57	60	61	62	62	63	64	65	65	66	67	67	68	69	69	70						
3°30'	1637.02	52	56	59	59	60	61	61	62	63	64	64	65	66	66	67	68	68						
3°45'	1527.89	51	54	57	58	59	59	60	61	61	62	63	63	64	65	65	66	67						
4°00'	1432.39	50	53	56	56	57	58	58	59	60	60	61	62	62	63	64	64	65						
4°30'	1273.24	48	51	53	54	55	55	56	57	57	58	58	59	60	60	61	61	62	63					
5°00'	1145.92	46	49	51	52	53	53	54	54	55	56	56	57	57	58	58	59	60	60					
5°30'	1041.74	45	47	50	50	51	51	52	52	53	54	54	55	55	56	56	57	57	58	58				
6°00'	954.93	43	46	48	48	49	50	50	51	51	52	52	53	53	54	54	55	55	56	56				
6°30'	881.47	42	44	46	47	47	48	49	49	50	50	51	51	52	52	53	53	54	54	55				
7°00'	818.51	41	43	45	46	46	47	47	48	48	49	49	50	50	51	51	52	52	53	53	53			
7°30'	763.94	40	42	44	44	45	45	46	46	47	47	48	48	49	49	50	50	51	51	52	52			
8°00'	716.20	39	41	43	43	44	44	45	45	46	46	47	47	47	48	48	49	49	50	50	51			
8°30'	674.07	38	40	42	42	43	43	44	44	44	45	45	46	46	47	47	48	48	48	49	49	50		
9°00'	636.62	37	39	41	41	42	42	43	43	43	44	44	45	45	46	46	46	47	47	48	48	49		
9°30'	603.11	36	38	40	40	41	41	42	42	42	43	43	44	44	45	45	45	46	46	47	47	47		
10°00'	572.96	36	37	39	39	40	40	41	41	42	42	42	43	43	44	44	44	45	45	46	46	46		
10°30'	545.67	35	37	38	39	39	39	40	40	41	41	42	42	42	43	43	44	44	44	45	45	45		
11°00'	520.87	35	36	38	38	38	39	39	40	40	40	41	41	42	42	42	43	43	43	44	44	45		
11°30'	498.22	34	36	37	37	38	38	39	39	39	40	40	40	41	41	41	42	42	43	43	43	44		
12°00'	477.46	34	35	36	37	37	38	38	38	39	39	39	40	40	40	41	41	41	42	42	43	43		
14°00'	409.26	32	33	34	35	35	35	36	36	36	37	37	37	38	38	38	39	39	39	39	40	40	40	
16°00'	358.10	30	31	33	33	33	34	34	34	34	35	35	35	36	36	36	37	37	37	37	38	38	38	39
18°00'	318.31	29	30	31	32	32	32	32	33	33	33	33	34	34	34	35	35	35	35	36	36	36	36	37
20°00'	286.48	28	29	30	30	31	31	31	31	32	32	32	32	33	33	33	33	34	34	34	34	35	35	35
22°00'	260.44	27	28	29	29	29	30	30	30	30	31	31	31	31	32	32	32	32	33	33	33	33	34	34
24°00'	238.73	26	27	28	28	28	29	29	29	29	30	30	30	30	31	31	31	31	31	32	32	32	32	33
26°00'	220.37	25	26	27	27	28	28	28	28	28	29	29	29	29	30	30	30	30	30	31	31	31	31	31
28°00'	204.63	25	25	26	27	27	27	27	27	28	28	28	28	28	29	29	29	29	30	30	30	30	30	31
30°00'	190.99	24	25	26	26	26	26	26	27	27	27	27	27	28	28	28	28	28	29	29	29	29	29	30
32°00'	179.05	23	24	25	25	25	26	26	26	26	26	27	27	27	27	27	28	28	28	28	28	29	29	29
34°00'	168.52	23	24	24	25	25	25	25	25	26	26	26	26	26	26	27	27	27	27	27	28	28	28	28
36°00'	159.15	22	23	24	24	24	24	25	25	25	25	25	26	26	26	26	26	26	27	27	27	27	27	27

$R=V^2/[15(e+f)]$

e=rate of superelevation
f= sidefriction factor
V= Vehicle speed, mph
R=Radius, ft

Speed	Friction Factor
25	0.23
30	0.20
35	0.18
40	0.16
45	0.15
50	0.14
55	0.13
60	0.12
65	0.11
70	0.10

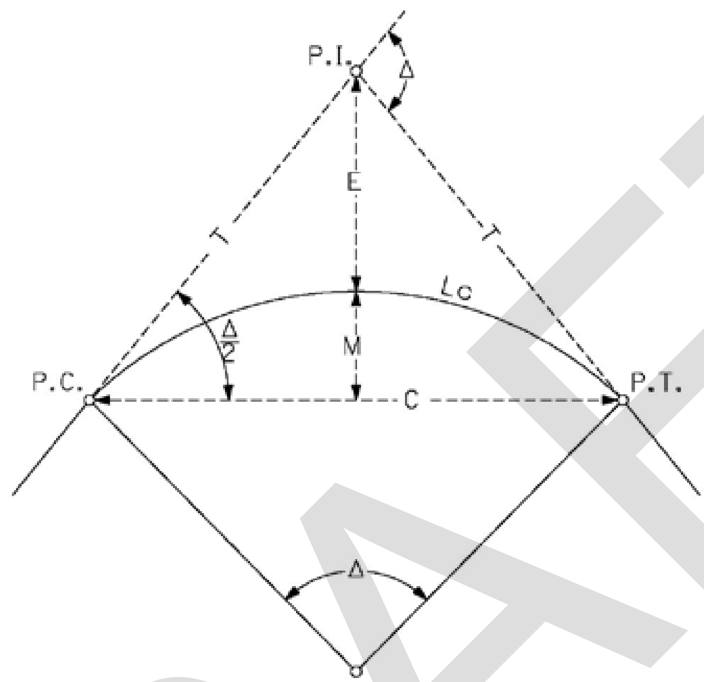
2

218.10 Horizontal Curve Equations and Examples

ODOT standard horizontal alignments typically use transition spirals instead of the basic circular curve. The following figures below present the circular curve definitions, spiral curve definitions, basic curve formulas, and accompanying nomenclature. Figure 200-23 describes the circular curve definition, Figure 200-24 through Figure 200-26 describe the spiral curve definition, and Figure 200-27 and Figure 200-28 describe the basic curve formulas.

Figure 200-23: Circular Curve Definitions

CIRCULAR CURVE DEFINITIONS



A circular curve is based on the arc definition using the degree as it's parameter designation.

P.C. = Beginning of curve.

P.I. = Point of intersection of the tangents.

P.T. = End of curve.

Δ = Deflection angle of the tangents at the P.I..

D = Degree of Curvature

T = Tangent distance from P.I. to P.C. or P.I. to P.T.

Lc = Length of curve from P.C. to P.T.

E = External distance from the P.I. to midpoint of curve.

M = Middle Ordinate distance from midpoint of chord to midpoint of curve.

C = Chord length from P.C. to P.T.

$$T = R \tan \frac{\Delta}{2}$$

$$Lc = \frac{\pi R \Delta}{180}$$

$$E = \left(R \div \cos \frac{\Delta}{2}\right) - R$$

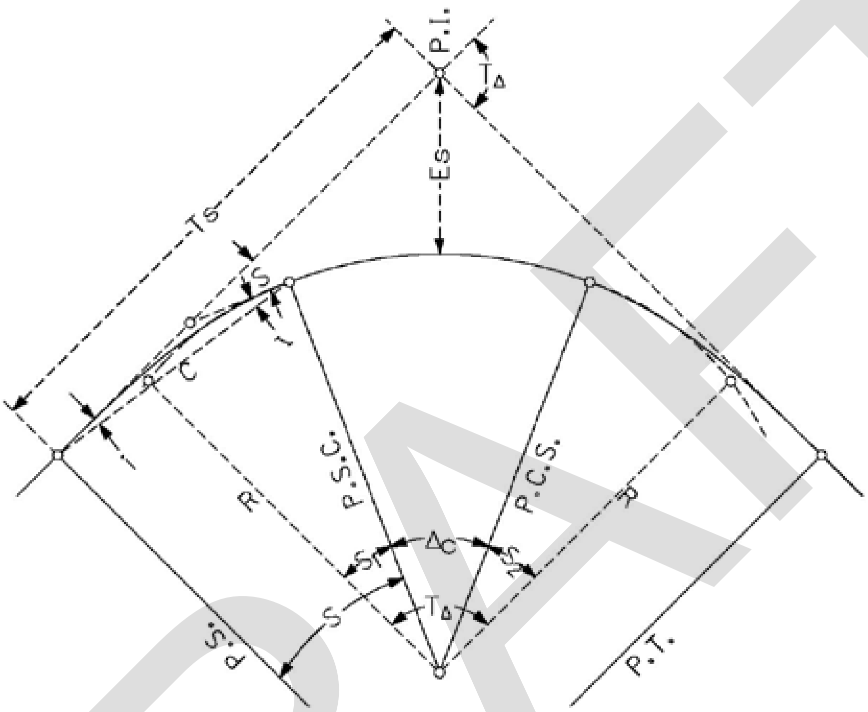
$$M = R - \left(R \cos \frac{\Delta}{2}\right)$$

$$C = 2R \sin \text{deflection} = 2R \sin \frac{\Delta}{2}$$

$$\text{Deflection per foot of arc} = \frac{90}{\pi R}$$

Figure 200-24: Spiral Curve Definitions

SPIRAL CURVE DEFINITIONS



T_Δ = Deflection angle of the tangents at the P.I.

$\Delta c = T_\Delta - (S_1 + S_2)$ = Central angle of circular curve.

S = The central angle of the whole spiral.

I = The angle from any point on the spiral between the tangent at that point and the chord from that point to the P.S.

i = The angle between the tangent at the P.S. and the chord from the P.S. to any point on the spiral or the deflection angle to any any point on the spiral.

Ts = The semi-tangent distance of the spiraled curve; distance from the P.I. to the P.S. or P.I. to P.T.

Es = External distance, shortest distance from P.I. to the curve assembly.

C = The chord from the P.S. to the P.S.C. or P.C.S. to P.T.

D = The degree of the central circular curve.

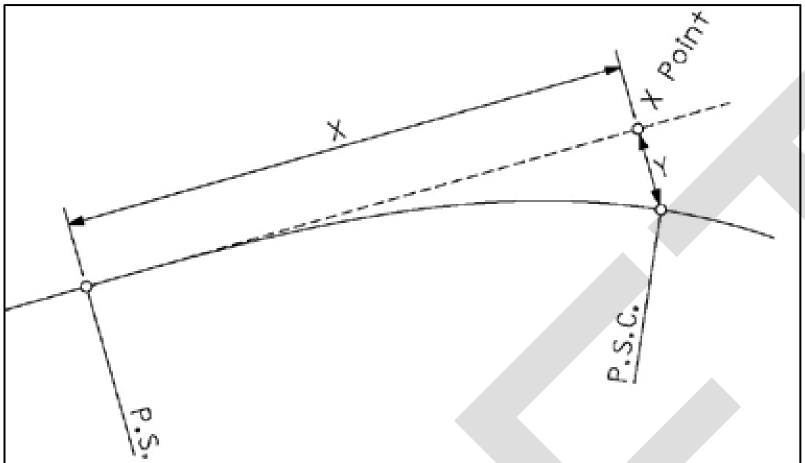
Ls = The length of the spiral from the P.S. to the P.S.C. or P.C.S. to P.T.

ℓ = The length of the spiral from the P.S. or P.T. to any given point on the spiral.

a = The rate of increase in degree of curve per station along the spiral (= (100) (D)/Ls).

d = The degree of curve at any given point on the spiral.

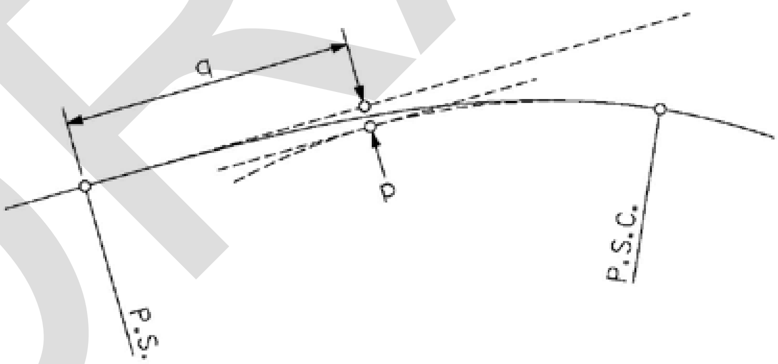
Figure 200-25: Spiral Curve Definitions (Cont'd)



X = The distance from the P.S. to a point on the tangent perpendicular to the P.S.C.

Y = Tangent offset to the spiral at the P.S.C. from semi-tangent.

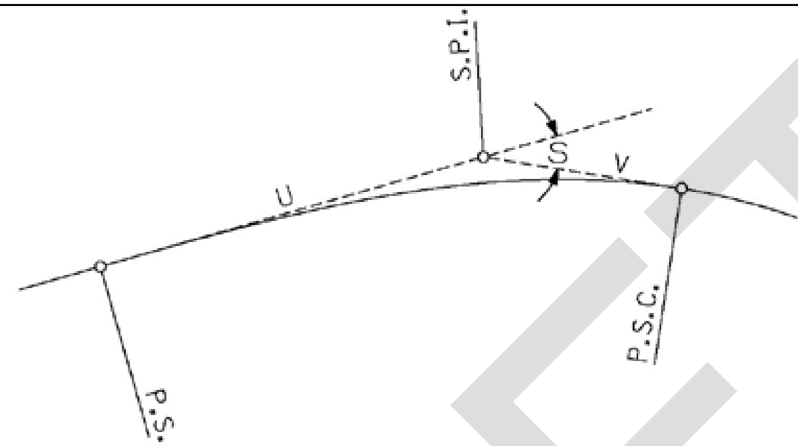
X Point = Point on the semi-tangent at X distance from the P.S. or P.T. Intersection of X and Y distances.



p = The offset from the semi-tangent to the point where the tangent to the circular curve (produced backward or forward) becomes parallel to the semi-tangent.

q = The distance measured along the semi-tangent from P.S. or P.T. to a point where the tangent to the circular curve (produced backward or forward) becomes parallel to the semi-tangent.

Figure 200-26: Spiral Curve Definitions (Cont'd)



S.P.I. = Intersection of spiral tangents.

U = The distance on the tangent from the P.S. to the intersection with a tangent through the P.S.C.; the longer spiral tangent.

V = The distance on the tangent through the P.S.C. from the P.S.C. to the intersection with the tangent through the P.S.; the shorter spiral tangent.

S = The central angle of the spiral from the P.S. to any given point on the spiral.

NOTATION

P.I. = Point of intersection of tangents.

P.S. = Point of change from spiral to tangent.

P.S.C. = Point of change from spiral to circular curve.

P.C.S. = Point of change from circular curve to spiral.

P.T. = Point of change from spiral to tangent.

P.R.S. = Point of reversing spirals.

P.S.S. = Point of change from spiral to spiral.

P.O.S. = Point on spiral.

P.O.C. = Point on circular curve.

P.O.S.T. = Point on semi-tangent.

P.O.T. = Point on tangent.

Figure 200-27: Basic Horizontal Curve Formulas

BASIC FORMULAS

Spiral Definition

The Standard Highway Spiral is a curve whose degree varies directly with its length, beginning at infinity at the P.S. and reaching a degree of curve equal to the circular curve at the P.S.C.

$\pi = 3.1415926536$

1 Radian = $57.295779513°$

$a = [(100)(D)/Ls]$

$D = [(a)(Ls)/100] = [(200)(S)/Ls]$

$Ls = (100)(D)/a = (200)(S)/D$

S = Spiral Angle in Degrees

$S = (D)(Ls)/200 = (a)(Ls^2)/20{,}000 = (D^2)/(2)(a)$

$R = 5729.5779513/D = (5729.5779513)(Ls)/(200)(S) = (28.647889757)(Ls)/S$

$$\frac{X}{Ls} = \sum\left(\frac{\theta^{2n-2}}{(2n-2)!\,(4n-3)\,(-1)^{n+1}}\right)$$

$$\frac{Y}{Ls} = \sum\left(\frac{\theta^{2n-1}}{(2n-1)!\,(4n-1)\,(-1)^{n+1}}\right)$$

Following is the expanded form for values to n = 8 ("n" is not equal to 0)

θ = S in Radians

$$X = Ls\left(1 - \frac{\theta^2}{10} + \frac{\theta^4}{216} - \frac{\theta^6}{9360} + \frac{\theta^8}{685{,}440} - \frac{\theta^{10}}{76{,}204{,}800} + \frac{\theta^{12}}{11{,}975{,}040{,}000} - \frac{\theta^{14}}{2{,}528{,}170{,}444{,}800}\right)$$

Note: Designations of X and Y have been reversed to match most software. The ODOT Standard Highway Spiral Book values for X and Y are still accurate, just reversed.

$$Y = Ls\left(\frac{\theta}{3} - \frac{\theta^3}{42} + \frac{\theta^5}{1320} - \frac{\theta^7}{75{,}600} + \frac{\theta^9}{6{,}894{,}720} - \frac{\theta^{11}}{918{,}086{,}400} + \frac{\theta^{13}}{168{,}129{,}561{,}600} - \frac{\theta^{15}}{40{,}537{,}905{,}408{,}000} - - -\right)$$

Figure 200-28: Basic Horizontal Curve Formulas (Cont'd)

$$\text{Tan } i = \frac{Y}{X}$$

$$I = S - i$$

$$q = X - R \sin S = X - \frac{28.647\,889\,757 \; Ls}{S} \sin S$$

$$p = Y - R\,(1 - \text{Cos } S) = Y - \frac{28.647\,889\,757 \; Ls}{S}(1 - \text{Cos } S)$$

$$U = X - \frac{Y}{\tan S}$$

$$V = \frac{Y}{\sin S}$$

$$C = \sqrt{X^2 + Y^2}$$

$$Ts = q + (R + p) \tan \frac{T\Delta}{2}$$

$$Es = \frac{R + p}{\text{Cos} \frac{T\Delta}{2}} - R$$

$$Lc = \text{Length of circular curve} = \frac{\pi R \Delta c}{180} = \frac{\pi R (T\Delta - S_1 - S_2)}{180}$$

Note: Designations of X and Y have been reversed to match most software. The ODOT Standard Highway Spiral Book values for X and Y are still accurate, just reversed.

Figure 200-29: Parallel Tangents - Equal Length Reversing Curves

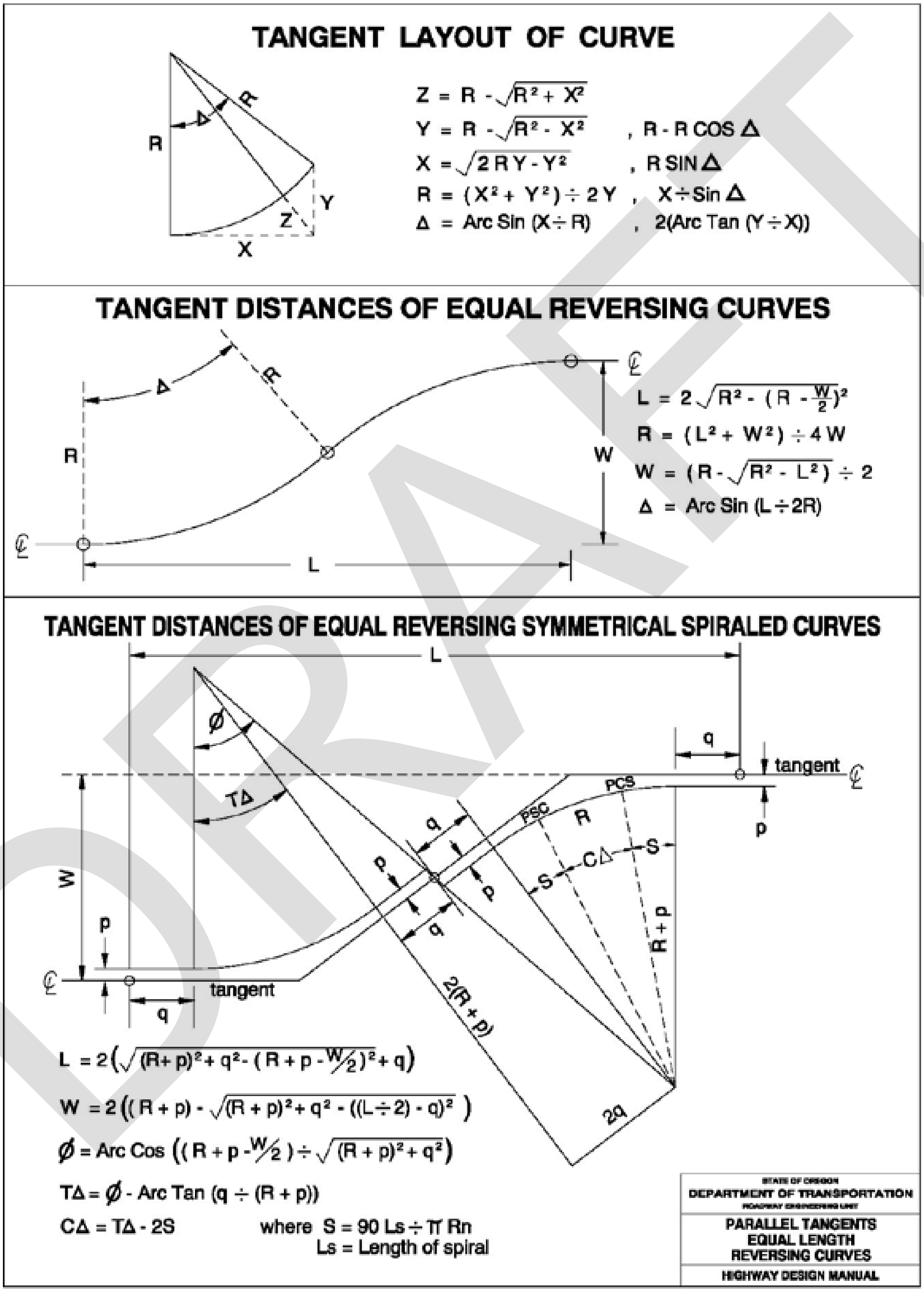


Figure 200-30: Parallel Tangents - Unequal Length Reversing Curves

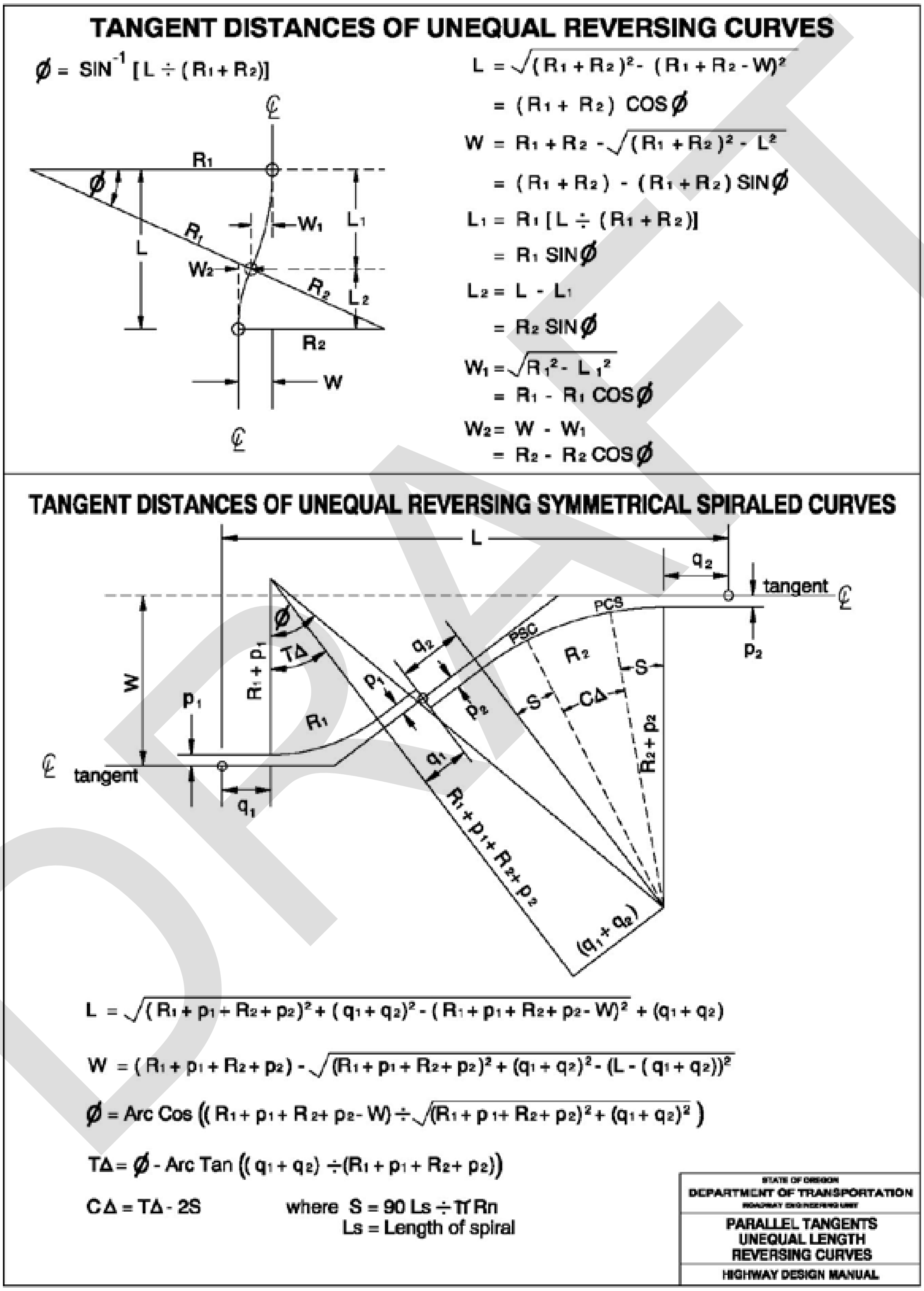


Figure 200-31: Spiral Solution - Example 1

TYPICAL SOLUTION OF SPIRAL ELEMENTS AND DEFLECTION ANGLES
(Curve with spirals of equal length)

Given:

- D = 6°
- TΔ = 45°
- L_s = 400'
- Station of P.S. = 321 + 11.50

Find:

Elements of spiral and main curve and to determine deflection angles from P.S. to points on the spiral.

Solution:

$$a = (100)(D)/Ls = 600/400 = 1.5$$

$$S = (D)(Ls)/200 = (6)(400')/200 = 12°00'$$

$$i = \text{ArcTan}\frac{Y}{X} = 4°26'36''$$

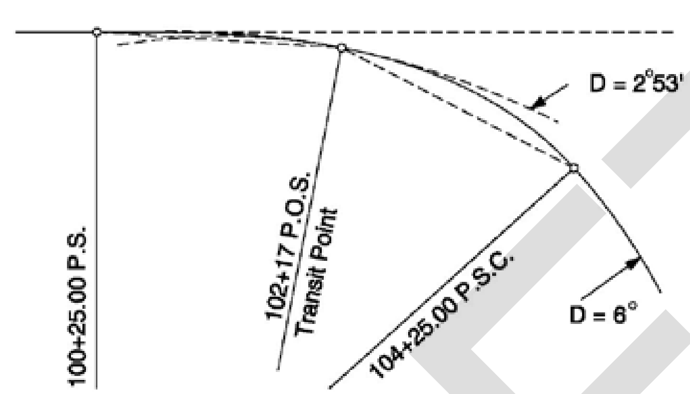
$$Ts = q + (R+p)\ \text{Tan}\frac{T_\Delta}{2} = 598.14'$$

From Formula

- X = 398.25'
- Y = 27.84'
- C = 399.22'
- U = 267.28'
- V = 133.89'
- p = 6.97'
- q = 119.71'

Figure 200-32: Spiral Solution - Example 2

INTERMEDIATE SETUP ON SPIRAL WITH DEFLECTIONS



Given:

S = 12° 00'
D = 6°
a = 1.5
Ls = 400'
P.S. = 100 + 25.00
P.S.C. = 104 + 25.00

Find:

Assume it is necessary to make intermediate setup at station 102 + 17

Solution:

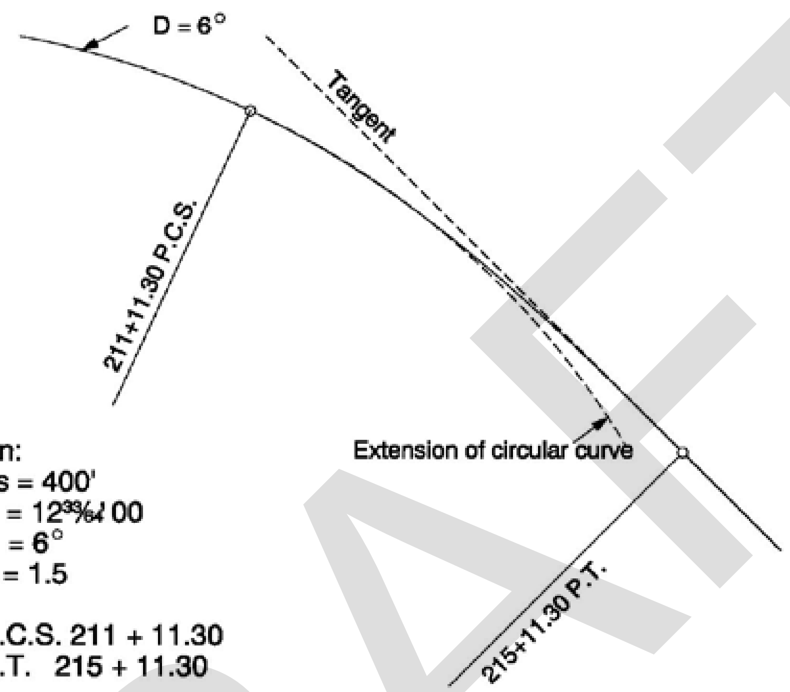
RULE: A spiral deviates from the circular curve common to it at any point at the same rate as it deviates from the tangent at the P.S. Therefore, at any point on the spiral the deflection angle from the tangent at that point to any other point on the spiral is equal to the deflection angle for a circular curve of the same radius as the spiral at the intermediate setup plus or minus the deflection from tangent at the P.S. to a point at an equivalent distance from the P. S. thus:

* Degree of curve at point of intermediate setup Sta. 102+17 $= \frac{(a)(\ell)}{100} = \frac{(1.5)(192)}{100} = 2^\circ\ 52'\ 48''$

	Simple Curve Deflection		Spiral Deflection		Deflection (Instr. at Sta. 102+17)
P.S. 100 + 25.0	2°45'54"	-	0°55'18"	=	1°50'36"
+ 50	2°24'18"	-	0°41'48"	=	1°42'30"
101 + 00	1°41'12"	-	0°20'30"	=	1°20'36"
+ 50	0°57'54"	-	0°06'42"	=	0°51'12"
102 + 00	0°14'42"	-	0°00'24"	=	0°14'21"
Transit Pt. + 17	0°00'00"	-	0°00'00"	=	0°00'00"
+ 50	0°28'30"	+	0°01'36"	=	0°30'06"
103 + 00	1°11'42"	+	0°10'18"	=	1°22'00"
+ 50	1°54'54"	+	0°26'30"	=	2°21'24"
104 + 00	2°38'06"	+	0°50'12"	=	3°28'18"
P.S.C. 104 + 25.0	2°59'42"	+	1°04'54"	=	4°04'36"

Figure 200-33: Spiral Solution - Example 3

DEFLECTIONS TO SPIRAL FROM P.S.C. OR P.C.S.



Given:

Ls = 400'
S = 12%/100
D = 6°
a = 1.5

P.C.S. 211 + 11.30
P.T. 215 + 11.30

Find:

Deflections angles from the tangent to the curve at P.C.S.

Solution:

To back the spiral in from P.C.S.:

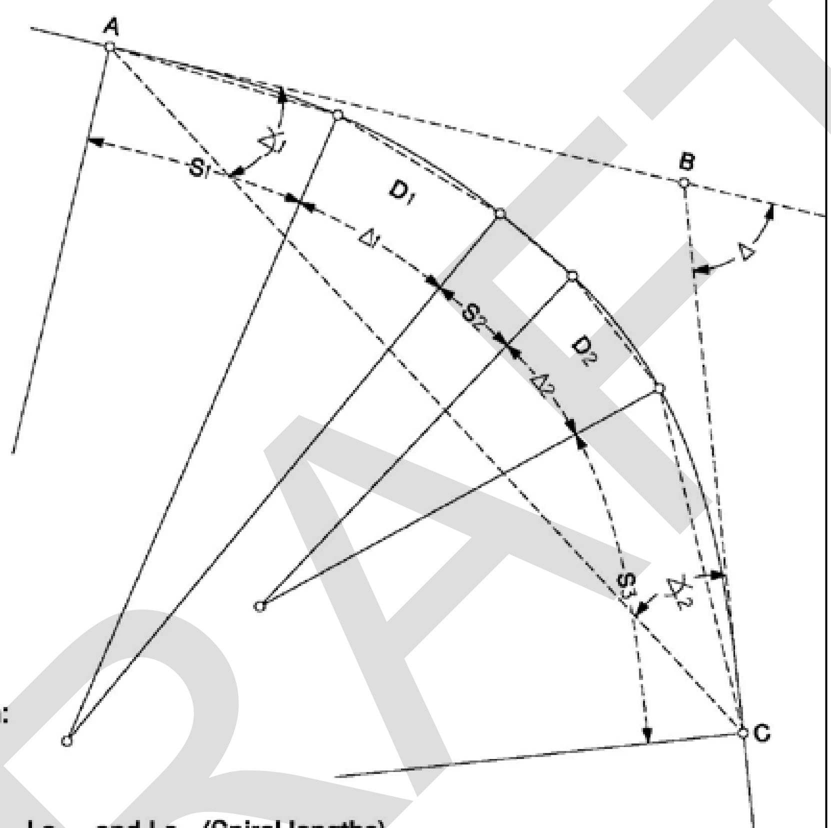
RULE: A spiral curve and a circular curve which coincide at any point (as at the P.C.S.) deviate from each other at the same rate as the spiral does from the tangent at the P.S.

Therefore, to obtain deflection angles from the tangent to the curve at the P.C.S. to the spiral, compute deflection angles to the circular curve and subtract therefrom the deflection angles to the spiral at corresponding distances from the P.S.

STATION	Simple Curve Deflection (D = 6°)		Spiral Deflection		Deflections (Instrument Setup at P.C.S.)
P.C.S.211+11.30	0°00'00"	—	0°00'00"	=	0°00'00"
211+50	1°09'42"	—	0°02'12"	=	1°07'30"
211+75	1°57'42"	—	0°06'06"	=	1°48'36"
212+00	2°39'42"	—	0°11'48"	=	2°27'54"
212+35	3°42'42"	—	0°23'00"	=	3°19'42"
212+80	5°03'42"	—	0°42'42"	=	4°21'00"
213+20	6°15'42"	—	1°05'18"	=	5°10'24"
213+50	7°09'42"	—	1°25'30"	=	5°44'12"
214+00	8°39'42"	—	2°05'00"	=	6°34'42"
214+50	10°09'42"	—	2°52'06"	=	7°17'36"
215+00	11°39'42"	—	3°46'36"	=	7°53'06"
P.T. 215+11.30	12°00'00"	—	4°00'00"		8°00'00"

Figure 200-34: Spiral Solution - Example 4

FITTING A SPIRAL BETWEEN TWO PARTS OF A COMPOUND CURVE WITH SPIRAL TRANSITIONS AT EACH END



Given:

Δ
D_1
D_2
Ls_1, Ls_2, and Ls_3 (Spiral lengths)

Find:

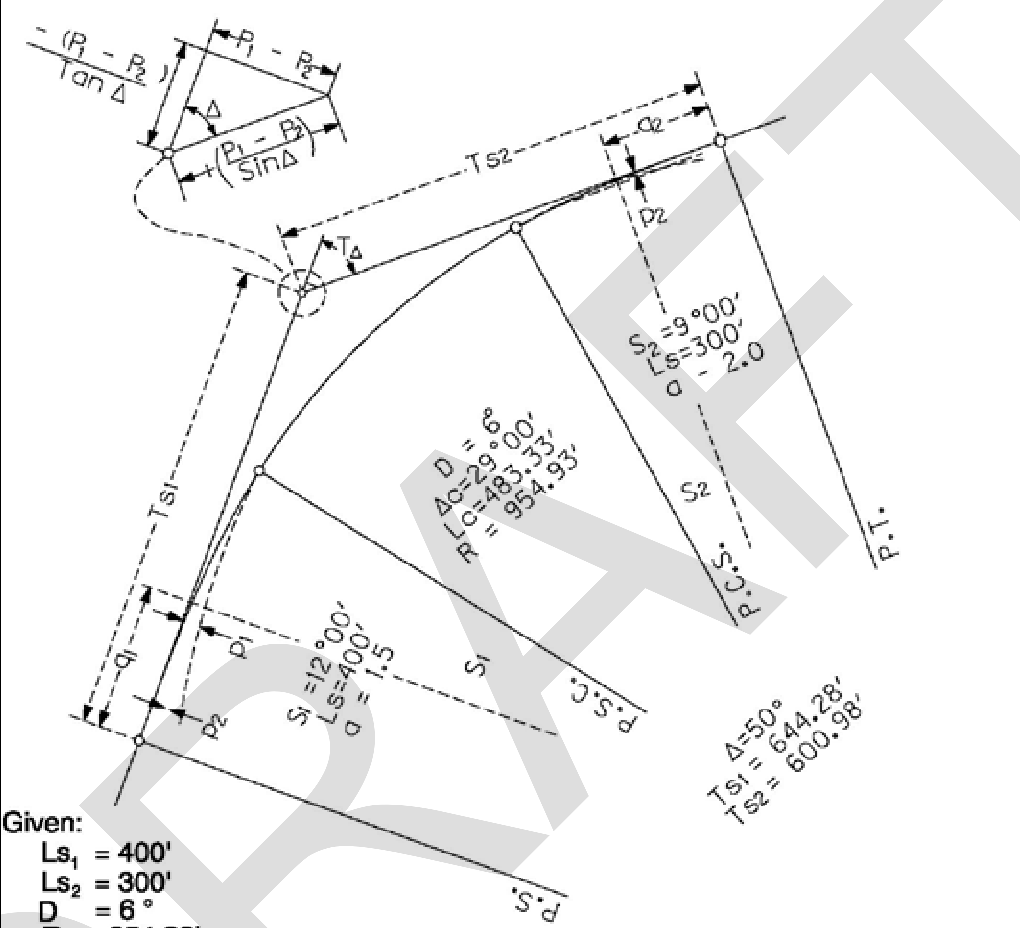
Semi-tangents

Solution:

(1) Ascertain Δ_1 (by assumption or measurement).
(2) Then $\Delta_2 = \Delta - \Delta_1 - S_1, - S_2, - S_3$.
(3) Find long chords for circular curves and spirals.
(4) Figure bearings for chords.
(5) Compute coordinates for point C.
(6) Compute length and bearing of long chord A - C.
(7) Then $\measuredangle_2 = \Delta - \measuredangle_1$:
(8) Solve triangle ABC for semi-tangents AB and BC. (Three angles and one side known).
(9) Spiral S_2 may be used to connect curves D_1 and D_2 by choosing that portion of the spiral having curvature intermediate between the radius of the two circular curves: thus if $D = 3°$ and $D_2 = 10°$ the connecting spiral will have a varied radius from 3° to 10° omitting the portion of the spiral below 3°. Deflection angles from P.C.S. or P.S.C. may be computed in the same manner as an intermediate setup on the spiral (see Example II).

Figure 200-35: Spiral Solution - Example 5

COMPUTING SEMI-TANGENTS FOR CURVES WITH SPIRALS OF UNEQUAL LENGTH



Given:

$Ls_1 = 400'$
$Ls_2 = 300'$
$D = 6°$
$R = 954.93'$
$\Delta = 50° 00'$

Find: Semi-tangents (Ts_1 and Ts_2) and external (Es_1 or Es_2).

Solution:

To compute semi-tangents ascertain the spiral elements.

Then

$Ts_1 = q_1 + (R + p_2)\ \mathrm{Tan}\ \frac{T\Delta}{2} - \frac{p_1 - p_2}{\mathrm{Tan}\ T\Delta}$ $\quad Ts_2 = q_2 + (R + p_2)\ \mathrm{Tan}\ \frac{T_\Delta}{2} + \frac{p_1 - p_2}{\mathrm{Sin}\ T_\Delta}$

Es_1 and Es_2 formulas are valid only if S_1 and S_2 are equal to or less than ½ Δ.

$Es_1 = \sqrt{(Ts_1 - q_1)^2 + (R + p_1)^2} - R$ $\qquad Es_2 = \sqrt{(Ts_2 - q_2)^2 + (R + p_2)^2} - R$

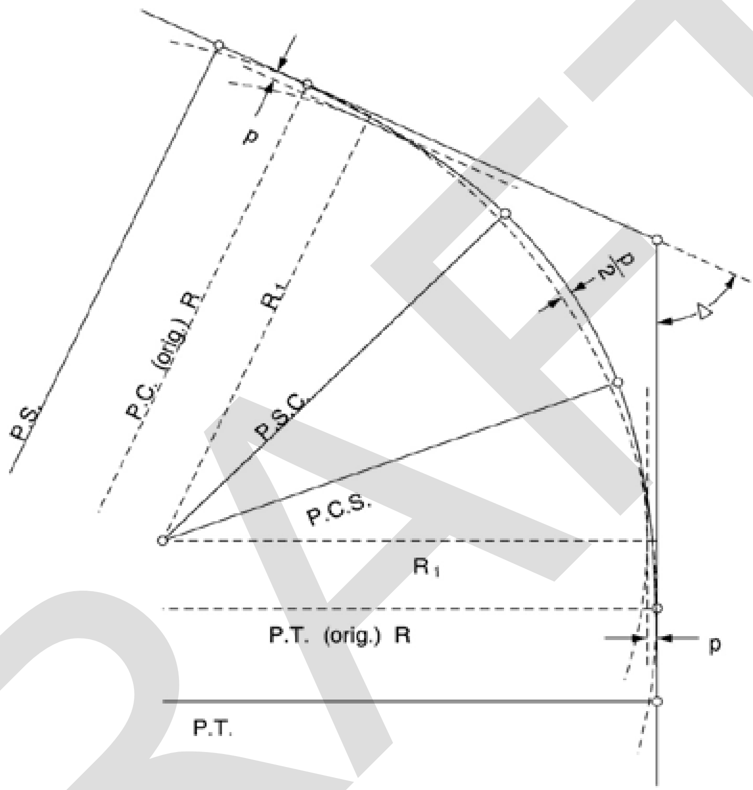
$$Ts_1 = 199.71' + (954.93' + 3.92') \times 0.466\,307\,7 - \frac{(6.97' - 3.92')}{1.191\,754} = 644.28'$$

$$Ts_2 = 149.88' + (954.93' + 3.92') \times 0.466\,307\,7 + \frac{(6.97' - 3.92')}{0.766\,044} = 600.98'$$

Rule: Ls_1 = Longer spiral

Figure 200-36: Spiral Solution - Example 6

FITTING EXISTING CIRCULAR CURVE ALIGNMENT WITH SPIRALED CURVES REQUIRING A MINIMUM SHIFT OF ALIGNMENT



Given:
- R
- Δ
- Ls

Find: R_1

Solution:

To retain present tangents and fit spiraled alignment with least possible shift of circular curve.

The new curve will be sharper and it should lay outside of the old curve at the vertex, and the distance between the vertexes of the two curves should be equal to half the spiral

offsets, $\frac{p}{2}$

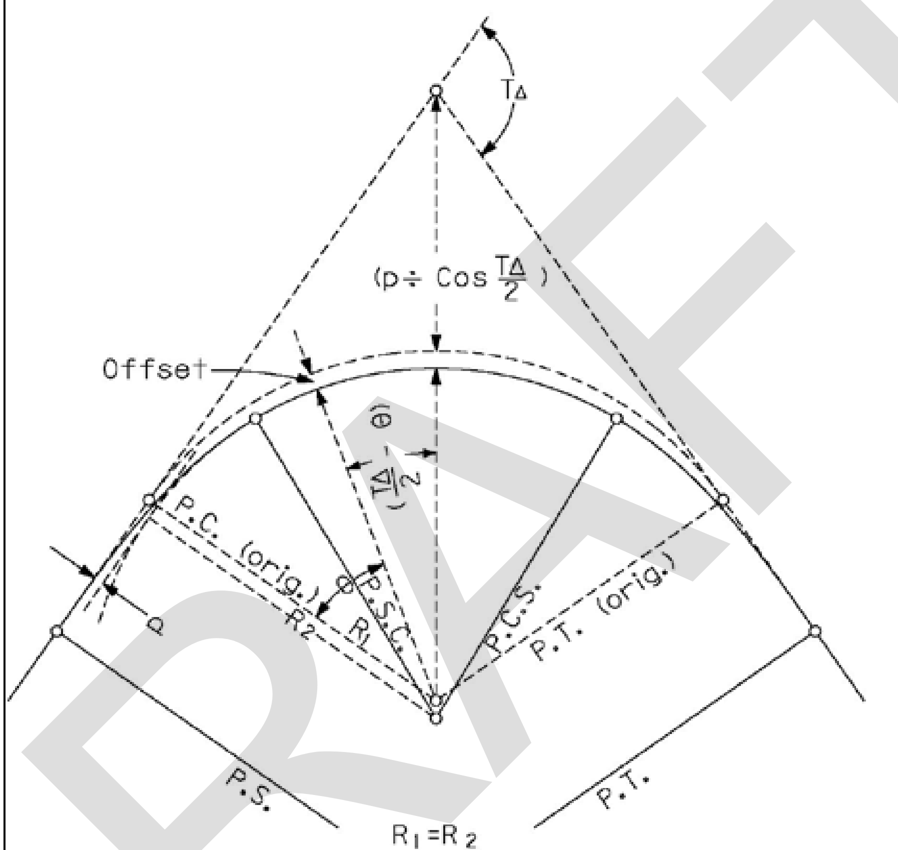
$$\text{Then } R_1 = R - \frac{p + \frac{p}{2}\cos\frac{\Delta}{2}}{1 - \cos\frac{\Delta}{2}}$$

In solving this equation, first assume a value for "p" slighty greater than the value of "p" for a radius of curve equal to the original curve. Base the assumption on an estimate of the new curve radius required.

Then revise the value of "p" to fit alignment.

Figure 200-37: Spiral Solution - Example 7

OFFSETS FROM CIRCULAR CURVE ALIGNMENT TO SPIRALED ALIGNMENT USING SAME RADIUS OF CURVE AND ORIGINAL TANGENTS



In fitting spiraled alignment to existing circular curve alignment, while retaining the same degree of main curve and the original tangents, it will be found that the new main curve will not be concentric with nor parallel to the original curve. The offset varies from a value of "p" as shown on the sketch to a value of ($p \div \cos T_\Delta \div 2$) at the vertex. Between the point where the value of "p" applies to the P.S.C., the offsets from the original alignment to the new alignment may be found by obtaining the X coordinate to the point in question on the spiral and making correction for the offset to the original circular curve where that is necessary. Beyond the P.S.C. the following approximate formula will give values of the offset sufficiently close for practical purposes.

$$\text{Offset} = p \div \cos\frac{T_\Delta}{2}\left[\cos\left(\frac{T_\Delta}{2} - \theta\right)\right] \quad \text{Approximately}$$

Where θ = angle from the P.C. or P.T. of original circular curve to the point desired.

Figure 200-38: Spiral Solution - Example 8

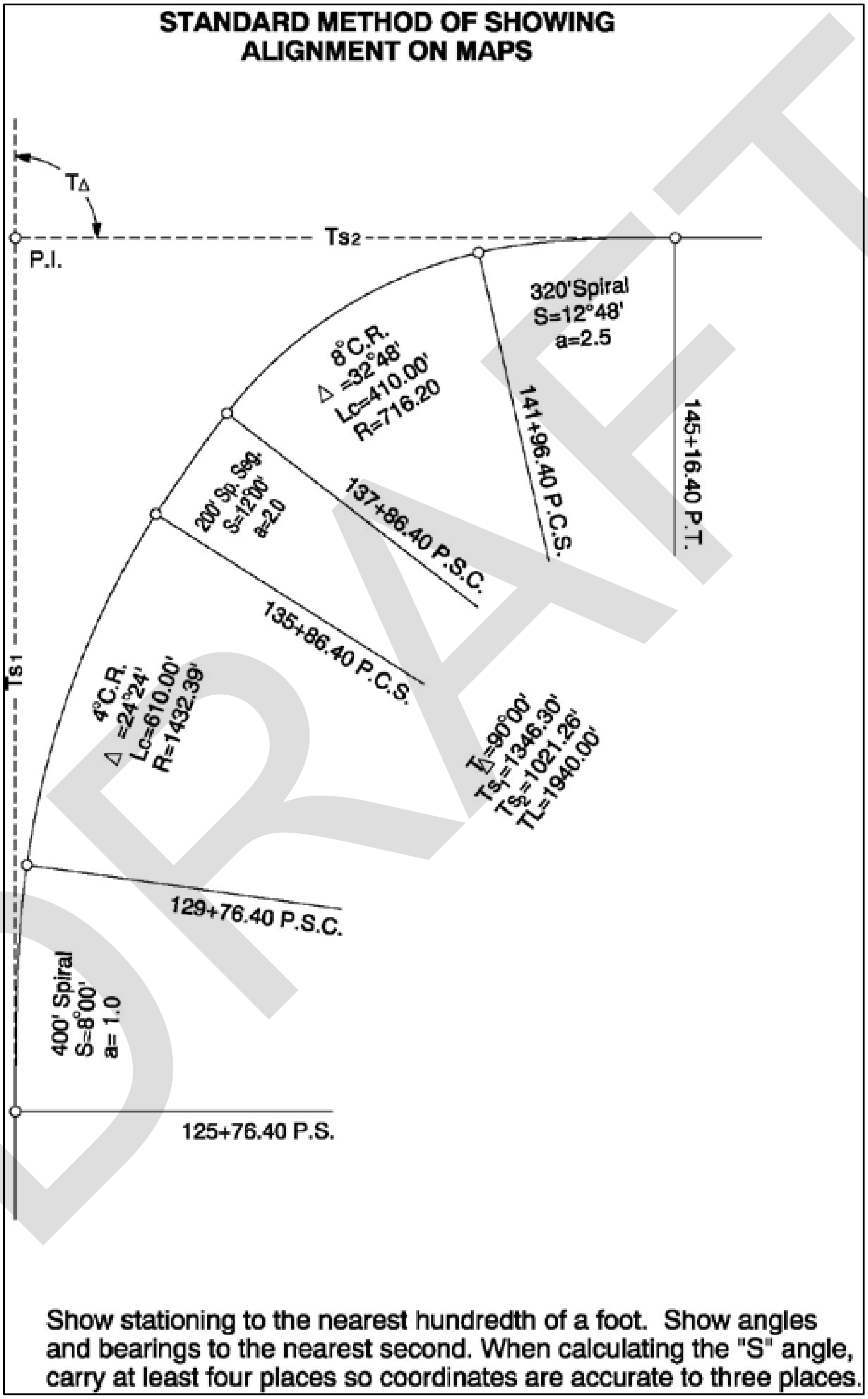
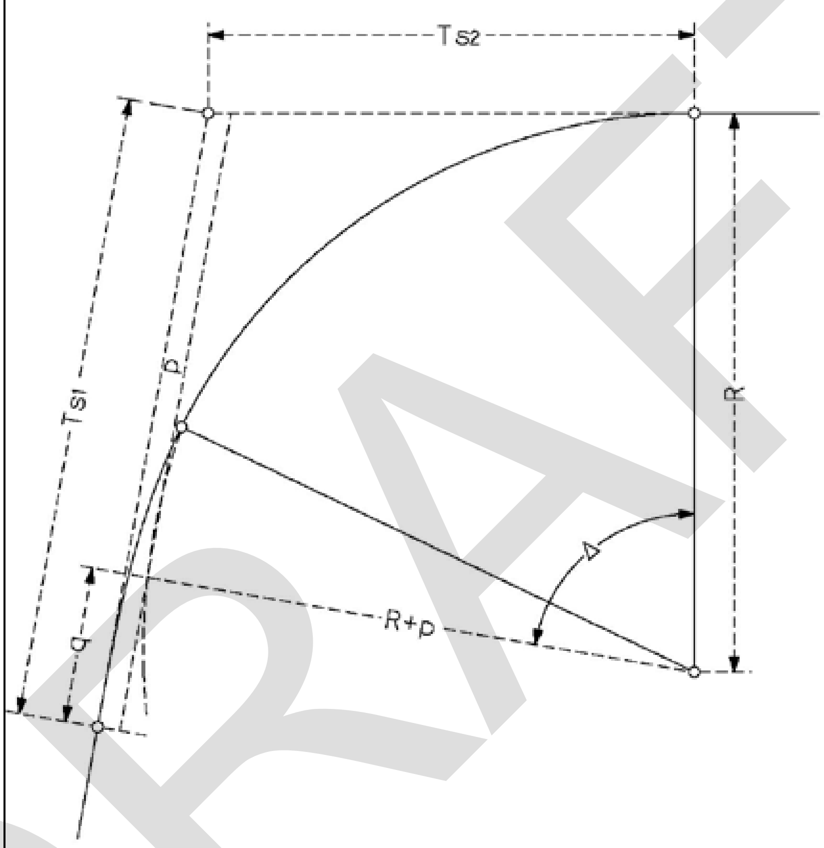


Figure 200-39: Spiral Solution - Example 9

METHOD OF COMPUTING SEMI-TANGENTS OF CURVE WITH SPIRAL AT ONE END ONLY



Given:
Δ, R, p. and q.

Find:
Semi-Tangents.

Solution:

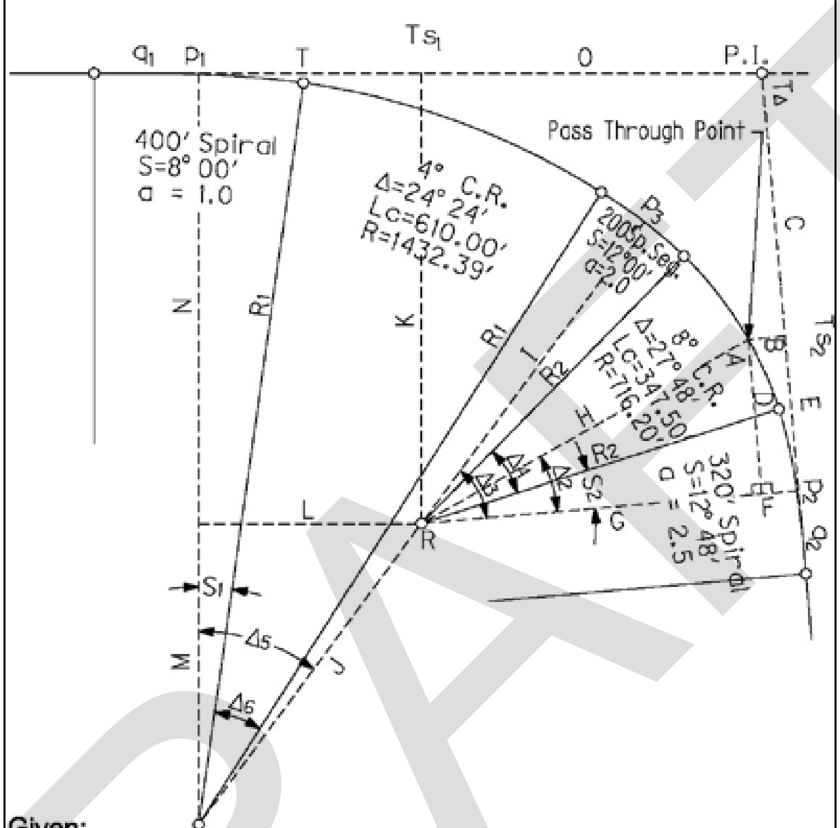
$$Ts_1 = \frac{R - (R + p)\ Cos\Delta}{Sin\ \Delta} + q$$

$$Ts_2 = \frac{(R + p) - (R\ cos\Delta\ )}{Sin\ \Delta}$$

When Δ is over 90°, the cosine function has a negative value.

Figure 200-40: Spiral Solution - Example 10

FITTING COMPOUND CURVE WITH THREE SPIRALS



Given:

With a fixed pass through point or a given or assumed semi-tangent (Ts_2), known P.I., TΔ, R_1 and R_2, spiral lengths.

Find:

Ts_2 (for fixed point) or Ts_1 (for known Ts_2)

Solution:

<u>FIXED PASS THROUGH POINT</u>

Calculate C and B along and perpendicular to the Ts semi-tangent tangent Then ....

$B = F$, $G = (R_2 + p_2) - F$, $H = R_2$, $\cos\Delta_2 = \frac{G}{H}$, $D = H \sin\Delta_2$,
$E = D$ and $Ts_2 = C + E + q_2$

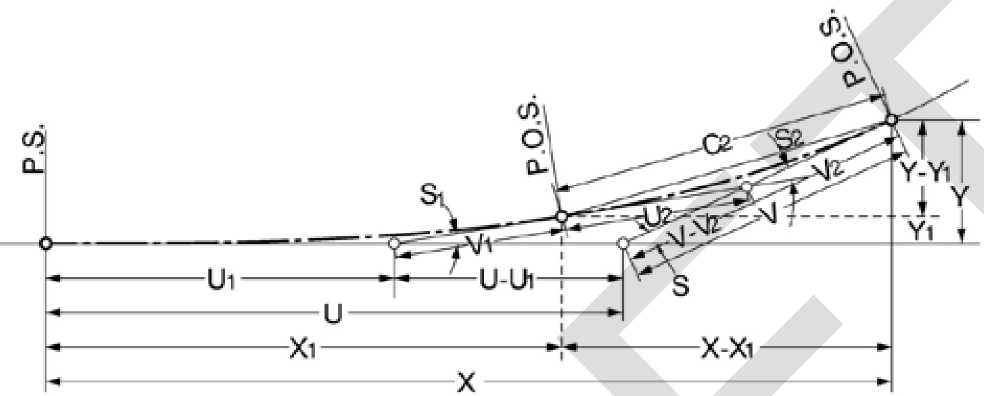
<u>GIVEN OR ASSUMED SEMI-TANGENT (Ts_2)</u>

Calculate coordinates for the radius point of "R_2" from Ts_2. Calculate O and K along and perpendicular to the Ts_1, semi-tangent. 'p_3' is the perpendicular distance between R_1 and R_2, when tangent to each other. Then $I = R_2 + p_3$.

$J = R_1 - I$, $K = N$, $M = (R_1 + p_1) - N$, $\cos\Delta_5 = \frac{M}{J}$, $L = J \sin\Delta_5$,
$T = L$, $\Delta_6 = \Delta_5 - (S_1 + \Delta$ for D_1 for ½ length of intermediate spiral), $\Delta_3 = T\Delta - \Delta_5$, $\Delta_4 = \Delta_3 - (S_3 + \Delta$ for R_2 for ½ length of intermediate spiral) $Ts_1 = O + T + q_1$; the use of ½ the length of the intermediate spiral is a close approximation of the true answer.

Figure 200-41: Spiral Solution - Example 11

DETERMINING U, V, AND C DISTANCES FOR SEGMENT OF A SPIRAL



Given:

200' spiral segment, a=1.0, connecting 3° curve to 5° curve.

Find:

S, U, C, and V distances for that spiral segment.

Solution:

The given spiral segment is that portion of the Standard Highway Spiral , a=1.0, between the P.O.S. at Ls = 300' and the P.O.S. at Ls = 500'. In the solution of the given problem S,U,V, X, and Y are values for L = 500', S_1,U_1,V_1,X_1, and Y_1 are values for L = 300' m and S_2,U_2, C_2 and V_2 are the values to be found for the given spiral segment.

Ls = 500', S = 12° 30' , U = 334.17', V = 167.43', Y = 36.24'
X = 497.63'

Ls = 300', S_1 = 4° 30' , U_1= 200.06', V_1= 100.06', Y_1= 7.85'
X_1 = 299.81'

$$S_2 = S - S_1 \qquad V_2 = V - \frac{(U - U_1)\text{Sin } S_1}{\text{Sin } S_2}$$

$$U_2 = \frac{(U - U_1)\text{ Sin } S}{\text{Sin } S_2} - V_1 \qquad C_2 = \sqrt{(X_1 - X)^2 + (Y_1 - Y)^2}$$

$$S_2 = 12°\ 30' - 4°\ 30' = 8°\ 00'$$

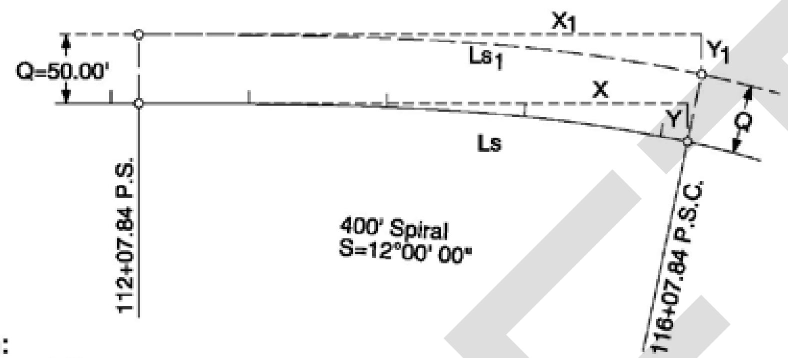
$$U_2 = \frac{(334.17' - 200.06')\text{ Sin } 12°30'}{\text{Sin } 8°00'} - 100.06' = 108.506'$$

$$V_2 = 167.43' - \frac{(334.17' - 200.06')\text{ Sin } 4°30'}{\text{Sin } 8°00'} = 91.83'$$

$$C_2 = \sqrt{(36.24' - 7.85')^2 + (497.63' - 299.81')^2} = 199.847'$$

Figure 200-42: Spiral Solution - Example 12

COMPUTING OFFSET SPIRALS



Given:

Ls = 400'
a = 1.5
S = 12° 00' 00"
Q = 50.00' (Outside offset)

Find:

Offset spiral.

NOTE:
The offset spiral is not related to the Standard Highway Spiral. Therefore use the following method.

Solution:

θ = S (in radians) for the base spiral = $\frac{S}{57.29578}$

Q = Offset in feet

$Ls_1 = Ls \pm Q(\theta)$ (+) for outside offset

$X_1 = X \pm Q \sin S$ (-) for inside offset

$Y_1 = Y \pm Q(1 - \cos S)$ Use (+) for outside offset

To compute the spiral offset as it would be run in the field; setting stakes at right angles to and "Q" offset from the corresponding stations on the base spiral with transit setup at the P.S. or P.T. of the offset spiral:

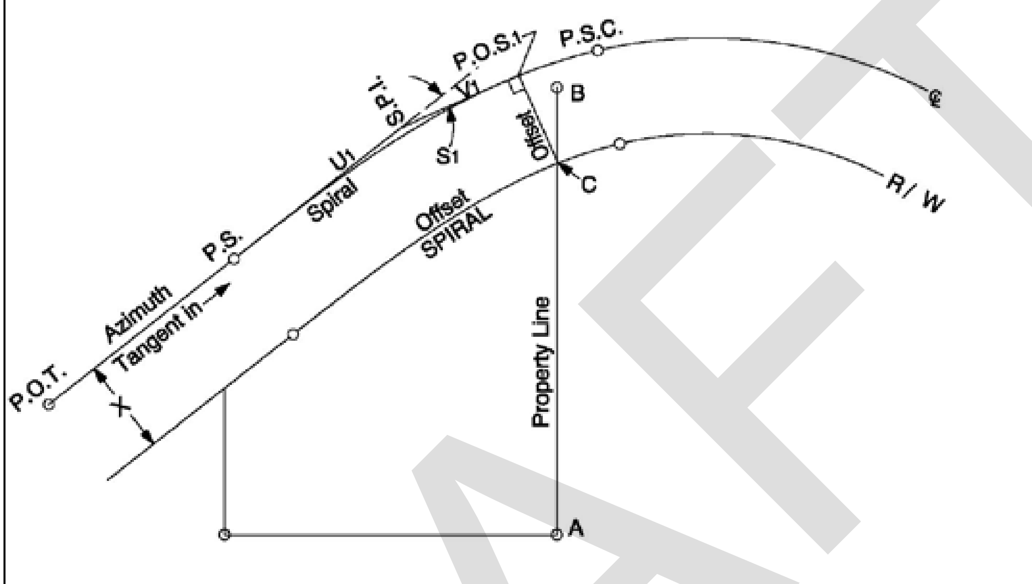
(1) Find the S angle for each station.
(2) Determine length of the offset spiral, Ls_1, from P.S. or P.T. to each station.
(3) Using S angles found in step 1, determine the corresponding X and Y values for each station of the base spiral.
(4) Determine the X_1 and Y_1 values for the offset spiral.
(5) Determine the offset spiral deflections from $\tan i = \frac{Y_1}{X_1}$
(6) Calculate chords using formula in example XI.

TABULATION OF RESULTS FOR ABOVE DATA

STATION	Ls	S	L1	Y	X	Y1	X1	i1	C1
112+07.84 P.S.	0.00	0°00'00"	0.00	0.00	0.00	0.00	0.00	0°00'00"	0.00
112+50	42.16	0°08'00"	42.28	0.03	42.16	0.03	42.28	0°02'24"	42.28
113+00	92.16	0°38'13"	92.72	0.34	92.16	.034	92.72	0°12'36"	50.44
113+50	142.16	1°30'57"	143.48	1.25	142.15	1.27	143..47	0°30'36"	50.76
114+00	192.16	2°46'10"	194.58	3.10	192.12	3.16	194.54	0°55'48"	51.10
114+50	242.16	4°23'53"	246.00	6.20	242..01	6.35	245.84	1°28'48"	51.39
115+00	292.16	6°24'07"	297.75	10.88	291.79	11.19	297.36	2°09'18"	51.75
115+50	342.16	8°46'50"	349.82	17.45	341.35	18.04	348.98	2°57'30"	52.07
116+00	392.16	11°32'03"	402.23	26.25	390.57	27.26	400.57	3°53'36"	52.41
116+07.84 P.S.C.	400.00	12°00'00"	410.47	27.84	398.25	28.93	408.65	4°03'00"	8.24

Figure 200-43: Spiral Solution - Example 13

SOLUTION OF OFFSET SPIRAL INTERSECTING WITH PROPERTY LINE



Given:

Centerline geometry, offset value, coordinate of P.O.T. on tangent in, azimuth of tangent in, coords of point A and B or coords of A or B and azimuth to the other. "Lg" is a generic value representing the guess length of spiral to offset point.

Find:

Coordinate of intersect point C.

Solution:

This problem has no direct solution. It can be solved by iteration. This is not as difficult as it seems.

Begin at the P.S. of the spiral and guess an "Lg" length. Using the "Lg" and the "a" value generate "U_1" and "V_1" and "S " values for trial solution. The solution is to coordinate from the P.S. to the S.P.I. to the P.S.C. of the P.O.S. along the spiral. Next coordinate a point "C" from the P.O.S.$_1$ 90° off the tangent between the S.P.I. and P.O.S. out the offset distance "X". Finally inverse between point "C" and point "A" and determine the azimuth of point "C" to "A". Compare this azimuth to the azimuth between point "B" to "A". When azimuths are identical you have solved for the intersect.

ALGORITHM FOR ITERATION

Lg_1 = $Guess_1$ = Length of spiral for Trial #1
Lg_2 = $Guess_2$ = Length of spiral for Trial #2
Ls_3 = ? = Projected length from linear regression

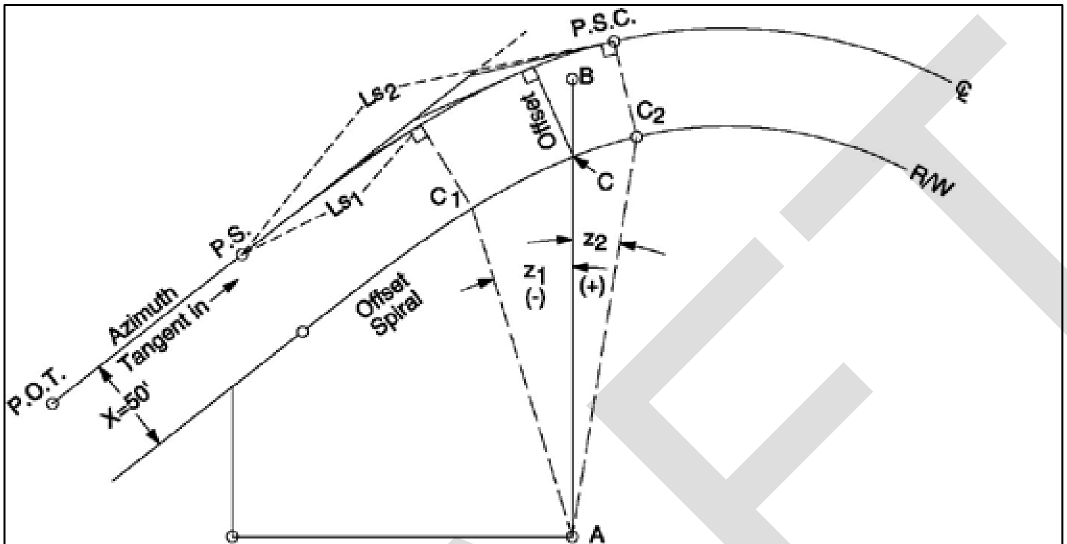
"Equation" is all calculations to produce difference in azimuths (d_1 , d_2).

Solve "equation" using Lg_1 - result is z_1
Solve "equation" using Lg_2 - result is z_2

Given Lg_1 , z_1 , Lg_2 , z_2 , compute Ls_3:

$$Ls_3 = Lg_2 - (z_2 (Lg_1 - Lg_2) / (z_1 - z_2))$$

Figure 200-44: Spiral Solution - Example 14



Given:

Centerline geometry, D - 8, Spiral 400', offset 50', coordinate of P.O.T. on tangent in, azimuth of tangent in, coords of point "A" and "B" or coords of (A or B) and azimuth to the other.

Find:

Coordinate of intersect point C.

Solution:

$Lg_1 = Guess_1 = 300'$ $\quad$ $Lg_2 = Guess_2 = 400'$

Calculate "z_1" by assuming a "Ls_1" length and computing for "U_1", "V_1" and "S_1". Turn a 90° and "X" distance from "V_1" tangent at point on spiral to offset spiral. Inverse between point "C_1" and "A" for azimuth. Take the difference between "C " to "A" and "B" to "A" and this is angle z_1. Repeat steps for z_2.

Note:

To reduce the number of iterations select "Lg_1" and "Lg_2" as close as possible to point "C". Keep in mind the positive and negative "z" values.

$Ls_3 = 400' - (8.9151\ (300' - 400') / (-3.3458 - 8.9151) = 327.28839'$

$Ls_3 = 327.28839' - (0.299(400' - 327.28839') / (8.9151 - 0.299) = 324.76512'$

$Ls_3 = 324.76512' - (-0.0276(327.28839' - 324.76512') / (0.299 - (-0.0276)) = 324.97835'$

$Ls_3 = 324.97835' - (0.0001\ (324.76512' - 324.97835') / (-0.0276 - (0.0001)) = 324.97758'$

In this example the L_3 starts to repeat itself to significant figures, & it is solved.

Flow Diagram for "Lg" in Ls_3 equation

Lg_1 $\quad Lg_2$ $\quad Ls_3$

Lg_1 $\quad Lg_2$ $\quad Ls_3$ $\quad$ Lg_2 becomes new Lg_1, and Ls_3 becomes, new Lg_2.

Lg_1 $\quad Lg_2$ $\quad Ls_3$

1 Figure 200-45: Establish Local Tangent on Horizontal Curves

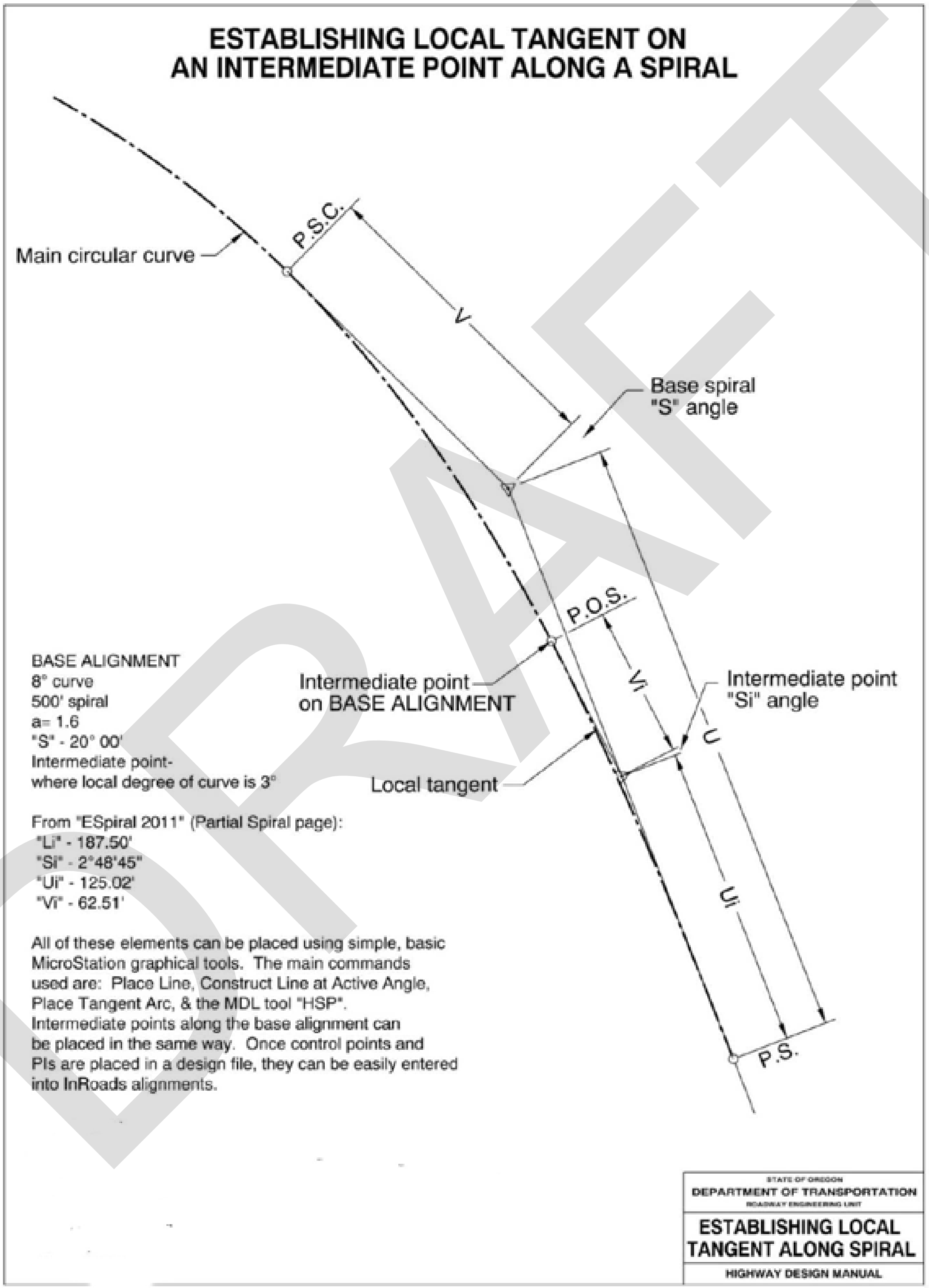


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Figure 200-46: Using Spiral Segment in Compound Horizontal Curve Situations

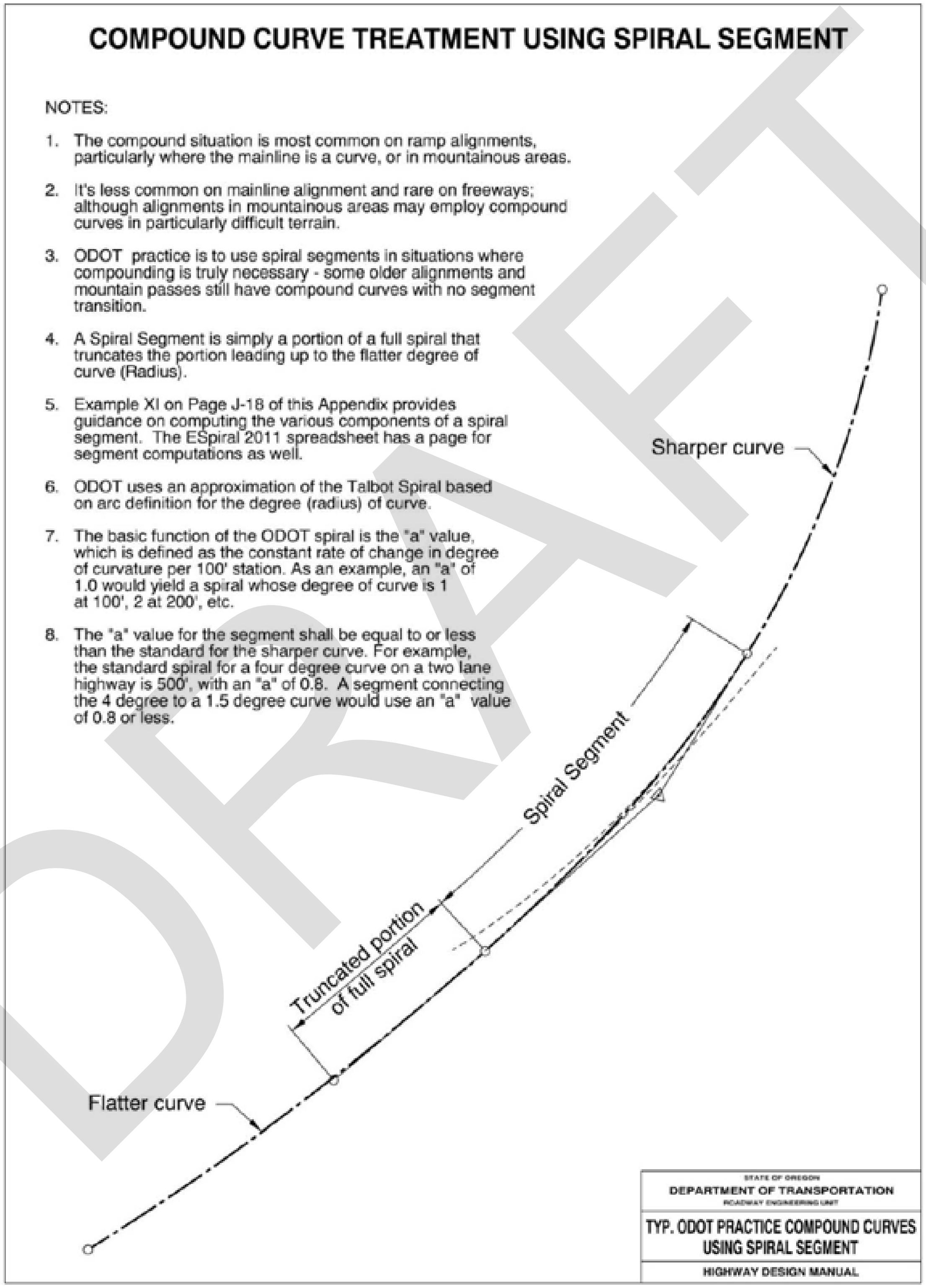


Figure 200-47: Establishing Ramp Takeoff/Touchdown Points and Ramp Angles from Local Tangent

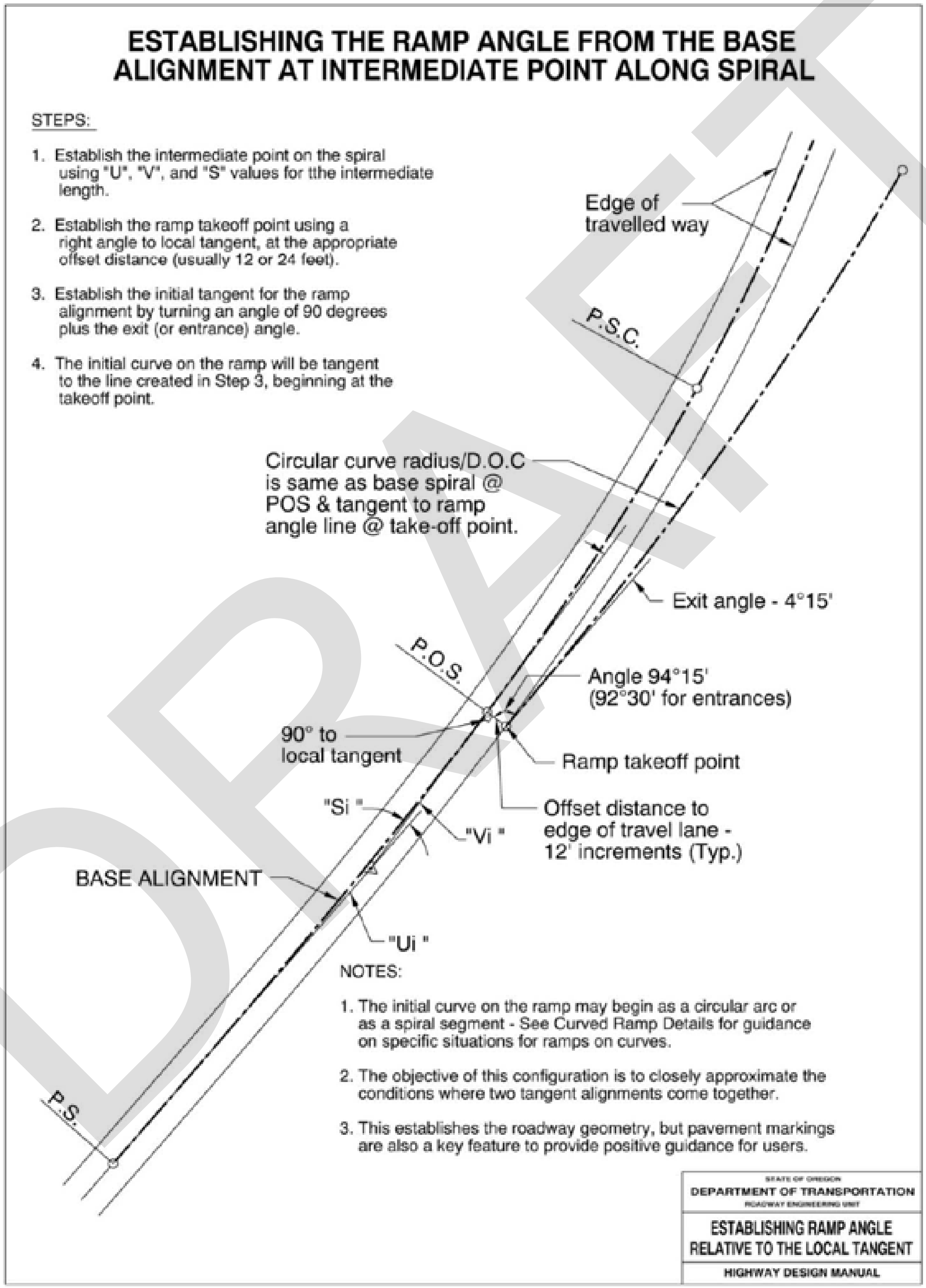


Figure 200-48: Establishing Spiral Segment Control Points
(in conjunction with ESpiral 2011 spreadsheet)

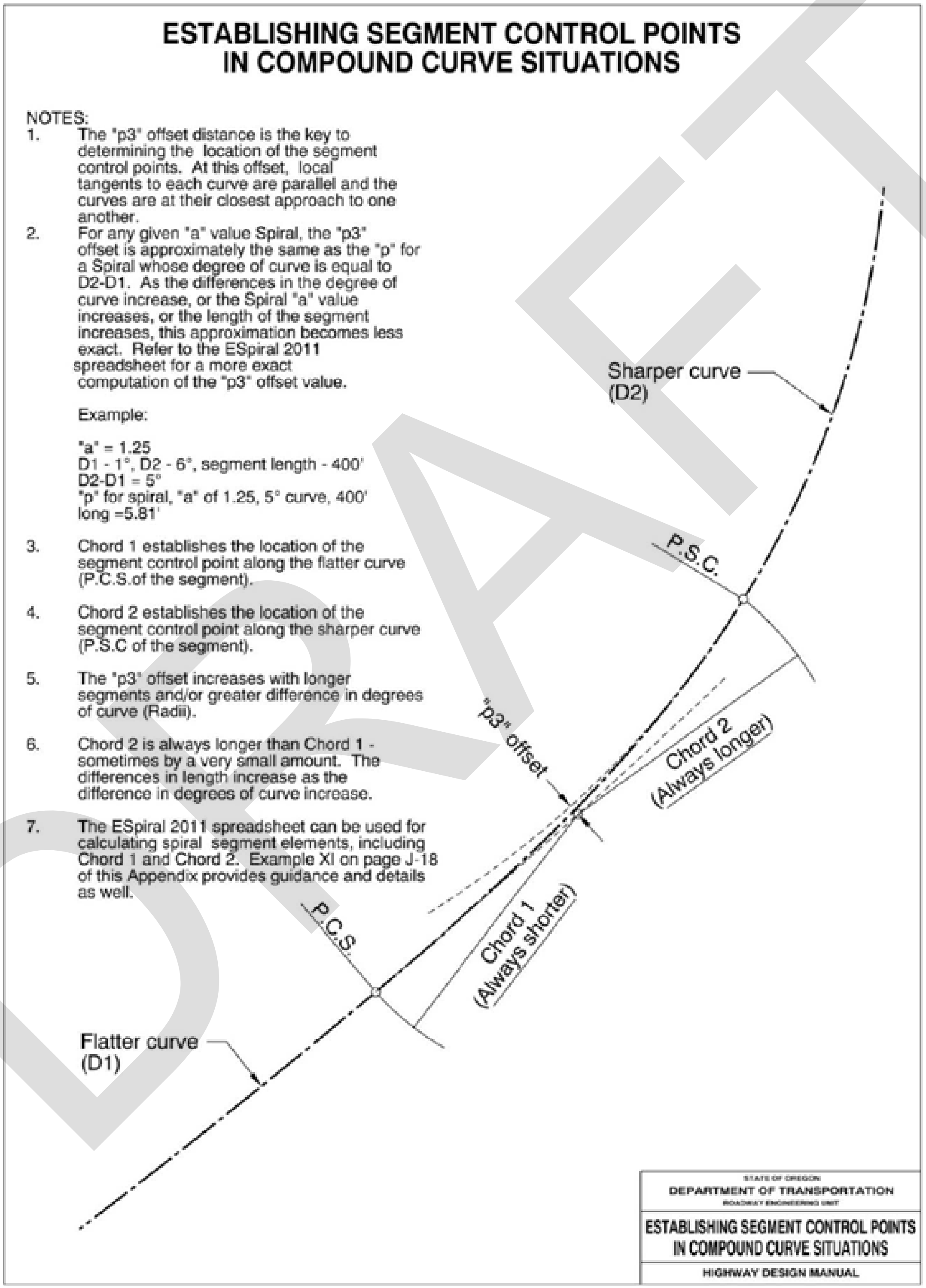
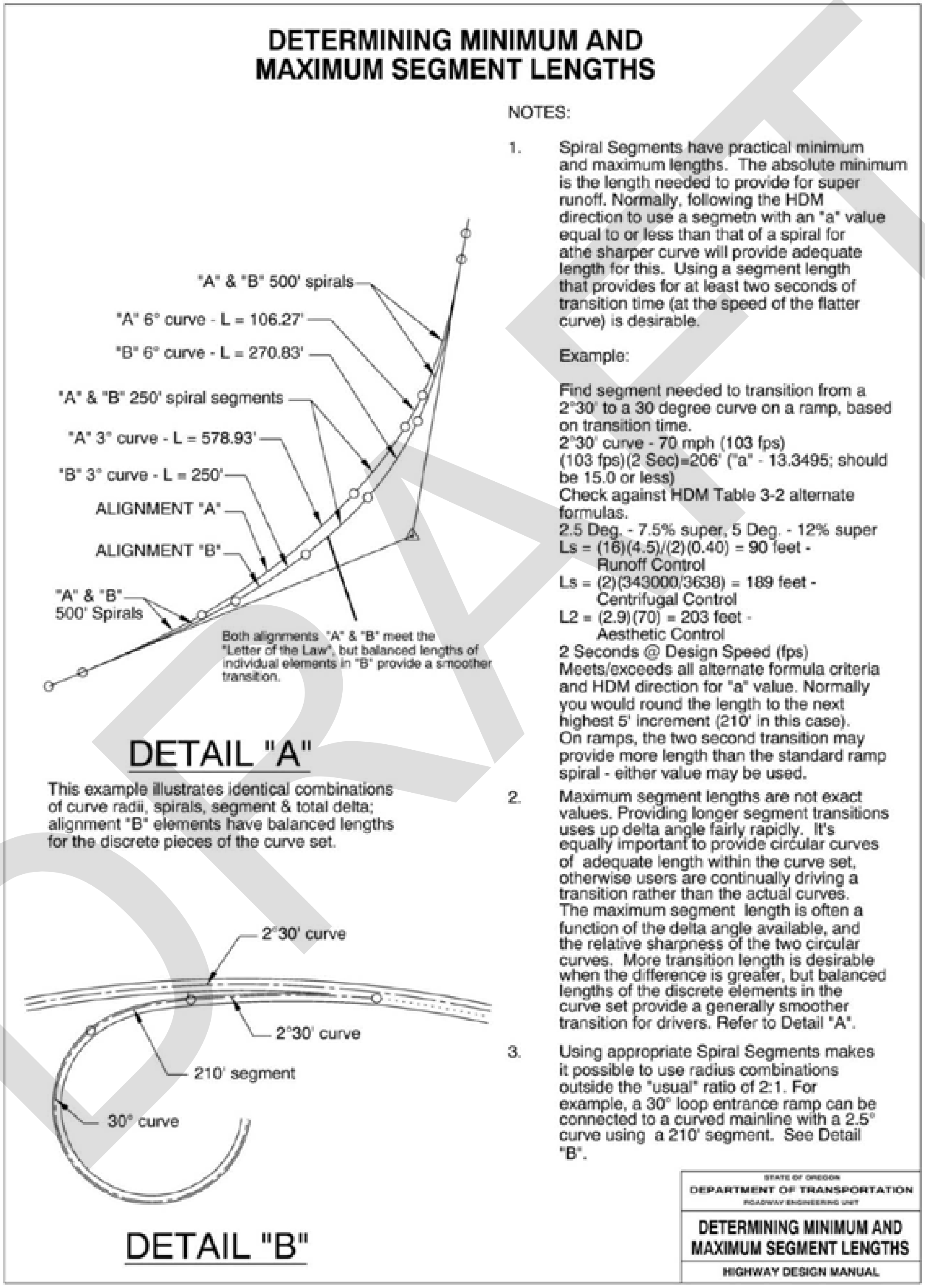


Figure 200-49: Example of Spiral Segment in a Mainline Alignment Situation



Section 219 Vertical Alignment

Design vertical curves to provide sight distance at least equal to the stopping sight distance for the indicated design speed. The vertical sight distance is the distance from the operator's eye, assumed to be 3.5 feet above the pavement to the point 2 ft above the pavement. While objects less than 2 ft in height may be encountered on Oregon highways, it is rare that a complete emergency stop would be required to avoid such an object. Therefore, it is typically not practical to design for an object height of less than 2 ft. The minimum lengths of vertical curves which may be used for the various design speeds are shown in Figure 200-50 and Figure 200-51.

It is desirable to increase the length of vertical curves over that shown whenever it is economically possible. When the algebraic difference in the grades is small, the minimum curve length is three times the design speed. This is represented by the vertical lines in the lower left hand corner of Figure 200-50 and Figure 200-51. An angle point is considered a curve with a length of zero, and therefore, does not meet the minimum standard.

The intent of 3R projects is to preserve and extend the pavement life of the roadway. Reconstructing the vertical alignment of preservation projects is typically outside the project purpose, need, and scope.

219.1 3R Freeway Vertical Curvature and Stopping Sight Distance

For all 3R freeways, stopping sight distance shall be those values established in the AASHTO Green Book for the selected design speed. See Section 217 for sight distance information.

219.2 3R Vertical Curvature and Stopping Sight Distance (All Highway Except Freeways)

For 3R projects, evaluate reconstruction of crest vertical curves if all of the following criteria are met:

1. The crest obstructs from view major hazards such as intersections, sharp horizontal curves, or narrow bridges, and the current year ADT is greater than 2000, or
2. The design speed based on the existing Stopping Distance is more than 20 mph below the ODOT Urban Standard (urban) or project design speed (rural) and the current year ADT is greater than 2000.

If reconstruction of the vertical curve is not justified or cost effective, or the curve is not reconstructed to new construction standards, appropriate mitigation measures should be applied.

219.3 4R Vertical Curvature (All Highways)

The minimum lengths of vertical curves which may be used for the various design speeds for crest vertical curves and sag vertical curves are shown in Figure 200-50 and Figure 200-51. The figures provide the Rate of Vertical Curvature (K) values based on design speed and stopping sight distance requirements. It is desirable to increase the length of vertical curves over that shown whenever it is economically possible. When the algebraic difference in the grades is small, the minimum curve length is three times the design speed. This is represented by the vertical lines in the lower left hand corner of Figure 200-50 and Figure 200-51. An angle point is considered a curve with a length of zero, and therefore, does not meet the minimum standard.

Figure 200-50: SSD Crest Vertical Curve

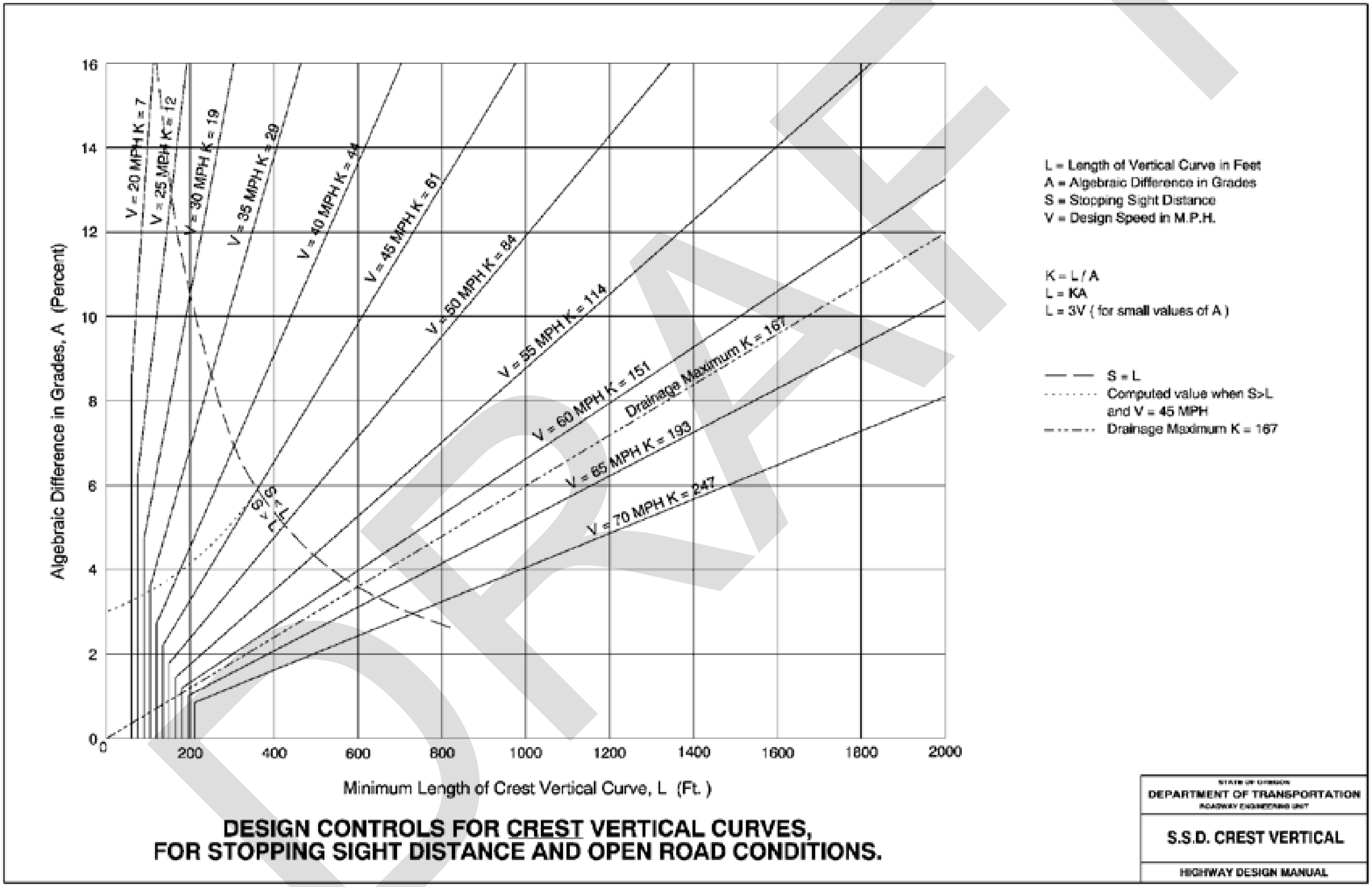
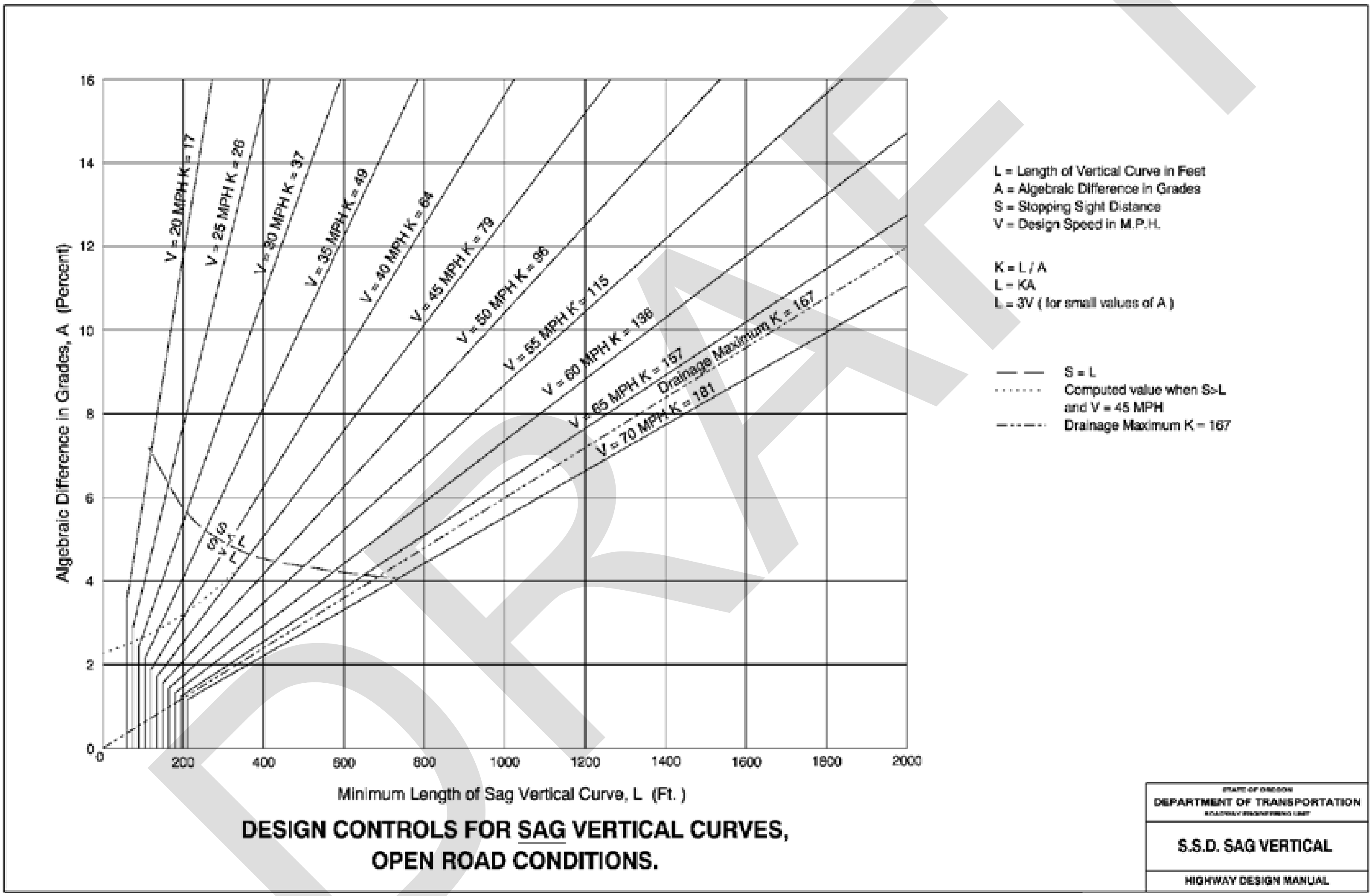


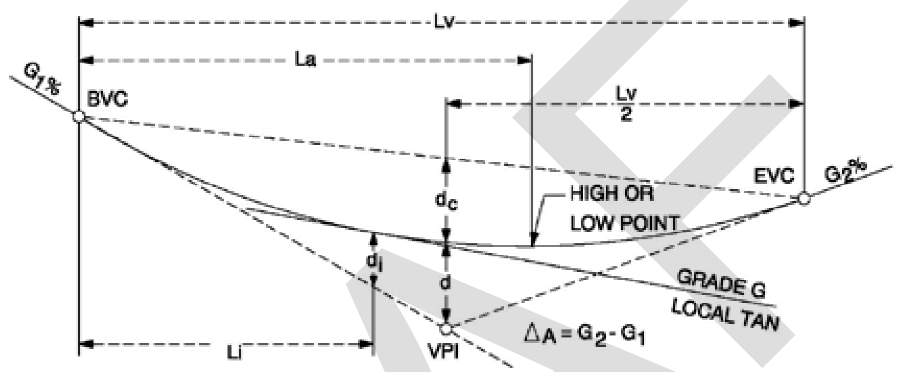
Figure 200-51 : SSD Sag Vertical Curve



219.4 Vertical Curve Formulas

Figure 200-52: Vertical Curve Formulas

VERTICAL CURVE SYMMETRICAL PARABOLIC



L_i = Distance from beginning point of vertical curve to any point along the curve.
G_1, G_2 = Tangent grades in percent, positive for ascending forward, negative for decending forward.
$K = Ls / \Delta A$ = feet to affect a 1% change in grade.
ΔA = algebraic difference in grades, percent.
Lv = Length of vertical curve in feet, measured horizontally.
d = Vertical offset from the vertex (called PI) to the middle of curve.
d_i = Vertical offset from a tangent to the vertical curve vary as the square of the distance from the PC.
d_c = Vertical offset from the chord to the vertical curve.

$$\Delta_A = G_2 - G_1 \qquad K = \frac{Lv}{\Delta_A}$$

$$d = d_c = \frac{\Delta_A \, Lv}{800} = \frac{K \Delta_A^2}{800}$$

$$d_i = \frac{L_i^2}{\left(\frac{Lv}{2}\right)^2} \qquad d = \frac{\Delta_A \, L_i^2}{200\,Lv} = \frac{L_i^2}{200\,K}$$

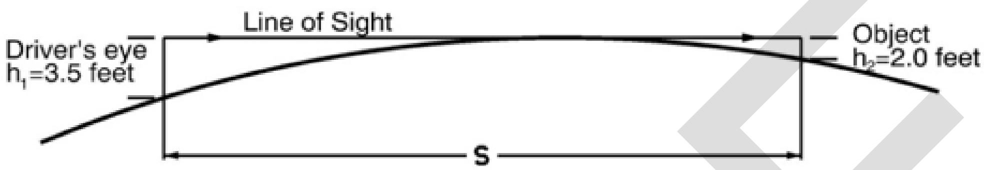
$$G = G_1 - \frac{L_i}{K} \qquad L_a = G_1 \, K$$

Note: Distances Lv, d, d_c, L_a, L_i, d_i, are in feet.
Grades G_1, G_2, ΔA, G are in percent.

Figure 200-53: Crest and Sag Vertical Curves

CREST CURVATURE

Design Speed (V) mph	25	30	35	40	45	50	55	60	65	70
Design (K)	12	19	29	44	61	84	114	151	193	247



$$K = \frac{S^2}{200\ h_1\ (1 + \sqrt{h_2 / h_1})^2}$$

Stopping Sight Distance (S) is derived from this formula:

$S = 1.47Vt + (1.075)(V^2/a)$

where:

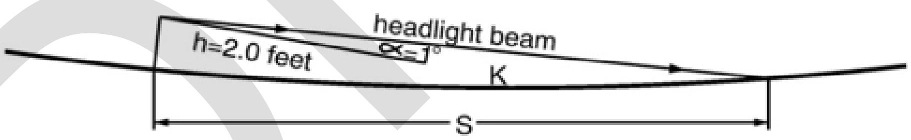
t = brake reaction time, 2.5 seconds;

V = design speed, mph;

a = deceleration rate - 11.2 ft/s^2

SAG CURVATURE

Design Speed (V) mph	25	30	35	40	45	50	55	60	65	70
Design (K)	26	37	49	64	79	96	115	136	157	181



Where the length of curve exceeds the stopping sight distance, K is given.

S Less Than or Equal to Lv $\quad K = \frac{S^2}{200\ (h + S\ \tan\alpha)}$

Where the stopping sight distance exceeds the curve length, K is given.

S > Lv $\quad K = \frac{2\,S}{\Delta A} - \frac{200\,h_1}{\Delta A^2}(1 + \sqrt{h_2 / h_1})^2$ where:
A = Algebraic Difference in Grades

Minimum sag vertical curvature for comfort critera, illumination may be required.

$L = \frac{AV^2}{46.5}$ where:
A = Algebraic Difference in Grades

Section 220 Combined Horizontal and Vertical Alignment

The combined effect of the horizontal and vertical alignment must be considered during design of a highway (see the AASHTO Green Book). In addition, the designer is responsible for providing all the final horizontal and vertical geometry for the project, including bridges.

When designing for the coordination of horizontal and vertical alignment, the following issues need to be considered.

1. Balance curvature and grades. Tangent alignment mixed with steep grades or flat grades with excessive curvature is poor design. A balance of both elements leads to uniform operation, aesthetically pleasing, and safe designs.
2. Vertical and horizontal alignments should complement each other.
3. Avoid locating sharp horizontal curves at or near the top of a crest vertical curve or at the low point of a sharp vertical curve.
4. Design horizontal and vertical curvature to be as flat as possible in the area of intersections to allow for proper sight distance.

On summits with both horizontal and vertical curves, make the horizontal curve longer than the vertical curve. There is a limit of one vertical curve within a horizontal curve. It is desirable to provide a tangent grade on tangent alignment. Once the sight distance is broken by a curve in either the vertical or the horizontal alignment, there is little value in maintaining a tangent. The ideal alignment extends from control point to control point without unnecessary curvature in between. However, extremely long tangents may cause problems, due to driver boredom. (See the AASHTO Green Book)

In the design of two-lane arterials, provide for passing at frequent intervals. Work with the Region Traffic Engineer on locations for passing opportunities, or passing or climbing lanes.

Section 221 Grades

221.1 General

On grades of 4% or over, carry the profile grade at the edge of the traveled way to the right of the centerline ascending the grade. The superelevation is obtained by raising the center and left side of the roadway on curves turning to the right going uphill, and by lowering the center and left side of the roadway on curves turning to the left. Where this rule applies and the horizontal curve passes over a summit, the profile grade is carried on the outside of the curve developing superelevation by lowering the center and inside edge of the roadway. For grades less than 4%, use the standard method of superelevation in conformance with Section 218.

It is important to take into account the impact from grades in the different design elements such as acceleration and deceleration lanes, stopping sight distance, passing sight distance, and intersection sight distance. Figure 3-2 in the 2018 AASHTO Green Book page 3-6 shows the effects of grade on stopping sight distance.

Due to 3R projects primarily dedicated to preservation, excluding freeways, the design requirement for 3R grades is to maintain the existing grade.

221.2 3R and 4R Freeway Grades

3R projects that include modernization work will need to follow the 4R grade requirements for that portion of the preservation project that includes the modernization work type. Table 200-14 provides design guidance for both 3R and 4R Freeway Grades. Generally grades on urban and rural freeways are very similar. In urban and mountainous areas, increased grades are allowed due to terrain. Care should be taken in urban areas to minimize the use of steep grades due to the close spacing of interchanges and the multiple speed changes needed in an urban area. In an urban environment, the driver must process large amounts of information in short periods of time. Steep grades make it more difficult for lane changes and other maneuvers to be made. The 4R maximum grade for flat, rolling, or mountainous are 3%, 4%, and 5% respectively.

Table 200-14: Maximum Freeway Grades

	Maximum Freeway Grades (%) for Specific Design Speed								
Design Speed(mph)	50	60	70		50	55	60	65	70
Design Standard	**4R***				**3R***				
Terrain									
Flat/Level	-	_	3		4	4	3	3	3
Rolling	-	_	4		5	5	4	4	4
Mountainous	5	5	5		6	6	6	5	5

* In urban areas grades may be 1% steeper. Grades 1% steeper in urban areas requires a design exception.

221.3 4R Urban and Rural Expressway Grades

The length and percentage of grade affects the operation of the expressway. Long, steep grades reduce the efficiency of the facility, especially when there are high truck volumes. Table 200-15 below provides design standards for Urban and Rural Expressway Grades.

Table 200-15: Expressway Maximum Grades

	Maximum Expressway Grades (%) for Specific Design Speed					
Design Speed (mph)	**45**	**50**	**55**	**60**	**65**	**70**
Urban	6	6	5	5	5	5
Rural		6		4		3

221.4 4R Rural Arterial Grades

Rural arterials cover a wide range of topographic areas. Highway grades can have a significant effect on traffic flow and operations and therefore should be as flat as possible. Highways that carry substantial amounts of truck or recreational vehicle traffic will be greatly affected by steep grades. Wherever possible, steep grades should be avoided. Where this is not practical, the length of grade should be minimized. The maximum grade allowed on rural arterial highways can be found in Table 200-16. Where terrain impacts traffic flow, provide frequent passing opportunities where possible.

In some mountainous terrain, long steep grades are unavoidable. In these instances consider the use of truck climbing lanes. On continuous steep downhill grades, the use of truck escape ramps may be necessary. Where truck escape ramps are deemed necessary, they should be designed as an ascending grade type as per the AASHTO Green Book. Climbing lanes are covered in more detail in Part 700.

1 Table 200-16: Rural Arterial Maximum Grades

	Rural Arterial Maximum Grades (%) for Specific Design Speed					
Design Speed(mph)	45	50	55	60	65	70
Terrain						
Level	5	4	4	3	3	3
Rolling	6	5	5	4	4	4
Mountainous	7	7	6	6	5	5

2 Table 200-17: Rural Collector Maximum Grades

	Rural Collector Maximum Grades (%) for Specific Design Speed					
Design Speed(mph)	**45**	**50**	**55**	**60**	**65**	**70**
Terrain						
Level	5	4	4	3	3	3
Rolling	6	5	5	4	4	4
Mountainous	7	7	6	6	5	5

3 Table 200-18: Rural Local Route Maximum Grades

	Rural Local Route Maximum Grades (%) for Specific Design Speed					
Design Speed(mph)	**45**	**50**	**55**	**60**	**65**	**70**
Terrain						
Level	5	4	4	3	3	3
Rolling	6	5	5	4	4	4
Mountainous	7	7	6	6	5	5

221.5 4R Urban Arterial Grades

As with any urban arterial, the grade selected can have an effect on how well an arterial operates, especially on urban arterials that have a high percentage of trucks, heavy vehicles, and transit vehicles. Steep grades impact speeds and stopping distances and can have an effect on intersection operations. Although grades should be kept as flat as possible, the existing terrain and context of an urban arterial may make it difficult to achieve the design grade requirements. Table 200-19 below provides the design requirements for maximum urban arterial grades.

Table 200-19: Urban Arterial Maximum Grades

	Urban Arterial Maximum Grades (%) for Specific Design Speed					
Design Speed(mph)	25	30	35	40	45	50+
All ODOT Urban Contexts	8	8	7	7	6	6

Section 222 Design Vehicles and Accommodation of Design Vehicles

In selecting the appropriate design vehicle, many factors must be considered such as the number and type of trucks, functional classification of the highway, freight route designation, and the effect on other modes including pedestrians and bicycles. The design vehicle is typically the largest vehicle that normally uses the highway without a special permit. After determining the appropriate design vehicle, a decision needs to be made as to the level of design accommodation to be made. For example, at an intersection, will the radii be designed for the design vehicle or to accommodate the design vehicle? The concept of designing for the design vehicle is to provide a path for the vehicle that is free of encroachments upon other lanes. Providing a design that accommodates the design vehicle means that some level of encroachment upon other lanes is necessary for the vehicle to make a particular movement (see Part 500). A balanced design approach takes into consideration more than just the amount of room the design vehicles requires. For example, what is the intended operating speed of the facility? Fully designing for a large design vehicle may result in higher than desired speeds. What is the context? In a traditional downtown, it is desirable to provide priority to pedestrians over other modes. An example of an intersection that would need to be designed for the design vehicle with no encroachment into adjacent lanes would be a rural stop controlled intersection with a state highway, the highway being two lane or multi-lane with higher speeds and/or high traffic volumes. If a traffic study concludes that finding a gap in multiple traffic flows is not possible, the intersection would need to be designed for the design vehicle so it can turn into a single lane. Other factors to consider are the effects on pedestrians and bicycles: For example, large turning radii at intersections result in long crossing distances and longer exposure times for pedestrians with potential negative impact to safety. Also, with larger radii, motorists tend to take turns at higher speeds. So, designing for a large design vehicle tends to make the intersection less desirable for most of the users of the intersection. Therefore, rather than designing for the design vehicle, the design should normally accommodate the design vehicle in consideration of the overall safety of the highway.

In addition to the design vehicle, the occasional larger vehicle may need to use the highway. Coordination with the Commerce and Compliance Division and the Statewide Mobility Program group in the Statewide Project Delivery Branch is required to determine if any vehicles larger than the design vehicle are allowed on a highway by permit and what level of accommodation needs to be provided. The Commerce and Compliance Division (CCD) receives requests to move special loads through the state. Although these loads are not to be used for design purposes, there will be occasion where the appropriate route for these special loads, which are typically accompanied by pilot vehicles, will need to be developed. These special load requests from CCD normally are sent to Technical Services, but the Region Technical Centers may be also receive the requests. Region staff should work with the Region Mobility liaison and with Technical Services when CCD requests for these special loads occur. Additional information can also be found in the ODOT Mobility Procedures Manual.

For more information on design vehicle accommodation for private and public road approaches and intersections, see Part 500 (Intersection Design).

Section 223 Traffic Characteristics

Roadway designers need a basic understanding of traffic flow and characteristics (including bicycle, pedestrian, freight and transit) to be able to develop safe and effective facility designs. This understanding is as fundamental to sound design as geometric, hydraulic, or structural considerations. Designers don’t necessarily need to be experts on analysis, but they do need to be familiar with basic concepts in order to develop projects that will meet agreed upon goals and objectives.

There are four major components that affect the character and flow of traffic:

1. Vehicles (including autos, trucks, bikes, pedestrians, and transit)
2. Facility character and functional requirements (not the same as Functional Class)
3. Drivers/Users
4. Traffic Demand that is to be accommodated (again, for all types of traffic)

Additionally, there are other factors that affect the four main components, including:

1. Weather/Seasonal Variations
2. Completeness of the facility network (Arterials, Collectors, Locals)
3. Overall context/location (Rural, Suburban, Urban) and development patterns
4. Availability of Transit/Park & Ride, etc.
5. Intermodal connections (such as Rail to Highway, Highway to Ports)

Analysis of traffic data (for all modes) can be complex and is subject to many variables. Designers need to consult with ODOT's Transportation Planning Analysis Unit (TPAU) and Region Traffic Units to get a clear understanding of traffic data and characteristics. Since traffic staff are always included as members of Project Teams, they can provide specific and detailed guidance to design personnel. Decision making on projects needs to be a collaborative effort - designers should also communicate back the "physical world" perspective during decision making and design. Neither traffic nor geometric design is an exact science, so allowances are necessary to accommodate the inherent uncertainties.

Tools are available to aid design personnel in understanding traffic needs and analysis. Chapter 2 of the AASHTO Green Book has an excellent detailed discussion on Traffic Characteristics – it is written with designers in mind. TPAU has developed an "*Analysis Procedures Manual*". This document provides current methodologies, practices, and procedures for conducting long term analysis for ODOT plans and projects.

Section 224 Accommodation of other Modes in Design

Roadway facilities should be designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. The design team should understand the difference between "accommodating" versus "designing for" a given mode and apply consistent principles within the project context. Multimodal design considerations depend on the intended function of the corridor, as well as balancing trade-offs and objectives from local plans. For example, consider a roadway designed primarily for mobility for motorized vehicles. The design is required to "accommodate" other users, such as pedestrians and bicycles, but it will not attract a wide range of vulnerable users. A roadway intended to serve and attract non-auto users, however, should be "designed for" multimodal users. This means mobility for motorized vehicles as a lower priority and allows some congestion.

224.1 Accommodation and Design for Pedestrians and Bicyclists

ORS 366.514 requires that ODOT, cities and counties provide walkways and bikeways wherever a highway, road or street is being constructed, reconstructed, or relocated. They are not required if:

1. Scarcity of population or other factors indicate an absence of any need;
2. Costs are excessively disproportionate to need or probable use; or
3. Where public safety is compromised. The designer should start with the assumption that accommodation is required, and seek an exemption only where it is obvious that one of the three above exceptions applies. The designer should also reference planning documents to see if prior efforts have already established if sidewalks or bikeways are needed.

On a simple preservation project additional accommodation is not required. As part of the practical design process, the project charter will identify the purpose and need of the project, including any required accommodation for pedestrians and bicyclists.

The Americans with Disabilities Act (ADA) is a federal Civil Rights law that mandates both the private and public sectors to make their facilities accessible. For ODOT, that means that pedestrian facilities must be built so people with mobility, visual or cognitive limitations can easily use them. Consult the most current ADA Standards for Accessible Design and Public Right-Of-Way Accessibility Guidelines in addition to the information provided in this manual.

One of ODOT's three goals tied to the agency mission statement is to "improve Oregon's livability and economic prosperity". Many ODOT highways operate as the "Main Street" in a community. Shopping districts with the most comfortable and pleasurable pedestrian walking environments have shown to be the most successful. Therefore, comprehensive pedestrian design, rather than basic accommodation should be considered in Special Transportation Areas (STAs) (see Part 800) and downtown districts. Bicycle tourism is a significant industry in Oregon that also impacts Oregon's livability and economic prosperity. Comprehensive bicycle facility design, rather than basic accommodation should be considered along designated bicycle routes.

Refer to Parts 800 and 900 for design standards of pedestrian and bicycle facilities. The following principles should be considered when designing pedestrian and bicycle facilities.

Design Principles for Pedestrians

This section is a general discussion of designing for pedestrians. For in-depth discussion and information, see Part 800.

1. Pedestrians tend to take the shortest route between two points. The pedestrian's path of travel should be direct with minimal out-of-direction travel.
    - Pedestrian walkways should not meander.
    - Provide walkways on both sides of a street. When sidewalk is provided on one side of the street, but not the other, most pedestrians tend to stay on the side without sidewalk, rather than cross the street; the sidewalk itself does not lure most pedestrians to cross the street.
    - The typical maximum distance pedestrians walk are as follows: 1 mile for work commute, ½ mile for transit and other trip purposes.
2. Pedestrian travel patterns are less predictable than those of bicyclists or motorists.
3. About 50 percent of pedestrian traffic is shopping-related. About 11 percent is commute-related. Peak pedestrian volumes are not during the peak commuter times for motor vehicles, they usually occur near the noon hour.
4. Designs must accommodate pedestrians of varying abilities and disabilities.
    - Obstructions in walkways reduce the effective width for pedestrians and can make walkways inaccessible for persons with disabilities.
5. Regular pedestrian crossing opportunities should be provided in business districts.
    - All legs of an intersection should be open to pedestrians.
    - All legs of an unmarked intersection are crosswalks.
    - When a crosswalk is striped across one leg of an intersection, the un-striped, opposite leg is no longer a lawful crosswalk.

Design Principles for Bicyclists

This section is a general discussion of designing for bicyclists. For in-depth discussion and information, see Part 900.

1. Bicycle accommodation is required on all highways, except those described in OAR 734-020-0045.
    - Bike accommodation should be continuous on both sides of the roadway.

2. Bicycles are vehicles and should be accommodated as roadway users where possible.
    - The path for bicyclists should be direct, logical and close to the path of motor vehicle traffic, making bicyclist movements visible and predictable to motorists.
    - Safe on-street bicycle accommodation includes bicycle-safe drainage grates and adjusting manhole covers to street grade.
3. Designs may also accommodate bicyclists of lesser abilities.
    - Only in rare cases should bicyclists be required to proceed through intersections as pedestrians.
    - Oregon law (ORS 814.420) requires bicyclists to use a bike path or bike lane, rather than the roadway travel lanes, if a bike path or bike lane is provided.
4. Bicyclists are affected by steep grades more than motorists or pedestrians are.

Section 225 References

Blueprint for Urban Design (BUD), ODOT, 2019.

Main Street…When a Highway Runs Through It: A Handbook for Oregon Communities, DLCD/ODOT, 1999

Oregon Roadway Design Concepts, ODOT.

Creating Livable Streets - Street Design Guidelines for 2040, Metro, 1997.

Roadside Design Guide, AASHTO - 2011.

Oregon Bicycle and Pedestrian Guide, ODOT - 2011.

AASHTO: A Guide For Achieving Flexibility in Highway Design (2004)

AASHTO: A Policy on Geometric Design of Highways and Streets

FHWA: Flexibility in Highway Design

Part 300 Cross Section Elements

Section 301 Introduction

Part 300 Provides direction for applying the appropriate design criteria to project cross section design. Performance-based Practical Design and design flexibility is a strategy to deliver focused benefits for the State's transportation system while working with the realities of a fiscally constrained environment. ODOT's development of the Blueprint for Urban Design (BUD) has been incorporated into the Highway Design Manual to further provide flexibility, particularly in the urban context. These strategies encourage project teams to use engineering judgment to make cost effective system improvements. Understanding of the cross section elements contained herein will allow the practitioner to make sound decisions in keeping the project within scope and budget. The first portion of this Part 300 provides information on urban and rural contexts, the current industry direction on urban design, connecting ODOT's current highway segment designations to ODOT's six urban contexts, determining the context, and evaluating and prioritizing design elements.

The cross section elements of the roadway are as important as the alignments of the roadway and can have as much effect on traveling vehicles. Corresponding care must be given to the cross section elements to assure safe operation of the facility. In addition to cross-section elements for the six ODOT urban contexts, Part 300 provide the 3R, 4R, 1R, and Single Function cross section criteria for urban and rural freeways, urban and rural expressways, rural arterials, collectors, and local routes, as well. In addition this Part provides design guidance for cross slope, vertical clearance, roadside design, curb placement, shy distance and roadside barriers, safety edge, rumble strips, ditches, earthwork, rounding cutbanks, and median design.

Projects that are not intended to modernize the roadway, thus leaving the existing widths and alignments, still can make significant improvements to the overall safety of the facility by addressing the cross sectional elements discussed in this chapter.

Within this manual are specific font changes that are used to show the documentation and/or approval that is required for not meeting the value shown.

301.1 Definitions

1R/3R Record of Decision - Documentation to determine whether the 1R or 3R standard applies to a paving project.

Context Sensitive Solutions (CSS) - A planning and design approach to advance programs and projects in a collaborative manner and in a way that fits into the community and environment.

Design Exception - Approval authorized by the State Traffic-Roadway Engineer to deviate from a design criteria standard. Design Exceptions are submitted on the Design Exception Request Form (see HDM Part 1000).

Design Concurrence Document - Documentation to determine project context, define project design criteria, and document project design decisions for projects. The Design Concurrence Document is included in the DAP submittal.

Urban - Relating to, or characteristic of a town or city

Urban Context - Relates to all nearby built and natural features, as well as social, economic and environmental factors impacting a location. Urban context is based on existing and future land use characteristics, development patterns, and roadway connectivity in an area. For purposes related to the Highway Design Manual, urban context is not limited to places within the current Urban Growth Boundary (UGB)

Urban Design - For the HDM, the term applies to urban contexts relating to land uses that broadly identify the various built environments along ODOT roadways.

301.2 Acronyms

CC - Commercial Center

EOR - Engineer of Record

OHP - Oregon Highway Plan

STA - Special Transportation Area

UBA - Urban Business Area

UDC - Urban Design Concurrence

Section 302 Approval Processes

302.1 Design Exceptions

Any deviation from any design standard or approved design criteria range requires design exception approval by the State Traffic-Roadway Engineer. Design exceptions require signature by both the Engineer of Record (EOR) and State Traffic-Roadway Engineer. Design exceptions and the design exception process is address in Part 1000 of the HDM. Design exception may also require approval by the Federal Highway Administration (FHWA) for project of interest.

302.2 Urban Design Concurrence Document

The Blueprint for Urban Design (BUD), which has been incorporated into the HDM established the urban design concurrence document form to determine project context, define design criteria, and document design decisions. Authority for approval of the urban design concurrence document resides in the Region Technical Center. The Region Technical Center Manager provides final approval of design concurrence with collaborative input from Region Planning, Traffic, Roadway, and Maintenance.

302.3 1R/3R Record of Decision Document

The 1R/3R Record of Decision document is to be filled out by Pavements staff, Region Roadway staff, and Traffic staff. Approval signatures are the Pavements Engineer, the Region Roadway Manager, and the Region Traffic Manager. Project Leader's role is to coordinate.

Section 303 Cross Section Elements

The Standard Roadbed Sections and the ODOT 4R/New Standards outlined in **Error! Reference source not found.** through 322.1 give the dimensions to be used for the design of new facilities, the modernization of existing facilities, and the preservation of facilities. These include shoulders, travel lanes, medians, and other cross sectional elements. Design frontage roads in accordance with the anticipated traffic and their location.

When the width computed for the lateral support of the surfacing material is a fractional width, round the lateral support width up to the nearest foot.

In cases of very rugged terrain and where grading costs are high, give consideration to using steeper slopes or curb sections for lateral support. The use of either must be approved by the State Traffic-Roadway Engineer. Curbs should be avoided on rural highways.

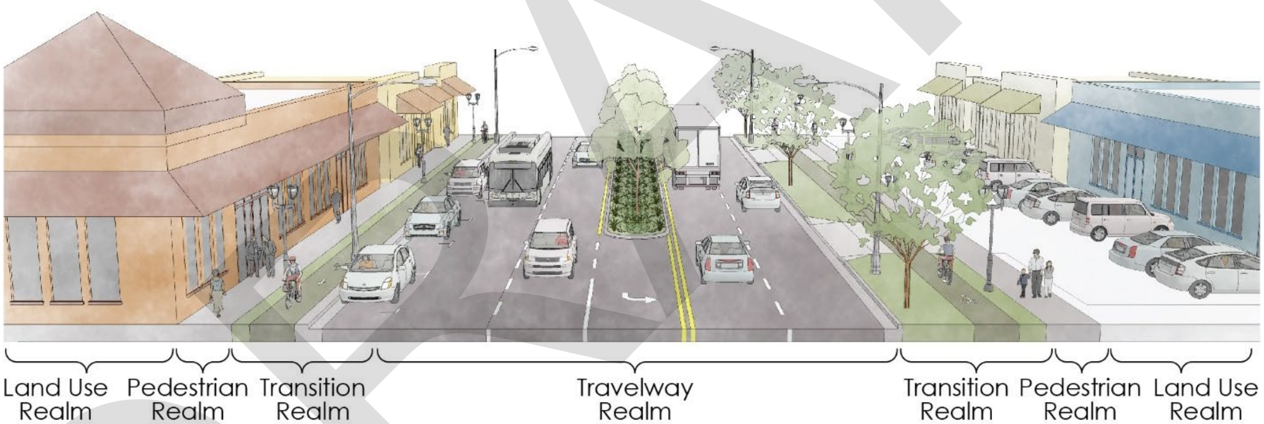
When the slope at the edge of the surfacing material is 1:6 and continuous sections of guardrail are required, consider reducing the surfacing material slope to a minimum of 1:3 behind the guard rail to minimize impacts on the total horizontal width. This may apply in the case of railway encroachments, high fill, or very high cost right of way.

Section 304 Cross Section Realms

304.1 Cross Section Realms and Considerations

This section provides an overview of the importance of integrating design, safety and operations in conjunction with maintenance needs and provides a summary of potential tools for measuring and evaluating considerations and trade-offs. This discussion provides the next level of detail and the range of considerations for design elements within the roadway cross section, which are organized into "cross section realms" as shown in Figure 300-1. The figure provides a graphical overview of the various cross section realms, their positions across the section and the intended function they may serve in an urban area. The elements and dimensions of these realms will vary depending on the urban context, the anticipated users, and desired project outcomes. Table 300-1 is a summary of the Cross Section Realms.

Figure 300-1 Example of Cross Section Realms



1 Table 300-1 Summary of Cross Section Realms

Street Realm	Location	Function
Land Use Realm	Immediately adjacent to the roadway right-of-way	• Typically, privately owned, the land use realm contributes to the urban context of the place. • This space can also serve a variety of other functions in some cases, including pedestrian space, amenities such as bicycle parking, utilities, landscaping, parking, and other uses. • Awnings or building appurtenances, signs and other activities that require use of the public right-of-way or overhang into the Pedestrian Realm must be permitted by ODOT or the local agency (if sidewalk is locally owned).
Pedestrian Realm	Includes the sidewalk and the buffer or furniture zone	• Serves pedestrians and access to land uses • Buffer/furniture zone often used as a place for utilities, lighting, signs, street trees, and other furnishings • May also serve as public space for art, sidewalk seating, or other types of public uses if sidewalk is locally owned.
Transition Realm	The area immediately adjacent to the curb or sidewalk edge (e.g., parking, loading, transit stops). May also include non-pedestrian areas behind the curb (e.g., curb-separated bicycle lanes).	• Bicycle movement or parking, pedestrians, planters, transit stops, parking, loading/unloading, pick-up/drop-off • May serve multiple functions in same block or location, may vary by time of day. • May also include street trees and/or other green streets treatments
Travelway Realm	The center of the right-of-way used for movement, typically including travel lanes, median, and/or turn lanes	• Primarily functions to serve various types of vehicle movement (including motor vehicles, buses, light rail vehicles, streetcars, bicycles, motorcycles, freight, etc.) • Can provide or manage vehicular access through turn lanes, medians, and other treatments • Median can function as a place for vegetation, green streets storm water treatments, and as a pedestrian refuge.

The next set of figures (Figures 300-2 through Figure 300-7) and tables (Table 300-2 through 300-6) provide key questions and considerations for primary design elements typically found within each of the cross section realms. These questions and considerations guide practitioners in making decisions about how to apply, evaluate, and design the cross-sectional elements. Subsequent sections provide specific design guidance for elements within the realms for each urban context. If a project team finds that a roadway is not able to attain the design recommendations, the information in these tables can support the project team’s approach to evaluating trade-offs and documenting design decisions as part of the ODOT urban design concurrence process. Project teams consider the existing urban context and the potential future context desired by the community. Understanding the context considerations, while outlining clear desired project outcomes (for the near-term and long-term needs of the community) can help guide project teams with decision making.

304.2 Land Use Realm

The land use realm shown, in Figure 300-2 and described in Table 300-2, is a key defining feature of the urban context. ODOT does not typically own or control the adjacent land use directly. Instead, it is typically private property, regulated by the local jurisdiction code. ODOT project teams work in parallel with the local jurisdiction to verify that the street design supports the desired context and desired project outcomes.

The function of the land use realm in a Traditional Downtown/CBD area is different from that in the other contexts. Where there is zero setback in a downtown area, business entrances are at the back of the sidewalk, so the roadway speed, volume, and operations influence the attractiveness of the businesses. By contrast, in a Commercial Corridor, entrances farther from the roadway are typically preferred. The road noise caused by higher speeds may impact real estate and the attractiveness of businesses. However, there can also be zero setback in a Commercial Corridor (typically the back wall of a business).

Figure 300-2: Land Use Realm

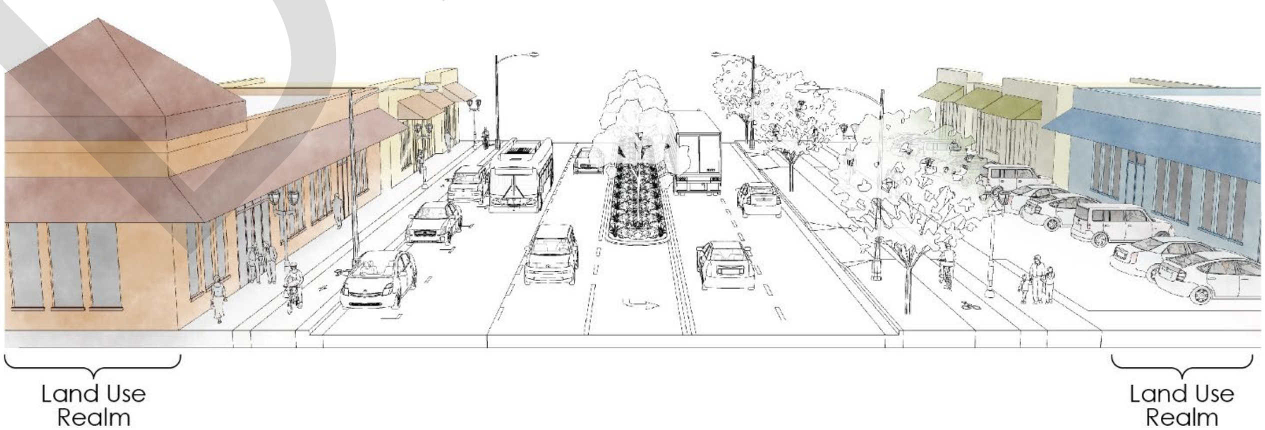


Table 300-2 Design Element Considerations within the Land Use Realm

Design Element	Considerations
Access to commercial development / storefront	• In traditional downtown type land use, buildings often have zero setback, creating a welcoming environment for pedestrians. To ensure adequate space for building frontage in addition to pedestrian movement, wider sidewalks may be necessary. • In other contexts, buildings may have zero setback or a significant setback. In these situations, evaluate and consider the likely pedestrian path between land uses and to/from transit stops to determine where there is likely a demand for street crossings.
Elements supportive of pedestrian realm	• In some urban contexts, the land use realm can offer space that is supportive of the pedestrian realm, potentially reducing demands on the street right-of-way. Consider whether there is the potential to work with the local jurisdiction and property owners to include any of the following: o Additional sidewalk width o Pedestrian plazas / parks o Landscaping adjacent to the sidewalk o Stormwater facilities (green streets) • Awnings or building appurtenances, signs, and other activities that require use of the public right-of-way must be permitted by ODOT or the local agency (if sidewalk is locally owned).
Elements supportive of other street functions	• The land use realm can also provide space to support other functions. o Consider whether it would be appropriate to rely on the adjacent land use for parking. o In many cases, local jurisdiction development code requires property owners to provide bicycle parking. o In some cases, an easement can allow for utilities to be located on adjacent land.

304.3 Pedestrian Realm

The pedestrian realm, shown in Figure 300-3 and described in Table 300-4 includes the frontage zone, the pedestrian zone (Pedestrian Access Route), the buffer zone, and, in some urban contexts, this may also include the curb zone. Exhibit 300-1 illustrates the Pedestrian Zones within the Pedestrian Realm. Section 810.4, Pedestrian Zones, provides more in-depth discussion about pedestrian zones. Depending on how or where a bicycle facility is included, the curb zone may be considered in either the Pedestrian realm or the Transition Realm. For consistency in this document, it is shown in the Pedestrian Realm. However, bear in mind, if a separated bicycle facility is incorporated with the final design, the curb may be included with the Transition Zone. Where a multi-use path design is employed, both the curb and the bicycle facility could be included as part of the Pedestrian Realm.

The greatest need for pedestrian accommodation is along urban highways where sidewalks separated with a buffer are the preferred facility for pedestrians. Provide sidewalks on all urban highways within city limits with the possible exception of limited access expressways or interstate highways. Sidewalks will most likely also be needed on highways beyond city limits, within the urban growth boundary, or in unincorporated areas, based on existing and planned land use.

Understanding pedestrian activity along a corridor, needed access to land use, and potential buffers in the Pedestrian Realm helps prioritize the design decisions for this section of the roadway and support the need to balance the trade-offs amongst the various cross section constraints. When considering the Pedestrian Realm, pedestrian permeability across the roadway is of critical importance in urban locations. Sidewalks provide mobility along the highway, but full pedestrian accommodation also requires frequent, safe and convenient crossing opportunities. Determine final decisions on crossing spacing needed by pedestrian activity in the area. Look at pedestrian origins and destinations within adjacent blocks to help determine spacing needs. Wide highways carrying large traffic volumes can be barriers to pedestrians, making facilities on the other side difficult to access. Consider mid-block and uncontrolled intersection crossings, as people will take the shortest route to their destination. Prohibiting such movements is counter-productive if pedestrians cross the road with no protection. It is better to design highways that enable pedestrians to cross safely. Evaluate pedestrian crossing locations in relation to origins and destinations to determine appropriate spacing to meet demand. Table 300-3 provides target spacing for pedestrian crossings. These values are starting points with further analysis needed to determine appropriate spacing for a given corridor location. Section 307, Pedestrian Crossing Location, provides more information for crossing spacing. See Part 800 for detailed information about designing for pedestrians

Table 300-3: Target Crossing Spacing

Traditional Downtown/ CBD	250-550
Urban Mix	250-550
Commercial Corridor	500-1,000
Residential Corridor	500-1,000
Suburban Fringe	750-1,500
Rural Community	250-750

All pedestrian crossings must meet Americans with Disabilities Act criteria and requirements. HDM Part 800, Pedestrian Design, provides detailed information and guidance to design appropriate and compliant pedestrian facilities.

Figure 300-3 Pedestrian Realm

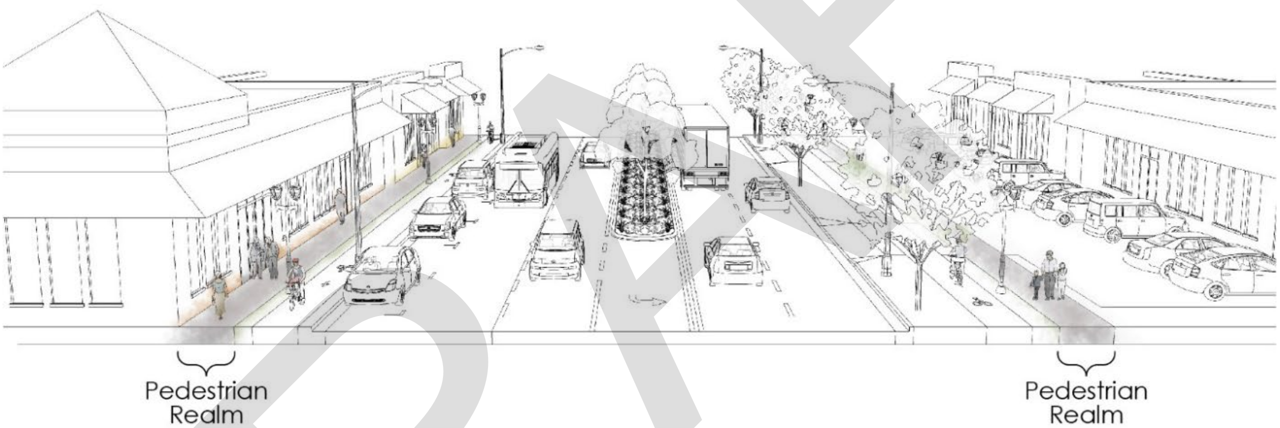
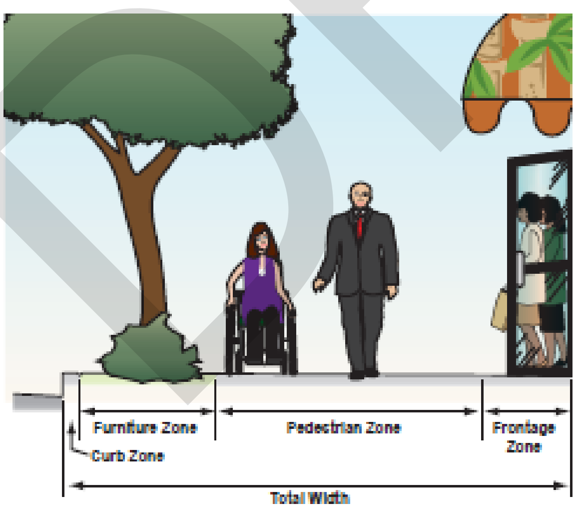


Exhibit 300-1, Pedestrian Realm Zones



1 Table 300-4 Design Element Considerations within the Pedestrian Realm

Design Element	Considerations

Frontage Zone	• The frontage zone is located between the pedestrian zone and the right-of-way.
	• Depending on the available space, this zone may include items such as sandwich boards (if sidewalk locally owned), bicycle racks, and benches.
	• This area is used by window shoppers and is where people enter and exit buildings.
	    o The width of the frontage zone is needed to prevent adjacent property owners from installing a fence at the back of walk, or for maintenance personnel to make sidewalk repairs.
	    o In a Traditional Downtown/CBD context, additional width is needed to provide space for merchandise and sidewalk cafés (if sidewalk is locally owned and permitted), and opening doors (typically needs 4 feet).

Pedestrian Zone	• What is the travel speed next to the sidewalk?
	• Is the street a high priority for pedestrian activity, based on community input and local jurisdiction planning efforts?
	    o If so, prioritize serving pedestrians with a high-quality facility (width and buffer).
	• What level of pedestrian activity is occurring today? Is there a desire or potential for higher pedestrian activity?
	    o Select sidewalk widths with sufficient space to accommodate anticipated/desired level of activity.
	• What is the target pedestrian level-of-traffic-stress for this location?
	• A pedestrian accessible route is provided in the pedestrian zone.

2

Table 300-4 (cont.) Design Element Considerations within the Pedestrain Realm

Design Element	Considerations

Buffer Zone	• People walking need to be buffered from motor vehicle movement. Ensure that a buffer is provided within the pedestrian realm or the transition realm, or that generous sidewalk width provides sufficient space for buffering if sidewalk is curb-tight.
	• Permitted items such as sandwich boards, bicycle racks, and other street furniture are typically placed in this zone.
	• Additional design elements to consider in sidewalk design include:
	  o Pedestrian scale lighting
	  o Utility pole placement
	• Do transit stops need extra buffer?
	  o Where vehicle speeds or volumes are high, sufficient buffer is important.
	  o Downtown area may have parked cars that can serve as a buffer.
	• Suburban areas have no parking but may include a planter strip.

Curb Zone	• The curb zone is the transition between a sidewalk to the roadway at a crosswalk or intersection.
	  o The design of the gutter pan (apron) is important for ADA access standards.
	  o A curb and gutter is typically 2 feet, and the gutter portion can be part of the adjacent transition realm.
	• Where separated bicycle lanes exist, the curb is on the other side of the bicycle lane, so in lieu of the curb zone being defined as the curb between the bicycle lane and sidewalk, this zone is characterized by the buffer space between the bicycle lane and the sidewalk.
	• Most urban streets with sidewalks are typically curbed.
	• A vertical curb channelizes drainage and prevents vehicle from parking on the sidewalk.

304.4 Transition Realm

The transition realm, shown in Figure 300-4 and described in Table 300-5 includes the area immediately adjacent to the curb or sidewalk edge (e.g., parking, loading, transit stops) and may also include non-pedestrian areas behind the curb (e.g., curb-separated bicycle lanes). The primary design elements within this realm are the right-side shoulder, bicycle facilities, and on-street parking. Storm water and landscape considerations are also relevant in this realm and can impact the overall roadway cross section.

Figure 300-4 Transition Realm

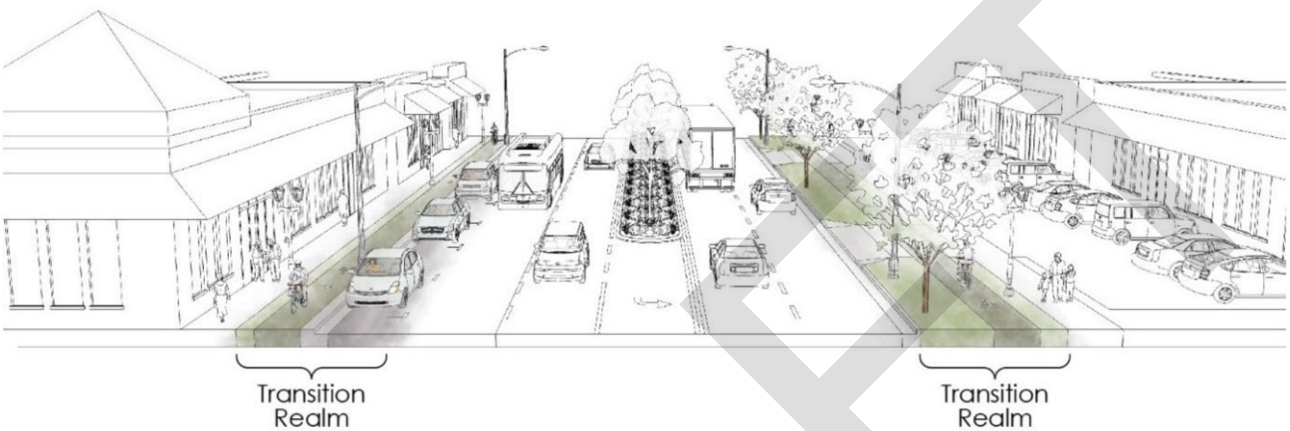


Table 300-5 Design Element Considerations within the Transition Realm

Design Element	Considerations
Right Side Shoulder	• What is the purpose of this space? • Is there a need for roadside recoverable area or shy distance based on the urban context, target speed, and/or run-off the road crashes? • Is storm water allowed to encroach into travel lanes (spread) given the context and target speed?
Bicycle Facility (See Part 800 for Design Details)	• What cross-sectional elements are next to the bicycle lane (e.g. narrow travel lane with higher percentage of trucks)? • What are speeds? ○ When speeds are higher, the project team needs to consider additional separation, such as extra buffer or moving bicycles behind the planter strip. ○ Street buffers function to increase the sense of comfort and safety for bicyclists. This space can serve many functions from green treatments to transit boarding platforms. Features that are necessary to be accessed from the travel lane, typically located in the sidewalk buffer, such as mailboxes, should be in the street buffer. • Is the street part of the regional bicycle network? ○ If so, prioritize serving bicycle access and mobility.

	• What type of bicyclist is currently served? What are the forecast volumes of bicyclists, and is the width sufficient to serve them? • If curb and gutter is used for drainage, consider how the gutter pan affects the functionality of the bicycle facility. Bicycles need a usable space, not just space.

Table 300-5: Design Element Considerations within the Transition Realm (Cont'd)

Design Element	Considerations
Bicycle Facility (cont.)	• What level of facility is needed to serve riders of all ages and abilities? o On a shoulder bicycle lane, bicyclists can pass other bicycles by using part of the adjacent vehicle lane. However, when bicycle lanes are constrained between curbs or other objects, passing may be restricted. Where separated bicycle lanes are used, the bicycle lane should consider the ability for a bicycle to be passed or for two bicycles to travel side-by-side. • What are the forecast volumes of bicyclists, and is the width sufficient to serve them? • Can buffer widths be minimized by providing greater physical protection? • Is there a parallel route that is equally direct/accessible and/or that has been identified in a local jurisdiction plan? • Can anticipated volumes of bicyclists and pedestrians be served with a multi-use path on one or both sides of the street?

Bicycle / Street Buffer Zone	Stormwater/Landscape Strip
	• What are the green street treatment locations that present the fewest trade-offs on this street?
	  ○ Curb extensions work well with on-street parking, but are more challenging to implement in conjunction with separated bicycle facilities.
	  ○ Linear facilities in transition zone provide "greening" benefits along the length of street but require width for the entire cross section. Street trees are often required by local jurisdictions in the landscape zone and must meet site distance standards and be permitted by ODOT.
	  ○ Basins can be implemented in right-of-way remnants.
	• Are there opportunities to reduce impermeable surface to reduce run-off volumes?
	Transit Stops
	• Are buses stopping in the travel lane or in a bus pull-out? What is the transit agency's guidance along the specific corridor?
	• Are bus stops upstream or downstream of intersection?
	• What would be the interaction between the bus stop and the bicycle facility, as well as access to pedestrian facilities?
	• Transit stops may be incorporated in the buffer and curb zones that are part of the pedestrian zone.

Table 300-5: Design Element Considerations within the Transition Realm (Cont'd)

Design Element	Considerations
On-Street Parking	• What is the off-street parking situation? What about parking availability on side streets? • Consult a parking study if available or determine available capacity on side streets or off-street, and compare that to the utilized capacity on the study street. • Ensure availability of ADA spaces. • Identify the need to allocate space for the following: ▪ Bicycle parking ▪ On-street loading/unloading ▪ Freight ▪ Pick-up/drop-off of people
Maintenance	• When determining appropriate elements for the transition zone, the ability for maintaining the facility shall be considered. Consult ODOT maintenance staff for input when determining the following: o Sweeping, snow removal, and maintaining constrained cycle track facilities. o Restriping and maintaining markings for buffered bicycle lanes. o Maintaining vertical elements like tubular markers used for delineation and separation of the bicycle facility and the travel lane. • Consider intergovernmental agreements with the local jurisdiction for maintenance of the transition zone and elements within it. This may include the pedestrian realm as well.

304.5 Travelway Realm

The travelway realm, shown in Figure 300-5 and described in Table 300-6, focuses on the movement of motor vehicles and includes travel lanes, median, and/or turn lanes. Understanding the user priorities and desired outcomes for a project can help prioritize the trade-offs for the design elements within the travelway realm.

Figure 300-5 Travelway Realm

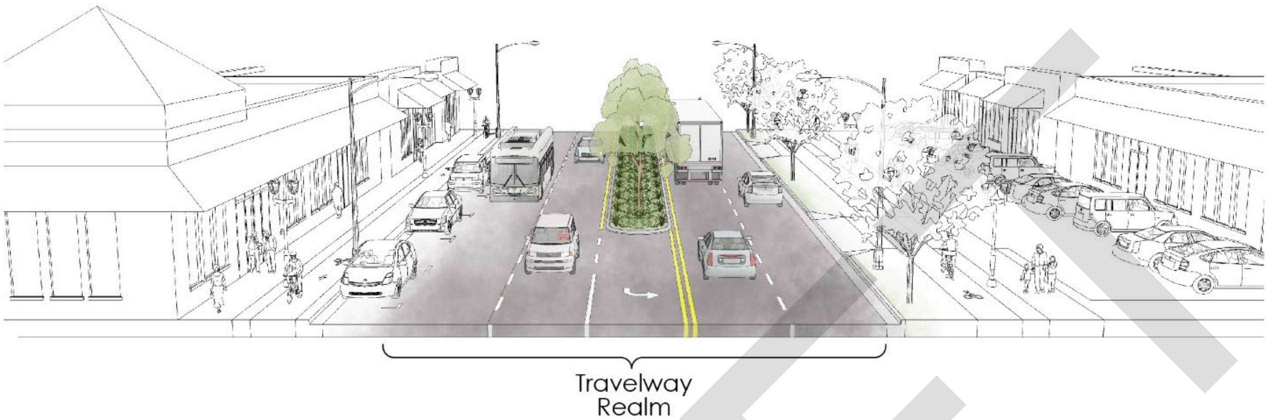


Table 300-6 Design Element Considerations within the Travelway Realm

Design Element	Considerations

Travel Lane Width	• What is the land use context and target speed for the street?
	  ○ In slower, denser urban contexts, consider narrow, minimum lane widths.
	  ○ In suburban contexts, consider narrower lane width.
	  ○ In higher speeds, maintain wider lane.
	  ○ Maintain typical lane width for the context.
	• What design elements are adjacent to the lane?
	  ○ Evaluating the appropriate lane width may depend on the design elements adjacent to the lane.
	  ○ The width of a travel lane adjacent to shy distance or a buffered bicycle lane, may have flexibility to be narrowed while still meeting the roadway needs.
	  ○ A travel lane directly adjacent to a curb may benefit from a full width to allow for adequate width for users on the roadway.
	• What are the appropriate number of through travel lanes?
	  ○ If a street has several through lanes per direction, consider a detailed operational evaluation of a road reorganization (i.e., road diet) to reallocate space to other functions and get public input.
	  ○ Consider if it is appropriate to accept higher levels of congestion.
	• What role does this street play in the regional transit network?
	  ○ If the street is part of the frequent bus network (or any rail or High Capacity Transit), prioritize designs that prioritize transit.
	• What role does this street play in the freight network?

	○ If the street is part of the regional or statewide freight network, prioritize designs that preserve adequate vehicular capacity for the demand.

Table 300-6: Design Element Considerations within the Travelway Realm (Cont'd)

Design Element	Considerations
Travel Lane Width (cont.)	• What role does this street play in Reduction Review Route? ○ Follow the appropriate process outlined in OAR 731-012.I

Turn Lane Width	• What design elements are adjacent to the left-turn lane?
	  ○ Is there a median with a shy distance that may provide an opportunity to narrow the lane width?
	  ○ What is the median striping width in the opposing direction?
	• What design elements are adjacent to the right-turn lane?
	  ○ How are bicycles addressed at right-turns?

Left Side Shy Distance	• In low-speed urban contexts, consider minimizing additional width needed for “shy” distance (e.g. median or curb).
	  ○ Lower target speeds
	  ○ Use fewer vertical elements (which require shy)
	  ○ Zero foot shy may be acceptable when considering trade-offs and design considerations in relation to the context

Striped Median Width	• What is the speed along the street and the potential of vehicles to cross into oncoming traffic?

Raised Curb Median	• What is the purpose of the median?
	  ○ Access management.
	  ○ Landscaping to create “boulevard” effect.

As noted previously, Table 300-1 through Table 300-6 provide guidance to help project teams consider various design elements typically found within each of the cross section realms. Having an understanding of all the elements and how they interact with each other will guide practitioners in making decisions about how to apply, evaluate, and design the cross-sectional elements. A holistic evaluation of the cross section that considers the individual design elements together, rather than separately, can help verify that the overall roadway cross section aligns with desired project outcomes and balances the needs of each user.

The next section, Section 305, includes Table 300-7 through Table 300-12 that provide recommendations for design elements within the cross-section realms in relation with the six urban contexts illustrated in Part 2 that include:

- Traditional Downtown/CBD
- Urban Mix
- Commercial Corridor
- Residential Corridor
- Suburban Fringe
- Rural Community

Section 305 Cross-Section and Realm Design Guidance

A holistic evaluation of the cross section that considers the individual design elements together, rather than separately, can help verify that the overall roadway cross section aligns with desired project outcomes and balances the needs of each user. Sections 305.1 through 305.6 including Table 300-7 through Table 300-12 and Figure 300-6 through Figure 300-11 provide recommendations for design elements within the six urban contexts illustrated in Part 200.

- Section 305.1 - Traditional Downtown/CBD
- Section 305.2 - Urban Mix
- Section 305.3 - Commercial Corridor
- Section 305.4 - Residential Corridor
- Section 305.5 - Suburban Fringe
- Section 305.6 - Rural Community

These sections provide design guidance recommendations for roadway cross sections within each ODOT urban context. The ODOT Urban Design Concurrence document and the decision-making process described in Part 100 are used to justify and document the project team decisions and reasoning for the preferred solutions and final cross-section design. When reviewing the tables and figures from a pedestrian and bicycle user perspective, the higher end of the dimension range should be the starting point, as shown first in the tables. For travel lanes, the intent is to begin with the smaller dimension and increase if needed depending on the context, users, and roadway characteristics. Dimensions chosen from within the acceptable ranges are determined by project goals and design outcomes in conjunction with roadway user needs. The individual dimensions need to be appropriate for the context and project parameters as a whole and not chosen because they are what one wants them to be. Trade-offs will need to be made between design elements and realms to determine an appropriate final cross-section that meets all user needs and project goals.

The design elements with each of the design tables relating to the design contexts developed for Table 300-7 through Table 300-12, cannot be used in isolation. Each element across the section is integral to the others. Key considerations to keep in mind when determining the final cross-section elements and their dimensions are:

1. How urban context influences roadway design while designing for multimodal users considering highway designations, classifications, characteristics, operations and safety.
2. How design elements fit together within the respective cross section realms as well as with each other
3. How the final cross-section meets the modal needs of all users and fits with goals and outcomes for the project

Design decisions related to each design element within the respective urban context should consider integrating the trade-offs for design, operations, maintenance and safety. Practitioners need to have an understanding of the considerations within the respective cross section realms within the urban context. See Part 305 Cross-Section Realms

305.1 Traditional Downtown/Central Business District

Table 300-7 provides design criteria for the respective design elements for ODOT roadways through the Traditional Downtown/CBD context. With this design approach, the goal is to design roadways in the Traditional Downtown/CBD context for a target speed of 20-25 mph. Target speed is discussed in Section 207.10. Figure 300-6 illustrates various cross section scenarios for how the design elements within this type of context may be arranged.

Exhibit 300-2 is an example of land types in this context and depicts the Traditional Downtown/CBD context with higher development and greater building heights containing mixed uses that are generally built up to the sidewalk and street within a well-connected roadway network. It is the responsibility of the project team to determine final cross-section elements.

Exhibit 300-2 Typical Traditional Downtown/CBD Context - Tillamook (US101: OR131-OR6)

Table 300-7 Design Element Recommendations for Traditional Downtown/CBD Context

Design Element		Guidance
Pedestrian Realm	Frontage Zone	4′ to 2′
	Pedestrian Zone	10′ to 8′
	Buffer Zone	6′ to 0′
	Curb/Gutter[1]	2′ to 0.5′
Transition Realm[6]	Separated Bicycle Lane (Curb Constrained Facility)[2]	8′ to 7′
	On-Street Bicycle Lane (not including Buffer)[2]	6′ to 5′
	Bicycle/Street Buffer[2]	3′ to 2′
	Right Side Shoulder (if travel lane directly adjacent to curb)[3,5]	2′ to 0′
	On-Street Parking	7′ to 8′
Travelway Realm[5]	Travel Lane[4,5]	11′
	Right Turn Lane (including Shy Distances)	11′ to 12′
	Left Turn Lane[4]	11′
	Left Side / Right Side Shy Distance	1′ to 0′
	Two-Way-Left-Turn Lane	11′ to 12′
	Raised Median – No Turn Lane (including Shy Distances)	8′ to 11′
	Left-Turn Lane with Raised Curb Median/separator (includes 16″ separator & Shy Distances)	12′ to 14′

[1] Where curb and gutter is used and on-street parking is provided or travel lane is directly adjacent to curb, gutter pan should be included in shoulder/shy or on-street parking measurement. Gutter pan should be included in travel lane, bicycle lane or turn lane measurements only where a smooth transition from gutter pan to roadway surface is provided.

[2] Refer to Bicycle Facility Selection process (Section 3.2.2) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. 5-foot on-street bicycle lane is allowed only with a street buffer. When a raised buffer is used to protect the bicycle lane, the width should be 6′ if parking is adjacent or if signs or other features are anticipated.

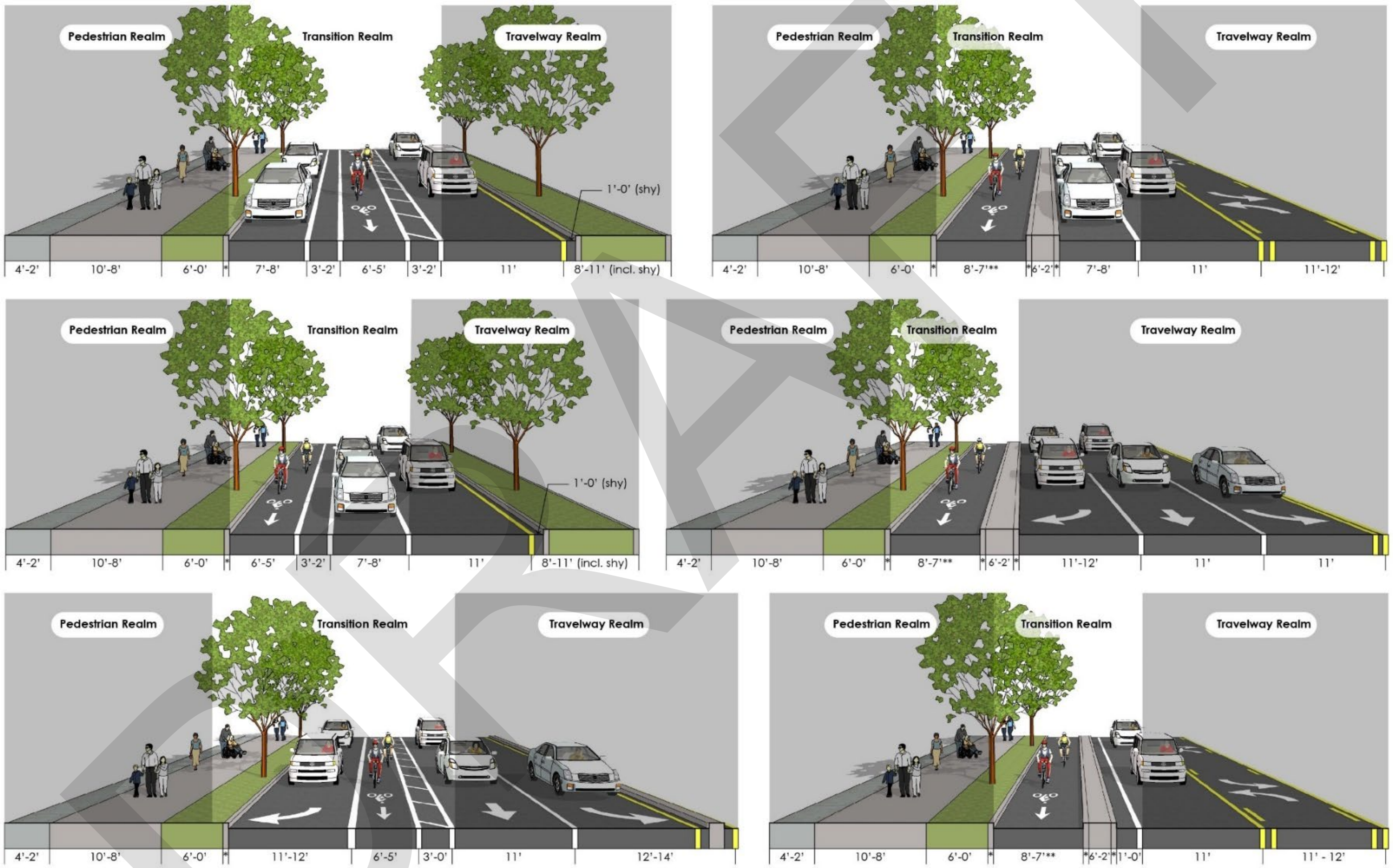
[3] Overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), the gutter typically serves as the right-side shoulder. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs.

[4] 11-foot lane width preferred to 12-foot lane; 10-foot lane width requires design approval from the State Roadway Engineer. On freight- or transit-oriented streets, a 10-foot travel lane is generally not appropriate without a buffer zone or shoulder.

[5] On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

[6] When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

Figure 300-6 Example Cross-Section Options for Traditional Downtown/CBD, See Table 300-7 for additional information



* 0.5' (curb) or 2' (curb & gutter)

** Consider raised bicycle lane

Note: When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

305.2 Urban Mix

Table 300-8 provides design criteria for the respective design elements for ODOT roadways through the Urban Mix context. With this design approach, the goal is to design roadways for a target speed of 25-30 mph. Figure 300-7 illustrates various cross section scenarios for how the design elements within this type of context may be arranged.

Exhibit 300-3 is an example of the Urban Mix context that includes a mix of land uses within a well-connected roadway network. Commercial or retail uses front on the street and may be mixed with older residential properties, some of which have been repurposed as professional offices. Residential neighborhoods are often directly behind the properties fronting on the highway. Modal integration in the Urban Mix context is a balance between vehicle mobility/throughput and bicycle, pedestrian and transit needs. Exhibit 306-3 is an example of the land use typically found in an Urban Mix context. It is not intended to depict specific design aspects. It is the responsibility of the design team to determine the final design criteria for a project cross-section to meet the goals and outcomes of a specific project.

Exhibit 300-3 Example of Urban Mix Context - Hillsboro, SE Baseline St. (OR 8, Tualatin Valley Hwy.)

Table 300-8 Design Element Recommendations for Urban Mix

Design Element		Guidance
Pedestrian Realm	**Frontage Zone**	1′
	Pedestrian Zone[7]	8′ to 5′
	Buffer Zone	6′ to 0′
	Curb/Gutter[1]	2′ to 0.5′
Transition Realm[6]	**Separated Bicycle Lane (Curb Constrained Facility)**[2]	8′ to 7′
	On-Street Bicycle Lane (not including Buffer)[2]	6′ to 5′
	Bicycle/Street Buffer (preferred for On-Street Lane)[2]	4′ to 2′
	Right Side Shoulder (if travel lane directly adjacent to curb)[3,5]	2′ to 0′
	On-Street Parking	8′
Travelway Realm[5]	**Travel Lane**[4,5]	11′ to 12′
	Right Turn Lane (including Shy Distances)	11′ to 12′
	Left Turn Lane[4]	11′ to 12′
	Left Side / Right Side Shy Distance	1′ to 0′
	Two-Way-Left-Turn Lane	11′ to 12′
	Raised Median – No Turn Lane (including Shy Distances)	8′ to 11′
	Left-Turn Lane with Raised Curb Median/Separator (including 16″ separator & Shy Distances)	12′ to 14′

[1] Where curb and gutter is used and on-street parking is provided or travel lane is directly adjacent to curb, gutter pan should be included in shoulder/shy or on-street parking measurement. Gutter pan should be included in travel lane, bicycle lane or turn lane measurements only where a smooth transition from gutter pan to roadway surface is provided.

[2] Refer to Bicycle Facility Selection process (Section 3.2.2) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. 5-foot on-street bicycle lane is allowed only with a street buffer. When a raised buffer is used to protect the bicycle lane, the width should be 6′ if parking is adjacent or if signs or other features are anticipated.

[3] Overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), the gutter typically serves as the right-side shoulder. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs.

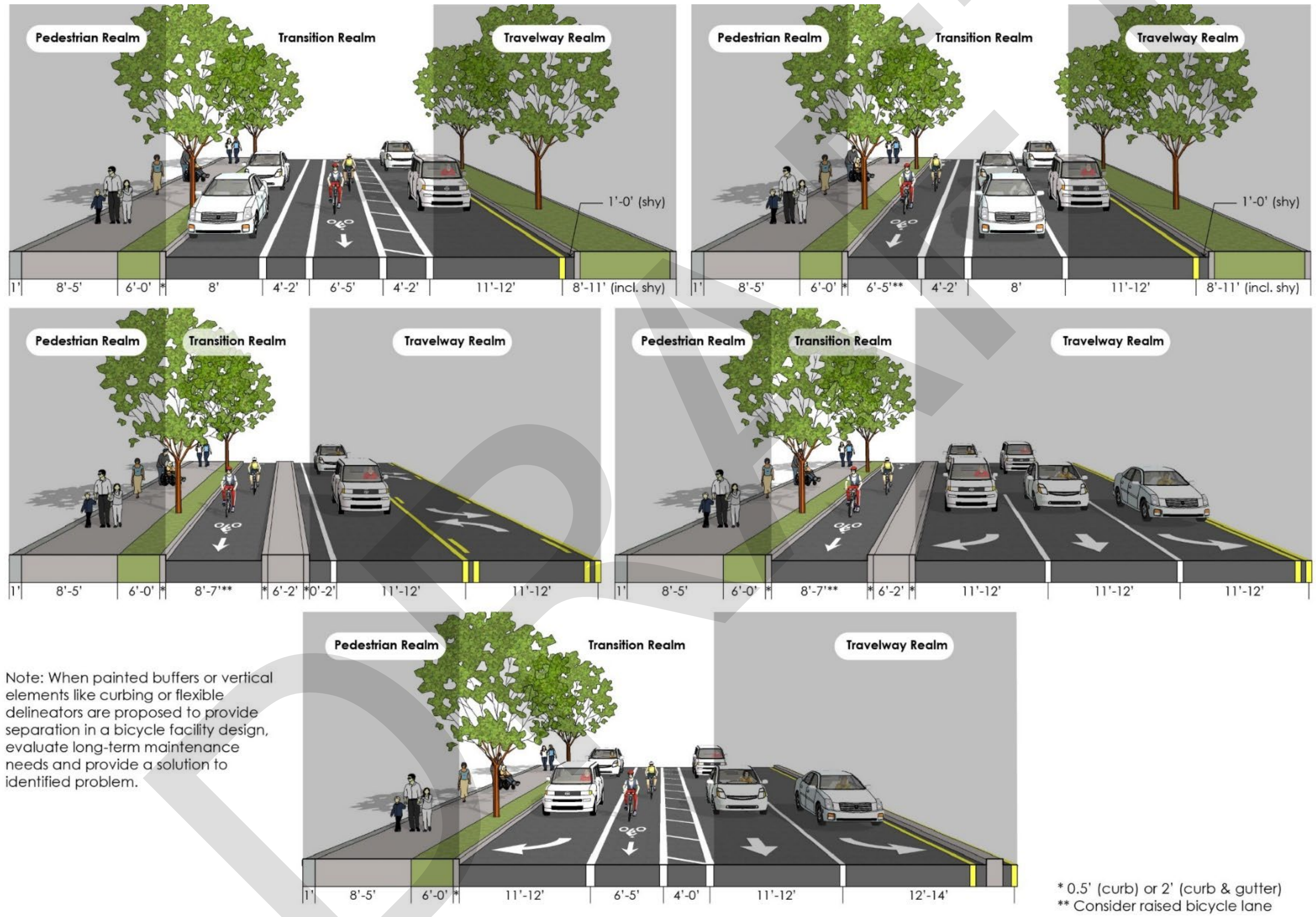
[4] 11-foot lane width preferred; 10-foot lane width requires design approval from the State Roadway Engineer. On freight- or transit-oriented streets, a 10-foot travel lane is generally not appropriate without a buffer zone or shoulder.

[5] On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

[6] When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

[7] 5-foot pedestrian zone requires a paved frontage zone and/or a paved buffer zone. Minimum "sidewalk" width is 6-feet.

Figure 300-7 Example Cross-Section Options Urban Mix, See Table 300-8 for additional information



305.3 Commercial Corridor

Table 300-9 provides design criteria for the respective design elements for ODOT roadways through the Commercial Corridor context. With this design approach, the goal is to design roadways for a target speed of 30-35 mph. Figure 300-8 illustrates various cross section scenarios for how the design elements within this type of context may be arranged.

Exhibit 300-4 depicts a Commercial Corridor context with large building footprints set within large blocks, large parking lots and a disconnected or sparse roadway network. The Commercial Corridor context can also include industrial land uses and is traditionally focused heavily on vehicle mobility. It is important in this context to also provide access for transit, bicycles and pedestrian needs to the highest level possible to encourage multi-modal use. Exhibit 306-3 is an example of the land use typically found in the Commercial Corridor context. It is not intended to depict specific design aspects. It is the responsibility of the design team to determine the final design criteria for a project cross-section to meet the goals and outcomes of a specific project.

Exhibit 300-4 Typical Commercial Corridor Context - Grants Pass (Or 199, Redwood Hwy.)

Table 300-9 Design Element Recommendations for Commercial Corridor

Design Element		Guidance
Pedestrian Realm	Frontage Zone	1′
	Pedestrian Zone[9]	8′ to 5′
	Buffer Zone	5′ to 0′
	Curb/Gutter[1]	2′ to 0.5′
Transition Realm[8]	Separated Bicycle Lane (Curb Constrained Facility)[2]	8′ to 7′
	On-Street Bicycle Lane (not including Buffer)[2]	6′ to 5′
	Bicycle/Street Buffer (preferred for On-Street Lane)[2]	5′ to 2′
	Right Side Shoulder (if travel lane directly adjacent to curb)[3,5]	4′ to 0′
	On-Street Parking	N/A
Travelway Realm[5]	Travel Lane[4,5]	11′ to 12′
	Right Turn Lane (including Shy Distances)	12′ to 13′
	Left Turn Lane[6]	12′ to 14′
	Left Side / Right Side Shy Distance[3]	1′ to 0′
	Two-Way Left-Turn Lane[6]	12′ to 14′
	Raised Median – No Turn Lane (including Shy Distances)	8′ to 11′
	Left-Turn Lane with Raised Curb Median/Separator (including 16″ separator & Shy Distance)[7]	14′ to 16′

[1] Where curb and gutter is used and on-street parking is provided or travel lane is directly adjacent to curb, gutter pan should be included in shoulder/shy or on-street parking measurement. Gutter pan should be included in travel lane, bicycle lane or turn lane measurements only where a smooth transition from gutter pan to roadway surface is provided.

[2] Refer to Bicycle Facility Selection process (Section 3.2.2) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. 5-foot on-street bicycle lane allowed only with a street buffer. When a raised buffer is used to protect the bicycle lane, the width should be 6′ if parking is adjacent or if signs or other features are anticipated.

[3] Overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), the gutter typically serves as minimum right-side shoulder width. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs. At 35 mph and above, at a minimum, include a 1-foot shoulder/shy distance.

[4] 10-foot lane width requires design approval from the State Roadway Engineer. On freight- or transit-oriented streets, a 10-foot travel lane is generally not appropriate without a buffer zone or shoulder.

[5] On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

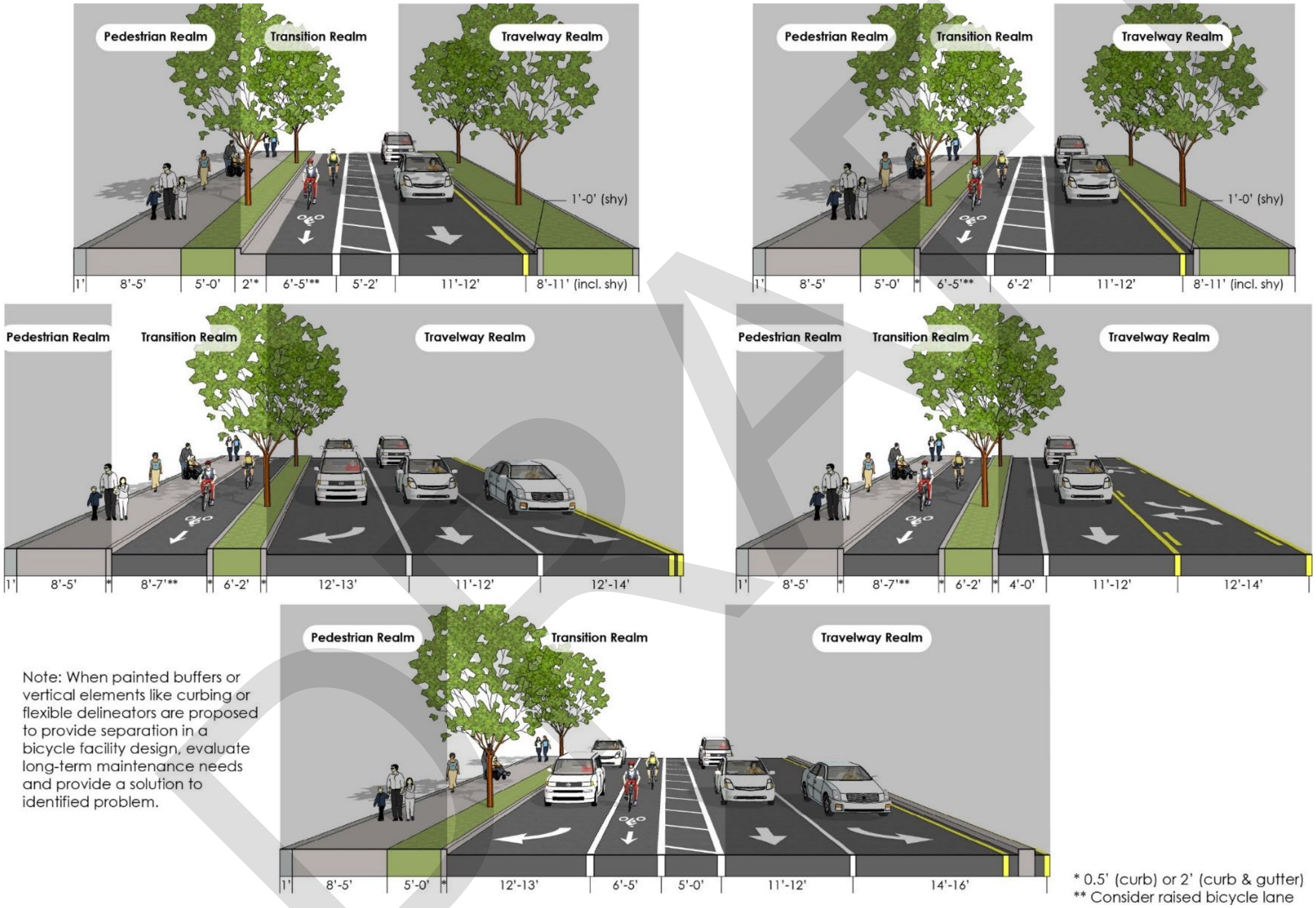
[6] At 40 mph and above, a 14-foot lane is preferred.

[7] At 40 mph and above, a 16-foot lane is preferred.

[8] When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

[9] 5-foot pedestrian zone requires a paved frontage zone and/or a paved buffer zone. Minimum "sidewalk" width is 6-feet.

Figure 300-8 Example Cross-Section Options for Commercial Corridor, See Table 300-9 for more information



305.4 Residential Corridor

Table 300-10 provides the design criteria for the respective design elements for ODOT roadways through the Residential Corridor context. With this design approach, the goal is to design roadways for a target speed of 30-35 mph. Figure 300-9 illustrates various cross section scenarios for how the design elements within this type of context may be arranged.

Exhibit 300-5 depicts a Residential Corridor context. This context contains mostly residential land uses with a well-connected to somewhat connected roadway network. The Residential Corridor context may extend for long distances with single-family homes or apartment complexes intermixed that have direct access to the roadway. However, access is often through public street connections on major arterials where vehicle mobility is more of a focus. With residential uses being the primary land use in a Residential Corridor, it is important to provide access for transit, bicycles and pedestrian needs to the highest level possible to encourage multi-modal use and provide equity for all socioeconomic groups. Residential Corridors are often on the fringes of Commercial Corridors or Urban Mix areas. Having a variety of modal choices for residents living along the Residential Corridor to access adjacent Commercial Corridors or Urban Mix areas to obtain goods and services is critical to livability and sustainability. Providing alternative modal facilities can affect change and work towards statewide goals to reduce greenhouse gas levels as well as reducing the overall carbon footprint. Exhibit 306-4 is an example of the land use typically found in the Residential Corridor context. It is not intended to depict specific design aspects. It is the responsibility of the design team to determine the final design criteria for a project cross-section to meet the goals and outcomes of a specific project and fit the needs of all roadway users.

Exhibit 300-5 Example of a Residential Corridor context - Tigard - OR 141 (Hall Blvd.)

Table 300-10 Design Element Recommendations for Residential Corridor

Design Element		Guidance
Pedestrian Realm	Frontage Zone	1′
	Pedestrian Zone[9]	8′ to 5′
	Buffer Zone	6′ to 0′
	Curb/Gutter[1]	2′ to 0.5′
Transition Realm[8]	Separated Bicycle Lane (Curb Constrained Facility)[2]	8′ to 7′
	On-Street Bicycle Lane (not including Buffer)[2]	6′ to 5′
	Bicycle/Street Buffer (preferred for On-Street Lane)[2]	5′ to 2′
	Right Side Shoulder (if travel lane directly adjacent to curb)[3,5]	4′ to 0′
	On-Street Parking	N/A
Travelway Realm[5]	Travel Lane[4,5]	11′ to 12′
	Right Turn Lane (including Shy Distances)	12′ to 13′
	Left Turn Lane[6]	12′ to 14′
	Left Side / Right Side Shy Distance[3]	1′ to 0
	Two-Way Left-Turn Lane[6]	12′ to 14′
	Raised Median – No Turn Lane (including Shy Distances)	8′ to 11′
	Left-Turn Lane with Raised Curb Median/Separator (including 16″ separator & Shy Distances)[7]	14′ to 15′

[1] Where curb and gutter is used and on-street parking is provided or travel lane is directly adjacent to curb, gutter pan should be included in shoulder/shy or on-street parking measurement. Gutter pan should be included in travel lane, bicycle lane or turn lane measurements only where a smooth transition from gutter pan to roadway surface is provided.

[2] Refer to Bicycle Facility Selection process (Section 3.2.2) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. 5-foot on-street bicycle lane allowed only with a street buffer. When a raised buffer is used to protect the bicycle lane, the width should be 6′ if parking is adjacent or if signs or other features are anticipated.

[3] Overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), the gutter typically serves as minimum right-side shoulder width. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs. At 35 mph and above, at a minimum, include 1-foot shoulder/shy distance.

[4] 10-foot lane width requires design approval from the State Roadway Engineer. On freight- or transit-oriented streets, a 10-foot travel lane is generally not appropriate without a buffer zone or shoulder.

[5] On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

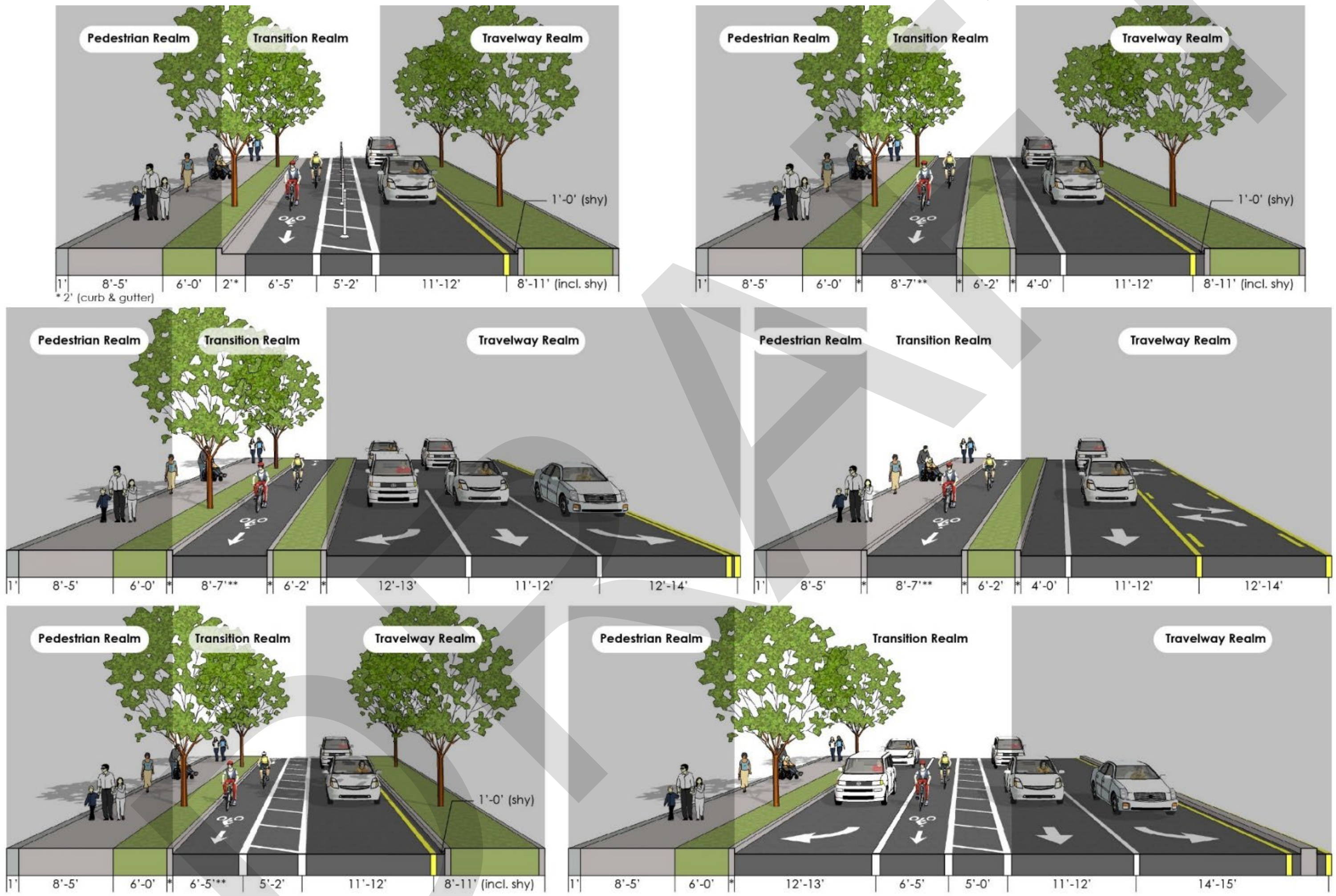
[6] At 40 mph and above a 14-foot lane is preferred.

[7] At 40 mph and above, a 15-foot lane is preferred.

[8] When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

[9] 5-foot pedestrian zone requires a paved frontage zone and/or a paved buffer zone. Minimum “sidewalk” width is 6-feet.

Figure 300-9 Example Cross-Section Options for Residential Corridor, See Table 300-10 for additional information



* 0.5' (curb) or 2' (curb & gutter) ** Consider raised bicycle lane

Note: When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

305.5 Suburban Fringe

Table 300-11 provides design criteria for the respective design elements for ODOT roadways through the Suburban Fringe context. With this design approach, the goal is to design roadways for a target speed of 35-40 mph. Figure 300-10 illustrates various cross section scenarios for how the design elements within this type of context may be arranged.

Exhibit 300-6 depicts the Suburban Fringe context that generally contains sparsely developed lands that are typically at the edge of the urban growth boundary of a city or the established urban area of a town. Land uses can include large lot residential, small scale farms or intermittent commercial or industrial properties. The Suburban Fringe context is often the area between higher speed rural roads and lower speed urban roads. A key component of design in this context is to indicate to drivers they are entering an urban area and need to slow their speed for the upcoming urban context. Rural transit stops may be present within the Suburban Fringe area and need to be designed to accommodate buses stopping and starting with higher speed traffic. It is critical to investigate and determine existing and future pedestrian activity to and from these rural transit stops to develop and design appropriate access. Local transit agencies can be a resource for information. Bicycle facilities are incorporated as needed for connectivity to facilities within the adjacent urban context.

Exhibit 300-6 Example of Suburban Fringe, Prineville, SE Combs Flat Rd. (OR 380)

Table 300-11 Design Element Recommendations for Suburban Fringe

Design Element		Guidance
Pedestrian Realm	Frontage Zone	1′
	Pedestrian Zone[9]	8′ to 5′
	Buffer Zone	6′ to 0′
	Curb/Gutter[1]	2′ to 0.5′
Transition Realm[8]	Separated Bicycle Lane (Curb Constrained Facility)[2]	8′ to 7′
	On-Street Bicycle Lane (not including Buffer)[2]	6′
	Bicycle/Street Buffer (physical separation preferred for On-Street Lane)[2]	5′ to 2′
	Right Side Shoulder (if travel lane directly adjacent to curb)[3]	6′ to 0′
	On-Street Parking	N/A
Travelway Realm[5]	Travel Lane[4,5]	11′ to 12′
	Right Turn Lane (including Shy Distances)	12′ to 13′
	Left Turn Lane[6]	12′ to 14′
	Left Side / Right Side Shy Distance[3]	1′ to 0′
	Two-Way Left-Turn Lane[6]	12′ to 14′
	Raised Median – No Turn Lane (including Shy Distances)	8′ to 13′
	Left-Turn Lane with Raised Curb Median/Separator (including 16″ separator & Shy Distances)[7]	14′ to 16′

[1] Where curb and gutter is used and on-street parking is provided or travel lane is directly adjacent to curb, gutter pan should be included in shoulder/shy or on-street parking measurement. Gutter pan should be included in travel lane, bicycle lane or turn lane measurements only where a smooth transition from gutter pan to roadway surface is provided.

[2] Refer to Bicycle Facility Selection process (Section 3.2.2) to determine appropriate bicycle facility type. The preferred bicycle and pedestrian facility in Suburban Fringe is a 10-foot to 16-foot shared use path with a 6-foot buffer from the roadway. On-street bicycle lanes shall include the widest street buffer that can be accommodated and should include physical separation (e.g., flexible delineator posts) where feasible. Consider raised bicycle lanes where appropriate. When a raised buffer is used to protect the bicycle lane, the width should be 6 feet if parking is adjacent or if signs or other features are anticipated.

[3] Overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g. a 2-foot curb zone), the gutter typically serves as minimum right side shoulder width. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs. At 35 mph and above, at a minimum, include a 1-foot shoulder/shy distance. In transition areas from higher speed to lower

speed, shoulder width should taper from wider, higher speed shoulder width to appropriate lower speed urban shoulder width.

[4] 10-foot lane width requires design approval from the State Roadway Engineer. On freight- or transit-oriented streets, a 10-foot travel lane is generally not appropriate without a buffer zone or shoulder.

[5] On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

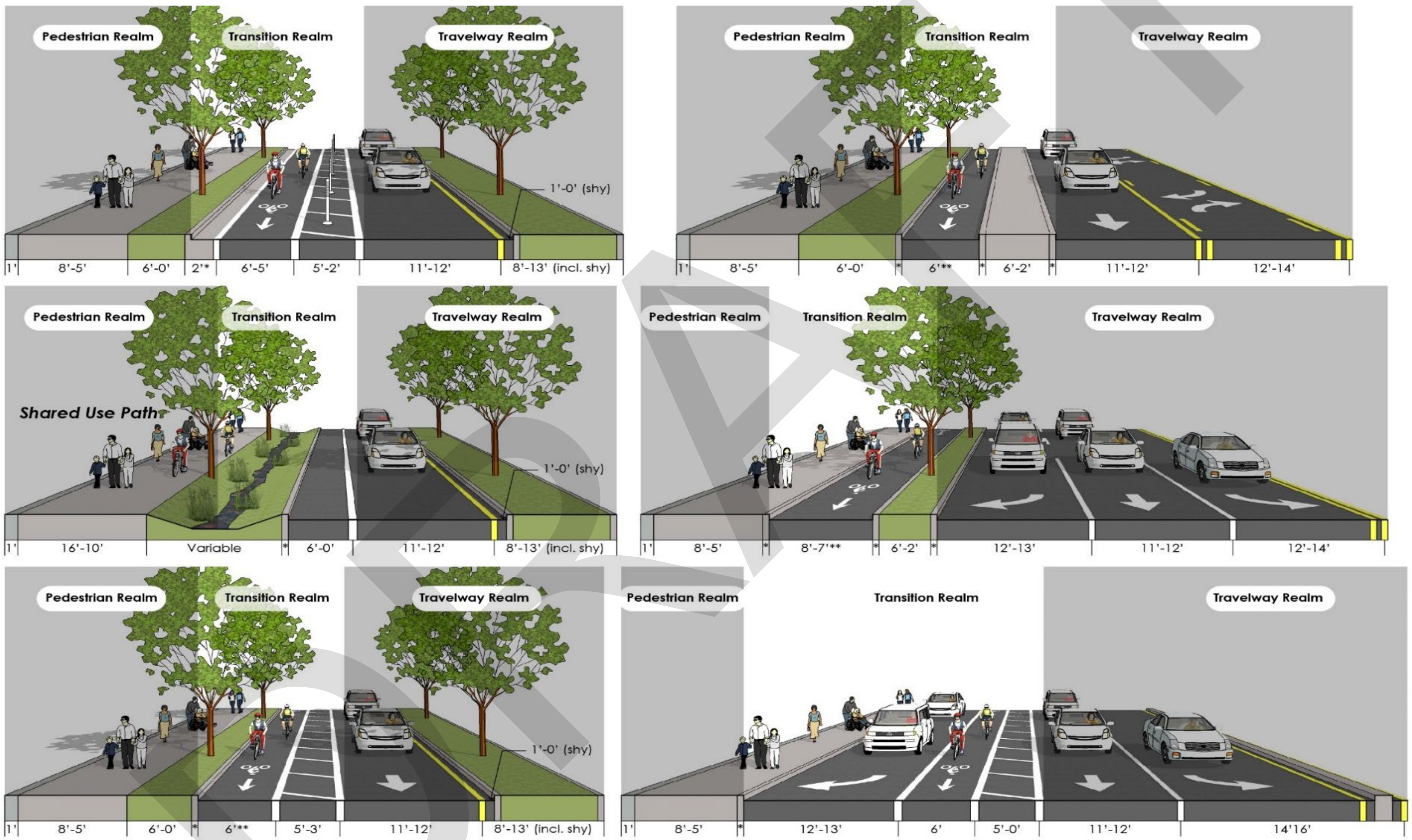
[6] At 40 mph and above a 14-foot lane is preferred.

[7] At 40 mph and above a 16-foot lane is preferred.

[8] When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

[9] 5-foot pedestrian zone requires a paved frontage zone and/or a paved buffer zone. Minimum "sidewalk" width is 6-feet

Figure 300-10 Example Cross-Section Options for Suburban Fringe, See Table 300-11 for more information



* 0.5' (curb) or 2' (curb & gutter) ** Consider raised bicycle lane

Note: When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

305.6 Rural Community

Table 300-12 provides design criteria for the respective design elements for ODOT roadways through the Rural Community context. With this design approach, the goal is to design roadways for a target speed of 25-35 mph. Figure 300-11 illustrates various cross section scenarios for how the design elements within this type of context may be arranged.

Exhibit 300-7 is an example of a Rural Community context. This context encompasses small concentrations of developed areas immediately surrounded by rural undeveloped areas. Areas considered a Rural Community context can take many forms and are comprised of primarily residential uses but also include other uses that help to make the community self-sufficient. The Rural Community context isn't just a cluster of buildings along the roadway. There needs to be a central focal point or gathering place like a post office, store, school or community center that creates activity and movement of people around the community. These areas area often smaller unincorporated towns that don't meet the federal minimum population density of 5,000 to be classified as urban, but still have communities that are clustered around the highway with urban type needs where people need to safely cross the roadway to access goods and services. In many of these locations, the highway carries a rural arterial or collector designation in terms of the statewide highway network, but consideration must be given to the need to create a more urban feel with project design through these communities.

Designers should be aware of several issues when designing a highway through a Rural Community context. Issues such as speed, pedestrian safety and access are very important to the local community. The speed of traffic on the highway is a primary concern. The highway classification, importance as a freight route, traffic volume, and importance as a recreational route in addition to the roadside characteristics of the community must all be considered when selecting design elements. When reduced traveling speeds are desired, traffic calming techniques and development of roadside culture can be effective.

Traffic speed often has a significant physical, emotional and psychological impact to pedestrian crossing safety. Utilizing appropriate techniques to manage traffic vehicle speed is important in the Rural Community context. There are a variety of techniques that could be employed including, but not limited to, roundabouts, lane narrowing, speed feedback signs, curb extensions, median islands, etc. It is the responsibility of the project team to determine what treatments are appropriate for the location and that meet the performance and project goals. The Technical Services / Roadway Engineering Unit can assist with developing traffic calming designs for these communities.

Pedestrian safety in rural communities is often a major concern. These communities often have small centers of activity on both sides of the highway that require pedestrians to cross. Providing safe and clear sidewalks is also an important design element to include in the Rural Community context as well. Sidewalks in these areas can be separated from the roadway with a buffer strip. This buffer strip can be landscaped to increase the visual appearance of the area and may also assist with speed management. Other techniques like providing clearly defined pedestrian crossings at adequate spacing and delineating them where appropriate by the use of markings, signing, and construction materials all may be considered to improve the visibility of pedestrian crossing areas. Other features such as curb extensions and raised medians may also improve pedestrian crossing safety. The designer also needs to be aware of and take into account historic elements, areas or sites, which may impact the use of certain roadway designs.

Rural communities often need a high level of highway access to preserve the economic vitality and functionality of the community. This is generally caused by the lack of a supporting roadway network to reduce the dependence upon direct highway access. OAR 734 Division 51 provides guidance for access spacing. Where access spacing is less than standard, the designer can investigate alternative access techniques including but not limited to frontage roads, shared access, restricting turn movements, and completing local street systems to reduce highway access dependency.

Speed control, pedestrian safety, bicycle safety, access management, and community goals are important considerations for the Rural Community context. However, the designer must still consider the highway classification and other highway designations for these locations. The designer needs to balance accommodating through traffic with local movements when developing project designs in the Rural Community context.

Exhibit 300-7 Example of Rural Community, Rhododendron, Mt. Hood Hwy (US 26)

Table 300-12 Design Element Recommendations for Rural Community

Design Element		Guidance
Pedestrian Realm	Frontage Zone	1′
	Pedestrian Zone[8]	9′ to 5′
	Buffer Zone	5′ to 0′
	Curb/Gutter[1]	2′ to 0.5′
Transition Realm[7]	Separated Bicycle Lane (Curb Constrained Facility)[2]	8′ to 7′
	On-Street Bicycle Lane (not including Buffer)[2]	6′ to 5′
	Bicycle/Street Buffer[2]	4′ to 2′
	Right Side Shoulder (if travel lane directly adjacent to curb)[3]	6′ to 0′
	On-Street Parking	8′
Travelway Realm[5]	Travel Lane[4,5]	11′ to 12′
	Right Turn Lane (including shy)	11′ to 12
	Left Turn Lane	11′ to 12′
	Left Side / Right Side Shy Distance[3]	1′ to 0′
	Two-Way Left-Turn Lane	11′ to 12′
	Raised Median – No Turn Lane (including Shy Distances)	8′ to 11′
	Left-Turn Lane with Raised Curb Median/Separator (including 16″ separator & Shy Distances)[6]	12′ to 14′

[1] Where curb and gutter is used and on-street parking is provided or travel lane is directly adjacent to curb, gutter pan should be included in shoulder/shy or on-street parking measurement. Gutter pan should be included in travel lane, bicycle lane or turn lane measurements only where a smooth transition from gutter pan to roadway surface is provided.

[2] Refer to Bicycle Facility Selection process (Section 3.2.2) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. 5-foot on-street bicycle lane allowed only with a street buffer. When a raised buffer is used to protect a bicycle lane, the width should be 6 feet if parking is adjacent or if signs or other features are anticipated.

[3] Overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), the gutter typically serves as minimum right-side shoulder width. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs. At 35 mph and above, at a minimum, include a 1-foot shoulder/shy distance. In transition areas from higher speed to lower speed, shoulder width should taper from wider, higher speed shoulder width to appropriate lower speed urban shoulder width.

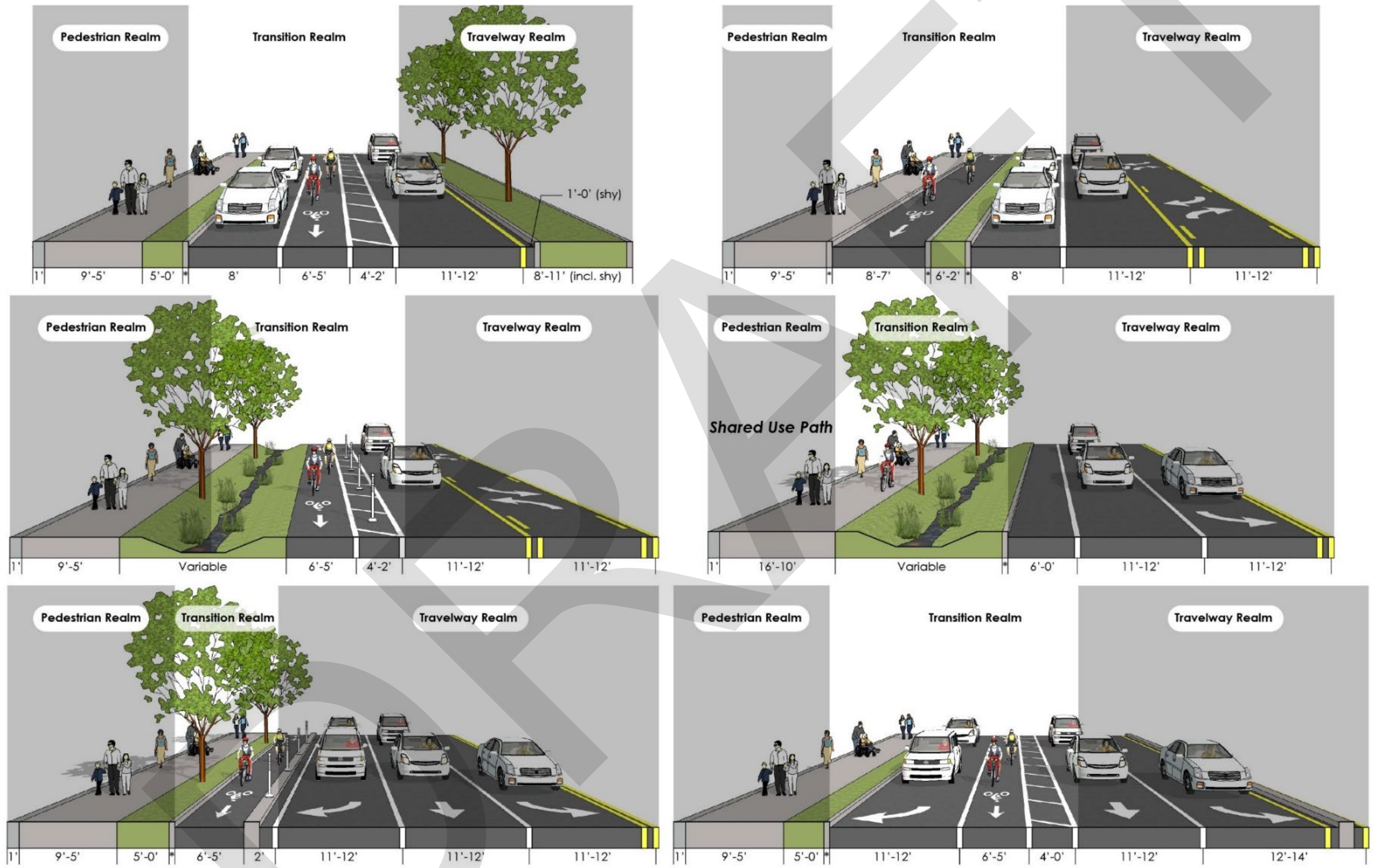
[4] 11-foot lane width preferred, at 40 mph and above, a 12-foot lane is preferred. 10-foot lane width requires design approval from the State Roadway Engineer. On freight- or transit-oriented streets, a 10-foot travel lane is generally not appropriate without a buffer zone or shoulder.

[5] On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

[6] At 40 mph and above, a 14-foot lane is preferred.

[7] When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.[8] 5-foot pedestrian zone requires a paved frontage zone and/or a paved buffer zone. Minimum “sidewalk” width is 6-feet.

Figure 300-11 Example Cross-Section Options for Rural Community, See Table 300-12 for additional information



* 0.5' (curb) or 2' (curb & gutter)

** Consider raised bicycle lane

Note: When painted buffers or vertical elements like curbing or flexible delineators are proposed to provide separation in a bicycle facility design, evaluate long-term maintenance needs and provide a solution to identified problems.

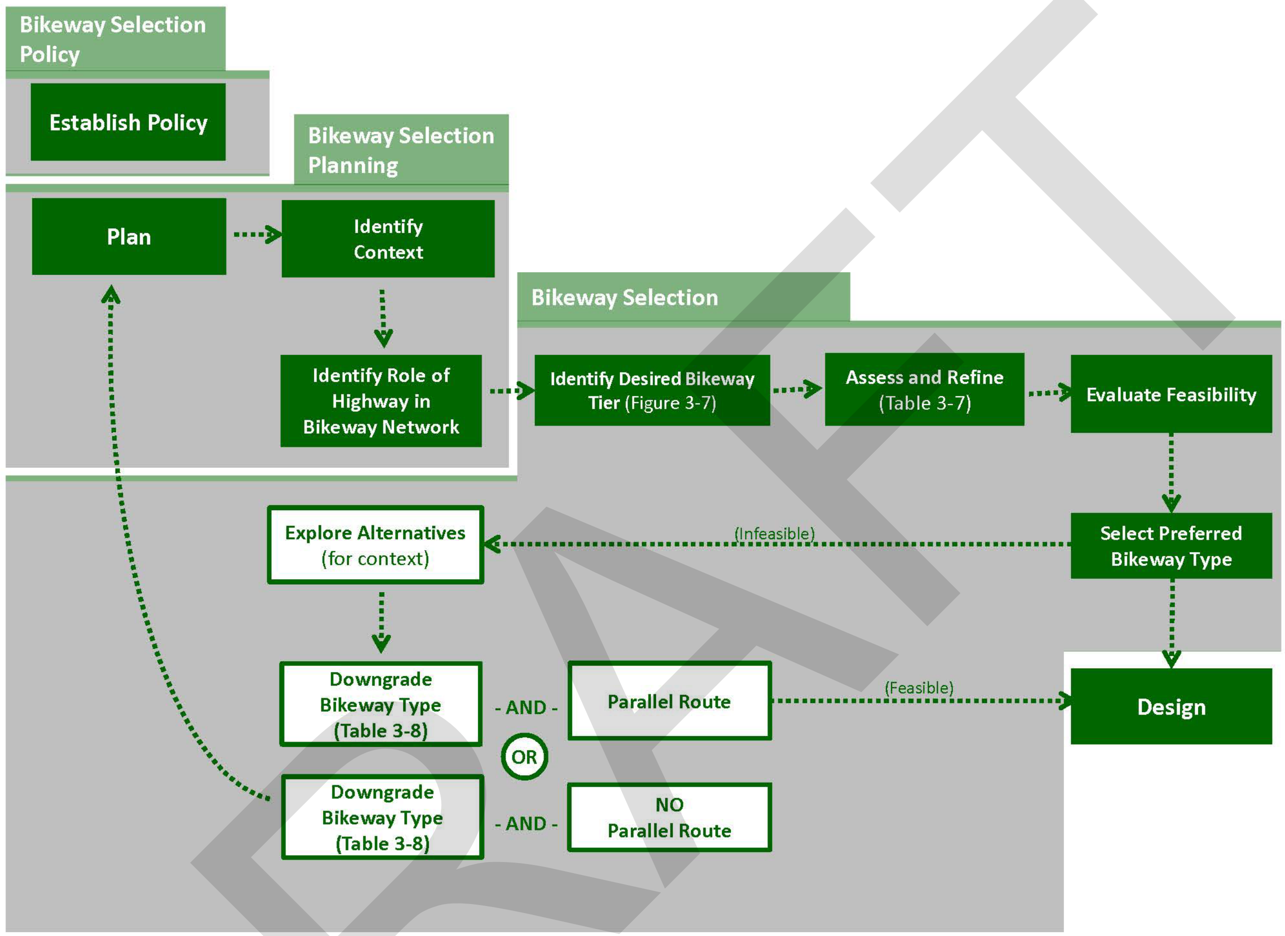
Section 306 Bicycle Facility Selection

In Oregon all public urban roadways should have appropriate walkways and bikeways provided, regardless of whether or not they are a “designated” route. Per ORS 366.514, walkways and bikeways must be provided whenever a roadway is “constructed, reconstructed, or relocated.” Providing the preferred bicycle facility type on ODOT facilities that are part of state, regional, local bicycle routes, scenic bikeways, US Bicycle Routes, or other designated bikeways is the primary goal. On highways that are not part of a planned bicycle route, accommodations for bicycle traffic is still the goal and a providing a facility with the “Interested but Concerned” rider in mind is beneficial, unless a low-stress parallel route has been identified by the local jurisdiction or an adopted network plan. When parallel routes are selected, they should be as direct as possible and well-signed for bicycle wayfinding. To be viable, parallel routes provide equivalent access to destinations along the highway, provide facilities and crossings for “Interested but Concerned” users, and increase average trip lengths by less than 0.27 miles or 1.5 minutes for short trips.

Encouraging and accommodating bicycles as a transportation mode is a priority within urban projects and an important aspect to be integrated into the cross-section. In order to expand the portion of the bicyclist demand served, appropriate bicycle facilities need to be evaluated and included early in project planning and development. Understanding current guidance about bicycle facility selection, identifying the degree of separation, and evaluating trade-offs are key to effective implementation. Reviewing various options using a decision-making framework can help prioritize trade-offs, refine decisions, and lead to a solution that supports the project needs. Bicycle facilities are generally located in the transition realm, but depending on facility type selected, could also be considered part of the pedestrian realm, as in a design that integrated the bicycle facility as a shared use path.

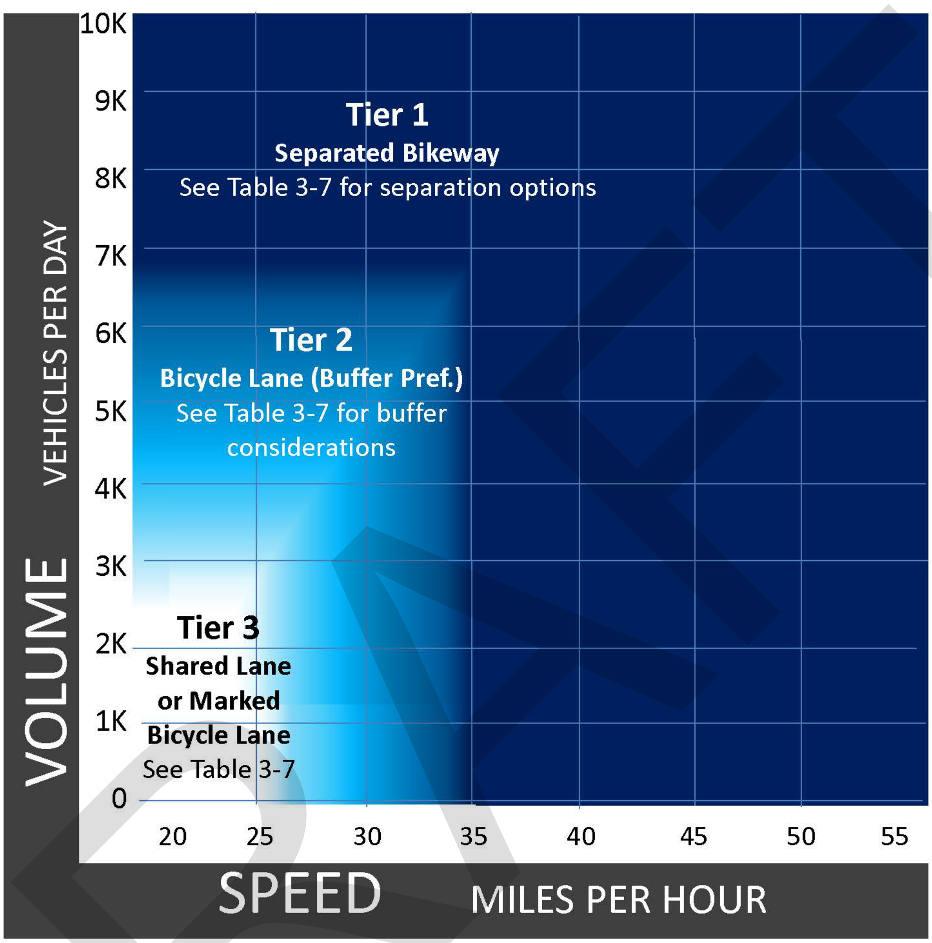
Figure 300-12 illustrates the framework for the bicycle facility selection process and Figure 300-13 depicts guidance on the type of bicycle facility to use based upon vehicle speeds and vehicle volumes commensurate with appropriate design tiers. This section is introductory for bicycle facility design and is included here in reference to the previous sections on realms and cross section design criteria. Additional detail on bicycle facility selection and design is located in Part 900.

1 Figure 300-12 Bicycle Facility Selection Process



2

Figure 300-13 Bicycle Facility Tier Identification Matrix



Section 307 Pedestrian Crossing Locations

Identifying and prioritizing pedestrian crossing locations on ODOT facilities is a priority within urban projects. Considerations for pedestrian crossing locations and the trade-offs of various options are decision topics that begin during the planning process through project delivery and maintenance. Planning level information and specific local needs are important aspects in the analysis. Guidance for determining target frequency (spacing) and appropriate locations for crossings in urban contexts can lead to effective project implementation and influence a project's ability to adequately serve the needs of each roadway user. Providing appropriate opportunities for pedestrians to cross the highway is important for ease of circulation through a community. The target spacing of crossings for each urban context is provided as a range and is considered as a starting point for discussion. Shorter spacing lengths may be appropriate depending on pedestrian origins and destinations. Density of land uses and pedestrian generators and their locations are evaluated to determine if a lesser or greater spacing is needed. When considered as part of a larger project, such as a corridor project, strive to meet the spacing targets. If the target crossing spacing cannot be met on a project, the project team provides documentation as part of ODOT design documentation process. Similarly, if a crossing is proposed for removal and would lead to a spacing distance beyond the target range for the context, justification is provided.

Once crossing locations have been identified, an engineering study is done at each crossing according to the ODOT Traffic Manual to determine what, if any, enhancements are needed at each crossing. If enhancements are proposed to be added along a section of highway listed as a Reduction Review Route that would change or restrict the cross-section for large vehicles, the project must follow the process outlined in OAR 731 012.

In Table 300-13 a range, rather than a single target, is provided for flexibility to adjust based on roadway network characteristics (e.g., frequency and spacing of intersections), pedestrian destinations (e.g., transit stops), and cluster of land uses. For example, within a mixed-use area, development may not be distributed uniformly, or practitioners may consider the lower end of the range where the land uses are more intense. Additional detail on pedestrian crossing locations and pedestrian design is located in Part 800.

Table 300-13 Target Crossing Spacing (Use as starting point for analysis)

Urban Context	Target Spacing Range (feet)
Traditional Downtown/ CBD	250-550
Urban Mix	250-550
Commercial Corridor	500-1,000
Residential Corridor	500-1,000
Suburban Fringe	750-1,500
Rural Community	250-750

Section 308 Median Design

308.1 General

Highway medians are important design elements that can significantly impact the safety, function, and/or efficiency of a highway. Highway medians provide separation of opposing traffic streams, separation of turning and through traffic, safety buffer and recovery area, positive longitudinal guidance, and positive control of turning movements. Some median designs improve pedestrian crossings by providing a refuge for pedestrians crossing, minimizing the exposure time to traffic and reducing the crossing distance. Other benefits may include enhanced aesthetics and reduced headlight glare. This section will discuss general design elements and standards for various median treatments on roadways other than freeways. Freeway median design is covered in Section 309, Urban and Rural Freeway. Section 309.4 discusses median treatment for 3R projects and Section 309.11 outlines median treatment for 4R projects.

Additional information for non-freeway median design relating to specific roadway classifications can be found in the following sections:

- Urban Expressways – Section 310.14
- Rural Expressways - Section 310.16
- Rural Arterials, Collectors, Local Routes – Section 311.6
- Urban Arterials, Collectors, Local Routes – Section 312.6

Medians can be either traversable or non-traversable designs. Traversable medians are those which do not physically prevent vehicles from crossing or entering the median. These include Continuous Two Way Left Turn Lanes (CTWLTLs) and painted medians. A non-traversable median is designed to discourage or prevent vehicles from crossing the median except at designated locations. Examples of non-traversable medians include raised curb, concrete barrier, or depressed medians. Designers need to be aware that medians striped with "double-double yellow lines with transverse markings" are physically traversable but specifically illegal to cross.

Where ever a raised median or concrete barrier is being considered for installation where it did not exist previously, considerations of access management criteria and freight mobility must be followed. Access management criteria found in ORS 374.305 to 374.330 must be included in the design. Highway designs must follow the procedure and guidelines in OAR 731-012 for the implementation of ORS 366.215, "Creation of state highways; reduction in vehicle carrying capacity" to ensure freight mobility issues have been addressed.

As noted above, the design of highway medians can significantly impact safety. Review of freeway median cross-over crashes resulted in changes in ODOT freeway median closure design. Specific guidance on the closing of interstate and freeway medians and freeway median barrier warrants can be found in Part 400, Section 401.

308.2 Continuous Two Way Left Turn Lanes

Continuous Two Way Left Turn Lanes (CTWLTLs) are often used in urban areas to provide full movement access to adjacent properties and roadways while minimizing impacts of left turning vehicles on through traffic. CTWLTLs are a reasonable tool to improve system safety and efficiency for roadways with low to moderate traffic volumes and speeds. CTWLTLs should generally not be used on roadways with any of the following conditions:

1. Traffic volumes over 28,000 vehicles a day
2. Speeds of 45 mph or more and with multiple, closely spaced accesses.

Under these types of conditions, the preferred median treatment is a non-traversable median that controls left turn movements. CTWLTLs can be considered in high volume and/or high speed locations when the access points are all located on one side of the highway or are spaced at least 1000 feet apart when the access points are on opposite sides of the highway. On roadways with existing CTWLTLs, the existing median should not be converted to a painted median until all private accesses have been removed; this is generally only true on limited access highways.

While CTWLTLs are generally a good safety technique to use, the designer needs to be aware of potential competing use of the CTWLTLs for making either a two stage left turn or at over lapping left turns access locations. Both of these conflicts place vehicles in a potential head-on configuration.

Continuous left turn lanes should be considered only on roadways where:

1. Access to adjacent properties is desired and not otherwise precluded.
2. Left turning vehicles stopped in travel lanes may present an unexpected obstacle.
3. Left turning vehicles significantly reduce roadway capacity.
4. Property access points are clearly defined and the safety of pedestrian traffic is given the highest priority.
5. Passing opportunities on two-lane roadways are not appreciably reduced.

When the use of a continuous left turn lane is deemed appropriate, the following design features should be considered.

1. The volume of left turning vehicles should not exceed the available storage nor create a high conflict potential in the turn lane.
2. The continuous left turn lane should not extend through a railroad crossing or signalized intersection.
3. Horizontal and vertical alignment should be considered in the design of the continuous left turn lane to maximize sight distance.
4. The design of the continuous left turn lane and other median treatments should be consistent within a given highway section.

5. Care should be given to avoid overlapping left turns. This may require relocating or offsetting approach points. Consideration should also be given to restricting the approaches to "right-in / right-out" configuration to mitigate overlapping left turns.

Design Criteria for an urban CTWLTL can be found in Sections 305.1 through 305.6 for the six ODOT urban contexts with additional information in Section 312.6 covering median design for Urban Arterials, Collectors, and Local Routes.

308.3 Painted Medians

Painted medians are generally narrower than CTWLTLs. This type of median is typically utilizes double solid yellow lines to define the median area. Painted medians are intended to prohibit vehicles crossing the median or using it as a CTWLTL. This type of median control may be used on moderate volume and speed highways in rural areas. In these situations, the painted median is often used as a precursor to installing a non-traversable median such as a concrete barrier. In urban areas however, this median treatment should be used carefully. For new applications this treatment should be limited to urban areas where no adjacent property approach exists and intersection spacing is very long, one-half mile or longer. Generally these conditions will only be present on limited access highways. The major concern is that the painted median will be used as a CTWLTL and may increase accident experience due to the narrow width.

308.4 Non-Traversable Medians (Non-Freeway)

By law, all proposals to install raised or depressed barriers on two-lane segments of state highways requires collaboration specifically with representatives of the freight industry and automobile users and may include representatives of local government and other transportation stakeholders, as appropriate (See ORS 374.326).

Raised medians are the preferred type of median treatment for most Statewide NHS and some Regional highways (See Oregon Highway Plan, Appendix D for Highway Classification information). Raised medians should also be considered on other highway classifications where the safety and operational benefits are significant and where improved pedestrian crossing opportunities are desired. Refer to the Median Policy from the Oregon Highway Plan for more information on raised median locations. Raised medians can be designed with either curbs or concrete barriers. Curbed raised median designs are the preferred treatment in urban areas as they are often more aesthetic than the concrete barrier and provide pedestrian crossing opportunities. However, the concrete barrier may be a more appropriate treatment in rural areas with high speeds or where right of way is constrained. Most of the design elements discussed apply to either type of median design. The remainder of this section will describe design standards and guidelines for both types of raised medians. In addition, raised curbed medians are described as two sub-sets. Full width medians refer to the curb to curb dimensions of the median between intersections or over long distances. A median traffic separator is that portion of the median that defines left turn channelization areas.

308.5 Raised Median Design Standards

♦ Median Width

(Note: median widths include the raised portions only and do not include shy distance or left side shoulder).

The width of raised medians is variable between intersections. Factors such as pedestrian accommodation, landscaping, and right of way control median widths.

1. The minimum median traffic separator width at intersections is 4 feet when pedestrians are not to be accommodated in the median and the design speed of 55 mph. For design speeds below 55 mph, the median traffic separator can be reduced to 2 feet in constrained locations. However, for improved visibility, a wider median traffic separator may be preferred with widths up to 4 feet even when the design speed is less than 55 mph.
2. When crossing more than 6 lanes or 6 lanes and a 20-degree skew angle or more, the medians and median traffic separators must be designed to accommodate pedestrians mid-way across an intersection. The number of lanes includes turn and through lanes. Changes in the median traffic separator will impact the overall median width.
3. When pedestrians are to be accommodated mid-way, the median or median traffic separator width shall be as follows:

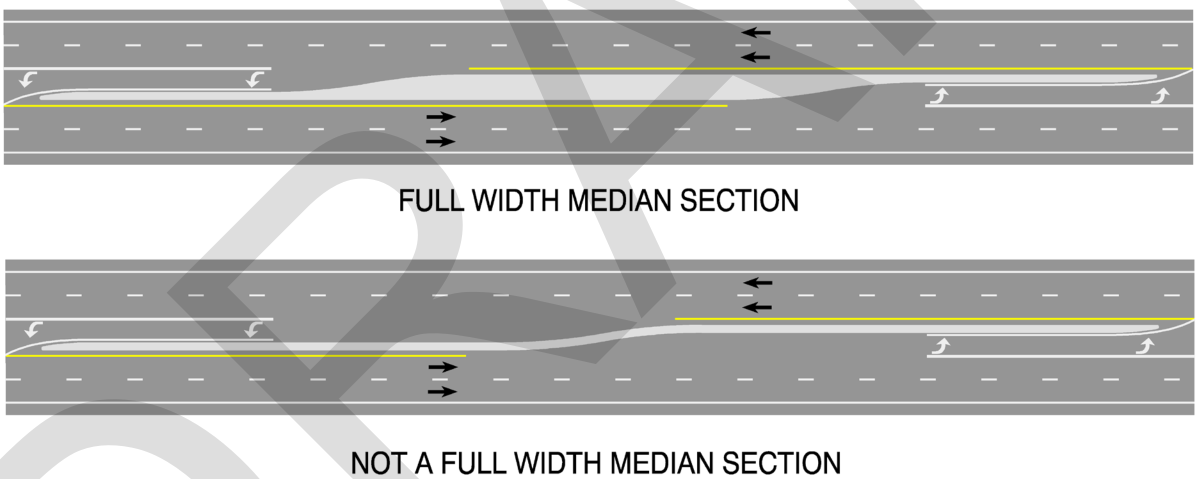
Design Hour Ped. Volume	Width
≤ 100	6 feet
≥ 101	8 feet

4. Where left turns are not accommodated over a significant length, one-half mile or longer, the minimum raised curb median width should be no narrower than 6 feet. Where left turn accommodation is provided at intersections the minimum median width preferred provides a 4 foot median traffic separator, a 12 foot left turn lane and the appropriate shy distance for opposing traffic. (See Table 300-14 for shy distance requirements.) The intent is to minimize the hour glass effect of widening the median at intersections and narrowing between.

5. Where intersection spacing is relatively short, left turn bays often become back to back in nature. It is desirable to have some full width median between the left turn bays. The full width median allows for better visibility of the driver and also allows a place to install signing. Figure 300-14 shows an example of a full width median. The desirable full width median section should be as follows:

Design Speed	Length of Full Width
≤ 30 mph	65 feet
35 mph	100 feet
45 mph	130 feet
≥ 50 mph	165 feet

Figure 300-14 Full Median Width



♦ Shy Distance From Raised Medians

Whenever barriers, such as curbs, are introduced into the roadscape it is desirable to provide a buffer space. This buffer helps improve safety of the users, traffic flow, and operational efficiency. This buffer is often referred to as "E" or Shy Distance. Table 300-14 establishes the shy distance requirements from raised medians. This table is not to be used for determining the shy distance for higher speed expressways (See Table 300-26and Table 300-30). The table also applies to left side shy distance for other conditions such as curbed sections on one-way roadways.

When raised curb or concrete barrier medians are not continuous, an additional 1 foot of shy distance should be added to the median width values shown above. Table 300-14 is used in place of the direction give in Section 317.

Table 300-14 Left Side Shy Distance

Design Speed (mph)	Shy Distance (feet)		
	Curb		Concrete Barrier
	12 ft Lane	11 ft Lane	All Lane Width
25	1 (0)	1 (0)	2 (1)
30	1 (0)	1 (0)	2 (1)
35	2 (1)	2 (1)	2 (1)
45	2 (1)	2 (1)	2 (1)
50	2	3 (2)	3
55+	3	4	4

Note: Preferred Design Widths; ( ) Urban Context Minimum Widths

♦ Sight Distance

Sight distance at both unsignalized and signalized intersections is critical to provide a safe and efficient median opening. It is desirable to provide intersection sight distance at all median openings. However, in many situations, this is not practical. The designer is encouraged to provide the highest level of sight distance practical. Sight distance is covered in more detail in Part 200, Section 217.

♦ Landscaping Accommodation

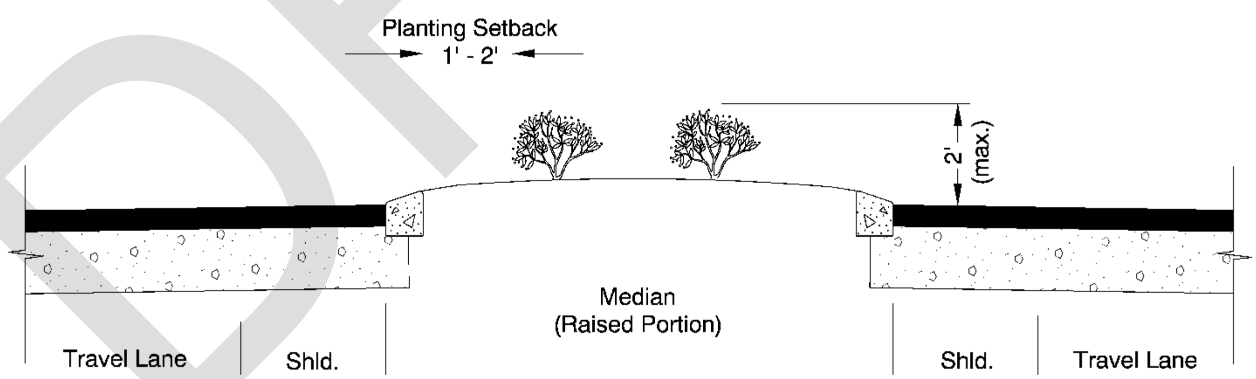
Landscaping is an important feature to raised curb medians. Landscaping enhances the visibility of the median as well as the aesthetics. Two major concerns with landscaping are sight distance and maintenance. Sight distance concerns are crucial at both signalized and unsignalized intersections. The maintenance concerns include the amount of maintenance, median access, and cost. However, not all landscape techniques are labor intensive. Many types of vegetation are considered native and require almost no special care. In addition, landscaping features such as paving blocks, bricks, rocks, or other materials are relatively maintenance free.

Figure 300-15 provides guidance for low vegetation in medians. Figure 300-16 provides guidance for median tree placement.

The following are important design elements to consider when landscaping medians:

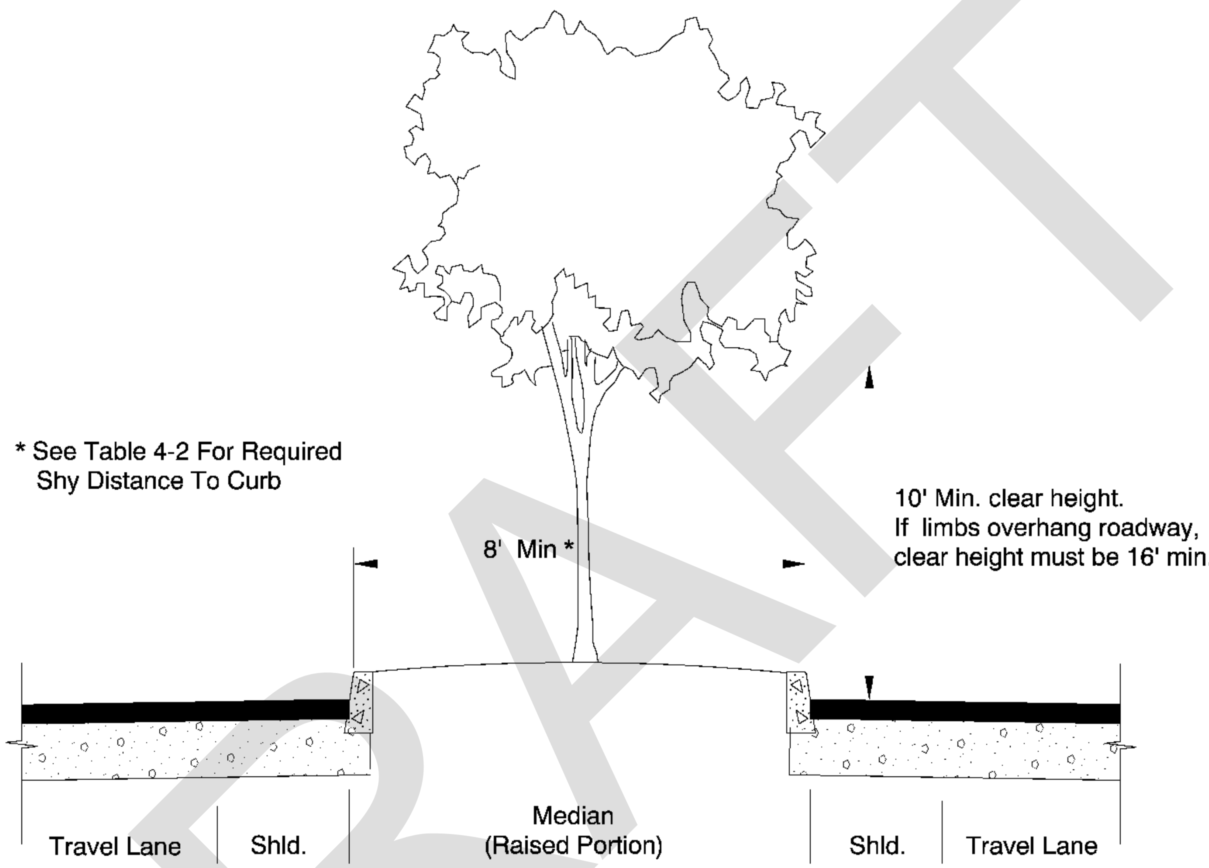
1. It is desirable to provide a vertical element within the median to increase visibility. However, to ensure sight distance lines are preserved, vegetation or mounding should not extend higher than 24 inches above the pavement surface within the functional area of intersections. Sight distance must also be preserved where pedestrian crossings are provided mid-block.
2. The minimum median width to accommodate landscaping is 6 feet. Care should be taken to not use landscaping that impairs sight distance. There should also be a planting setback. The use of trees in a raised median are typically not recommended and should only be considered in urban situations where the design criteria shown in (5) below can be met.
3. Side slopes within the median for mounding shall be no steeper than 1:3 and preferably flatter.
4. A planting set back of 1 foot to 2 feet should be considered where median width allows. The planter strip should be structural to support maintenance equipment. This could minimize the maintenance requirements or ease maintenance operations, such as mowing.
5. Consider using planter boxes rather than continuous vegetation to reduce maintenance. Planter boxes are also effective treatments for improving median visibility. Planter boxes may either be flush or raised. Raised planter boxes should be 6 inches or less above the curb height.

Figure 300-15: Landscaping Accommodation



Roadside and median trees are also discussed in Part 400.

Figure 300-16: Median Tree placement



♦ End Treatments

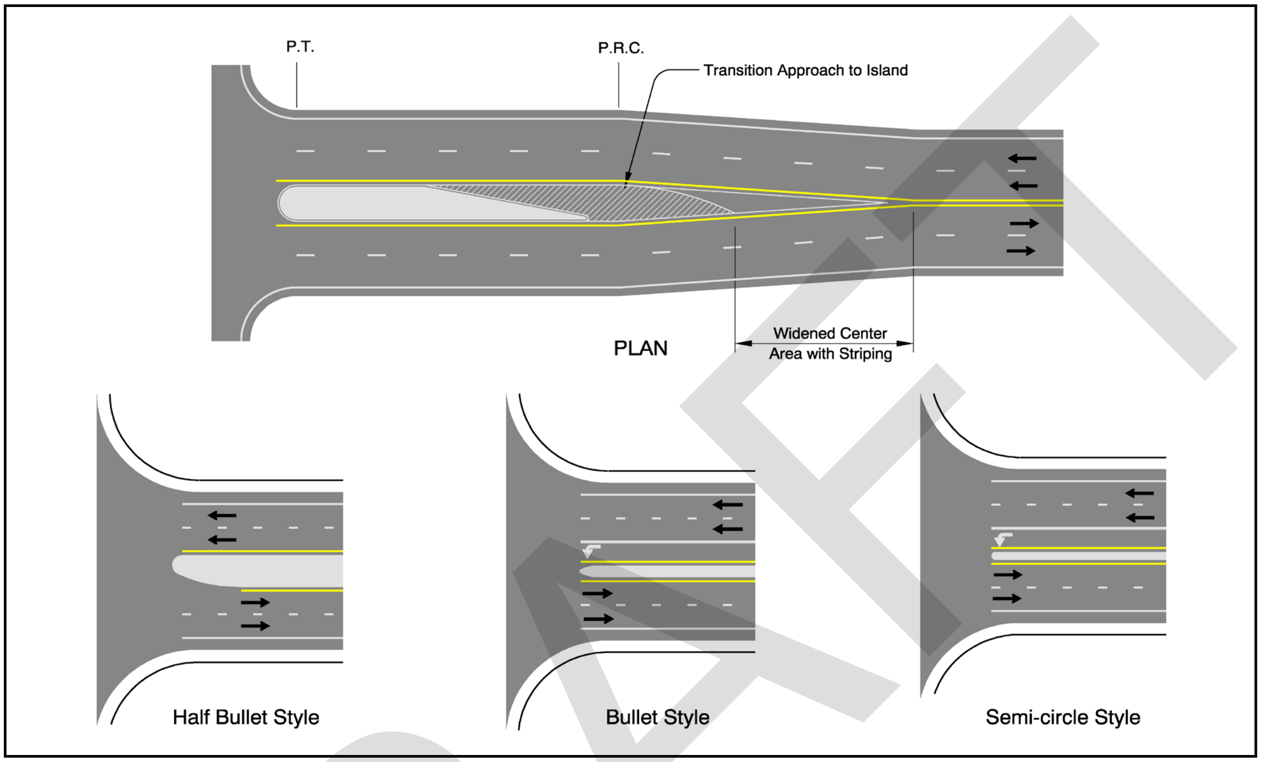
Starting and ending raised median treatments can create conflict areas to roadway users and must be designed carefully. Raised median sections should be designed with logical starting and ending points within a given section of highway. Haphazardly placing small sections of raised median throughout a highway segment may offset any safety benefits and may actually increase the accident frequency over that anticipated without any median treatment. In urban situations it is preferred to have the median begin and end at an intersection. Rural areas may not allow this intersection approach. In these cases, the designer is to determine logical termini based upon the intended function of the median and roadside character of the highway. It is important to remember that raised medians are a barrier and can be a roadway hazard. End treatments are critical to ensure the appropriate and safe function of the raised median.

Concrete barriers generally require an impact attenuator to protect the ends. The type of attenuator used must conform to the ODOT approved materials list. AASHTO's *"Roadside Design Guide - 2011"* can provide additional information regarding end treatment design for concrete barriers.

Raised curbed medians generally do not require any special end treatments but a squared off, blunt end style is an unacceptable end treatment. In high speed situations, design speeds over 45 mph, and where pedestrian accommodation in the median is not required, the curb line should be tapered to 2 inches in height. This tapered section should be accomplished over 15 feet. Standard Drawing RD706 provides additional detail for this tapered treatment.

Two other concerns about end treatments are pedestrian refuges and truck off-tracking. At signalized intersections, the preferred median treatment is to stop the raised median prior to the cross walk. Generally the pedestrian movement through a signalized intersection should be made in one stage. Pedestrian refuges create two stage crossings. At a signalized intersection, the refuge requires additional signal equipment and signal timing that needs to be considered prior to adding the refuge feature. The preferred design, when providing a pedestrian refuge for crossings at unsignalized intersections, is to utilize the cut-through option. This treatment requires a protective nose area that should be at least 13 square feet or more. The nose can be designed with either a semi-circle or half bullet type design. The semi-circle design type is only recommended for median traffic separator widths of 4 feet or less. Wider medians should utilize the half bullet type design to better facilitate truck turning movements. All end treatment designs need to consider the off-tracking characteristics of the appropriate design vehicle. The designer must use caution when providing a pedestrian refuge and using the half bullet type nose design. The half bullet design may reduce the available refuge for pedestrians. In some situations, the crossing may need to be moved back slightly to provide a full width refuge. This is especially prevalent where the nose must be moved back to provide for adequate truck turning movements. The transition approach to island area at the beginning and end of a raised median is the appropriate location for additional low cost warnings, such as rumble strips or painted chevrons. These additional warnings are not required at all locations. Figure 300-17 provides additional detail regarding end treatments for raised curb medians. For additional design specifics, see Part 500 Intersection Design.

Figure 300-17: End Treatments



♦ Accommodating U-Turns

The use of a raised median significantly reduces the opportunities for vehicles to make left turns. To facilitate traffic's ability to reach destinations on the left side of the highway, U-turn opportunities need to be included with the design. The preferred approach is to provide U-turn capabilities at signalized median openings. This approach offers greater protection for the U-turning vehicles. The second option is to utilize an unsignalized median opening. This approach should be used in conjunction with a jug handle design. Executing a U-turn through the oncoming traffic lanes creates a greater exposure to the U-turning vehicle and through traffic and should be avoided in high volume or high-speed conditions. When accommodating U-turning vehicles, the designer needs to consider the following:

1. Speed of the highway
2. Volume of traffic opposing and executing the U-turn
3. The design vehicle to be accommodated
4. The adjacent roadside culture, and
5. The opportunity to use existing roadways to accommodate U-turn movements

A left turn lane shall always be included when accommodating U-turning vehicles. U-turn movements are never to be allowed out of a through travel lane. Part 500, Section 504.6 provides additional information and illustrations for accommodating U-turns.

The Traffic-Roadway Section should be consulted when considering accommodating U-turns on state highways. U-turns must be located with respect to legal requirements [ORS 810.130(3), ORS 811.365, OAR 734-020-0025]. In addition, the State Traffic-Roadway Engineer must approve all U-turns at signalized intersections.

♦ Type of Curb

When using raised curb medians, the designer needs to determine the appropriate curb type. The preferred curb type is the mountable curb. Mountable curb is a design that provides some protection for pedestrians, landscaping, or other objects in the median, while also enhancing the aesthetics of the median. The use of low profile mountable curb also requires substantial mounding for visibility and safety. Standard curb can be substituted for mountable curb when desired by the project team when design speeds are less than or equal to 45 mph. The use of standard curb may also be appropriate for urban or urbanizing areas where the posted speed is 45 mph.

Section 309 Urban and Rural Freeway

This section provides 3R, 4R, 1R, and Single Function design guidance for urban and rural freeways, including the interstate. Freeways are the highest form of arterials and have full access control with the primary function of providing mobility and higher speeds for all vehicle modes. As Part 200 provided the geometric requirements such as vertical and horizontal curvature, vertical clearance, sight distance, and grades, this section focuses on the cross section elements such as lane width, shoulder width, cross slope, vertical clearance, roadside design, clear zone, median design, and other cross sectional features.

309.1 ODOT 3R Urban and Rural Freeway Typical Section

When a project on the freeway system has been classified as 3R, the standard cross section elements outlined in Table 300-16 below apply. The development of a freeway 3R project should also be responsive to the considerations given in Part 100 concerning purpose, applicability, scope, determination, and design process. The standards for those specific listed elements are based on the AASHTO publication, “A Policy on Design Standards-Interstate System”, which provides guidelines for work on the Interstate system. The following standards are considered as allowable minimums. For those design elements not specifically addressed below, the guidelines in the AASHTO Green Book are to be followed. 3R projects that include specific horizontal and vertical curve corrections are to use ODOT 4R standards for those curve correction design elements. In addition to these standards, Interstate Maintenance Design Features in Table 300-15, Interstate Maintenance Design Features are to be incorporated into all interstate freeway 3R projects. The “Have To” list is the recommended minimum treatment for the listed project elements. The “Like To” list includes treatments for elements which should be considered when economically feasible, i.e. minimal extra cost, or funds available from sources other than the Preservation Program.

Technical Resources have been identified for a number of the project elements. These resources should be utilized by the Project Team to aid in determining if a “Like To” measure is warranted, cost-effective and fundable or if a design exception should be sought to do less than the “Have To” requirements. Design exceptions should be identified as soon as possible (typically during project scoping) and the appropriate design exception request officially submitted for approval as soon as all pertinent information can be determined and analyzed. Design exceptions are covered in Part 1000.

Table 300-15: Interstate Maintenance Have To/Like To

Project Element	Corrective Measure		Technical Resource
	"Have To"	**"Like To"**	
Guardrail	• Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard. • Provide transitions at unconnected bridge ends. • Install protection at unprotected bridge ends • Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less. • Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less. • Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection.		Roadway Section
Concrete			Roadway

Project Element	Corrective Measure "Have To"	Corrective Measure "Like To"	Technical Resource
Barrier	• Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard. • Pre-350 concrete barrier with earth support behind the barrier may remain in service. • All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.		Section Roadway Section
Interchange Ramps	• Ramp surfacing to the ramp termini.		
Roadside Obstacles	• Cost effective removal or shielding of rock outcroppings, trees, concrete structures higher than 4", utility poles, non-breakaway sign and light poles and other potential hazards within the clear zone.		Roadway Section
Bridges	• See BDM	Bridge painting, widening, deck replacement, scour protection and seismic retrofit.	Bridge Section
Delineators	• Install missing delineators. • Replace damaged delineators.		
Fencing	• Replace damaged or rotting fencing.	Fill in incomplete sections	
Attenuators	• Replace damaged or non-standard attenuators. • Adjust attenuators as needed. • Install attenuators if warranted.		
Rumble Strips	• Install on rural portions as per ODOT Rumble Strip Standards and Policies.		
Pavement Life			Pavement Unit
Striping	• High volume, Urban areas would have all durable lines		Region Traffic

Project Element	Corrective Measure "Have To"	Corrective Measure "Like To"	Technical Resource
	• Mountainous sections with lots of curves would have all durable lines • Flat tangent sections will have durable skip lines only		
Drainage			Fish Program Manager & Hydraulics Unit
Signal Loops			Traffic Section

Table 300-16: ODOT 3R Freeway Design Standard Minimums

Design Feature	Terrain			
	Flat	Rolling	Mountainous	Urban
Design Speed	Posted Speed	Posted Speed	Posted Speed	Posted Speed
Lane Width	12′	12′	12′	12′
Right Shoulder Width	10′	10′	10′	10′
Left Shoulder				
4 Lane Section	4′	4′	4′	4′
6 Lane Section	10′	10′	10′	10′
Median Width	36′	36′	10′	10′
Vertical Clearance	See Section 316	See Section 316	See Section 316	See Section 316
Bridges to Remain in Place(Less than 200′ in length)	12′ Lane 10′ Right Shoulder 3.5′ Left Shoulder			
Bridges to Remain in Place (200′ or more in Length)	12′ Lane 3.5′ Right Shoulder 3.5′ Left Shoulder			

Tunnels(Desirable Width)	44′ 12′ Lane 5′ Left Shoulder 10′ Right Shoulder Two- 2.5′ Safety Walks
Tunnels(Minimum Widths)	30′ 12′ Lane Two- 1.5′ Safety Walks

309.2 ODOT 3R Urban and Rural Freeway Lane Width

All traffic lanes for 3R freeway projects are 12′ wide. AASHTO standards for lane width may be used on Local Agency jurisdiction roads.

309.3 ODOT 3R Urban and Rural Freeway Shoulders

On the left side of traffic on a four lane section, the standard shoulder width is 4 feet. On six or more lane sections, the standard shoulder width is 10 foot paved.

The designer should be aware of snow zone locations where there is a shoulder break and an overlay is being placed. There is potential for pavement removal by the snow plows cutting into the pavement in the shoulder break areas. The designer should work with the Project Team to discuss the need for additional leveling quantities to bring the shoulder slope up to match the existing slope of the travel lanes.

309.4 ODOT 3R Urban and Rural Freeway Medians

Medians in rural areas having level or rolling topography shall be at least 36 feet wide. Medians in urban and mountainous areas shall be at least 10 feet wide. Consideration should be given to decking median openings between parallel bridges when the opening is less than 30 feet wide. Due to terrain constraints many of the rural freeways were originally constructed with an urban median width of 8 to 10 feet. For those locations in rural and urban areas that have an existing median width of 8 to 10 feet, a design exception will not be required.

309.5 ODOT 3R Freeway Bridges to Remain in Place

Mainline bridges on the Interstate system may remain in place if, as a minimum, they meet the following values. The bridge cross section consists of 12 foot lanes, 10 foot shoulder on the right, and a 3.5 foot shoulder on the left. For long bridges (200 feet or more), the offset to the face of parapet or bridge rail on both the left and the right side is 3.5 feet measured from the edge of the nearest traveled lane. Bridge railing shall meet or be upgraded to current standards.

309.6 ODOT 3R Freeway Structure Cross Section

The width of all bridges, including grade separation structures, measured between rails, parapets, or barriers shall equal the full paved width of the approach roadways. The approach roadway includes the paved width of usable shoulders. **Long bridges, defined as bridges having an overall length of 200 feet or more**, may have a lesser width. Such bridges shall be analyzed individually. On long bridges, offsets to parapet, rail, or barrier shall be at least 3.5 feet measured from the edge of the nearest traffic lane on both the left and the right sides.

Narrow structures should be considered for widening to full shoulder on major rehabilitation projects; in particular, on those projects where the design life after rehabilitation is expected to be 20 to 30 years. Each structure should be looked at individually to determine whether widening is appropriate. For example, it may not be appropriate to widen a narrow, long structure or a structure that is 2 feet short of being able to accommodate full shoulders.

309.7 ODOT 3R Freeway Tunnels

The desirable width for tunnels is at least 44 feet. This width consists of two 12 foot lanes, 10 foot right shoulder, 5 foot left shoulder, and 2.5 foot safety walk on each side. However, because of the high cost, a reduced tunnel width can be accepted, but it must be at least 30 feet wide, including at least a 1.5 foot safety walk on both sides.

309.8 ODOT 4R Urban and Rural Freeway Typical Section

This section provides 4R design guidance for urban and rural freeways, including the interstate. As previously discussed, freeways are the highest form of arterial and provide for mobility and high speeds. The 4R cross section elements listed below are to be used on all 4R freeway projects.

Figure 300-18: Standard Urban Freeway Section (Includes Non-Interstate Facilities)

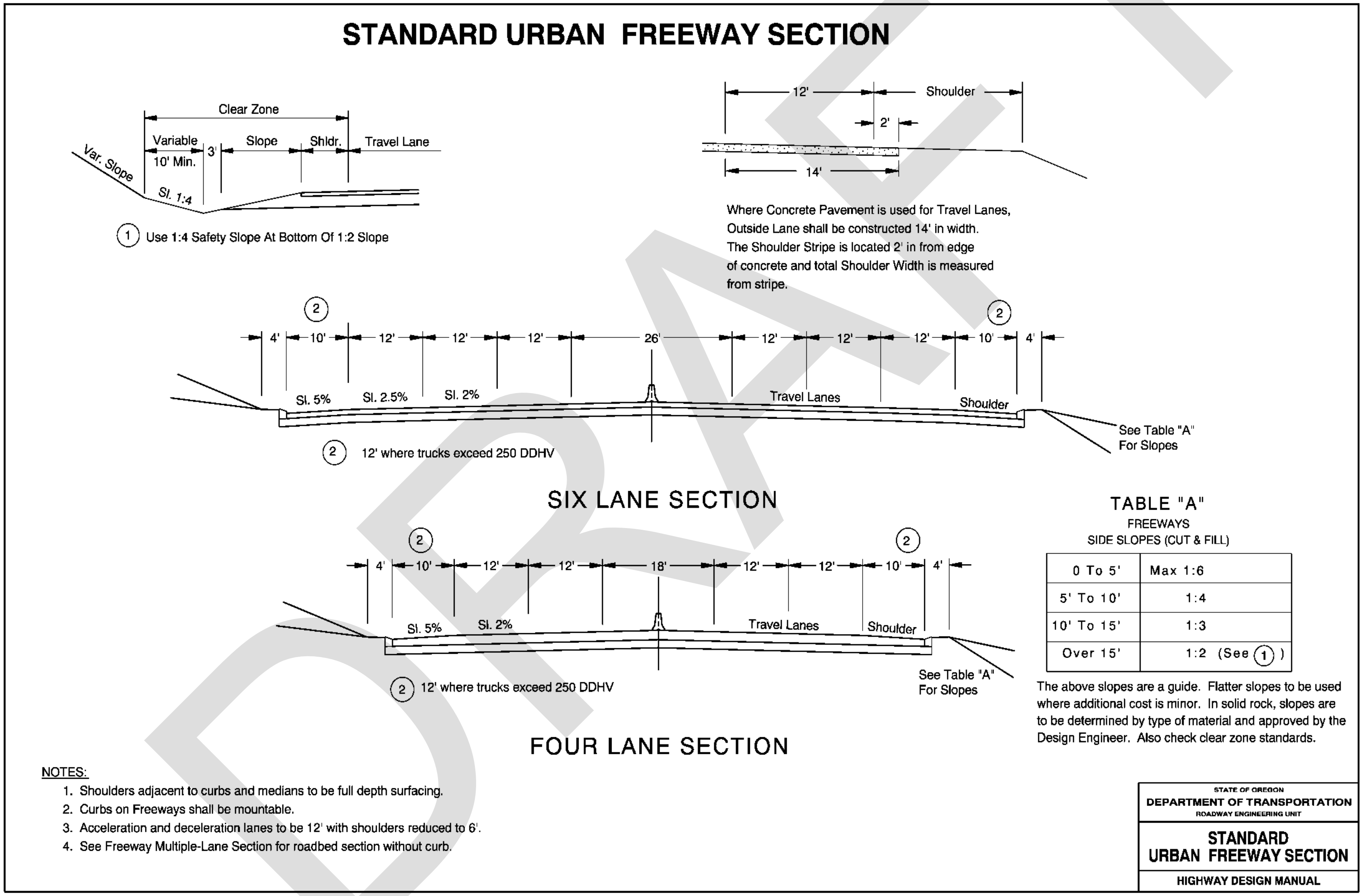
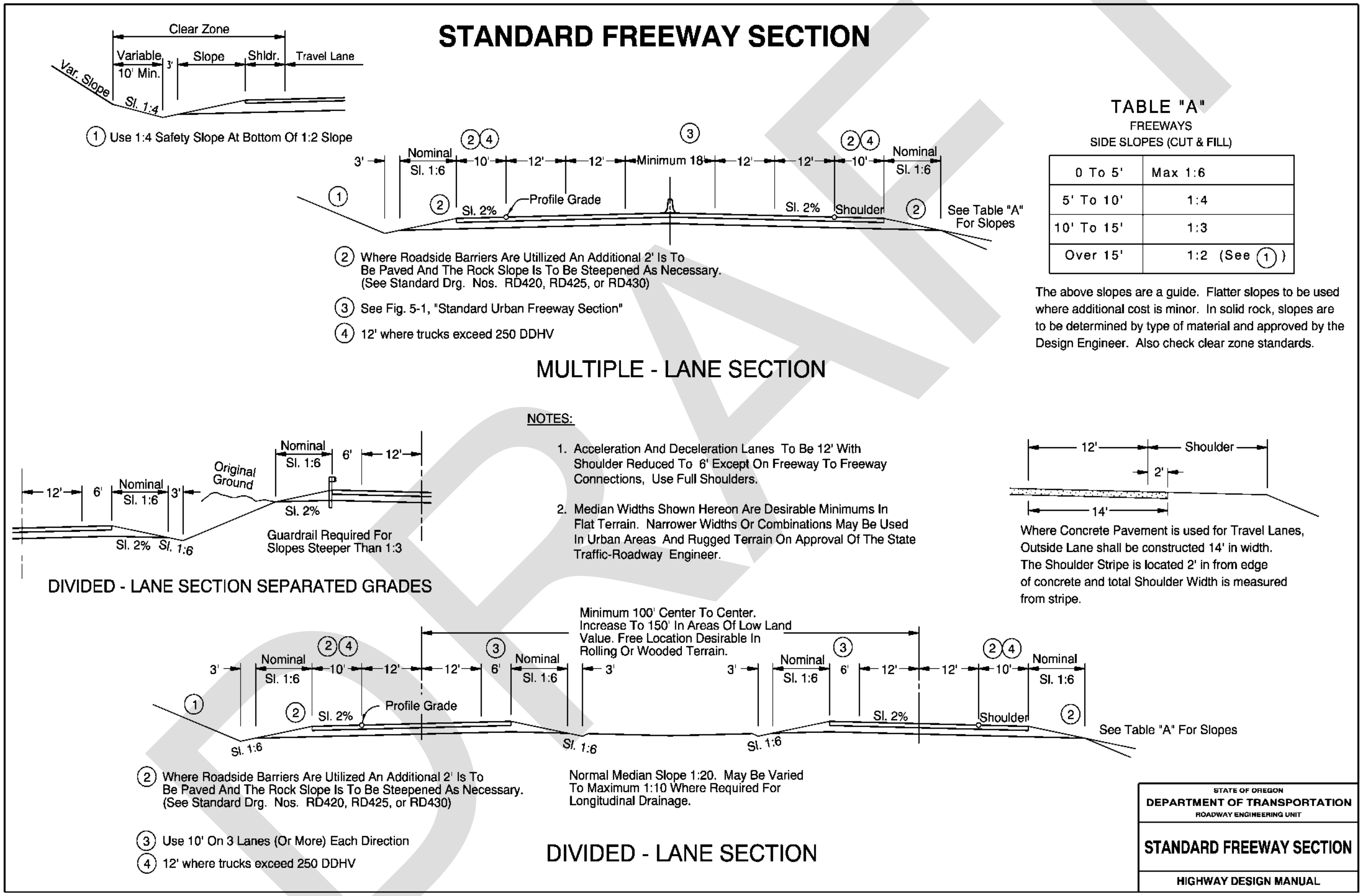


Figure 300-19: Standard Freeway Section (Includes Non-Interstate Facilities)



309.9 ODOT 4R Freeway Lane Width

The travel lane width for both urban and rural freeways shall be 12 feet. A design exception is required for lanes less than 12 feet.

309.10 ODOT 4R Urban and Rural Freeway Shoulders

The shoulder width of urban and rural freeways is dependent upon the number of lanes of the facility. The right side shoulder for both urban and rural freeways shall be 10 feet. This width allows for emergency parking of vehicles on the right hand shoulder. The left side shoulder is dependent on the number of freeway lanes. When there are two lanes in each direction on the freeway, the left side shoulder shall be a minimum of 6 feet wide. When the freeway consists of three or more lanes in each direction, the left side shoulder shall be a minimum of 10 feet wide. This wide left side shoulder on a multi-lane section allows for vehicles in the left lane to use the left side shoulder in an emergency instead of crossing two lanes of traffic to find refuge in the right side shoulder. Wider shoulders also provide other benefits in addition to emergency parking, such as providing space for incidence response, emergency vehicle travel, maintenance activities and stage construction of future modernization and preservation projects. The standard shoulder widths also apply to bridge shoulder widths.

For interstate freeways, when truck traffic Directional Design Hourly Volume (DDHV) is greater than 250, the right side shoulder shall be increased to 12 feet. For non-interstate freeways, when the truck traffic DDHV is greater than 250, widening the right shoulder to 12 feet should be evaluated.

For new construction, auxiliary and climbing lanes on the freeway should have the same shoulder and lane width as standard freeway shoulders. Typically the right side shoulder width should be 10 feet, with a minimum 8′ shoulder required, excluding shy distance requirements. Where truck traffic DDHV is greater than 250 or there is a roadside barrier, a 12 foot shoulder should be considered. In retrofit situations, such as operational and safety projects or adding auxiliary and climbing lanes to a preservation project, an attempt should be made to achieve new construction shoulder width (minimum 8′). When right side roadside barriers are used, the normal right side shoulder width shall be increased to provide a 2 foot "E" offset or "shy" distance. The 2 foot "shy" distance is not required when the shoulder width is 12 feet or more. When a roadside barrier is used on the left side shoulder of 10 feet or more in width, the left side shoulder shall also provide the 2 foot "E" distance. Exceptions to the 2 foot "E" widening may be approved by the State Traffic-Roadway Engineer when the additional shoulder widening is not practical.

309.11 4R Urban and Rural Freeway Medians

Freeway medians provide a separation between the travel ways of opposing traffic. Medians provide a sense of security and convenience to the operators of motor vehicles. The wider the median the more comfortable the driver becomes with the facility. The width of urban and rural freeway medians is dependent upon available right of way. Because urban freeways have high speed and high volume traffic, the median should be as wide and flat as possible. A wider median on an urban freeway can provide for future transit, rail, HOV (high occupancy vehicles), HOT (high occupancy toll), maintenance, construction staging, mitigation, or travel lanes. Many times the width of medians is restricted due to the highly developed and expensive right of way.

For urban freeways the minimum median width for a freeway with two lanes in each direction and a concrete barrier is 18 feet between edges of travel lanes. This allows for 6 foot shoulders, a 2 foot "E" distance, and a nominal 2 foot concrete barrier width. For urban freeways with three or more lanes in each direction and a concrete barrier, the median shall be 26 feet wide between edges of travel lanes. This distance allows for 10 foot shoulders, a 2 foot "E" distance, and a nominal 2 foot concrete barrier width. The designer should be considering future needs of the facility when dealing with minimum median designs, particularly accommodating future lanes or transit. When determining four lane median width, consideration should be given to future six lane expansion.

The desirable median width in an urban and rural area is 76 feet (inside edge of travel lane to inside edge of travel lane). This allows for a median that has the flexibility of allowing additional lanes in the future. In areas where the right of way is inexpensive the edge of travel lane to edge of travel lane distance should be increased to 126 feet.

Freeway medians with a width of 100 feet or less shall be closed with an appropriate barrier system. Evaluate site specific conditions and crash data for wider freeway medians to determine if they should also be closed.

Median widths ranging from 76 to 126 feet (inside edge of travel lane to inside edge of travel lane) are very common for rural freeways. The median width allows for future widening, grading of an earth median (slopes shall be 6:1 or flatter), or drainage facilities. In areas of steep topography, the use of a wide median allows for the designer to use independent profiles and proper sideslopes. In rural locations, where terrain prohibits the use of the rural median standard, the urban median width (18'/26') can be considered and evaluated. Use of the urban median standard in a rural freeway setting requires a design exception.

At freeway cloverleaf ramp terminals, there may be instances where some form of raised median placed between the exit and entrance ramps may be appropriate to reduce the potential for crossover crashes. See Section 600 for detail on ramp median treatments.

309.12 ODOT Single Function (SF) Freeway Standards

The specific design standards used for a Single Function Standard project will generally be the same design standards used for a 4R/New Construction project. The difference is that the scope of work is very limited on SF projects, so the SF Standard does not require addressing non-related non-standard features of the roadway. For example, if a guardrail upgrade qualifies as a Single Function project, it will not be necessary to address other non-standard features on the roadway, such as lane and shoulder width, horizontal and vertical alignment, etc.

Single Function projects include projects that are within the right of way but do not permanently impact the travel lanes or shoulders of the highway. Generally, projects that only include work outside the edge of pavement will qualify for the SF standard. The SF standard can also be applied to certain maintenance projects such as re-striping projects as long as the final configuration of the travel lanes and shoulders would not be changed in any way. These projects address a specific need. The scope of work is limited to features that are directly impacted as a result of addressing the specific need. For example, an urban freeway overlay project may impact drainage inlet adjustment. In no case shall safety, operations, pedestrian and/or bicycle conditions (ramp terminals) be degraded as a result of a SF project. Each feature constructed in a SF project must be built to the applicable standard for new construction. The SF Standard does not apply to resurfacing projects.

Section 310 Urban and Rural Expressway

Urban and rural highways can take several forms: freeways, expressways, arterials, collectors, and sometimes, local roads. Similar to urban and rural freeways, urban and rural expressways are a designation identified in the Oregon Highway Plan and mainly focus on vehicle mobility, although expressways may or may not have the high level of access control as freeways. The following is from the Oregon Highway Plan:

> "Expressways are complete routes or segments of existing two-lane and multi-lane highways and planned multi-lane highways that provide for safe and efficient high speed and high volume traffic movements. Their primary function is to provide for interurban travel and connections to ports and major recreation areas with minimal interruptions. A secondary function is to provide for long distance intra-urban travel in metropolitan areas. In urban areas, speeds are moderate to high. In rural areas, speeds are high."

Because expressways may consists of grade separated or at-grade intersections, the level of modal accommodation will vary. Speeds are often relatively high ranging from 45 to 70 mph depending on urban or rural environments.

Designing urban and rural expressway highway projects presents designers with a variety of challenges. Designers must balance the needs of autos, trucks, transit, bicyclists, and pedestrians, while considering highway function, speed, safety, alignment, channelization, right of way, environmental impacts, land use impacts, and roadside culture. Part 200, Section 208 though Section 222 address the design standards for design speed, horizontal alignment and superelevation, vertical curvature, grades, and stopping sight distance while cross sectional design criteria are addressed in this section and will discuss a variety of issues, concerns, and areas for consideration when designing urban and rural expressways for all project types.

One critical distinction when designing a project on an urban expressway is if the section has grade-separated intersections or if intersections are at-grade.

- If the expressway section has at-grade intersections, then the six urban contexts and their respective design criteria apply to determine appropriate design decisions and the Urban Design Concurrence document is used. (Sections 204 – 209 and Section 311)

If the expressway section has grade-separated intersections (interchanges), then design decisions are based on freeway and higher operating speed design criteria.

310.1 ODOT 3R Urban Expressway Typical Section

As noted in Part 200, the 3R urban design guidance for urban expressways is generally the same as the 3R urban arterial design guidance found in Section 311 through Section 315 below. The urban expressway 3R guidance is slightly different than the rural expressway 3R guidance and is listed separately. Additionally, urban expressways with at-grade intersections meeting one of the six urban contexts described in Part 200 use design criteria from Sections 205 through 211 as well as Section 306 and Section 307 in conjunction with Section 310. Urban expressways not considered in the six urban contexts use Tables in Section 310 for relevant design criteria. These expressways generally have posted speeds 45 mph or above.

In general the intent of 3R projects is pavement preservation with additional focus on safety items. Some of those safety items include mandatory 3R design features such as ADA curb ramps and deficient guardrail, consideration of low-cost safety mitigation measures, and in the case of urban expressways, the corrective measures located in the 3R urban preservation strategy and the consideration of additional urban design features. Table 300-17 below provides the cross section minimums for urban expressways not categorized as one of the six urban contexts outlined in Part 200.

3R Urban Expressway projects are a good opportunity to provide incremental improvements towards long-range urban corridor goals. Work with region Active Transportation Liaisons to determine feasible options for alternative transportation users that can be included.

Table 300-17: ODOT 3R Urban Non-Freeway Design Standards (Use for Urban Expressways with Interchanges and/or Posted Speeds 45 mph and Above)

Highway Feature	Highway Average Daily Traffic (ADT)			
	< 750	750 - 2000	2001 - 4000	> 4000
Travel Lane [1] <10% Trucks [2] >10% Trucks [2]	 10′ 10′	 10′ 11′	 11′ 12′	 11′ 12′
Left Turn Lane [3]	12′	13′	13′	14′
Right Side Shoulder [4]	2′	3′	4′	6′
Left Side Clearance (Shy Distance) [5] posted speed 40-45 mph posted speed ≥ 45 mph	 1′ 2′	 1′ 2′	 1′ 2′	 1′ 2′
Curbside Sidewalk[5]	6′	6′	6′	6′
Cross Slope (crown) [6]	2%	2%	2%	2%
Maximum Superelevation [7] design speed ≤ 40 mph design speed ≥ 45 mph	 4% 6%	 4% 6%	 4% 6%	 4% 6%
Vertical Clearance	See Section 316			

[1] A minimum 12 foot travel lane is required on nationally recognized truck routes (see current Route Map 7) and a minimum 11 foot lane is required on all NHS Routes on State jurisdiction roadways only. Local Agencies may use AASHTO standards for lane width on Local Agency jurisdiction roads.

[2] Trucks are defined as heavy vehicles, single unit configuration or larger (six or more tires).

[3] Left turn lane width include 2 foot median separator.

[4] Where a right side shoulder is not used, a right side shy distance from curb or on-street parking is required. This shy distance is 2 feet for posted speeds up to 35 mph and 3 feet for 40 mph and above.

[5]Left side clearance (shy distance) required from the curb or on-street parking and is the only applicable to one way roadways. Curbside sidewalks are discouraged when design speed is greater than 45 mph.

[6]See Table 300-19 and Table 300-20 for improvement criteria and corrective measures.

[7] Numbers shown are for new design.

310.2 Mandatory 3R Urban Expressway Design Features

The following is a list (Table 300-18) of mandatory design features that must be incorporated into Preservation projects:

Table 300-18: Mandatory 3R Design Features

Geometric Deficiency	Mandatory Corrective Measure
ADA/Sidewalk Ramps	Ramps shall be added at intersections where absent. Existing non-standard Ramps shall be upgraded to current standards.
Narrow Bridges/Deficient Rails	Refer to the BDM
Guardrail	Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard. Provide transitions at unconnected bridge ends. Install protection at unprotected bridge ends Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less. Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less. Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection.

Concrete Barrier	Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard. Pre-350 concrete barrier with earth support behind the barrier may remain in service. All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.

310.3 Low-Cost Safety Mitigation Measures 3R Urban Expressway

Table 300-19 is a list of low cost safety measures that should be considered on all projects utilizing ODOT 3R urban design standards and can be used as mitigation in justification for design exceptions.

Table 300-19: Low-Cost Safety Measures

	Low-Cost Safety Measure
Narrow Lanes and/or Shoulders	Pavement edge lines Raised pavement markers
Steep Sideslopes/Roadside Obstacles	Remove or relocate obstacle Roadside hazard markings Round ditches Install guardrail Slope flattening Breakaway hardware
Narrow Bridges/Deficient Rails	Install supplementary signing Hazard and pavement markings
Sharp Horizontal Curve	Install supplementary signing Correct superelevation Gradual sideslopes Pavement anti-skid treatment Obstacle removal or shielding Install post delineators

Poor Sight Distance at Hill Crest	Install supplementary signing Fixed-hazard removal Driveway relocation Illumination
Intersection	Install supplementary signing Signalization Illumination Pavement anti-skid treatment Speed control (traffic calming, visual queues, etc.)

NOTE: Designers need to exercise engineering judgment based upon engineering principles and practices in selecting appropriate mitigation measures from the above list.

310.4 ODOT 3R Urban Preservation Strategy

The 3R Urban Preservation Strategy is a good place to utilize the ODOT Performance-based, Practical Design Policy and design flexibility. Urban areas are complex with many conflicting needs. An urban 4R project would attempt to rebuild and improve a roadway section on the whole. Whereas, the intent of a 3R project is pavement preservation with improvements to selected design elements for safety and operations. Improvements to some of those design elements may be required by regulation or mandate. Other design elements may or may not be improved at the discretion of the project team. It is these elements where Practical Design can be employed to aid in the determination of the amount of value added to the system or corridor by making the improvements on either a wholesale basis or as an incremental improvement.

Due to the complexity and cost of urban preservation type projects, the Urban Preservation Strategy has developed a set of criteria for evaluating other design features for possible modifications or improvements. Table 300-20 contains the list of “Have To” and “Like To” corrective measures. The corrective measures listed under the “Have To” column must be addressed on all urban 3R preservation projects. The corrective measures listed under the “Like To” column should be considered where economically feasible (i.e., minimal extra cost or funds available from sources other than Preservation funding). Design exceptions are required for each design feature not meeting the “Have To” corrective measures.

Under some conditions, the “Like To” corrective measures are required as part of an Urban Preservation Project. These conditions include:

1. Pavement condition requiring reconstruction, or
2. Curb exposure less than 6 inches, or
3. Cross slope greater than 8%.

If any of these above conditions are met, design exceptions are required for not meeting the corrective measures from the "Like To" column of Table 300-20.

Urban Preservation projects must meet the design standards and features described above or obtain a design exception, depending upon certain conditions. However, it is often desirable to provide additional improvements in urban environments. Table 300-21 shows other design features considered only if additional funding sources are available other than Preservation and where improvements are cost effective. This optional list is not a requirement for Urban Preservation projects and does not require design exceptions if these items are not included in a project.

Table 300-20: Urban Preservation Design Features

Project Element	Corrective Measure		Technical Resource
	"Have To"	"Like To"	
Pavement Life	8 to 15 year minimum (unless life cycle benefit/cost justifies an alternative) for overlays, inlays or appropriate treatment.	15 year minimum life for reconstruction (may be triggered by cross slope, curb exposure or pavement condition).	Pavement Unit
Signal Loops	Adjust or replace with non-invasive detection (e.g., radar detection) as necessary.		Traffic-Roadway Section
Striping	Redo.	Redo with Durable products as supported by the Statewide & Regional Striping Plans.	Region Traffic
Signing	Replace signs in poor condition (damaged or no longer visible or discernable).	Replace signs not up to current standards	Traffic-Roadway Section
Utilities (manholes, valves, vaults)	Adjust.		Traffic-Roadway Section
Drainage	Adjust as necessary to maintain basic system. Address high priority fish culverts identified in Salmon program.	Reroute bridge drains which drain directly into waterway. Address lower priority fish culverts as required.	Fish Prog. Mgr. & Hydraulics Unit
Obstacles behind curbs	Reconstruct curb to re-establish delineation and drainage	Meet required clear zone standards for obstacles behind curb. Relocate if necessary.	Traffic-Roadway Section

Project Element	Corrective Measure "Have To"	Corrective Measure "Like To"	Technical Resource
	function if grades & existing R/W permit. Relocate to meet standards where practical.		
Roadside obstacles with demonstrated safety issues	Remove or mitigate.		Traffic-Roadway Section
ADA/ Sidewalk Ramps	Ramps shall be added where absent. Existing Pedestrian Control locations may require special treatment to meet compliance. Upgrade or Replace Existing Sub-Standard Ramps to meet accessibility requirements	Meet ADA standards on sidewalks and driveways.	Traffic-Roadway Section
Vertical Clearances	Maintain existing or minimum vertical clearances. See Section 315.	Meet required vertical clearance.	Bridge Section
Guardrail	Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard. Provide transitions at unconnected bridge ends. Install protection at unprotected bridge ends Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less. Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less. Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection.	Meet required standard.	Traffic-Roadway Section

Project Element	Corrective Measure		Technical Resource
	“Have To”	**“Like To”**	
Concrete Barrier	Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard. Pre-350 concrete barrier with earth support behind the barrier may remain in service. All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.		Traffic-Roadway Section
Narrow Bridges/ Deficient Rails	See BDM	Widen bridge, where practical Meet current standard for bridge rails and connections	Bridge Section
Curb Exposure	4 inch minimum curb exposure for delineation of roadway. Additional exposure may be required for drainage.	Meet required standard.	Traffic-Roadway Section
Cross Slope	Maintain existing where applicable. Minimize cross slope to meet standards where practical. Maximum cross slope not to exceed 8%.	Meet required standard for superelevation rates and cross slopes.	Traffic-Roadway Section

The following optional items should be considered, IF cost effective AND additional funding (other than Preservation funding) is available.

Table 300-21: Additional Urban Design Features

Project Element	Corrective Measure	Technical Resource
Drainage	Upgrade systems.	Traffic-Roadway Section
Access Issues	Driveway relocations/closures.	Region Access Mgr.

Operational Issues	Modify curb radii to facilitate truck movement. Islands (replacing, adding or removing). Install/upgrade traffic control devices.	Traffic-Roadway Section
Safety Issues	SPIS site addressed. Rumble strips, pavement markings, slope flattening, illumination, etc.	Transportation Safety & Traffic-Roadway Section
Sidewalk Infill	If less than 10% missing in length of project.	Traffic-Roadway Section

310.5 ODOT 3R Rural Expressway Typical Section

As noted in Part 200, the 3R rural design guidance for rural expressways is the same as the 3R rural arterial design guidance found in this section. The rural expressway 3R guidance is slightly different than the urban expressway 3R guidance and is listed separately. In general the intent of 3R projects is pavement preservation with additional focus on safety items. Some of those safety items include mandatory 3R design features such as ADA curb ramps and deficient guardrail, consideration of low-cost safety mitigation measures, and in the case of urban expressways, the corrective measures located in the 3R urban preservation strategy. Table 300-22 below provides the cross section minimums for urban expressways.

310.6 ODOT 3R Rural Expressway Roadway Widths

Table 300-22: Minimum 3R Lane and Shoulder Widths - Rural Non-Freeway (Arterials, Collectors, Local Streets)

Design Yr Volume (ADT)	Average Running Speed	Lane Width	Shoulder Width
Less Than 750 Vehicles	All Speeds	10′	2′
750 to 2000 Vehicles	Under 50 mph	11′	2′
	50 mph or Over	11′	3′
Over 2000 Vehicles	All Speeds	11′	4′

NOTE: A minimum 11 foot lane is required on all NHS Routes on ODOT jurisdiction roadways only. Local Agencies may use AASHTO standards for lane width on Local Agency jurisdiction roads.

310.7 Mandatory 3R Rural Expressway Design Features

Following is a list of mandatory design elements that must be incorporated with 3R projects:

Table 300-23: Mandatory Design Features

Geometric Deficiency	Mandatory Corrective Measure
ADA/Sidewalk Ramps	Ramps shall be added where absent and upgraded where deficient*.
Narrow Bridges/Deficient Rails	See BDM
Guardrail	Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard. Provide transitions at unconnected bridge ends. Install protection at unprotected bridge ends Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less. Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less. Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection.
Concrete Barrier	Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard. Pre-350 concrete barrier with earth support behind the barrier may remain in service. All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.

* See Part 800.

310.8 Low-Cost Safety Mitigation Measures 3R Rural Expressway

Table 300-24 is a list of low cost safety measures that should be considered on all 3R projects. They can also be used as mitigation in justification for design exceptions.

Table 300-24: Low-Cost Safety Measures

	Low-Cost Safety Measure
Narrow Lanes and/or Shoulders	Pavement edge lines Raised pavement markers Post delineators Rumble strips Safety Edge
Steep Sideslopes/Roadside Obstacles	Roadside hazard markings Round ditches Install guardrail Remove or relocate obstacle Slope flattening Breakaway hardware Rumble Strips
Narrow Bridges/Deficient Rails	Install supplementary signing Hazard and pavement markings
Sharp Horizontal Curve	Install supplementary signing Shoulder widening Shoulder paving Lane Widening Correct superelevation Gradual sideslopes Pavement antiskid treatment Obstacle removal or shielding Raised Pavement Markers Install post delineators Rumble Strips
Poor Sight Distance At Hill Crest	Install supplementary signing Fixed-hazard removal

	Low-Cost Safety Measure
	Shoulder widening Driveway relocation Illumination
Intersections	Install supplementary signing Illumination Pavement antiskid treatment Speed control

310.9 ODOT 3R Urban and Rural Expressway Bridge Width

A decision must be made to retain, widen or replace any bridge within the limits of a 3R project. Widening versus replacement should be evaluated to determine the most cost-effective treatment. Consider the AASHTO Green Book standards for bridges to remain in place, and Table 300-25, whichever is less, for minimum width. Additionally, analysis of the crash history and the cost of widening is required when determining if widening is cost effective. If the decision is made to replace an existing structure, new construction standards will apply to the bridge replacement portion of the project only, not to the roadway portion. Replacing structures does not change the remainder of a 3R Project to 4R.

When a decision is made to retain a bridge, evaluate the bridge rail to determine if it can adequately contain and redirect vehicles without snagging, penetrating or vaulting. Upgrade structurally inadequate or functionally obsolete bridge rail. Consideration may be given to design standard exceptions for railing upgrades, roadway widths, etc., when the structure is listed in or determined eligible for the National Register of Historic Places. Evaluate the bridge rail design for pedestrian needs and provide a design that accommodates pedestrians as necessary. If the clear roadway width on the structure is less than the approach roadway width, install appropriate traffic control devices. Refer to the ODOT Bridge Design Manual and the ODOT Bridge Section for additional information when determining bridge decisions on roadway projects.

Table 300-25: Minimum Useable Bridge Widths

Design Year Volume (ADT)	Useable Bridge Width

0 – 750	Width of approach lanes
751 – 2000	Width of approach lanes, plus 2 feet
2001 – 4000	Width of approach lanes, plus 4 feet
Over 4000	Width of approach lanes, plus 6 feet

310.10 ODOT 4R Urban and Rural Expressway Lane Width

As discussed in previous sections, urban expressways have two design categories, those with grade-separated interchanges and those with at-grade intersections. Urban expressway projects with at-grade intersections and a posted speed less than 45 mph utilize the urban context design criteria. Since a fundamental element of an expressway designation is a high level of mobility, most expressways, including many urban expressways, have posted speeds at or above 45 mph. As such lane widths should be held to a higher operating standard. All travel lane widths shall be 12 feet on all urban and rural expressways with speeds of 45 mph and above. Where right turn lanes are provided at intersections, they shall be in conformance with Figure 500-18 Right Turn Channelization. Left turn lanes shall include a 12 foot lane with a 4 foot traffic separator. The traffic separator shall be a minimum of 2 feet. For major intersections, dual left turn lanes may be required. In these instances, the design should follow the recommendations in Part 500. If the traffic separator is a raised curb, a 4 foot shy distance should be provided between the through travel lanes and the curb.

Rural expressways are very similar to freeways as they offer a high level of mobility and safety. In addition, expressways may become freeways in the future as the roadway is upgraded to meet the needs of traffic demand.

310.11 ODOT 4R Urban Expressway Shoulders

Expressways must include an adequate shoulder. The shoulder is necessary for emergency parking, disabled vehicles, and emergency response vehicles. The shoulder also provides significant safety benefits to motorists and bicyclists, as well as improves traffic flow and capacity. In addition, a shoulder provides space for necessary maintenance and construction activities. A minimum 8 foot right side shoulder shall be used for design speeds of 45 mph or greater where no roadside barriers are used. This width of shoulder is necessary to help distinguish expressways as a higher order of roadway facility that should ultimately move towards being an access controlled facility and provide an area for disabled vehicles and emergencies. The left side shoulder for four lane urban expressways with median barrier shall be 4’ to the face of barrier and 8’ to the face of barrier for six lane urban expressways.

Where roadside barriers are used such as guardrail, concrete barrier, or bridge rail, the right side shoulder should include an additional 2 foot shy distance from the shoulder to face of barrier.

Expressways can be physical barriers to well-connected bicycle route systems. As a result, when expressways run through urban areas, bicycles may need to use the expressway route as a connection to a destination if other routes are too far away. On higher speed expressways that resemble freeways, a separated facility or a viable parallel street are options to accommodate bicyclists. If there is not an acceptable parallel street system available, a bicycle facility should be included with expressways. Bike lanes adjacent to travel lanes are not appropriate on higher speed expressways due to large differentials in anticipated speed between motor vehicles and bicycles. In addition, when a shoulder is designated as a bike lane, it cannot serve disabled vehicles or other activities appropriate for shoulder use. A separated path that serves the same destinations as the expressway should be provided. Providing enough width is allocated, a two-way path is appropriate for an expressway because access is restricted thereby reducing conflicts with cross traffic or access.

Design for Bicycle accommodation along expressways can be challenging. However, *ORS 366.514* requires that ODOT, cities and counties provide walkways and/or bikeways wherever a highway, road or street is being constructed, reconstructed, or relocated. They are not required if:

1. Sparsity of population or other factors indicate an absence of any need;
2. Costs are excessively disproportionate to need or probable use; or
3. Where public safety is compromised.

However, the greatest need for walking and bicycling facilities is on urban highways. The designer should provide that accommodation as required, and seek an exemption only where it is obvious that one of the three above exceptions applies. In most situations the shoulder of a lower speed urban expressway with at-grade street connections can accommodate bicycle traffic if no other option is available. However, bicycle traffic is be better accommodated on a separated facility or a multi-use path that also provides pedestrian access. Right turn channelization located with at-grade intersections on expressways can pose challenges for through bicyclists. How to best accommodate bicycle traffic along expressways should be handled on a case by case basis and will depend on balancing the needs and expectations of the various users of the roadway. For more information on multi-use paths and other bicycle accommodation methods, refer to the Oregon Bicycle and Pedestrian Guide.

310.12 4R Urban Expressway Medians

Expressways must include a median treatment. Generally, the preferred design is to use a non-traversable type of median. Non-traversable medians are required on all new, multi-lane urban or rural expressways on new alignment. All other existing urban expressways should consider construction of a non-traversable median when projects are developed along these highways.

Modernization of all rural, multi-lane Expressways, including Statewide (NHS), Regional and District level roadways require non-traversable medians.

For access management purposes, the preferred median type for urban expressways is a raised curb median. When mitigation for lane departure or median cross-over crashes is a design condition, then a barrier type non-traversable median should be installed. If an urban expressway is also a freeway and the width between opposing travel lanes is 100 feet or less, then a barrier type non-traversable median must be installed. Guidance for Freeway Median Barrier Warrant and the closing of freeway medians can be found in Part 400.

At single left turn lane locations with a raised curb median, the raised portion should be a minimum of 12 feet wide (curb face to curb face) with two 4 foot left side (inside) shoulders (one for each direction of travel). This provides an overall travel lane to travel lane width of 20 feet. Consideration of double left turn lanes may be needed for high volume expressways with appropriate intersection spacing. With 4 foot inside shoulders, the overall median width for double left turn lanes would be 32 feet travel lane to travel lane.

Figure 300-20: Expressway Median Widths and Dual Left Turn Lanes

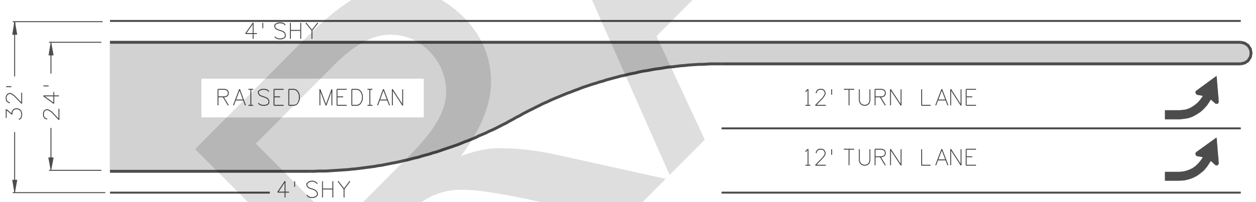
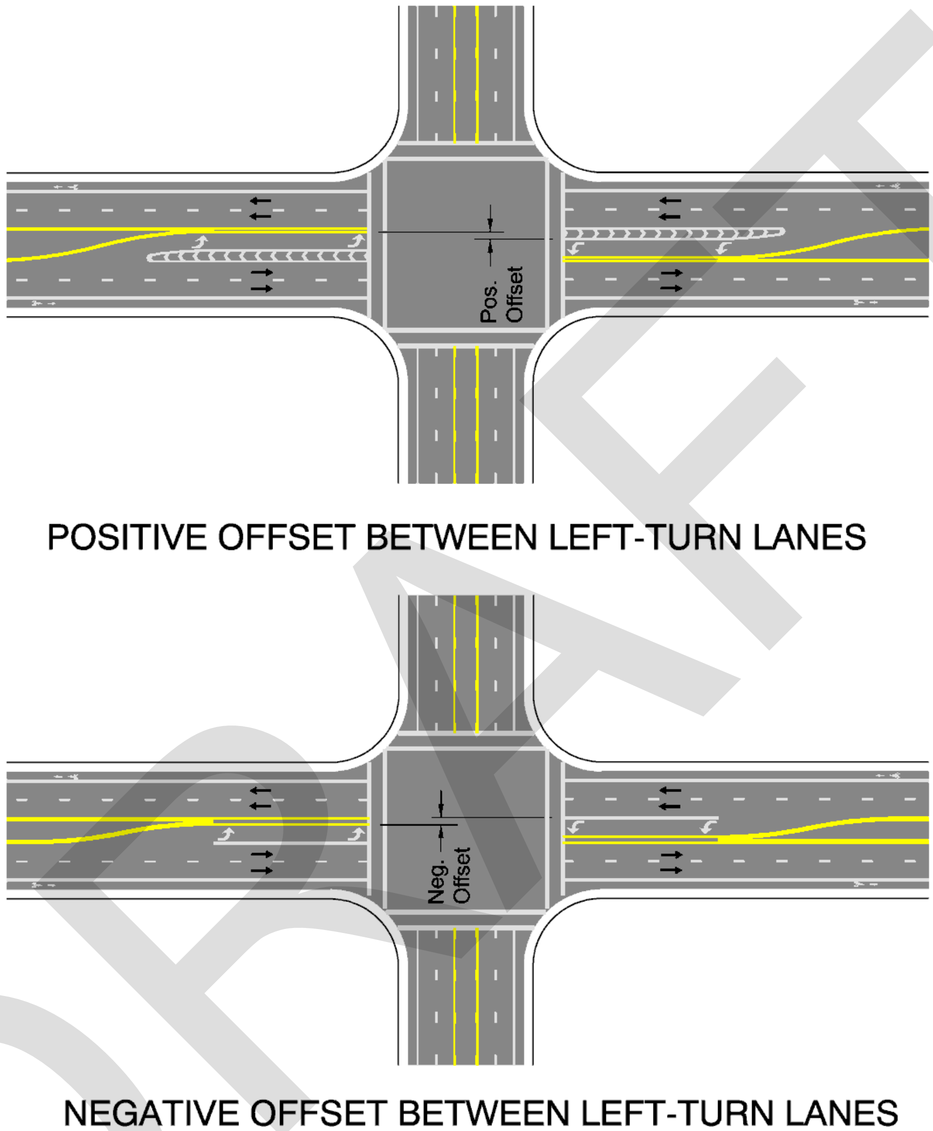


Figure 300-20 shows the different element widths for a double left turn. Even where only single left turn lanes are needed, the 32 foot width allows for future widening and also provides a positive off-set to oncoming traffic. To make a safe left turn, sight distance is important to a driver in order to see and identify an acceptable gap in oncoming traffic. A positive offset from the opposing left turn lane can increase sight distance for a left turning driver and is most applicable at signalized intersections operating as permissive or permissive/protected left turn movements. Depending on traffic volumes and queuing, a positive offset may aid left turning drivers at some unsignalized intersections as well. Negative offset can be a greater hindrance to left turning drivers as their line of site may be blocked by vehicles waiting to turn left from the opposing left turn lane. (See Figure 300-21 for more information on opposing left turn movements and positive/negative offsets).

Since expressways are, from a functional classification perspective, a higher order facility, the left side shoulder should be held to a higher standard than the normal shy distance for other urban arterials. Where extensive right of way is available, a depressed median could be used. However, depressed medians will generally not be an option within urban environments. Both the raised curb and depressed median options should be considered first as they offer the greatest design flexibility. In areas with right of way restrictions, a concrete barrier should be considered. The concrete barrier is 2 feet wide at the base and requires a 4 foot left side shoulder. Concrete barriers should be avoided in areas where pedestrian crossings or at-grade median openings may be expected. Openings in concrete barriers present many design challenges including reduced sight distance and the need for impact attenuators, although attenuators are designed for safer impact when protecting a blunt end, it is another object that could potentially be hit causing vehicle damage and increased maintenance cost. Where ever a raised median or concrete barrier is being considered for installation where it did not exist previously, considerations of access management criteria and freight mobility must be followed. On some expressways, those with a design speed equal to 45 mph, a minimum 10 foot painted median could be used. However, painted medians are not desirable on expressways and are strongly discouraged. Additional information about median design can be found in Section 308 Median Design.

Figure 300-21: Positive and Negative Offset



310.13 ODOT 4R Urban Expressways and Pedestrians

Design for and accommodation of pedestrians along expressways is accomplished on a case by case basis. On those expressways that look and function closer to a freeway, pedestrians generally are not accommodated adjacent to the roadway. For these types of expressways, pedestrian movements are better accommodated on parallel local roads and streets, if there is an appropriate parallel street system available. In some instances, a separate multi-use path may be constructed along expressways as the appropriate alternative. Where multi-use paths are used they should be a minimum of 10 feet wide. Where a multi-use path is parallel and adjacent to a roadway, there should be a 5 foot or greater width separating the path from the edge of roadway.

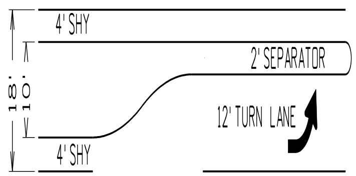
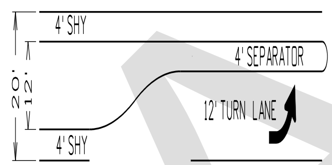
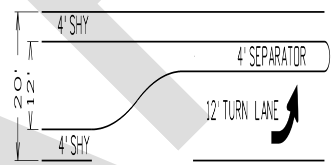
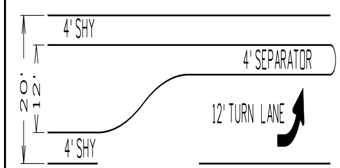
On some lower speed expressways, or along expressways in highly urbanized areas, pedestrians may be accommodated adjacent to the roadway. The preferred method is a sidewalk and buffer strip. The buffer strip should be at least 8 feet, but may be as low as 4 feet under constrained conditions. Sidewalks separated by a buffer strip should be at least 6 feet wide. Curbside sidewalks should be avoided along expressways. Part 900 and the Oregon Bicycle and Pedestrian Design Guide provide additional guidance to the design of pedestrian facilities in these areas.

In all instances, since expressways are designed for mobility rather than access, pedestrian crossings need to occur at signalized intersections or with grade-separation. Pedestrian activated crossings at uncontrolled locations are not appropriate on urban expressways and require special approvals for installation.

310.14 ODOT 4R Urban Expressway Typical Section

As established previously in Part 200 and in Part 300, Section 311, urban expressways can be categorized in two ways for design criteria purposes – those with interchanges and those with at-grade intersections. Most expressways, including many urban expressways, have posted speeds of 45 mph or greater. For urban expressways with at-grade intersections that fit with one of the urban contexts defined in Part 200 and have a posted speed less than 45 mph, use design criteria from sections 205 through 211 as well as sections 306 and 307. Table 300-26 provides 4R design guidance for urban expressway cross sectional elements for urban expressways with posted speeds of 45 mph or greater. The 4R cross section elements listed below are to be used on all 4R urban expressway projects with interchanges and urban expressways with at-grade intersections and a posted speed of 45 mph or greater.

Table 300-26: ODOT 4R/New Urban Standards – Expressways (Posted 45 mph or greater)

Design Elements	Design Speed			
	45 mph [1]	50 mph	55 mph	60 - 70 mph
Travel Lane	12′	12′	12′	12′
Right Turn Lane	12′ plus shoulder [2]	12′ plus shoulder [2]	12′ plus shoulder [2]	12′ plus shoulder [2]
Left Turn Lane				
Right Side Shoulder	8′	8′	8′	8′
Median Striped Median Raised Curb Median [3] Conc. Barrier Median	10′ 18′ Travel lane to travel lane 10′ (4 lane) 18′ (6 lane)	10′ 20′ Travel lane to travel lane 10′ (4 lane) 18′ (6 lane)	10′ 20′ Travel lane to travel lane 10′ (4 lane) 18′ (6 lane)	10′ 20′ Travel lane to travel lane 10′ (4 lane) 18′ (6 lane)
Continuous Left Turn Lane	N/A [4]	N/A [4]	N/A [4]	N/A [4]
Max. Superelevation [5]	6%	6%	6%	See Table 200-10
Max. Degree of Curvature	8°	6°45′	5°15′	See Table 200-10
Maximum Grade	6%	6%	5%	5%

Design Elements	Design Speed			
	45 mph [1]	50 mph	55 mph	60 - 70 mph
Bicycle Facility	Undesignated – Shoulder Designated - Separated Path or Parallel Streets			
Curbside Sidewalk	8′	Undesirable [6]	Undesirable [6]	Undesirable [6]
Separated Sidewalk	6′ [7]	6′ [7]	6′ [7]	6′ [7]
On-street Parking	N/A [8]	N/A [8]	N/A [8]	N/A [8]
Vertical Clearance	See Section 316			

[1] The 45 mph design speed should generally only apply to retrofit situations.

[2] Shoulder on curbed and uncurbed sections shall be 3 feet and 4 feet respectively

[3] Minimum raised curb median. Consideration of 6′ raised traffic separator for pedestrian crossing may increase median width.

[4] Continuous turn lanes are not allowed on expressways with interchanges.

[5] Superelevation at intersections may need modification; see Chapter 8.

[6] Curbside sidewalks are discouraged when design speed is greater than 45 mph.

[7] Pedestrians are not normally accommodated adjacent to expressways. Where separated sidewalks are used, a minimum 8 foot buffer strip should be provided.

[8] On-street parking is not allowed on expressways.

310.15 ODOT 4R Rural Expressway Shoulders

Rural expressways must have an adequate shoulder for emergency parking, disabled vehicles, and emergency response vehicles. The shoulder also provides significant safety benefits to motorists and bicyclists, as well as improving traffic flow and capacity. Rural expressways will typically have an 8 foot right hand shoulder for most design speeds on 4 lane facilities. The left side shoulder for rural four lane separated rural expressways shall be 4 feet. Separated rural expressways with more than two lanes in each direction shall have a 6 foot left side shoulder for a design speed of 50mph and 8 feet for 60 or 70 mph design speeds (See Part 900, Section 971). For four lane rural expressways with median barrier, the left shoulder shall be 4' to the face of barrier. For six lane rural expressways with median barrier, the left shoulder shall be 8' to the face of barrier for a 50 mph design speed and 10' to the face of barrier for a 60 mph or greater design speed.

In addition to the standard shoulder width, where roadside barriers are used (guardrail, concrete barrier, or bridge rail), the right side shoulder shall include an additional 2 foot "E" or shy distance from the face of barrier. On rural four lane expressways, left side shy distance is not required.

In most situations the shoulder can also accommodate bicycle traffic. In some situations, a shared-use path may better accommodate bicycle traffic. On access controlled facilities, a separated path for shared bicycle and pedestrian use is optimal. Refer to Part 900, Section 971 and the Oregon Bicycle and Pedestrian Design Guide (attached as Appendix L) for additional information on multi-use paths.

310.16 4R Rural Expressway Medians

Note: The addition of any median treatment will need to be investigated for freight mobility issues and comply with ORS 366.215, Creation of state highways; reduction of vehicle-carrying capacity. For guidance in complying with ORS 366.215, see ODOT guidance document Guidelines for Implementation of ORS 366.215, No Reduction of Vehicle-Carrying Capacity and the ODOT Highway Mobility Operations Manual.

Rural multi-lane expressways shall include some type of median treatment. This median could be a variety of types, such as depressed median, raised curb, or concrete barrier. For more information regarding types of median treatments refer to Section 308. The median should be a non-traversable type; however, in some situations a painted median is acceptable as in the case of at-grade intersections. The 1999 Oregon Highway Plan requires the construction of a non-traversable median for:

1. All new multi-lane highways constructed on completely new alignment; and

2. Modernization of all rural, multi-lane expressways, including Statewide (NHS), Regional, and District.

In rural developed areas such as rural communities and centers where left turn movements are necessary and would be allowed, the preferred median type is a raised curb median consisting of a 12 foot raised median (curb to curb). This would also require two 4 foot inside shoulders for an overall median width of 20 feet (travel lane to travel lane). Consideration of double left turn lanes on at-grade intersections on expressways should be given, resulting in a 24 foot raised island. The required two 4 foot inside shoulders would result in an overall median width of 32 feet (travel lane to travel lane).

For multi-lane expressways in most rural environments, a depressed median similar to freeways is the preferred median treatment. The depressed median allows flexibility on running independent grades, while providing a larger separation between travel directions. This type of median treatment should generally be used on rural multi-lane expressways, particularly where right of way is available. A 76 foot or wider (travel lane to travel lane) median is desirable for depressed medians on rural expressways. However, narrower medians could still be considered if adequate separation, proper side slopes, and drainage can be accommodated. Typically a median width of at least 46 feet is necessary to provide the necessary design features. Where the width is to be 60 feet or less, the median should be closed with concrete barrier or cable barrier to prevent crossover crashes. As mentioned above, raised curb is generally only appropriate near rural development centers.

The median width necessary for a concrete barrier is shown in Table 300-26. The minimum median width for a four lane facility is 10 feet (2 foot barrier and 4 foot shoulders). On six lane facilities, an additional 2 ft shy distance on each side of the barrier is required to account for the increased probability that the shoulder will be used for emergency parking. Wherever concrete median barrier is used, carefully consider appropriate end treatments. These could include attenuators, or transitions to other median types such as depressed or raised curb.

Not all expressways, particularly rural sections, will be multi-lane facilities. On two lane rural expressways, a controlled median is not required. A non-traversable median on a two lane expressway should generally be discouraged except at critical locations such as interchanges, access points, or at-grade intersections median treatments may be used as appropriate for access control.

Where a painted traversable median is acceptable in rural areas, the median width shall be a minimum of 14 feet for design speeds of 50 to 55 mph and 16 feet for a design speed of 60 mph or greater. Use of a 14 foot and 16 foot median should be in conjunction with access control measures to ensure that the median is not used as a continuous turn lane. The use of continuous two way left turn lanes (CTWLTL) on rural expressways is discouraged and should only be considered if other alternatives are not feasible. Left turn channelization may be provided at intersections only.

310.17 ODOT 1R Urban and Rural Expressway Resurfacing

The ODOT 1-R project category has direct correlation to the ODOT Practical Design Policy and design flexibility. The primary intent of a 1R project is to preserve the existing pavement before it deteriorates to a condition where extensive reconstruction would be necessary in order to rehabilitate the roadway section. Projects under the 1R category consist primarily of paving the existing roadway surface and generally deferring other improvements to future 4R, 3R, specific safety, or single function projects. When project programming and funding are being determined, the ODOT Practical Design Policy and design flexibility can be employed in deciding if a particular preservation project should be in the 1R category or if there is enough value being added to the highway system or corridor for the additional cost if the project is placed in the 3R category that would trigger additional improvements. Safety considerations outlined in the 1R guidance should also be part of the process in determining the appropriateness of a project being selected for 1R.

The ODOT 1R project standard will apply to Preservation projects that are limited to a single lift non-structural overlay or inlay. Many of the safety items that have traditionally been addressed in 3R projects can be more effectively dealt with in a statewide strategic program. For example, establishing a prioritized program for upgrading guardrail to current standards along a highway corridor instead of upgrading between specific project limits. A program of this nature has the ability to better utilize funding to target higher need locations for safety item improvements rather than only making safety item improvements based on paving projects. However, the replacement of safety items such as guardrail, guardrail terminals, concrete barrier, impact attenuators, and signs may be included in the 1R project category when necessary if funding other than Preservation funds are used and the added work will not delay the scheduled bid date. Any safety features that are impacted by the proposed resurfacing must be adjusted or replaced by the 1R project. Existing safety features cannot be degraded to a level below the existing condition as a result of the paving project.

310.18 Urban and Rural Expressway 1R Resurfacing Standards

These are projects that extend the pavement life of existing highways. Missing ADA ramps must be installed and ADA ramps that do not meet the 1991 standard must be upgraded to the current standard on all 1R projects except chip seals. Other safety enhancements are not required to be included; however, safety features may be added to 1R projects where other (non-preservation) funding is available. Any existing safety features that are impacted by the proposed resurfacing must be adjusted or replaced, thus necessitating some work in addition to paving. Also, since 1R projects will generally not address safety, pedestrian and/or bicycle concerns, in no case shall safety, pedestrian and/or bicycle conditions (ramp terminals) be degraded. Also, on facilities where the 1R standard is applied, it is intended that all safety features be inventoried and the applicable safety feature information is added to designated safety feature databases, and that the safety feature is addressed based on system priorities in standalone projects or other STIP projects. When scoping 1R projects, the safety feature databases are used to identify opportunities to add safety enhancements with other (non-preservation) funding. Following is an outline for the ODOT Resurfacing 1R project standard. While the criteria primarily relate to the paving treatment and the ability to pave without degrading existing conditions, there may be corridors where analysis of the crash history indicates that a full 3R project is warranted. Therefore projects are screened for 1R eligibility from a safety perspective as well.

♦ Scoping Requirements

In order to ensure the intent of the program is met in addressing pavement and safety needs, adequate advance information is needed to assure adequate statewide decisions are made with consistency.

1. **1R/3R Record of Decision Form**
    a. This form steps the scoping team through the scoping process. Parts of the form are filled out by different sections including: Pavements, Traffic, and Roadway.
    b. Use of this form provides a statewide uniform approach to determining the project design standard – 1R vs 3R – that will be applied to a pavement preservation project.
2. **Urban Design Concurrence Document (Draft)** – For Urban Expressway projects using context based design under 45 mph.

    This document identifies the project context and is used by the scoping team to provide a concept design and provide documentation of decisions leading to that design. The Draft Urban Design Decision document is part of the final scoping package for project initiation
3. **Urban Design Concurrence Memo** - or Urban Expressway projects using context based design under 45 mph.

    There may be a small number of urban projects with scope too limited and outside the roadway that an Urban Design Concurrence document may not be necessary. Projects that could meet the criteria are ITS projects installing cable, a bridge screening project that does not impact the roadway or similar type projects. The primary focus of the work is outside the roadway and peripheral to it. For these types of projects, an Urban

Design Concurrence Exemption Memo is required and, if granted, takes the place of the Urban Design Concurrence document.

♦ Project Initiation Requirements

1. At project initiation, the 1R/3R Record of Decision Form must be reviewed and validated to ensure the project will be developed under the appropriate design standard.
2. For urban expressway projects using context based design and under 45 mph, the project development team reviews the Draft Urban Design Concurrence (UDC) document to understand the decisions made by the project scoping team and to verify the conditions, decisions and concept are still appropriate to meet project goals and outcomes. Existing conditions may have changed between scoping and project initiation. If changes are needed, the project development team modifies the Draft UDC to meet project goals and/or planning needs. The Draft UDC is further developed as project development continues and is reviewed again at each project milestone to ensure the final design meets the scoping expectations, goals, aspirations and outcomes for the project.
3. For urban expressway projects using context based design and under 45 mph, if the scoping team determined an Urban Design Concurrence document isn't needed and obtains an Urban Design Concurrence Exemption Memo, the project development team reviews the project scope to determine the exemption memo is still appropriate for the project scope. At any time during project development, if the scope of the project changes to include work impacting the roadway, the project development team is required to complete the Urban Design Concurrence document for submittal at the Design Acceptance phase.

♦ 1R Project Requirements

1. A paving project is initially designated 1R based on the appropriate paving treatment – a single lift overlay or inlay. (There is no formal requirement for pavement design life for an individual project; however, since the 1R treatment is location specific, it is expected that an 8 year pavement life will be the goal of the program).
   a. Pavement Services is the final authority regarding the pavement design.
2. Where less than approximately 5% of a project (based on lane miles paved) includes more than a single lift non-structural overlay or inlay, the project may be designated 1R.

3. Where up to approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project may be designated 1R; however, this requires the approval of a design exception.
4. Where more than approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project must be designated 3R
   a. As an exception to this is rule, a grind and inlay plus an overlay may also be considered for development under the 1R standard; however, this would be uncommon and requires the approval of a design exception.
5. Where the appropriate course of action is not clear based on the percentages noted above, include Technical Services Roadway staff in the discussion.
6. Chip seals are 1R projects and subject to the requirements of the 1R standard. Chip seals do not require ADA work.

♦ Unprotected and Unconnected Bridge Ends

1. On 1R paving projects, any bridge rail with unprotected ends or unconnected transitions exposed to traffic must be mitigated. Provide an end treatment meeting the current standard, or a design exception must be obtained.
2. Unprotected ends – Where the end of the bridge rail is exposed with no end treatment such as a transition to guardrail or a crash cushion.
3. Unconnected transition – Where there is no crashworthy transition between the end of the bridge rail to the guardrail or other barrier.
4. For possible funding options, contact the Senior Roadway / Roadside Design Engineer in the Technical Services Traffic-Roadway Section.

♦ ADA Requirements for 1R Projects

All projects that include resurfacing (except for chip seals) shall install or upgrade curb ramps where applicable.

♦ Responsibilities

1. 1R/3R form filled out by Pavements staff, Region Roadway and Traffic Staff. There are approval signatures by the Pavements Engineer, Region Roadway Manager & Traffic Manger. It will be the Project Leaders role to coordinate. Form is housed in ProjectWise.

2. Final Urban Design Concurrence document is completed and approved by the Region Technical Center Manager, with concurrence from the Region Maintenance, Traffic and Roadway units. The final UDC is part of the Design Acceptance Package submittal. It is the Project Leaders role to ensure the final UDC is submitted.

310.19 ODOT Single Function (SF) Urban and Rural Expressway Standards

The specific design standards used for a Single Function Standard project will generally be the same design standards used for a 4R/New Construction project. The difference is that the scope of work is very limited on SF projects, so the SF Standard does not require addressing non-related non-standard features of the roadway. For example, if a guardrail upgrade qualifies as a Single Function project, it will not be necessary to address other non-standard features on the roadway, such as lane and shoulder width, horizontal and vertical alignment, etc.

♦ Application of Single Function (SF) Project Standards

Single Function projects include projects that are within the right of way but do not permanently impact the travel lanes or shoulders of the highway. Generally, projects that only include work outside the edge of pavement will qualify for the SF standard. The SF standard can also be applied to certain maintenance projects such as re-striping projects as long as the final configuration of the travel lanes and shoulders would not be changed in any way. These projects address a specific need. The scope of work is limited to features that are directly impacted as a result of addressing the specific need. For example, an urban freeway or rural expressway overlay project may impact drainage inlet adjustment. In no case shall safety, operations, pedestrian and/or bicycle conditions (ramp terminals) be degraded as a result of a SF project. Each feature constructed in a SF project must be built to the applicable standard for new construction. The SF Standard does not apply to resurfacing projects.

Section 311 Rural Arterials/Collectors/Local Routes

311.1 Typical Section and Design Elements

This section provides 3R, 4R, 1R, and Single Function typical section and design guidance for rural arterials, collectors, and local routes. As outlined in Part 200, arterials, make up a large percentage of the state highway mileage and cover a wide range of geographical and topographical conditions. As Part 200 provided the geometric requirements such as vertical and horizontal curvature, vertical clearance, sight distance, and grades, this section focuses on the cross sections elements such as; lane width, shoulder width, cross slope, vertical clearance, roadside design, clear zone, median design, and other cross sectional features for rural arterials, collectors, and local routes.

311.2 ODOT 3R Rural Arterials, Collectors, and Local Routes Typical Section

This section discusses the appropriate 3R design standards for rural non-freeway highway projects and is applicable to arterials, collectors, and local streets. In general the intent of 3R projects is pavement preservation with additional focus on safety items. Some of those safety items include mandatory 3R design features such as ADA curb ramps and deficient guardrail, consideration of low-cost safety mitigation measures. Table 300-27 below provides the cross section minimums for rural arterials. Table 300-28 provides the mandatory 3R design features and Table 300-29 provides the low-cost safety mitigation measures

311.3 ODOT 3R Rural Arterial, Collector, and Local Route Roadway Widths

See Table 300-27 for minimum 3R roadway widths.

Table 300-27: Minimum 3R Lane and Shoulder Widths Rural Non-Freeway
(Arterials, Collectors, Local Streets)

Design Yr Volume (ADT)	Average Running Speed	Lane Width	Shoulder Width
Less Than 750 Vehicles	All Speeds	10′	2′
750 to 2000 Vehicles	Under 50 mph	11′	2′
	50 mph or Over	11′	3′
Over 2000 Vehicles	All Speeds	11′	4′

NOTE: A minimum 11 foot lane is required on all NHS Routes on ODOT jurisdiction roadways only. Local Agencies may use AASHTO standards for lane width on Local Agency jurisdiction roads.

311.4 Mandatory 3R Rural Arterial, Collector, and Local Route Design Features

Following is a list of mandatory design elements that must be incorporated with 3R projects:

Table 300-28: Mandatory Design Features

Geometric Deficiency	Mandatory Corrective Measure
ADA/Sidewalk Ramps	Ramps shall be added where absent and upgraded where deficient*.
Narrow Bridges/Deficient Rails	See BDM.
Guardrail	Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard. Provide transitions at unconnected bridge ends. Install protection at unprotected bridge ends Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less. Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less.

	Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection.
Concrete Barrier	Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard. Pre-350 concrete barrier with earth support behind the barrier may remain in service. All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.

* See Part 800.

311.5 Low-Cost Safety Mitigation Measures

Table 300-29 is a list of low cost safety measures that should be considered on all 3R projects. They can also be used as mitigation in justification for design exceptions.

Table 300-29: Low-Cost Safety Measures

	Low-Cost Safety Measure
Narrow Lanes and/or Shoulders	Pavement edge lines Raised pavement markers Post delineators Rumble strips Safety Edge
Steep Sideslopes/Roadside Obstacles	Roadside hazard markings Round ditches Install guardrail Remove or relocate obstacle Slope flattening Breakaway hardware Rumble Strips
Narrow Bridges/Deficient Rails	Install supplementary signing Hazard and pavement markings
Sharp Horizontal Curve	Install supplementary signing Shoulder widening

	Low-Cost Safety Measure
	Shoulder paving Lane Widening Correct superelevation Gradual sideslopes Pavement antiskid treatment Obstacle removal or shielding Raised Pavement Markers Install post delineators Rumble Strips
Poor Sight Distance At Hill Crest	Install supplementary signing Fixed-hazard removal Shoulder widening Driveway relocation Illumination
Intersections	Install supplementary signing Illumination Pavement antiskid treatment Speed control

311.6 4R Rural Arterial, Collector, and Local Routes Medians

All multi-lane rural highways shall include a median. The preferred design for these types of highways is a non-traversable type of median. A non-traversable median may consist of a wide depressed median (similar to expressways), a raised mountable curb, cable barrier, or a concrete barrier. Of these, the concrete barrier should be avoided due to the difficulty of providing at-grade intersections that are common to rural highways. Both the depressed and raised curb medians can be easily and safely transitioned to provide turning and crossing opportunities. In some situations, a painted median may be acceptable. If there is a history of crossover crashes, low cost mitigation such as rumble strips should be applied, and consideration may be given to closing the median with concrete barrier or cable barrier if practical.

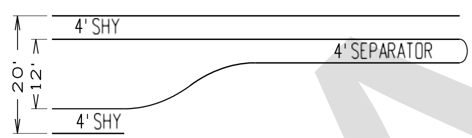
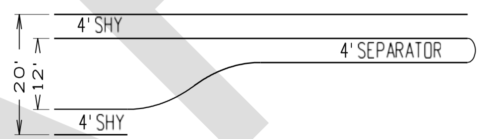
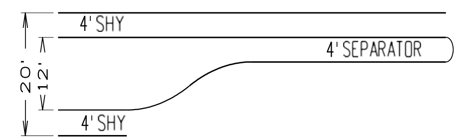
1. Non-traversable medians must be constructed for:
    a. All new multi-lane highways constructed on completely new alignment; and
    b. Modernization of all rural multi-lane expressways.

2. Non-traversable medians should be considered for:
    a. All multi-lane highways undergoing 3R or 4R improvements; and
    b. Highways not undergoing modernization where a median would improve safety.

Median openings must conform to the Access Spacing Standards contained OAR 734 Division 51. Where median openings in a non-traversable median are allowed, intersection sight distance should be provided from the intersection. This may require modification of the median design, or providing a median opening wide enough to ensure proper sight distance. The minimum median width is dependent upon the design speed of the highway. Figure 300-22 contains the standard median widths.

Where painted medians are acceptable, they should be a minimum of 8 feet on rural arterials. Rural collectors and rural local roads may have narrower medians. Painted medians must be clearly striped so as not to be confused with continuous two way left turn lanes (CTWLTL). CTWLTLs should be avoided in most rural environments. Short sections may be needed in some rural communities or where closely spaced accesses require it. Figure 300-22 provides standard details for median width, shoulder widths, slopes, and ditch widths.

Table 300-30 ODOT 4R/New Expressway Standards - Rural Expressway

Design Elements	Design Speed		
	50 mph	60 mph	70 mph
Terrain	Mountainous	Rolling/Flat	Flat
Travel Lane	12′	12′	12′
Right Turn Lane	12′ plus shoulder [1]	12′ plus shoulder [1]	12′ plus shoulder [1]
Left Turn Lane			
Right Side Shoulder	8′ (4 lane) 10′ (6 lane)	8′ (4 lane) 10′ (6 lane)	8′ (4 lane) 10′ (6 lane)
Left Side Shoulder	4′ (4 lane) 6′ (6 lane)	4′ (4 lane) 8′ (6 lane)	4′ (4 lane) 8′ (6 lane)
Median Striped Median Raised Curb Median[2] Concrete Barrier Median	14′ Minimum 20′ Travel lane to travel lane 10′ (4 lane) 18′ (6 lane)	16′ Minimum 20′ Travel lane to travel lane 10′ (4 lane) 22′ (6 lane, includes 2′ shy)	16′ Minimum 20′ Travel lane to travel lane 10′ (4 lane) 22′ (6 lane, includes 2′ shy)
Continuous Left Turn Lane	N/A [3]	N/A [3]	N/A [3]
Maximum Superelevation [4]	See Table 200-10	See Table 200-10	See Table 200-10
Maximum Degree of Curvature	8° 00′	5° 00′	3° 15′
Maximum Grade	6%	4%	3%
On-street Parking	N/A [5]	N/A [5]	N/A [5]
Vertical Clearance	See Section 316		

[1] The minimum shoulder on curbed and uncurbed sections is 3 feet and 4 feet respectively; 5 feet is required on curbed sections where no through bike lane is provided.

[2] Minimum raised curb median. Consideration of 6′ raised traffic separator for pedestrian crossing may increase median width.

[3] Continuous turn lanes are not allowed on expressways

[4] Superelevation at intersections may need modification, see Part 500 Superelevation rate used from Standard Superelevation Table 200-10, which is based on open road conditions.

[5] On-street parking is not allowed on expressways.

311.7 ODOT 3R Rural Arterial, Collector, and Local Route Bridge Width

A decision must be made to retain, widen or replace any bridge within the limits of a 3R project. Widening versus replacement should be evaluated to determine the most cost-effective treatment. Consider the AASHTO Green Book standards for bridges to remain in place, and Table 300-31, whichever is less, for minimum width. Additionally, analysis of the crash history and the cost of widening is required when determining if widening is cost effective. If the decision is made to replace an existing structure, new construction standards will apply to the bridge replacement portion of the project only, not to the roadway portion. Replacing structures does not change the remainder of a 3R Project to 4R.

When a decision is made to retain a bridge, evaluate the bridge rail to determine if it can adequately contain and redirect vehicles without snagging, penetrating or vaulting. Upgrade structurally inadequate or functionally obsolete bridge rail. Consideration may be given to design standard exceptions for railing upgrades, roadway widths, etc., when the structure is listed in or determined eligible for the National Register of Historic Places. Evaluate the bridge rail design for pedestrian needs and provide a design that accommodates pedestrians as necessary. If the clear roadway width on the structure is less than the approach roadway width, install appropriate traffic control devices.

Table 300-31: Minimum Useable Bridge Widths

Design Year Volume (ADT)	Useable Bridge Width
0 – 750	Width of approach lanes
751 – 2000	Width of approach lanes, plus 2 feet

2001 – 4000	Width of approach lanes, plus 4 feet
Over 4000	Width of approach lanes, plus 6 feet

311.8 ODOT 4R Rural Arterials, Collectors, and Local Routes Typical Section

Table 300-32 provides the cross section element guidance for all rural arterials, collectors, and local routes. Where discrepancies exist between the classifications assigned, the higher classification is used. Some rural highways with less than 5000 ADT are classified as rural arterials, yet go through small cities with a posted speed of 25 to 30 mph. In these locations, the use of the urban context standards in Sections 311 through 316 may be appropriate and careful consideration must be given to the transition from a high to low speed environment.

Table 300-32: ODOT 4R/New Rural Arterial Design Standards

ODOT Standards for New/Reconstruction Projects

For Non-Freeway **RURAL** Functional Classifications Including Arterials, Collectors and Local Classifications

Design Feature	**Functional Class**																	
	Two Lane														**Four Lane**			
	ADT under 400			**ADT 400 - 1500**			**ADT 1500 - 2000**				**ADT over 2000**				**DHV over 700**			
Design Speed (mph)	60	50	45	60	55	45	70	60	55	50	70	60	55	50	70	60	55	50
Width of Traveled Way (ft.)																		
Rural Arterials	24	22	22	24	24	22	24	24	24	22	24	24	24	24	2 X 24			
Rural Collectors	22	20	20	22	22	22	24	24	24	22	24	24	24	24	2 X 24			
Rural Local Routes	22	20	18	22	22	22	24	24	24	22	24	24	24	24	2 X 24			
Shoulder Width (ft.)																		
Rural Arterials	4	4	4	6	6	6	6	6	6	6	8	8	8	8	8	8	8	8
Rural Collector	2	2	2	5	5	5	6	6	6	6	8	8	8	8	8	8	8	8
Rural Local Routes	2	2	2	5	5	5	6	6	6	6	8	8	8	8	8	8	8	8
Recommended Max Grades (%)																		
Rural Arterials	3	5 (6)[a]	6 (8)[a]	3	4	6	3	4	4	6	3	4	4	6	3	4	4	6
Rural Collector / Local	5	6 (8)[a]	6 (9)[a]	4	6	6	4	5	5	6	4	5	5	6	4	5	5	6
	[a] Recommended Maximum Grades for ADT under 250																	
Maximum Degree of Curvature	5°	8°15′	10°30′	5°	6°30′	10°30′	3°15′	5°	6°30′	8°15′	3°15′	5°	6°30′	8°15′	3°15′	5°	6°30′	8°15′
Stopping Sight Distance (ft.)	570	425	360	570	495	360	730	570	495	425	730	570	495	425	730	570	495	425

Passing Sight Distance	-------------------------- As Available -------------------------------------- 1200 ft for 70 mph or less --
Surface Type	--- As determined by Pavements Engineer ---
Type of Shoulder Surface	-- Same as Traveled Way --
Width of Structures	------------ Width of future approach roadway and shoulders, as determined above plus offset to barrier, where applicable --------------
Width of Major Long Span Bridges	-- Special study may be required --
Vertical Clearance	--- See Section 316 --
Loading	-- Design Loading – HS 25 Design Truck or HL-93 Vehicular Loading --

Climbing or Passing Lanes shall be considered where combinations of horizontal and vertical alignment prevent passing opportunities. Passing lanes, use 2’ median when 3 or 4 lane sections result. Climbing lanes, use 2’ median in 4 lane section only. Desirable shoulder width is 6’ (minimum 4’). If the roadway has substantial bike use, consult the ODOT Bicycle-Pedestrian Program Manager for input.

Four lane construction standards should be utilized wherever the traffic is likely to approach or exceed capacity. Refer to median table in Figure 300-22 for four lane median width.

Where roadside barriers are used, increase the shoulder width by 2’ to provide barrier clearance and lateral support. (See Section 319.1 “roadside barriers” and Std. Drg. RD420 or RD425).

To convert ADT’s and DHV’s, contact Transportation Planning Analysis Unit or Region Traffic Unit.

Figure 300-22 Standard Sections for Highways Other Than Freeways

STANDARD SECTIONS FOR HIGHWAYS OTHER THAN FREEWAYS

TABLE "A"

SHOULDERS (Also See TABLE 7-2)

MINIMUM SHOULDER WIDTHS (ft.)			
Current Traffic	Local	Collector	Arterials
ADT under 400	2	2	4
ADT 400 - 1500	5	5	6
ADT 1500 - 2000	6	6	6
ADT over 2000	8	8	8
DHV over over 200 (4 LANES)	8	8	8

NOTES:
1. Min. 6' Shoulder For Urban Arterial When Barrier Curb Is Used.
2. Where roadside barriers are used, the shoulder width shall be increased by 2 feet to provide barrier clearance and lateral support. (See ODOT Standard Drawings)

TABLE "B"

SURFACING ROCK SLOPES AND DITCH WIDTHS

Shoulder Width (ft.)	Max. Surf. Rock Slope and Ditch Slope (when used)	Ditch Width (when used) (ft.)
10	1:6	3
8	1:6	3
6	1:4	2
4	1:4	2
2	1:3	1½

TABLE "C"

SIDE SLOPES (CUT & FILL) (ft.)

ADT below 1500	0 - 6 6 - 8 8 - 12 over 12	Max 1:4 1:3 1:2 1:½ (See 1)
ADT 1500 AND OVER	0 - 5 5 - 10 10 - 15 over 15	Max 1:6 1:4 1:3 1:2

The above slopes are a guide. Flatter slopes to be used where additional cost is minor. In solid rock, slopes are to be determined by type of material and approved by the State Traffic-Roadway Engineer. Also check clear zone standards.

TABLE "D"

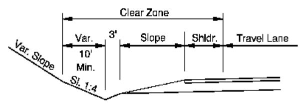
MEDIAN WIDTH TABLE

ROADWAY CLASSIFICATION	MINIMUM (ft.)	DESIRABLE (ft.) (Highway Design Speed)	
		Under 55mph	55mph & Over
Urban Collector Roads & Streets	2	12	14
Arterials - Rural	8	14	16
- Urban	4	14	16

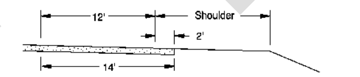
TABLE "E"

PARKING WIDTH TABLE

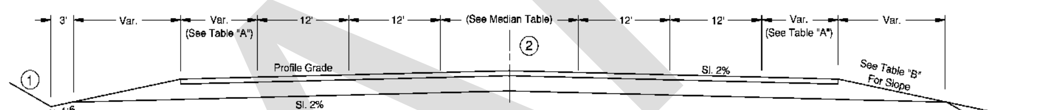
ROADWAY CLASSIFICATION	RESIDENTIAL (ft.)	COMMERCIAL / INDUSTRIAL (ft.)
Urban Arterials	8 - 10	8 - 10
Urban Collector	7 - 10	8 - 10
Urban Local	7	7



1 Use 1:4 Safety Slope At Bottom Of 1:2 Or Steeper Slope.

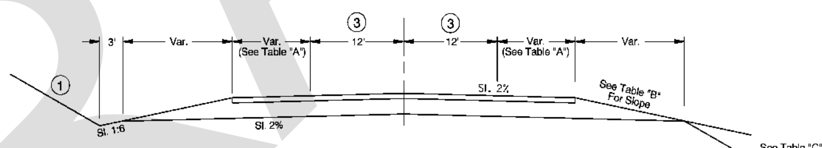


Where Concrete Pavement Is Used For Travel Lanes, Outside Lane Shall Be Constructed 14' In Width. The Shoulder Stripe Is Located 2' In From Edge Of Concrete And Total Shoulder Width Is Measured From Stripe.



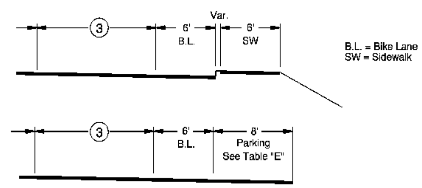
2 2' median where 4 lanes are a result of climbing or passing lanes. Median widths thru channelization and intersections.

4 LANE HIGHWAYS



3 See Table 7-2 For Minimum Widths

2 LANE HIGHWAYS



B.L. = Bike Lane
SW = Sidewalk

NOTES:
1. For minimum bike lane widths See Chapter 13.
2. Sidewalk width is exclusive of curb, utilities, signs, etc., to provide adequate operating clearance. Greater widths should be used in high use areas and against buildings.

BIKE LANE AND SIDEWALK DETAILS FOR URBAN ARTERIAL

NOTE: To Convert ADT's and DHV's Contact Planning Section

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

STANDARD SECTIONS

HIGHWAY DESIGN MANUAL

311.9 ODOT 4R Rural Arterial, Collector, and Local Route Lane Width

Rural highways carry many different types and volumes of traffic. Some highways may be major freight routes, others may be major recreational routes or commuter routes, while some may only serve an isolated farm to market industry or local traffic. Travel lanes need to be designed in accordance with this wide range of highway uses and functions. The number of lanes required is normally arrived at by consideration of projected volume, level of service, and capacity conditions.

When determining the appropriate lane widths for a particular section of highway, consider the highway classification, presence of trucks, highway function, and traffic volumes. Travel lane widths can significantly impact the capacity or mobility of a particular highway section as well as the safety of the section.

Highways that are identified as freight routes should have 12 foot lanes, regardless of volume. In addition, a 12 foot lane should generally be used for all statewide classified highways on the National Highway System (NHS). Lower volume collectors and local routes may have a narrower roadway width. Lane width for regional and district highways is typically based upon functional class and volume. Table 300-32 provides information on standard lane width.

311.10 ODOT 4R Rural Arterial, Collector, and Local Route Shoulders

Shoulders are a very important and often overlooked element of a rural highway. Right side shoulders provide lateral clearance from roadside objects, provide lateral support of the highway section, increase capacity, provide an area for emergency parking, provide an area to pass a stalled vehicle, can aid emergency vehicles reaching a crash site, and provide an area for motorists to recover if they drift outside of the travel lanes. Left side shoulders in separated roadways also provide many of the same benefits, but generally are narrower than the right side.

Paved right side shoulders are required on every rural state highway. The width of the shoulder is dependent upon traffic volumes, terrain, and to some degree by design speed. For most rural highways, shoulders of 4 feet to 8 feet are sufficient to provide the adequate level of safety. Lower classification facilities generally have narrower shoulders. Table 300-32 should be used to determine the appropriate shoulder width.

Another benefit of shoulders on rural highways is a safe area for bicycle use. These shoulders are not exclusively for bicycles, as are bike lanes since they also serve the functions described above. Many rural highways provide great recreational opportunities for bicyclists. Some rural highways are along designated tourism routes such as Scenic Bikeways, National Bike Routes and other recognized bikeways. These routes attract bicycle users internationally and from across the country. Recognized bikeways should have greater attention to bicycle accommodation, beyond the minimum shoulder widths.

311.11 ODOT 1R Rural (Non-Freeway) Arterial, Collector, and Local Route Design Standards

The ODOT 1R project standard will apply to Rural Preservation projects that are limited to a single lift overlay or inlay, which are considered non-structural treatment according to agreement with FHWA. Many of the safety items that have traditionally been addressed in 3R projects can be more effectively dealt with in a statewide strategic program. For example, a program for upgrading guardrail to current standards along a highway or in a District not just between specific project limits. A program of this nature has the ability to better utilize funding to target higher need locations for safety item improvements rather than only making safety item improvements based on paving projects. However, the replacement of safety items such as guardrail, guardrail terminals, concrete barrier, impact attenuators, and signs may be included in the 1R project category when necessary if funding other than Preservation funds are used and the added work will not delay the scheduled bid date. Any existing safety features that are impacted by the proposed resurfacing must be adjusted or replaced by the 1R project. Existing safety features cannot be degraded to a level below the existing condition prior to the paving project.

♦ Resurfacing (1R) Project Standards

These are projects that extend the pavement life of existing highways. Other safety enhancements are not required to be included; however, safety features may be added to 1R projects where other (non-preservation) funding is available. Any existing safety features that are impacted by the proposed resurfacing must be adjusted or replaced, thus necessitating some work in addition to paving. Also, since 1R projects will generally not address safety, pedestrian and/or bicycle concerns, in no case shall safety, pedestrian and/or bicycle conditions be degraded. For example, a resurfacing project that is limited to the travel lanes shall not leave a seam, sunken drainage grates or other hazards in the shoulder or bike lane. When scoping 1R projects, the safety feature databases are used to identify opportunities to add safety enhancements with other (non-preservation) funding. Following is an outline for the ODOT Resurfacing 1R project standard. While the criteria primarily relate to the paving treatment and the ability to pave without degrading existing conditions, there may be corridors where analysis of the crash history indicates that a full 3R project is warranted. Therefore projects are screened for 1R eligibility from a safety perspective as well.

♦ Scoping Requirements

In order to ensure the intent of the program is met in addressing pavement and safety needs, adequate advance information is needed to assure adequate statewide decisions are made with consistency.

1. 1R/3R Record of Decision Form
    a. This form steps the scoping team through the scoping process. Parts of the form are filled out by different sections including: Pavements, Traffic, and Roadway.
    b. Use of this form provides a statewide uniform approach to determining the project design standard – 1R vs 3R – that will be applied to a pavement preservation project.

♦ Project Initiation Requirements

At project initiation, the 1R/3R Record of Decision Form must be reviewed and validated to ensure the project will be developed under the appropriate design standard.

♦ 1R Project Requirements

1. A paving project is initially designated 1R based on the appropriate paving treatment – a single lift overlay or inlay. (There is no formal requirement for pavement design life for an individual project; however, since the 1R treatment is location specific, it is expected that an 8 year pavement life will be the goal of the program).
    a. Pavement Services is the final authority regarding the pavement design.
2. Where less than approximately 5% of a project (based on lane miles paved) includes more than a single lift non-structural overlay or inlay, the project may be designated 1R.
3. Where up to approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project may be designated 1R; however, this requires the approval of a design exception.
4. Where more than approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project must be designated 3R

a. As an exception to this is rule, a grind and inlay plus an overlay may also be considered for development under the 1R standard; however, this would be uncommon and requires the approval of a design exception.

5. Where the appropriate course of action is not clear based on the percentages noted above, include Technical Services Roadway staff in the discussion.

6. Chip seals are 1R projects and subject to the requirements of the 1R standard. Chip seals do not require ADA work.

♦ Unprotected and Unconnected Bridge Ends

1. On 1R paving projects, any bridge rail with unprotected ends or unconnected transitions exposed to traffic must be mitigated. Provide an end treatment meeting the current standard, or a design exception must be obtained.
2. Unprotected ends – Where the end of the bridge rail is exposed with no end treatment such as a transition to guardrail or a crash cushion.
3. Unconnected transition – Where there is no crashworthy transition between the end of the bridge rail to the guardrail or other barrier.
4. For possible funding options, contact the Senior Roadway / Roadside Design Engineer in the Technical Services Traffic-Roadway Section.

♦ ADA Requirements For 1R Projects

All projects that include resurfacing (except for chip seals) shall install or upgrade curb ramps where applicable.

♦ Responsibilities

1R/3R form filled out by Pavements staff, Region Roadway and Traffic Staff. There are approval signatures by the Pavements Engineer, Region Roadway Manager & Traffic Manger. It will be the Project Leaders role to coordinate. Form is housed in ProjectWise.

311.12 ODOT Single Function (SF) Rural (Non-Freeway) Arterial, Collector, and Local Route Design Standards

The specific design standards used for a Single Function Standard project will generally be the same design standards used for a 4R/New Construction project. The difference is that the scope of work is very limited on SF projects, so the SF Standard does not require addressing non-related substandard features of the roadway. For example, if a guardrail upgrade qualifies as a Single Function project, it will not be necessary to address other substandard features on the roadway, such as lane and shoulder width, horizontal and vertical alignment, etc.

♦ Application of Single Function (SF) Project Standards

Single Function projects include projects that are within the right of way but do not permanently impact the travel lanes or shoulders of the highway. Generally, projects that only include work outside the edge of pavement will qualify for the SF standard. The SF standard can also be applied to certain projects within the roadway such as re-striping projects as long as the final configuration of the travel lanes and shoulders is not changed in any way. These projects address a specific need. The scope of work is limited to features that are directly impacted as a result of addressing the specific need. For example, a signal upgrade at an urban intersection may impact the sidewalk and trigger the need to provide necessary ADA upgrades. In no case shall safety, operations, pedestrian and/or bicycle conditions be degraded as a result of a SF project. Each feature constructed in a SF project must be built to the applicable standard for new construction. The SF Standard does not apply to resurfacing projects.

Section 312 Urban Arterials

This section provides 3R, 4R, 1R, and Single Function typical section and design guidance for urban arterials, collectors, and local routes. As outlined in Part 200, arterials, make up a large percentage of the state highway mileage and cover a wide range of geographical and topographical conditions. As Part 200 provided the geometric requirements such as vertical and horizontal curvature, vertical clearance, sight distance, and grades, this section focuses on the cross sections elements such as; lane width, shoulder width, cross slope, vertical clearance, roadside design, clear zone, median design, and other cross sectional features for rural arterials, collectors, and local routes.

312.1 ODOT 3R Urban Arterial Typical Section

As the 3R requirements are the same for all of the six urban contexts defined in Part 200, the 3R requirements are listed only once but are applicable to all the urban contexts listed in Section 305. With Performance-based, Practical Design, even 3R projects are designed with the focus on project goals and outcomes, both short term and long term. These projects may not be able by themselves to meet all long range planning goals for a location or roadway section, but they can provide incremental improvements as a stepwise opportunity to work toward the overall goals, outcomes and long-term planning aspirations for a roadway corridor. Preservation projects can provide some level of improvement at relative cost and opportunities should not be overlooked if they can be appropriately incorporated in the final design.

For urban arterial 3R projects, an appropriate urban context is established as defined in Part 200 and the decision process, guidance and design criteria outlined in Section 307 is used in conjunction with the following sections to determine the final project cross-section. The Urban Design Concurrence document is used to document project decisions of what can and what cannot be included with the project.

Because urban preservation is generally more involved than rural, a number of processes are combined to develop the ODOT 3R urban criteria and guidelines. The ODOT 3R urban design criteria incorporate the Safety Priority Indexing System (SPIS) and Urban Preservation Pavement Strategy. The Urban Preservation Strategy adds design guidance which provides statewide consistency in the urban preservation program. As with the 3R program in general, urban 3R projects require a roadside inventory to be completed.

When preservation type projects involve the installation of left or right turn channelization, the width of the existing approach lanes or those widths given in Section 305 for the appropriate context are used as minimums. These widths also apply in the situation of a re-striping of an existing section of roadway. The widths of the channelized lanes conform to those specified in Section 307 and in Part 500 as applicable.

312.2 Mandatory 3R Design Features

The following is a list in Table 300-33 of mandatory design features that must be incorporated into Preservation projects:

Table 300-33 Mandatory 3R Design Features

Geometric Deficiency	Mandatory Corrective Measure

ADA/Sidewalk Ramps	Ramps shall be added at intersections where absent. Existing non-standard Ramps shall be upgraded to current standards.
Narrow Bridges/Deficient Rails	See BDM
Guardrail	Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard. Provide transitions at unconnected bridge ends. Install protection at unprotected bridge ends Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less. Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less. Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection.
Concrete Barrier	Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard. Pre-350 concrete barrier with earth support behind the barrier may remain in service. All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.

312.3 Low-Cost Safety Mitigation Measures

Table 300-34 below is a list of low-cost safety measures that should be considered on all projects utilizing ODOT 3R Urban design standards can be used as mitigation in justification for design exceptions.

Table 300-34 Low-Cost Safety Measures

	Low-Cost Safety Measure
Narrow Lanes and/or Shoulders	Pavement edge lines Raised pavement markers

Steep Sideslopes/Roadside Obstacles	Roadside hazard markings Round ditches Install guardrail Remove or relocate obstacle Slope flattening Breakaway hardware
Narrow Bridges/Deficient Rails	Install supplementary signing Hazard and pavement markings
Sharp Horizontal Curve	Install supplementary signing Correct superelevation Gradual sideslopes Pavement anti-skid treatment Obstacle removal or shielding Install post delineators
Poor Sight Distance at Hill Crest	Install supplementary signing Fixed-hazard removal Driveway relocation Illumination
Intersections	Install supplementary signing Signalization Illumination Pavement anti-skid treatment Speed control (traffic calming, visual queues, etc.)

NOTE: Designers need to exercise engineering judgment based upon engineering principles and practices in selecting appropriate mitigation measures from the above list.

312.4 ODOT 3R Urban Preservation Strategy

The 3R Urban Preservation Strategy is a good place to utilize the ODOT Performance-based, Practical Design process and the ODOT Practical Design Policy. Urban areas are complex with many conflicting needs. An urban 4R project would attempt to rebuild and improve a roadway section on the whole. Whereas, the intent of a 3R project is pavement preservation with improvements to selected design elements for safety and operations. Improvements to some of those design elements may be required by regulation or mandate. Other design elements may or may not be improved at the discretion of the project team. It is these elements where Performance-based, Practical Design can be employed to aid in the determination of the amount of value added to the system or corridor by making the improvements on either a wholesale basis or as an incremental improvement.

Due to the complexity and cost of urban preservation type projects, the Urban Preservation Strategy has developed a set of criteria for evaluating other design features for possible modifications or improvements. Table 300-35 contains the list of "Have To" and "Like To" corrective measures. The corrective measures listed under the "Have To" column must be addressed on all urban 3R preservation projects. The corrective measures listed under the "Like To" column should be considered where economically feasible (i.e., minimal extra cost or funds available from sources other than Preservation funding). Design exceptions are required for each design feature not meeting the "Have To" corrective measures or dimensions not meeting the guidance in the design tables in section 305 .

Under some conditions, the "Like To" corrective measures are required as part of an Urban Preservation Project. These conditions include:

1. Pavement condition requiring reconstruction, or
2. Curb exposure less than 6 inches, or
3. Cross slope greater than 8%.

If any of these above conditions are met, design exceptions are required for not meeting the corrective measures from the "Like To" column of Table 300-35.

Urban Preservation projects must meet the design standards and features described above or obtain a design exception, depending upon certain conditions. However, it is often desirable to provide additional improvements in urban environments. It is strongly encouraged to consider other design features in the "Like To" column in Table 300-35 when additional funding sources are available other than Preservation and where improvements are cost effective. This optional list is not all-inclusive and is not a requirement for Urban Preservation projects and does not require design exceptions if these items are not included in a project. The Performance-based, Practical Design approach includes providing incremental improvements working toward long-range planning goals and aspirations when possible and preservation projects are a good opportunity to include stepwise improvements.

Table 300-35 Urban Preservation Design Features

Project Element	Corrective Measure		Technical Resource
	"Have To"	"Like To"	
Pavement Life	8 to 15 year minimum (unless life cycle benefit/cost justifies an alternative) for overlays, inlays or appropriate treatment.	15 year minimum life for reconstruction (may be triggered by cross slope, curb exposure or pavement condition).	Pavement Unit

Project Element	Corrective Measure		Technical Resource
	"Have To"	"Like To"	
Signal Loops	Adjust or replace with non-invasive detection (e.g., radar detection) as necessary.		Traffic-Roadway Section
Striping	Redo.	Redo with Durable products as supported by the Statewide & Regional Striping Plans.	Region Traffic
Signing	Replace signs in poor condition (damaged or no longer visible or discernable).	Replace signs not up to current standards	Traffic-Roadway Section
Utilities (manholes, valves, vaults)	Adjust.		Traffic-Roadway Section
Drainage	Adjust as necessary to maintain basic system. Address high priority fish culverts identified in Salmon program.	Reroute bridge drains which drain directly into waterway. Address lower priority fish culverts as required.	Fish Prog. Mgr. & Hydraulics Unit
Obstacles behind curbs	Reconstruct curb to re-establish delineation and drainage function if grades & existing R/W permit. Relocate to meet standards where practical.	Meet required clear zone standards for obstacles behind curb. Relocate if necessary.	Traffic-Roadway Section
Roadside obstacles with demonstrated safety issues	Remove or mitigate.		Traffic-Roadway Section
ADA/ Sidewalk Ramps	Ramps shall be added where absent. Existing Pedestrian Control locations may require special treatment to meet compliance. Upgrade or Replace Existing Sub-Standard Ramps to meet accessibility requirements as	Meet ADA standards on sidewalks and driveways.	Traffic-Roadway Section

Project Element	Corrective Measure		Technical Resource
	"Have To"	"Like To"	
	shown on ODOT Standard Drawing RD755		
Vertical Clearances	Maintain existing or minimum vertical clearances. See Section 316	Meet required vertical clearance.	Bridge Section
Guardrail	Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard. Provide transitions at unconnected bridge ends. Install protection at unprotected bridge ends Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less. Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less. Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection.	Meet required standard.	Traffic-Roadway Section
Concrete Barrier	Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard. Pre-350 concrete barrier with earth support behind the barrier may remain in service. All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.		Traffic-Roadway Section
Narrow Bridges/ Deficient Rails	See BDM	Widen bridge, where practical Meet current standard for bridge rails and connections	Bridge Section

Project Element	Corrective Measure		Technical Resource
	"Have To"	"Like To"	
Curb Exposure	4 inch minimum curb exposure for delineation of roadway. Additional exposure may be required for drainage.	Meet required standard.	Traffic-Roadway Section
Cross Slope	Maintain existing where applicable. Minimize cross slope to meet standards where practical. Maximum cross slope not to exceed 8%.	Meet required standard for superelevation rates and cross slopes.	Traffic-Roadway Section

The following optional items in Table 300-36 should be considered, when cost effective AND additional funding (other than Preservation funding) is available.

Table 300-36 Additional Urban Design Features

Project Element	Corrective Measure	Technical Resource
Drainage	Upgrade systems.	Traffic-Roadway Section
Access Issues	Driveway relocations/closures.	Region Access Mgr.
Operational Issues	Modify curb radii to facilitate truck movement. Islands (replacing, adding or removing). Install/upgrade traffic control devices.	Traffic-Roadway Section
Safety Issues	SPIS site addressed. Rumble strips, pavement markings, slope flattening, illumination, etc.	Transportation Safety & Traffic-Roadway Section
Sidewalk Infill	If less than 10% missing in length of project.	Traffic-Roadway Section
Bicycle Facility	Upgrade existing facility or add facility if missing	Traffic-Roadway Section

Transit Stop	Upgrade existing facility or add facility if missing	Traffic-Roadway Transit Liaison
Planning Goals	Add improvements to meet long range planning activities	Region Planning/Region Traffic and Roadway

312.5 ODOT 3R Urban Arterial Bridge Width

A decision must be made to retain, widen or replace any bridge within the limits of a Preservation project. Widening vs. replacement should be evaluated to determine the most cost-effective treatment. Consider the AASHTO Green Book reference to "Standards for Bridges to Remain in Place", and Table 300-37, whichever is less, for minimum width. Additionally, consideration should be given to the accident history and the cost of widening when determining if widening is cost effective. If the decision is made to replace an existing structure, new construction standards will apply to the bridge replacement portion of the project only, not to the roadway portion.

When a decision is made to retain a bridge, the bridge rail should be evaluated to determine if it can adequately contain and redirect vehicles without snagging, penetrating or vaulting. Structurally inadequate or functionally obsolete bridge rail needs to be upgraded or replaced. A 1997 FHWA policy in conjunction with an AASHTO agreement stipulates that for 3R and preventative maintenance projects, bridge rails that do not meet NCHRP 230 requirements must be replaced. At a minimum, bridge rail on 3R projects must be NCHRP 350 compliant. Consideration should be given to design exceptions for railing upgrades, roadway widths, etc., when the structure is listed in or determined eligible for the National Register of Historic Places. Appropriate traffic control devices should be installed where the clear roadway width on the structure is less than the approach roadway width. Refer to the ODOT Bridge Design Manual and the ODOT Bridge Section for additional information when determining bridge decisions on roadway projects.

Table 300-37: Minimum Useable Bridge Widths

Design Year Volume (ADT)	Useable Bridge Width
0 – 750	Width of approach lanes
751 – 2000	Width of approach lanes, plus 2 feet
2001 – 4000	Width of approach lanes, plus 4 feet
OVER 4000	Width of approach lanes, plus 6 feet

312.6 4R Urban Arterial Medians

A median is the area of a roadway or highway that separates opposing directions of travel. Medians can either be traversable or non-traversable. A median can be raised curbed or simply a painted stripe.

All multi-lane state highways within this land use area, regardless of classification, shall use a median treatment. A median is the area of a roadway or highway that separates opposing directions of travel. Medians can either be traversable or non-traversable. A median can have a raised curb or simply be painted stripe. Non-traversable medians are used in urban areas for operational and safety purposes to control traffic movements to and from access points. Strong consideration should be given to installing a non-traversable median during all preservation or modernization work on existing roadways. The preferred type of non-traversable median for an urban arterial is a raised curb median and shall be designed and constructed for all new multi-lane highways constructed on completely new alignments. In addition, the Oregon Highway Plan provides direction where non-traversable medians are recommended and should be considered. These locations include:

1. All multi-lane highways with a forecasted volume of 28,000 vehicles a day or greater within the 20-year planning horizon.
2. Modernization of multi-lane highways which are:
    a. Statewide (NHS) Highways;
    b. Regional Highways where design speeds are greater than 45 mph.
3. Modernization or preservation of multi-lane highways with an annual accident rate greater than the average statewide rate for the same classification.
4. Topography and horizontal or vertical alignment result in inadequate left-turn intersection sight distance and it is impractical to relocate or reconstruct the connecting approach road or impractical to reconstruct the highway in order to provide adequate intersection sight distance.

In urban areas, a Continuous Two Way Left Turn Lane (CTWLTL) can be used on two-lane highways or any multi-lane highway where a traversable median is deemed appropriate. However, CTWLTLs should be avoided on multi-lane highways in urban suburban fringe context due to the induced pressure for local land access and development. Even where a CTWLTL is the preferred median choice, consideration of sections of raised curb medians may be appropriate to control turn movements at signalized intersections or to provide pedestrian crossing opportunities. See Section 308 Median Design and the Oregon Highway Plan, "Policy 3B: Medians for more information on median design and location". Table 300-14 provides the required left side shy distances.

Installation of raised medians in urban areas must be in compliance with ORS 366.215.

The use of medians in STAs or urban downtown/CBD contexts may or may not be needed. Medians in these locations are generally only located at spot locations to address left turn needs or specific pedestrian needs, such as a mid-block crossing. A left turn bay should be provided at intersections wherever significant left turning volumes are allowed. However, left turns from a through lane, may be acceptable in some situations. Generally, raised curb medians are not appropriate in STAs or urban downtowns , unless they are needed to improve pedestrian crossing opportunities, general mobility, access control or appropriate vegetation treatments. The use of highway medians in these areas should consider the classification of the highway, function of the highway, availability of other routes or parallel roadways, economic vitality of the area, impact to pedestrian crossings and pedestrian mobility, and safety for all travel modes. Median widths are addressed in PART 300 for all urban contexts and are dependent on project goals and outcomes. CTWLTLs should be avoided and should only be used where several continuous intersections are in need of left turn channelization. An additional shy distance is required where a raised curb median is used. Section 308 (Median Design) provides more detailed median design information. Table 300-14 provides the required left side shy distances.

Installation of medians in STAs urban downtowns can impact pedestrian crossings. Where medians are required to maintain acceptable traffic flow and safety, the designer needs to evaluate options that reduce the impact to pedestrian crossing and safety. The width of median used should take into consideration the pedestrians needs as well as the roadway needs. When medians are not needed for turning movements, but are needed for pedestrian crossings and bicycle access, the width of the pedestrian crossing median should be 6 feet at a minimum and preferably 8 feet. In tightly constrained areas a 4 foot median could be used. However, a standard adult bicycle is on the order of 6 feet in length from front wheel to rear wheel at a minimum – longer if a trailer for pulling young children or cargo is attached. Providing less than a 6 foot median in locations where bicycle traffic is expected to cross the highway may not provide adequate median width should a cyclist need to use the median as a refuge. In areas where recreational paths cross the roadway, median widths may need to accommodate more than the length of a standard bicycle. In addition to medians, options may include curb extensions, mid-block crossings, pedestrian refuges, or other treatments. Whether or not medians are used, improved pedestrian crossings should be the goal in urban environments. PART 300, Section 305 addresses median widths to consider based on urban context. Information is also provided in PART 800 (Pedestrian Design) and PART 900 (Bicycle Design).

Installing a raised median where one has not previously existed may require investigation and determination of its affect on truck traffic that uses the section of roadway. ORS 366.215, Creation of state highways; reduction of vehicle –carrying capacity, states that ODOT may not permanently reduce the vehicle-carrying capacity of an identified freight route when altering, relocating, changing or realigning a state highway unless safety or access consideration require the reduction. If a raised median is proposed to be installed, follow applicable ODOT guidance for determination of reduction of vehicle-carrying capacity and ORS 366.215 compliance. Additional information about median design can be found in Section 308.

312.7 ODOT 1R Urban (Non-Freeway) Arterial Design Standards

The ODOT 1R project category has direct correlation to the ODOT Practical Design Policy and Performance-based, Practical design decisions. The primary intent of a 1R project is to preserve the existing paving before it deteriorates to a condition where extensive reconstruction would be necessary in order to rehabilitate the roadway section. Projects under the urban 1R category consist primarily of paving the existing roadway surface and generally defer other improvements to future 4R projects, 3R projects, specific safety projects or single function projects. The ODOT 1R Urban Arterial standards apply to all six urban arterial contexts defined in Part 200 and included in Section 305. When project programming and funding are being determined, the ODOT Practical Design Policy and Performance-based, Practical Design decision process can be employed in deciding if a particular preservation project should be in the 1R category or if there is enough value being added to the highway system or corridor for the additional cost to place the project in the 3R category and trigger additional improvements.

The ODOT 1R project standard will apply to Urban Preservation projects that are limited to a single lift non-structural overlay or inlay. Many of the safety items that have traditionally been addressed in 3R projects can be more effectively dealt with in a statewide strategic program. For example, a program for upgrading guardrail to current standards along a highway or in a District not just between specific project limits. A program of this nature has the ability to better utilize funding to target higher need locations for safety item improvements rather than only making safety item improvements based on paving projects. However, the replacement of safety items such as guardrail, guardrail terminals, concrete barrier, impact attenuators, and signs may be included in the 1R project category when necessary if funding other than Preservation funds are used and the added work will not delay the scheduled bid date.

Even on a 1R urban project, perform evaluation and include feasible improvements to bicycle and pedestrian facilities within 1R guidelines. Restriping after paving may provide a low-cost opportunity within a 1R project to provide buffered bicycle lanes where appropriate. Preservation paving projects can provide opportunities to make incremental improvements to facilities and should not be overlooked when striving to meet long term planning goals. The Urban Design Concurrence document is used on 1R projects to document project context and decisions to establish the final design.

312.8 Resurfacing (1R) Project Standards

These are projects that extend the pavement life of existing highways. Missing ADA ramps must be installed and ADA ramps that do not meet the 1991 standard must be upgraded to the current standard on all 1R projects except chip seals. Other safety enhancements are not required to be included; however, safety features and other enhancements like bicycle or pedestrian improvements may be added to 1R projects where other dedicated (non-preservation) funding is available. Any existing safety features that are impacted by the proposed resurfacing must be adjusted or replaced, thus necessitating some work in addition to paving. Also, since 1R projects will generally not address safety, pedestrian and/or bicycle concerns, in no case shall safety, pedestrian and/or bicycle conditions be degraded. For example, a resurfacing project that is limited to the travel lanes shall not leave a seam, sunken drainage grates or other hazards in the shoulder or bike lane.

Also, on facilities where the 1R standard is applied, it is intended that all safety features be inventoried and the applicable safety feature information is added to designated safety feature databases, and that the safety feature is addressed based on system priorities in standalone projects or other STIP projects. When scoping 1R projects, the safety feature databases are used to identify opportunities to add safety enhancements with other (non-preservation) funding. Following is an outline of the ODOT Resurfacing 1R project standard design criteria. While the criteria primarily relate to the paving treatment and the ability to pave without degrading existing conditions, there may be corridors where analysis of the crash history indicates that a full 3R project is warranted. Therefore, projects are screened for 1R eligibility from a safety perspective as well.

312.9 Scoping Requirements

In order to ensure the intent of the program is met in addressing pavement and safety needs, adequate advance information is needed to assure adequate statewide decisions are made with consistency.

1. **1R/3R Record of Decision Form**
    a. This form steps the scoping team through the scoping process. Parts of the form are filled out by different sections including: Pavements, Traffic, and Roadway.
    b. Use of this form provides a statewide uniform approach to determining the project design standard – 1R vs 3R – that will be applied to a pavement preservation project.
2. **Urban Design Concurrence Document (Draft)**

    This document identifies the project context and is used by the scoping team to provide a concept design and provide documentation of decisions leading to that design. The Draft Urban Design Decision document is part of the final scoping package for project initiation
3. **Urban Design Concurrence (UDC) Exemption Memo**

There may be a small number of urban projects with scope too limited and outside the roadway that an Urban Design Concurrence document may not be necessary. Projects that could meet the criteria are ITS projects installing cable, a bridge screening project that does not impact the roadway or similar type projects. The primary focus of the work is outside the roadway and peripheral to it. For these types of projects, an Urban Design Concurrence Exemption Memo is required and, if granted, takes the place of the Urban Design Concurrence document.

312.10 Project Initiation Requirements

1. At project initiation, the 1R/3R Record of Decision Form must be reviewed and validated to ensure the project will be developed under the appropriate design standard.
2. The project development team reviews the Draft Urban Design Concurrence (UDC) document to understand the decisions made by the project scoping team and to verify the conditions, decisions and concept are still appropriate to meet project goals and outcomes. Existing conditions may have changed between scoping and project initiation. If changes are needed, the project development team modifies the Draft UDC to meet project goals and/or planning needs. The Draft UDC is further developed as project development continues and is reviewed again at each project milestone to ensure the final design meets the scoping expectations, goals, aspirations and outcomes for the project.
3. If the scoping team determined an Urban Design Concurrence document isn't needed and obtains an Urban Design Concurrence Exemption Memo, the project development team reviews the project scope to determine the exemption memo is still appropriate for the project scope. At any time during project development, if the scope of the project changes to include work impacting the roadway, the project development team is required to complete the Urban Design Concurrence document for submittal at the Design Acceptance phase.

312.11 1R Project Requirements

1. A paving project is initially designated 1R based on the appropriate paving treatment – a single lift overlay or inlay. (There is no formal requirement for pavement design life for an individual project; however, since the 1R treatment is location specific, it is expected that an 8 year pavement life will be the goal of the program).
    a. Pavement Services is the final authority regarding the pavement design.

2. Where less than approximately 5% of a project (based on lane miles paved) includes more than a single lift non-structural overlay or inlay, the project may be designated 1R.
3. Where up to approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project may be designated 1R; however, this requires the approval of a design exception.
4. Where more than approximately 25% of a project (based on lane miles paved) includes more than a single lift non-structural overlay, the project must be designated 3R
    a. As an exception to this is rule, a grind and inlay plus an overlay may also be considered for development under the 1R standard; however, this would be uncommon and requires the approval of a design exception.
5. Where the appropriate course of action is not clear, based on the percentages noted above, include Technical Services Roadway staff in the discussion.
6. Chip seals are 1R projects and subject to the requirements of the 1R standard, with one exception. Chip seals do not require ADA work.

312.12 Unprotected and Unconnected Bridge Ends

1. On 1R paving projects, any bridge rail with unprotected ends or unconnected transitions exposed to traffic must be mitigated. Provide an end treatment meeting the current standard, or a design exception must be obtained.
2. Unprotected ends – Where the end of the bridge rail is exposed with no end treatment such as a transition to guardrail or a crash cushion.
3. Unconnected transition – Where there is no crashworthy transition between the end of the bridge rail to the guardrail or other barrier.
4. For possible funding options, contact the Senior Roadway / Roadside Design Engineer in the Technical Services Traffic-Roadway Section.

312.13 ADA Requirements for 1R Projects

All projects that include resurfacing (except for chip seals) shall install or upgrade curb ramps where applicable.

312.14 Responsibilities

1. 1R/3R form filled out by Pavements staff, Region Roadway and Traffic Staff. There are approval signatures by the Pavements Engineer, Region Roadway Manager & Traffic Manger. It will be the Project Leaders role to coordinate. Form is housed in ProjectWise.
2. Final Urban Design Concurrence document is completed and approved by the Region Technical Center Manager, with concurrence from the Region Maintenance, Traffic and Roadway units. The final UDC is part of the Design Acceptance Package submittal. It is the Project Leaders role to ensure the final UDC is submitted.

312.15 ODOT Single Function (SF) Urban (Non-Freeway) Projects

All Urban Contexts and all ODOT Highway Segment Designations can utilize the Single Function category. Single Function projects include projects that are within the right of way but do not permanently impact the travel lanes or shoulders of the highway. Generally, projects that only include work outside the edge of pavement will qualify for the SF standard. The SF standard can also be applied to certain projects within the roadway such as re-striping projects as long as the final configuration of the travel lanes and shoulders is not changed in any way. These projects address a specific need. The scope of work is limited to features that are directly impacted as a result of addressing the specific need. For example, a signal upgrade at an urban intersection may impact the sidewalk and trigger the need to provide necessary ADA upgrades. In no case shall safety, operations, pedestrian and/or bicycle conditions be degraded as a result of a SF project. Each feature constructed in a SF project must be built to the applicable standard for new construction. The SF Standard does not apply to resurfacing projects

312.16 ODOT Single Function (SF) Urban (Non-Freeway) Design Standard

The specific design standards used for a Single Function Standard project will generally be the same design standards used for a 4R/New Construction project. The difference is that the scope of work is very limited on SF projects, so the SF Standard does not require addressing non-related non-standard features of the roadway. For example, if a guardrail upgrade qualifies as a Single Function project, it will not be necessary to address other non-standard features on the roadway, such as lane and shoulder width, horizontal and vertical alignment, etc.

Section 313 Oregon Highway Plan Special Overlays

Rural arterial highways cover many miles of varying terrain and roadside development. They also are located in areas of high scenic or historical significance. Designers need to consider the need for special consideration of scenic byways, rural communities, historical markers and viewing sites as they develop design plans. The Oregon Highway Plan includes special overlays for designating roadways needing additional design considerations. These include Scenic Byways, Freight Routes, and Lifeline Routes.

313.1 Scenic Byways

The OHP establishes a Scenic Byway Policy. Scenic Byways have exceptional scenic value to the state. The OTC must designate a route as a Scenic Byway. The intent of the designation is to ensure that the scenic qualities of the highway are preserved and may be enhanced by highway designs and projects. In general, the Scenic Byway designation should not impact the design of urban arterials. Scenic Byways ae located primarily in more rural locations. However, the designer should contact the Scenic Byway Program to make sure the Scenic Byway Corridor Management Plan will not affect the urban highway design. (Page 68 of the OHP contains a map of Oregon's designated Scenic Byways.)

However, should the Scenic Byway designation apply to an urban roadway section context, ODOT has established a process for portions or segments of highway routes that have been, or are going, to be designated as Scenic Byways. Of the six urban contexts, the Rural Community context is most probably the one that could overlap with the Scenic Byway designation. However, it is possible that some of the other urban context locations could also fall under parts of a Scenic Byway.

Scenic Byways are those routes or segments that are located in significant scenic or historic corridors. ODOT has adopted many State and Federal Scenic Byway routes. These routes are described in the Oregon Highway Plan, pages 67-69. Scenic Byways are eligible for special federal funding. In addition, federal legislation encourages flexibility in design when designing projects within a Scenic Byway corridor.

When designing projects on a Scenic Byway, the designer should try to minimize the impacts to the natural and historic resources along the corridor. This may require the designer to use non-standard designs to avoid and minimize impacts. However, it is still the responsibility of the project design team to provide a safe and appropriate level of operation of the roadway section for all road users. Some special considerations to minimize impacts within Scenic Byway corridors are:

1. Utilize alternative guardrail types or walls. Consult Roadway and/or Bridge Engineering.

2. Utilize alternative bridge rails.
3. Consider visual impacts and obstructions from guardrail. Reconsider the need for it.
4. Make sure the appropriate design speed is used so as not to change design elements unnecessarily.
5. Consider blending cut and fill slopes with the natural terrain.

Designers need to coordinate early with Region Planners and the Scenic Byway program to identify key resource issues and concerns. The Scenic Byway program can provide valuable services for determining the scope, issues, and parameters to consider. They are also knowledgeable regarding various flexible design solutions to minimize impacts.

313.2 Scenic Byway Policy

The OHP establishes a Scenic Byway Policy. Scenic Byways have exceptional scenic value to the state. The OTC must designate a route as a Scenic Byway. The intent of the designation is to ensure that the scenic qualities of the highway are preserved and may be enhanced by highway designs and projects. The Scenic Byway designation should not impact the design of urban arterials. However, the designer should contact the Scenic Byway Program to make sure the Scenic Byway Corridor Management Plan will not affect the urban highway design. Page 68 of the OHP contains a map of Oregon's Scenic Byways.

313.3 Freight Route

The Oregon Freight Route system carries a significant tonnage of goods and materials within and through the state. They are shown with the nomenclature of FR in the OHP Highway Classification tables. These routes are also known as Reduction Review Routes as determined by legislative action in ORS 366.215 and OAR 731-012. These routes are to provide a higher level of service and mobility than other statewide highways. However, other state highways serve significant volumes of truck traffic as well and have been pre-approved for use of interstate size trucks. These routes are identified on Route Map 7 that is published by the ODOT Commerce and Compliance Division, Over-Dimension Permit Unit. Although Route Map 7 includes all highways, it identifies those highways where the use of interstate size trucks are allowed and should accommodate those vehicles in the design.

Route Map 7 is color coded and identifies where the interstate truck is allowed without permit. Projects on routes identified by either the OHP Freight Map or pre-approved for WB-67 size trucks as shown on Route Map 7 should strongly consider freight needs in the design, particularly intersections. A WB-67 size truck is a single tractor trailer truck with a 67 foot wheelbase; this is currently the largest single tractor trailer approved for travel on Oregon highways without a permit. It is often referred to as the "interstate" design truck. Reducing design standards and through carrying capacity is discouraged on OHP designated Freight Routes. These Freight Routes will generally be the most important facilities to the local jurisdiction as well as surrounding region and possibly the state. As such, they should maintain an appropriate level of functionality. ORS 366.215, Creation of state highways; reduction of vehicle-carrying capacity, states that ODOT may not permanently reduce the vehicle-carrying capacity of an identified freight route when altering, relocating, changing or realigning a state highway unless safety or access consideration require the reduction. When a project is proposed on a designated freight route, follow applicable ODOT guidance for determination of reduction of vehicle-carrying capacity and ORS 366.215 compliance. OAR 731-012 provides a process to follow when working through compliance with ORS 366.215.

In conjunction with the OHP Freight Route system, the Oregon Highway Plan also recognizes the national truck route network. These routes are federally designated truck routes and are denoted in the OHP with the nomenclature TR for Truck Route in order to differentiate them from the FR used for the Oregon Freight Route system. In many instances, the FR routes and the TR routes are coincident. The FR routes are routes specific to Oregon designation for freight movement within and through the state. Whereas, the TR routes are specific to federal designation designed to carry freight effectively from state to state at the national level and are part of the national network of truck routes. TR routes are part of the National Highway System (NHS) and in most cases, when a TR route is located on a state highway that is not designated as part of the FR system, it is still subject to the requirements of ORS 366.215. Projects on these routes must follow the guidelines set out for implementation of ORS 366.215 and OAR 731-012.

A third group of roadways that comprise the freight route system in Oregon are roadways designated as Intermodal Connectors. Intermodal Connectors are part of the National Highway System and connect freight origin and destination points like ports, rail yards or major industrial areas to the arterial highway networks and interstate highways throughout the state. These routes are generally short in length with the majority of them less than a mile long. However, they are of vital importance for freight to get to and from origin and destination points. These roadway segments are located all across the state. A listing of them is included in Appendix E of the Oregon Highway Plan. All of these roadways must meet federal guidelines as part of the NHS. However, not all of these roadways are on state highways. Some of them are part of local jurisdiction networks. Intermodal Connectors located on state highways will need to meet ORS 366.215 requirements and projects on these segments must follow the guidelines set out for implementation of ORS 366.215 and OAR731-012.

313.4 Lifeline Route

Another overlay is the Lifeline Route designation. These routes have been identified as critical connections between areas of the state that may become generally inaccessible during an emergency situation such as earthquakes, tsunamis or flooding. It is critical to keep these facilities operating during such disasters to aid evacuation and relief efforts. This designation will generally not have much effect on the final design of a particular highway except for structures that are critical to maintaining accessibility. However, impacts to effective evacuation along the Lifeline Route if a reduced roadway section is proposed must be considered and mitigation provided, if necessary, before a final design is completed and approved.

Section 314 Cross Slope

The rate of cross slope is an important element in cross section design and is complicated by two contradictory controls. A reasonably steep lateral slope is desirable to quickly remove surface water and thus reduce hydroplaning of the vehicles. On the other hand, steep cross slope is undesirable because of the tendency of vehicles to drift toward the low edge of the traveled way. Cross slopes up to and including 2 percent are barely perceptible in terms of vehicle steering. However, cross slopes steeper than 2 percent are noticeable and require a conscious effort in steering. Steep cross slopes increase the susceptibility to lateral skidding when vehicles brake on icy or wet pavements or when stops are made on dry pavement under emergency conditions.

314.1 ODOT 3R Urban and Rural Freeway Cross Slope

3R urban and rural freeway standards are to use the cross slope guidance provided in AASHTO’s A Policy on Geometric Design of Highways and Streets.

314.2 ODOT 3R Urban and Rural Arterial Cross Slope

Appropriate leveling quantities should be included in the project to correct cross slope to 2%. However, for 3R projects, if existing cross-slope is 1.5%, it may not be cost effective to correct it to the full standard 2% unless the correction would also mitigate other problems or concerns in terms of safety or drainage issues. In addition, correction of the superelevation should be applied if the comfort speed of the curve is lower than the project design speed. If the comfort speed exceeds the project design speed the superelevation should be maintained unless there is a justifiable reason to change it.

314.3 ODOT 4R Urban and Rural Freeway Cross Slope

The cross slope for four lane (two lanes in each direction) urban and rural freeways is 2%. When an urban or rural freeway consists of three or more lanes in each direction, the cross slope shall be increased to 2.5% for the outside lanes and is applicable to the outside shoulder cross slope. The two inside lanes shall retain a cross slope of 2%. At locations where curb is introduced (typically urban areas), the shoulder cross slope shall be increased to 5%. At locations where the curb is intermittent, increasing the shoulder cross slope to 5% should be analyzed on a case by case basis. Figure 300-18and Figure 300-19 indicate the proper cross slope and standards for the different width freeway sections. These figures also provide information and design details on cut and fill slopes, safety slopes, and separated grades.

314.4 ODOT 4R Urban and Rural Arterial Cross Slope

For state highways, the cross slope standard is 2 percent. This allows a balance between surface drainage and vehicle steering effort. The central crown line will not have a total rollover or cross slope change of over 4 percent without approval by the State Traffic-Roadway Engineer.

On facilities with 3 or more lanes inclined in the same direction, each successive pair of lanes outward from the first two lanes may increase the cross slope by 0.5 percent.

For non-modernization projects correcting poor cross slope can be an inexpensive safety feature to add to the project. Project ends are typical locations for compromised cross slope transitions unless enough length is used for the transition. Sections that transition between a single cross slope and crown cross slope can be problematic if the transition is too abrupt. Vehicles with high centers of gravity can unexpectedly be caused to sway from side to side when traveling at high speed and control of the vehicle may be difficult to maintain. These tangent transitions need to be addressed similarly to the superelevation run out of a horizontal curve.

Section 315 Horizontal Clearances

Figure 300-23: Interstate Clearance Envelopes for Single Lane (Temporary Traffic Control)

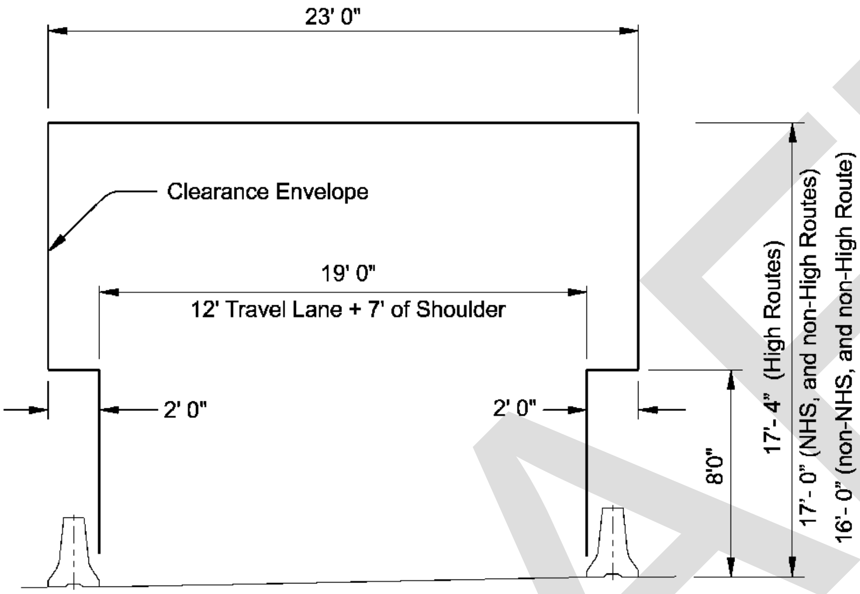
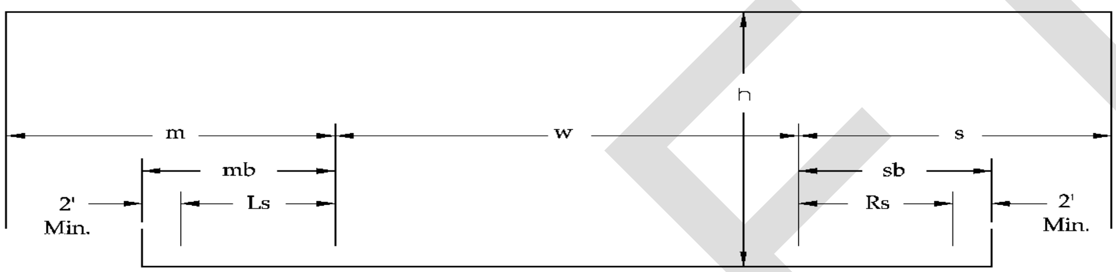


Figure 300-24: Freeway & Highway Clearances

ALL FREEWAY AND HIGHWAY CLEARANCES

(To be adjusted to provide minimum stopping sight distance when necessary)



h Minimum Vertical Clearance includes shoulder area
m Distance from Edge of Traveled Way to Obstacle on Left
mb* Distance from Edge of Traveled Way to Barrier on Left
Ls Left Shoulder
w Width of Traveled Way
s Distance from Edge of Traveled Way to Obstacle on Right
sb Distance from Edge of Traveled Way to Barrier on Right
Rs Right Shoulder

NOTE: On two-lane, two-way highways, s and sb apply to shoulders on both sides of highway.
* When barrier is warranted.

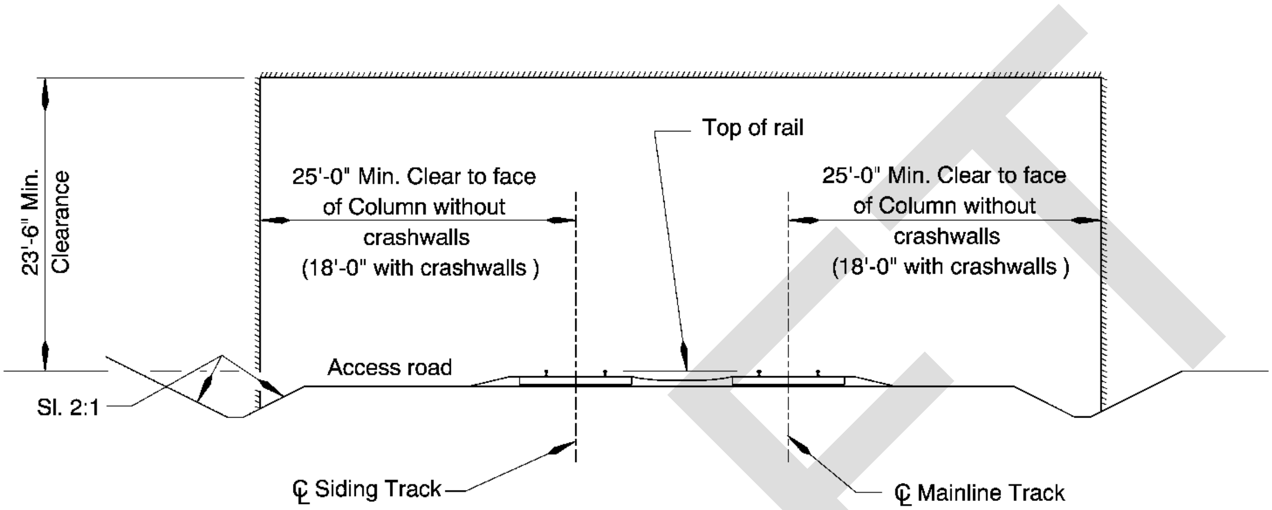
	INTERSTATE FREEWAY	NON-INTERSTATE FREEWAY	ALL FREEWAY RAMPS		ALL OTHER HIGHWAYS
			ONE LANE	TWO LANES	
h	See Figure 4-6				
w	12' Lanes	12' Lanes	16'	24'	12' Lanes
m	See The 2011 AASHTO Roadside Design Guide				
s					
Ls	Full Shoulder	Full Shoulder	4'	6'	Full Shoulder
Rs	Full Shoulder (1)	Full Shoulder	6' (2)	10' (1)	Full Shoulder

(1) Where curb is introduced intermittently for drainage on interstate it shall be set back 2' from edge of shoulder at guardrail locations.

(2) 10' on freeway to freeway ramps.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT
ROADWAY CLEARANCES
HIGHWAY DESIGN MANUAL

Figure 300-25: Railroad Clearances



Section 316 Vertical Clearance

In 2007, Motor Carrier Transportation Division (MCTD) (now called Commerce and Compliance Division, CCD) completed a study on the frequency of permitted loads that where over dimensional for height. Using this data it is determined that the actual measured height of bridges needs to be at least 17' – 4". CCD also identified the routes that are of major significance for the mobility of high loads. These "High Routes" are primarily on the National Highway System (NHS), but there are portions that are on highways other than the NHS. Some of these routes are in rural portions of the state where there are no over passes, so high loads can move freely without physical restrictions. Some high routes require the use of detours, including "up and over" use of interchange ramps, for high vehicles to use the route. The Vertical Clearance Standards are minimum heights. The Vertical Clearance Standard is required for the full roadway width including shoulders for the through lanes, and to ramps and collector-distributor roadways in Interstate-to-Interstate interchanges. Future overlays of the highway are not included in the Vertical Clearance Standard and need to be considered when determining the clearance needed for new construction.

Minimum Bridge Vertical Clearance Standards are:

- 17'-4" on High Routes
- 17'-0" on NHS Non-High Routes
- 16'-0" on Non-NHS and Non-High Route

For vertical clearance on Local Agency jurisdiction roadways, see Section 316.4

Proposed new construction that reduces vertical clearance shall require consultation with MCTD to ensure understanding of the impact of the proposed decrease to the user. All other projects, which result in final vertical clearances at or above the minimum vertical clearance, require notification of MCTD to ensure all vertical clearance inventories are current and updated for the appropriate routing of permit vehicles.

In addition to the vertical clearance requirements above there may be projects that impact freight mobility even though minimum vertical clearance is achieved. In coordination with the traffic designer, the Region Mobility Liaison is to be contacted when any proposed project (new construction, reconstruction, preservation, or maintenance) adds a new or modifies an existing overhead structure (such as Truss Sign Bridge, Monotube Cantilever, Signal Mastarm, and Signal Strain Pole) regardless of meeting the existing minimum vertical clearance standards. In addition, contact the Region Mobility Liaison for any project that reduces the existing vertical clearance regardless of meeting the minimum vertical clearance standards. The Region Mobility Liaison will provide the appropriate coordination with the Region, and MCTD. This coordination is intended to address not only project specific mobility requirements, but also any corridor level vertical clearance and mobility needs. However, because vertical clearance greater than 19’-0” for sign, VMS, and signal support structures are considered non-standard and the additional height may result in other significant issues, a design exception is required. The Traffic designer is to follow the procedures outlined in Part 1000. The design exception request process for increasing the vertical clearance greater than the above mentioned 19’-0” will need to consider safety, operations, and impact to other design features in order to support the approval of the design exception.

The lateral clearances shown in Section 315 are to the face of rail and assume the barrier is warranted. The 19 feet-0 inch dimension does include off tracking. The design engineer may determine that accommodation for off tracking is not required in tangent sections and may use a minimum dimension of 18 feet-0 inch.

In addition to ODOT vertical clearance standards, the FHWA has agreed that all exceptions to the AASHTO vertical clearance standard of 16 feet for the rural Interstate and the single routing in urban areas will be coordinated with the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) of the Department of Defense. Regardless of funding, this agreement applies whether it is a new construction project, a project that does not provide for correction of an existing nonstandard condition, or a project which creates a nonstandard condition at an existing structure.

Clearance requirements for transmission and communication lines vary considerably and must comply with the National Electrical Safety Code. Clearance information should be obtained from the State Utility Liaison.

See Appendix C for Oregon Vertical Clearance Standards High Route Highways Table and the High Route map.

316.1 3R Vertical Clearance - Urban and Rural Freeway

The 3R vertical clearance for freeways is to comply with the overall system management goal to maintain current system mobility and not lose any effective usage of the system during preservation activities. 3R freeway projects shall have:

1. No reduction in existing vertical height clearance below the Minimum Vertical Clearance standards outlined in Section 316. Reduction in current vertical clearance which results in a vertical clearance at or above the minimum vertical clearance requires notification of Motor Carrier Transportation Division (MCTD).
2. No reduction in vertical clearance if the existing vertical height clearance is below the Minimum Vertical Clearance standards outlined in Section 316. Consultation with Commerce and Compliance Division is required.

3R projects that do not meet the vertical clearance standards will need to apply for a design exception and will require consultation with MCTD. As with the 4R vertical clearance requirements, communication and coordination with MCTD and stakeholders is critical to ensure an understanding of the system requirements. Vertical clearance for pedestrian overpasses shall follow the standards above.

The vertical clearance to sign trusses and cantilever sign structures shall be a minimum of 18 feet. The vertical clearance from the deck to the cross bracing on through truss structures shall also be a minimum of 18 feet. For vertical clearance requirements on Local Agency jurisdiction roadways, see Section 316.4

The vertical clearance for tunnels shall be at least 16 feet. Any reduction in vertical clearance for tunnels shall require a design exception and consultation with Commerce and Compliance Division. Maintaining the existing vertical clearance for tunnels on all 3R Freeway projects requires notification of Commerce and Compliance Division.

316.2 3R Vertical Clearance - Urban and Rural Arterial

Maintain the existing clear height on all structures. On projects utilizing ODOT 3R standards (Resurfacing, Restoration, and Rehabilitation), the vertical clearance of structures is considered over the entire roadway width, including usable shoulder width. For 3R projects, no reduction of the existing vertical clearance below the minimum vertical clearance is allowed. No reduction in vertical clearance is allowed if the existing vertical height is currently below the minimum vertical clearance.

Projects that do not meet these Vertical Clearance Standards will need to apply for a Design Exception and will require consultation with Commerce and Compliance Division (CCD). CCD will then involve the industry stakeholders in the consultation process necessary to fully evaluate user impacts, project construction, and design options. For vertical clearance requirements on Local Agency jurisdiction roadways, see Section 316.4.

316.3 4R Vertical Clearance – Urban and Rural Freeways, Expressways, and Arterials

The vertical clearance guidance provided in the introduction to Section 315 is applicable to all 4R vertical clearance requirements. In addition, the Vertical Clearance standards for all 4R urban and rural projects is as follows:

- 17'-4" on High Routes
- 17'-0" on NHS Non-High Routes
- 16'-0" on Non-NHS and Non-High Route

The vertical bridge clearance on all High Routes shall be 17' 4". Additional height may be needed to provide 17'-4" clearance if future overlays are anticipated. All urban and rural Interstate Freeways are designated High Routes, and therefore, shall have a minimum vertical clearance of 17' 4". The vertical clearance of all urban and rural non-Interstate freeways will depend on the freeway being designated as a High Route, National Highway System (NHS) route (not on High Routes), or non-NHS (not on High Routes). The vertical clearance standards also apply to non-freeway urban and rural highways. The minimum vertical clearance for NHS (not on High Routes) is 17' 0" and 16'0" for non-NHS (not High Routes). The designation of the facility (High Route, NHS, non-NHS, etc.) is critical in determining the minimum vertical clearance requirement and should be verified prior to determining the vertical clearance requirement. The vertical clearance shall be from the top of the pavement to the bottom of the structure and includes the entire roadway width including the usable shoulder width. Any proposed decrease in vertical clearance in new construction, regardless of the vertical clearance standard, requires consultation with Commerce and Compliance Division.

The clearance requirements for transmission and communication lines vary considerably and must comply with the National Electrical Safety Code. Clearance information should be obtained from the Utilities Engineer.

The vertical clearance for sign trusses, cantilever sign supports, and through-truss structures shall be a minimum of 18 feet and a maximum of 19' because of their lesser resistance to impacts. The vertical clearance for pedestrian overpasses shall be 17'-4" (does not include buffer for future overlays).

316.4 Vertical Clearances for Local Jurisdiction Roads

Local Jurisdiction roads that are part of the NHS are required to meet AASHTO standards for vertical clearance. Also, any project using federal funds on Local jurisdiction roads are required to meet AASHTO standards for vertical clearance. For new construction or reconstruction, provide 16 ft clearance over the entire roadway width (including travel lanes and paved shoulders). Existing clearances of 14 ft may be retained. In highly urbanized areas, a minimum clearance of 14 ft may be provided if there is an alternate route with 16 ft clearance, or if a local ordinance exists.

316.5 Vertical Clearance – Railroads

The minimum railroad clearance to be provided on crossings shall conform to Oregon Administrative Rule (OAR) 741 and as shown in Figure 300-25. Additional clearance may be required and should be determined individually for each crossing. Information regarding clearances shall be obtained from the Railroad Liaison. For vertical clearance requirements on Local Agency jurisdiction roadways, see Section 316.4.

Section 317 Curbs

When curbs are used on any freeway, expressway or rural highways with higher speeds, they should be mountable. Vertical faced barrier curbs shall not be used on urban or rural freeways. The Oregon Standard Drawings 700 series provides information on curb type. Only the low profile mountable curb has been approved for freeway application. The low profile mountable curb, mountable curb, and mountable curb and gutter are the mountable curb types approved for other locations. Full shoulder width shall be provided and paved to the same depth as the main roadway.

Where a standard curb is introduced, it should be curved away from the edge of the travel lane on the end of the curbed section approached by traffic. It need not be curved away where traffic leaves the curbed section. When curbs are used on highways with narrow shoulders, the beginning of a curb on the right shall be offset a minimum of 6 feet. On the left, the offset shall not be less than 3 feet greater than the normal curb offset (Figure 500-32 Channelization & Intersection Island Details).

Where roadway grades are 0.5 to 0.3 percent, monolithic curb and gutter design (either curb and gutter, or mountable curb and gutter types) shall be used. The monolithic curb and gutter design is the most hydraulically efficient curb design. As such, this design type is required when the grades are flat to increase the efficiency of removing water from the road surface. On grades greater than 0.5 percent, low profile mountable curb, standard curb, or mountable curb may be used. Refer to ODOT Standard Drawings RD700 and RD701.

Consideration of the impact to bicycles needs to be given when using monolithic curb and gutter. The gutter forms a grade break where typically there is a change of surface materials. Bicyclists tend not to ride on the gutter material. A minimum bike lane width of 5 feet and the use of a monolithic curb and gutter system need careful evaluation with regard to the competing needs of all users.

Although curbs are typically installed in urban areas, there may be instances where curbs are not installed due to water quality reasons. The Senior Hydraulics Engineer should be contacted for discussion on curbs and water quality issues.

Section 318 Drainage

318.1 General

Drainage facilities enable the carrying of water across the highway right of way and also provide a mechanism for removing storm water from the roadway itself. There are many type of drainage facilities including channels, bridges, culverts, curbs, gutters, and a variety of drains. Typically, the roadway designer designs roadside ditches, cut-off ditches, inlet spacing and locations, drainage systems for storm sewers pipes, 24 inches or less, culverts 48 inches or less, and outlet protection. The designer should work with the regional hydraulics engineer in determining drainage needs for projects with systems larger than described above, or when flood plains, bridge hydraulics, scour or bank protection, fish passage, detention, water quality, or temporary erosion control are involved. More discussion is provided on hydraulic issues in Section 1211 Hydraulics and Section 1214 Temporary and Permanent Erosion and Sediment Control. The Hydraulics Manual should be referred to when performing hydraulic designs.

318.2 Longitudinal Slope

Experience has shown that the recommended minimum values of roadway longitudinal slope will provide safe, acceptable pavement drainage. A minimum longitudinal gradient can be more important for a curbed pavement than for an uncurbed pavement since the water is constrained by the curb. However, flat gradients on uncurbed pavements can lead to drainage problems if vegetation is allowed to build up along the pavement edge. Desirable gutter grades should not be less than 0.5 percent for curbed pavements with an absolute minimum of 0.3 percent. The designer should consult with the regional hydraulic engineer for potential solutions to flat longitudinal grades. Superelevation and/or widening transitions can create a gutter profile different from centerline profile. The design should carefully examine the gutter profile to prevent the formation of ponds potentially created by superelevation and widening transitions. Water cross flow in superelevation transitions need to be considered and inlet locations need to be carefully designed to catch excess flows. The cross flows can contribute to hydroplaning or be locations of ice. Sag vertical curves require analysis to ensure adequate drainage and removal of "flat" areas that impede storm water runoff.

318.3 Selection of Inlets

The performance of inlets and cross slope has an impact on hydraulic capacity. In a past study, the performance of the CG-3 inlet was compared to the standard grated inlets. The efforts of the study provided the following results. The CG-3 inlet outperformed the CG-1 and G-1 inlets when the gutter grade were less than 1%. The CG-3 inlet provided about the same performance as the CG-2 and G-2 inlets when the gutter grade was less than 0.8%. When the gutter grade exceeded 1%, bypass became a problem with CG-3 inlets and required close inlet spacing to control the bypass flow. In summary the study concluded that the CG-3 inlets are cost effective when the gutter grade is less than 1%.

318.4 Storm Water Management

Most projects must address water quality and some projects must address flow control issues. ODOT's water quality goal is to design and implement highway projects in a manner that manages project runoff to protect the beneficial uses of the receiving surface and ground waters, and to manage project runoff quantities and flows to protect the receiving water's stream form, function, and stability.

The ODOT Hydraulics Manual provides design guidance for stormwater water quality and flow control (detention). Other manuals may be referenced such as Metro's "Green Streets" on a project by project basis in urban environments.

Coordinate the design of stormwater water quality and flow control facilities with the region hydraulics engineer.

Section 319 Shy Distance

Whenever barriers, such as guardrail, concrete traffic barriers, traffic separators, curbs or other significant vertical elements are introduced into the roadscape it is desirable to provide a buffer space. This buffer helps improve safety of the users, traffic flow, and operational efficiency. This buffer is often referred to as "E" or Shy Distance.

319.1 Roadside Barriers

Where right side roadside barriers are used on higher speed roadways, the standard right shoulder width will be increased to provide a 2 foot shy (or “E”) distance. This applies to all divided arterial locations, freeway (including ramps), or non-freeway. Studies show that drivers tend to leave extra room on the right side of the vehicle when near a vertical obstruction. The shy distance or “E” allows a horizontal distance for the driver to shy away from the vertical obstruction. When the right hand shoulder is 12 feet or greater, the 2 foot “E” is not required, since a 12 foot right side shoulder is adequate to park a disabled vehicle and drivers do not tend to require extra width when vertical obstructions are 12 feet or more horizontally from the traveled way. The 2 foot shy distance applies to both concrete barrier and guardrail.

The 2 foot “E” is not added to the left side shoulder except under the following conditions:

1. On freeways only, when the standard shoulder is 10 feet. (This occurs on 6 lane minimum facilities). The minimum edge line to edge line distance in this configuration is 26 feet.

2. Four lane mainline section of all roadway types using concrete median barrier when the left side shoulders (6 feet or less) of the opposing lanes is separated by only barrier. Shoulders that are 6 feet in width require an edge line to edge line distance of 18 feet in this configuration.

3. This standard does not require the additional 2 foot “E” for the left shoulder at spot roadside barrier locations such as bridges and interchange areas unless the above criteria is met. Interchange ramps with left side roadside barriers do not require the 2 foot “E” on the left side.

For more information on roadside barrier design and location refer to Part 400, Roadside Design.

319.2 Shy Distance From Raised Medians

Table 300-38 establishes the shy distance requirements from raised medians for most arterials, except expressways. Use Table 300-38 to determine shy distance for higher speed urban expressways and for rural expressways. Table 300-38 also applies to left side shy distance for other conditions such as curbed sections on one-way roadways.

When raised curb or concrete barrier medians are not continuous, an additional 1 foot of shy distance should be added to the values above. Table 300-38 is used in place of the direction given in Section 317 relating to curb placement. For higher speed expressways see Table 300-26 and Table 300-30. See Section 308 for more discussion about median design.

Table 300-38: Left Side Shy Distance

Design Speed (mph)	Shy Distance (feet)		
	Curb		Concrete Barrier
	12 ft Lane	11 ft Lane	All Lane Width
25	1	1	2
30	1	1	2
35	2	2	2
45	2	2	2
50	2	3	3
55+	3	4	4

Section 320 Safety Edge

Lane departure crashes in which a vehicle departs from its lane and crashes with another vehicle, rolls over, or hits a fixed object represent from 60 to 80 percent of rural Oregon crashes. In 2007, fixed object crashes accounted for 70 percent of the rural crashes with an additional 10 percent involving overturned vehicles. This translates to 80 percent of the crashes being these two types and accounts for 90 percent of the fatal crashes and 90 percent of the injury crashes. These numbers have remained consistent for a number of years not only in Oregon but in states with a large number of miles on rural roads.

Safety Edge is a counter measure developed to address potential problems with tire rubbing along the edge of pavement. When a vehicle's tires drop off the edge of the paved surface the driver tends to over steer in the attempt to return the vehicle onto the paved surface. Safety Edge provides a sloped edge surface to assist the vehicle in returning to the paved surface without over steering.

On paving projects with shoulder widths of 6 feet or less and new pavement thickness of two inches or more, Safety Edge will be included in the project and shown on the typical sections. Details for Safety Edge are shown on Oregon Standard Drawing RD610.

Roadside features can impede the paving operation and successful construction of the Safety Edge. These features commonly are guardrail, mailboxes, approaches, intersections and deep roadside ditches. Consecutive features may require Safety Edge to be omitted for portions of the project due to constructability issues.

Section 321 Rumble Strips

Safety is a very important component of design and roadway departures and head-on crashes make up a significant portion of Oregon’s fatalities and serious injury crashes. Rumble strips are a relatively low cost engineering treatment designed to alert drivers of a lane departure through vibration and noise created when a vehicle’s tires contact the rumble strip. Rumble strips may be placed on the shoulders, between opposing travel lanes (centerline), or in the travel lanes (transverse). Rumble strips are considered a traffic control device and require the approval of either the State Traffic-Roadway Engineer or Region Traffic Engineer depending on the application.

Guidelines have been established on when it may be necessary to install the rumble strips for safety reasons on state highways. Historically, rumble strips have not been used often on urban highways. However, there are sections of urban highways that could benefit from the application of rumble strips. There are newer rumble strip design that can reduce the noise level of tires running over the strips. If rumble strips are proposed, the accommodation of bicyclists and shoulder width should be considered along with maintenance activities. The ODOT Traffic Manual provides specific details to determine if a particular project should have rumble strips installed.

Section 322 Earthwork

When the standard sections do not provide for stable slopes and roadbed, a special design is necessary. The design shall be based on soil tests and other factors and must have the approval of the Geotechnical Engineer.

Care in the design of individual cuts and fills must be used when varying the rate of the slope due to height variations in order to avoid unsightly, irregular faces.

Table 300-39 below provides guidance for additional width for fill sections where there is a concern for the stability of slopes.

Table 300-39: Additional Embankment Widening on High Fills

Fill Height (Feet)	**Widening of Subgrade as Appropriate, Each Side of Centerline (Feet)**

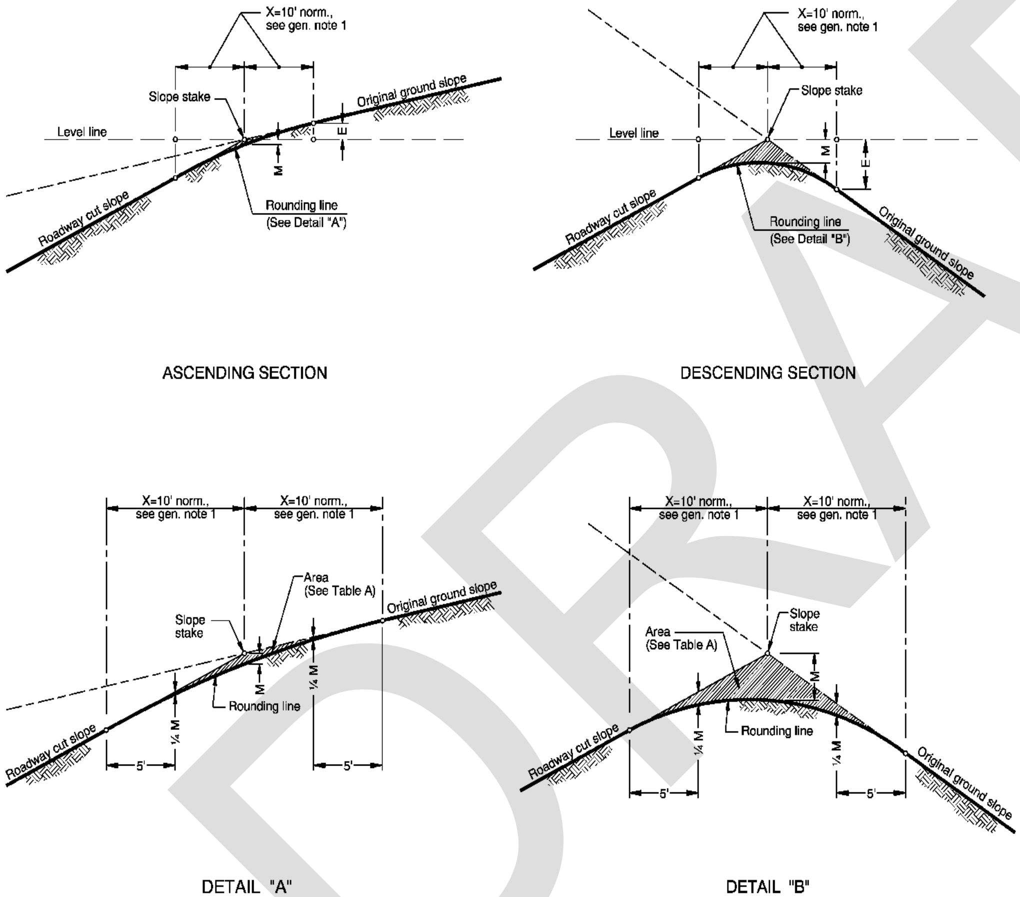
0-20	No Widening
20-30	1
30-40	2
40-50	3
Over 50	4

Fill height is to be considered as the difference in elevation between the subgrade shoulder and the adjacent toe of slope.

322.1 Rounding Cutbanks

Cut slopes shall be designed to blend in with the surrounding terrain. This is accomplished by rounding the top of the cutbanks as shown on Figure 300-26 also as specified in the Oregon Standard Specifications for Highway Construction (Section 00330). The rounding limits also have an impact on right of way requirements.

1 Figure 300-26: Rounding Of Cutbanks



* See general note 2

TABLE A *

	E (ft)	CUT SLOPE 1 : 1 M (ft)	1 : 1 AREA (sqft)	1 : 1.5 M (ft)	1 : 1.5 AREA (sqft)	1 : 2 M (ft)	1 : 2 AREA (sqft)	1 : 3 M (ft)	1 : 3 AREA (sqft)	1 : 4 M (ft)	1 : 4 AREA (sqft)
ASCENDING GROUND	4	1.50	10								
	3	1.75	12								
	2	2.00	13								
	1	2.25	15	1.42	9						
LEVEL		2.50	17	1.67	11						
DESCENDING GROUND	1	2.75	18	1.92	13	1.50	10				
	2	3.00	20	2.17	14	1.75	12				
	3	3.25	22	2.42	16	2.00	13	1.58	11		
	4	3.50	23	2.67	18	2.25	15	1.83	12	1.63	11
	5	3.75	25	2.92	19	2.50	17	2.08	14	1.88	13
	6	4.00	27	3.17	21	2.75	18	2.33	16	2.13	14
	7	4.25	28	3.42	23	3.00	20	2.58	17	2.38	16
	8	4.50	30	3.67	24	3.25	22	2.83	19	2.63	18
	9	4.75	32	3.92	26	3.50	23	3.08	21	2.88	19
	10	5.00	33	4.17	28	3.75	25	3.33	22	3.13	21

Rounding not required within these limits.

GENERAL NOTES FOR ALL DETAILS:

1. Extend slope rounding 10' or to right of way line, whichever is less. Use the same X dimension on both sides of slope break point.
2. Table A values are only for slope rounding with an X dimension of 10'.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

SLOPE ROUNDING

HIGHWAY DESIGN MANUAL

2

Section 323 Truck Weigh Stations

On freight routes and other major highways, truck weigh stations may be necessary. The Commerce and Compliance Division should be consulted when a weigh station is being impacted or considered. Appropriate acceleration and deceleration lanes are to be provided for truck weigh station locations. The station should also be set back from the highway to provide separation from high speed traffic and stopped trucks. Truck weigh stations may also be located at non-freeway locations. Due to location and type of facility, the design of non-freeway weigh stations will vary. For freeway and non-freeway weigh station design guidance, contact the Roadway Engineering Unit of the Traffic-Roadway Section.

Section 324 Safety Rest Areas

Safety rest areas are a facility removed from the traveled way with parking and such facilities for the traveler deemed necessary for rest, relaxation, comfort and information needs. Rest areas are located on freeways and other highways where there is a need.

The design of rest areas will vary depending upon location and need. Some rest areas are quite large while other rest areas only serve a few vehicles and are more of a wayside. Roadway Engineering should be contacted concerning design guidance for rest areas.

Rest areas located on the freeway system are to be designed with exit and entrance ramps. The exit and entrance ramps should be designed in the same manner as interchanges. Because rest areas accommodate large numbers of trucks, the design should consider exit and entrance ramps that better accommodate trucks. As mentioned above, rest areas have different functions. One of those functions is providing travel information. Many times the rest area will be closed for long periods of time and this has an impact on the travel information provider. In cases where the rest area requires remodeling or repair, the designer should see that tourist information facilities are kept in service if possible or look at ways of minimizing the closure time.

Section 325 Emergency/Truck Escape Ramps

Rural highways are often located in steep terrain. In some sections, long continuous grades may be the only reasonable design option. Where long continuous down grades are present or being considered, the designer should investigate the need for emergency/truck escape ramps. Generally, truck escape ramps are only needed where long descending grades exist. Section 3.4.5 of AASHTO's *"A Policy on Geometric Design of Streets and Highway - 2018"*, has additional design guidance on escape ramps.

Section 326 Chain-up And Brake Check Areas

Chain-up areas are used to allow drivers of trucks or other vehicles to install and remove chains in areas where there is inclement weather. Chain-up areas are typically located at the base of a sustained grades and where there is a demonstrated need. Chain-up areas are typically located adjacent to the mainline, where the shoulder can be easily widened. Brake check areas are typically located just prior to long descending grades. The width of chain up and brake check areas should be at least 20 feet wide (including the existing shoulder width). Exit and entrance tapers for chain up and brake check areas should be 20:1 and 25:1 respectively. The length of chain-up and brake check areas will vary depending on the location and truck volumes.

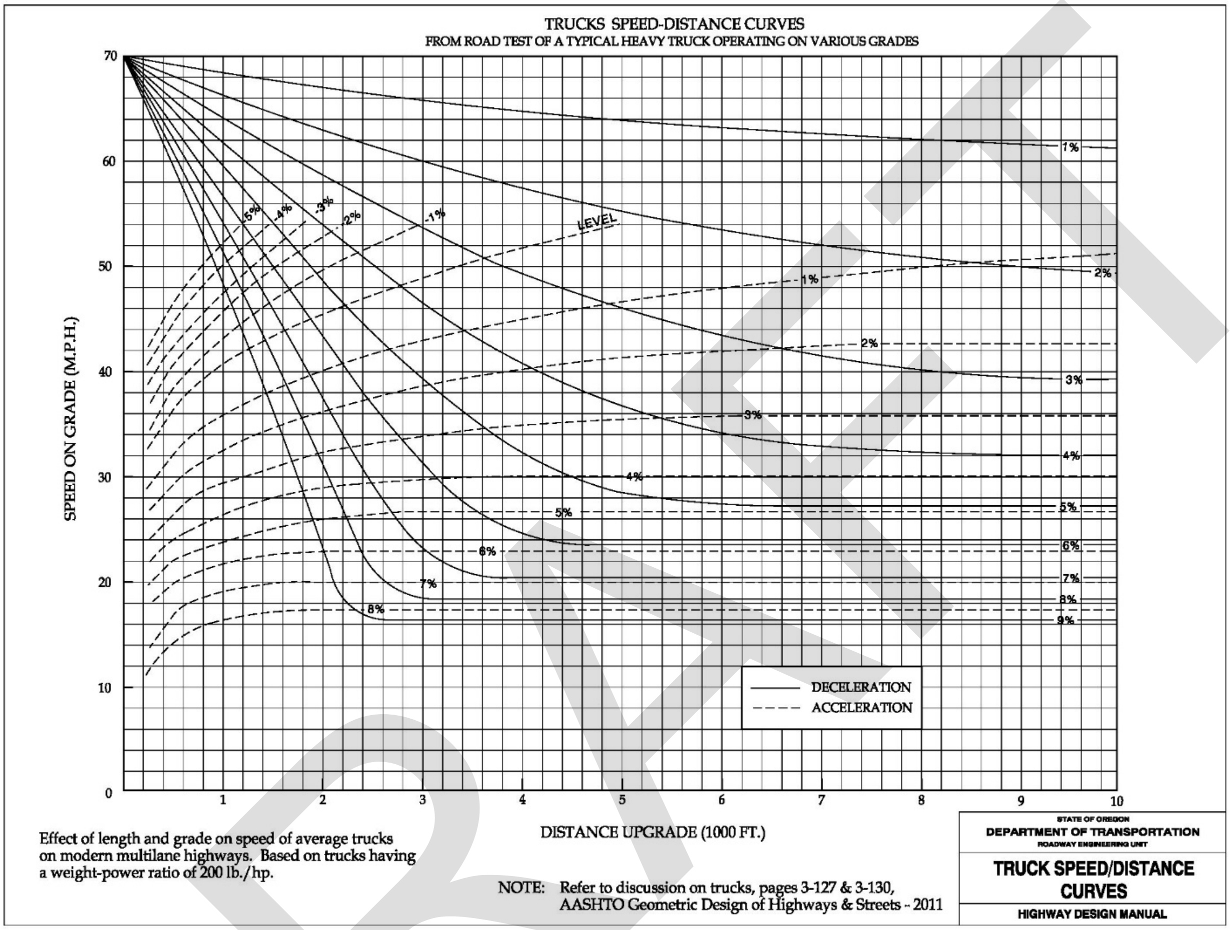
Section 327 Climbing Lanes

Climbing lanes are normally provided to prevent unreasonable reductions in operating speeds. Normally the combination of heavily loaded vehicles operating on long uphill grades results in the need for climbing lanes. A climbing lane section is not considered a three lane section but a two lane section with an additional lane for uphill slow moving vehicles. (See AASHTO's "*A Policy on Geometric Design of Highways and Streets - 2018*".)

Where climbing lanes are warranted as specified in Part 300 ODOT 4R/New Standards, the location of the beginning and the end of the lane can be determined by the chart, "Truck Speed - Distance Curves", . In using this chart for design purposes, vertical curves are not considered, and the speeds are taken from the chart assuming that the vehicle travels in a straight line from one point of grade intersection to the next. Vertical curves can be broken up into straight line segments if additional accuracy is desired. The taper section added at the beginning of a climbing lane should have a 25:1 ratio desirably, that should be at least 300 feet in length. The taper section added at the end of a climbing lane should have a 50:1 ratio desirably, that should be at least 600 feet in length.

Whenever climbing lanes are warranted, the feasibility of supplemental downhill passing lanes should be investigated. Both climbing lanes and downhill passing lanes shall be the same width as the travel lanes used for normal construction. The desirable adjacent shoulder width is 6 feet with a minimum of 4 feet. If the roadway has substantial bike use, consult the ODOT Bicycle-Pedestrian Facility Specialist for input on shoulder width. When climbing lanes are supplemented with downhill passing lanes, a 2 foot wide median shall be introduced. Four-lane construction with appropriate shoulder and median widths should be substituted for climbing lanes wherever traffic is likely to approach or exceed capacity.

Figure 300-27: Truck Speed Distance Curve



Section 328 Passing Lanes

Passing lanes should be considered on two-lane arterials where it is not practical to achieve adequate passing sight distance or where increased traffic volumes have an adverse impact on the desired volume to capacity ratio. Ideally, passing lanes should be considered only in areas where the roadway can be widened on both sides to provide simultaneous passing opportunities for both directions.

The standard travel lane for a passing lane section is 12 feet. The desirable shoulder width should be 6 feet with a minimum of 4 feet. Consult the ODOT Bicycle-Pedestrian Facility Specialist for input on shoulder width. The minimum median width in a passing lane section (three or four lanes) shall be 2 feet.

If at all possible, passing lanes should be located where there are no approaches. If there are existing approaches, the type of approach is critical. Consideration of closing the approach should be given. It may be possible to allow a passing lane where there are single residential approaches or possible forest service type roads, but the approach to public/county roads and approaches that serve multiple trip generation opportunities are problematic in a passing lane section. There are expectations in a passing lane such that the drivers will only be focused on the through movement vehicles. Entering and exiting vehicles violate the driver expectations, for example a vehicle stopped in the left lane waiting to make a left turn. In cases where higher volume access points exist in a passing lane section, left turn lanes are strongly encouraged. The ending point and transition section of a passing lane is critical and these specific types of locations need to be avoided for ending the passing lane: the crest of a hill, on a horizontal curve, and locations that have the potential for a left turn.

Passing lanes should be clearly identified to prevent motorists from thinking they are entering a four lane section of roadway. The minimum length of a passing lane should be 1250 feet, plus tapers. The taper section at the end of a passing lane should be computed by the following formula:

$$\boxed{L = WS}$$ (L=Length in feet, W=Width in feet, S=Posted Speed in mph).

The recommended length for the lane addition taper is half to two-thirds of the lane drop length. Optimum passing length is 1.25 miles. It is very important to have passing lanes long enough to allow the passing of vehicles but not too long as to make the added passing lane seem like an additional travel lane. The Transportation Planning Analysis Unit (TPAU) or the Region Traffic Engineer should be contacted to determine the appropriate length of passing lane.

Design considerations for providing passing lanes on two-lane highways are as follows:

1. Horizontal and vertical alignment should be designed to provide as much length as feasible with sight distance for safe passing.
2. To maximize safe operations, drivers should be able to clearly recognize both lane additions and lane drops.
3. For volumes approaching design capacity, the effect of lack of passing lanes in reducing capacity should be considered.
4. Where the traffic is slowed or capacity reduced because of trucks climbing long grades, construction of climbing lanes should be considered.
5. Where the passing opportunities provided by application of Items 1 and 4 are still inadequate, the construction of a four-lane highway should be considered. Inability to economically justify climbing lanes or multi-lanes may require that the roadway be designed for a much higher volume to capacity ratio.

Consider providing extensions to the passing lane section to allow slower vehicles the opportunity to attain free flow speed prior to merging. This reduces the speed differential between vehicles at the merge, improving safety and operations.

Section 329 References

(HDM Section 4.2.5- Roadside Barriers is in HDM Chapter 4) and will need to be addressed PART 400, Section 401-Roadside Barriers)

(HDM Section 4.2.6- Roadside Trees is in HDM Chapter 4) and will need to be addressed in PART 400, Section 403-Roadside Trees)

(HDM Section 4.6 - Guardrail and Concrete Barrier are in HDM Chapter 4) and will need to be addressed in PART 400, Section 401)

(HDM Section 4.4- Traffic Control is in HDM Chapter 4) and will need to be addressed in PART 400, Section 416)

(HDM Section 4.7- Drainage is in HDM Chapter 4) and will need to be addressed in PART 400, Section 402)

Part 400 Roadside Design

Section 401 Introduction

The design of the roadside environment is a critical part of any highway segment. A well designed roadside can significantly improve the safety and operation of a particular segment. Steep slopes or obstacles should be avoided or mitigated where possible and practical. Fixed object and run off the road type accidents often account for a significant number of crashes on a segment of highway. Therefore, providing a safe roadside environment should be a goal of every project. The 2011 AASHTO "Roadside Design Guide" should be used to determine the clear zone distance and mitigation measures to use for different highway conditions. Section 402 and Section 403 have additional information and examples on proper clear zone requirements and roadside design.

As AASHTO's "Roadside Design Guide" directs, the preferred treatment of roadside obstacles is to relocate them outside of the clear zone. Only where this is not possible or cost effective, should shielding be considered. Where a barrier along a roadway is used to shield a roadside obstacle, provide a 2 foot shy distance from the normal edge of shoulder to the face of barrier. This shy distance maintains the useable shoulder width and provides some additional distance from the traveled way to the barrier.

401.1 Definitions

NCHRP Reports 230 and 350 - Roadside hardware crash testing has evolved since the 1962 publication of Highway Circular 482. In 1974 NCHRP Report 153, Recommended Procedures for Vehicle Crash Testing for Highway Appurtenances developed the first criteria for crash testing of roadside safety systems, followed by the 1980 NCHRP Report 230, Recommended Procedures for the Safety Performance Evaluation of Highway Safety Appurtenances. This report served as the first national standard for the evaluation and crash testing of roadside hardware. The NCHRP Report 230 was superseded by NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features, in 1993.

MASH – First published by AASHTO in 2009 and updated in 2016, the Manual for Assessing Safety Hardware (MASH) is an update to and supersedes NCHRP Report 350 for the purposes of evaluating new safety hardware devices. The only substantial update in the current 2016 edition is the criteria for crash testing cable barrier.

401.2 Acronyms

MGS - Midwest Guardrail System

MASH - Manual for Assessing Safety Hardware

NCHRP - National Cooperative Highway Research Program

Section 402 3R Clear Zone and Sideslopes (All Highways)

On all 3R projects, a roadside inventory, along with the accident summary and analysis, gives the designer the information necessary to make good design decisions regarding roadside safety improvements. Evaluation and improvement considerations of roadside features should be consistent with the following:

1. Flatten sideslopes of 1:3 or steeper at locations where run-off-road accidents are likely to occur (e.g., on the outside of horizontal curves).
2. Retain current slope ratios. Do not steepen sideslopes when widening lanes and shoulders, unless warranted by special circumstances.
3. Remove, relocate or shield isolated roadside obstacles.
4. Remove vertical drop-offs at the edge of pavement after paving. See Safety Edge in Part 300, Section 303 for shoulders 7 ft or less.

Part 100 outlines the 3R design process that should be used in development of all 3R projects.

For ODOT 3R projects, Clear Zone issues are the responsibility of the Region Technical Center and should be documented in the project design narrative or related project files, as well as in a separate depository or library set up for the purpose of long term retention and future access as needed. Design Exceptions for clear zone on 3R projects are approved by the Region Roadway Manager using the design exception form shown in Part 1000.

Section 403 4R Clear Zone (All Highways)

This section will address elements of roadside design including: clears zone; clear zone requirements; clear zone distances; horizontal curve adjustments; and sideslopes. This section will also address the lateral clearances required, both vertical and horizontal, for interstate freeway single lane clearance envelopes.

The AASHTO “Roadside Design Guide - 2011” is the most recent publication written to provide guidance in roadway design regarding roadside clearances. The AASHTO “Roadside Design Guide - 2011” gives procedures and tables to determine the correct clear zone distance for use in the placement of barrier, sign installation, guard rails, ditch location, and other roadside appurtenances. It provides the criteria for the placement or removal of any object which may influence the trajectory of a vehicle which has left the travel lanes, either in a controlled or uncontrolled situation.

The AASHTO "Roadside Design Guide – 2011", in chapter 10, gives additional assistance to designers with clear zone in the urban context. Understanding of the role delineation plays between the travel way and non-travel way along a highly urban environment gives the designer more options than before.

The clear zone is determined by several factors, including design speed, ADT, horizontal curvature, and embankment slope. These distances given in the tables in this section are not absolute and the design options selected to mitigate the effect of roadside hazards require good engineering judgment in order to balance cost effectiveness with the expected increase in safety.

The AASHTO "Roadside Design Guide - 2011" suggests the following options to be considered when evaluating a roadside hazard:

1. Removing or redesigning the obstacle
2. Relocating the obstacle
3. Reduce impact severity by breakaway devices
4. Redirection of vehicle by installation of barrier device
5. Delineation of object

General information on clear zone is covered in Section 402 and Section 403. Of specific importance for both rural and urban freeways is the safety slope located at the back of curb or from edge of travel lane. In order to provide a recommended ditch section, the 1:6 rock foreslope and ditch section must be followed by a 1:4 backslope for a minimum of 10 feet. A variable back slope can then be used. This type of safety slope is also required for urban freeways with ditch sections or curb. Typically, an urban freeway has a curbed section that is followed by 2% slope for 4 feet. The 2% slope must then be followed by a 1:4 or flatter back safety slope for a minimum of 10 feet. The backslope adjacent to the 1:4 safety slope can then be varied. This urban treatment will meet the recommended ditch section requirements of the "Roadside Design Guide - 2011". These standards should also be followed when designing center medians. In a curbed median section a 4 foot (2%) slope shall be followed by the 1:4 back safety slope.

The clear zone distance can be determined by using Table 400-1 and Table 400-2 shown at the end of this section. These tables were taken from the AASHTO "Roadside Design Guide - 2011". They are provided as a quick reference source for the experienced designer who is already familiar with the determination process. Table 400-1 is used to determine general clear zone distance. Table 400-2 is used for horizontal curve adjustments.

Care must be taken in arriving at the proper clear zone distance. Table 400-1 lists the different clear zone distances for cut and fill slopes. Many times multiple slopes have to be used to determine the appropriate clear zone distance. At times the roadway typical section will have both a foreslope and backslope. When this occurs the procedure for determining the proper clear zone requires more than pulling a number from Table 400-1. Following is an example of the proper procedure for determining clear zone distance for a typical section that includes both a foreslope and a backslope.

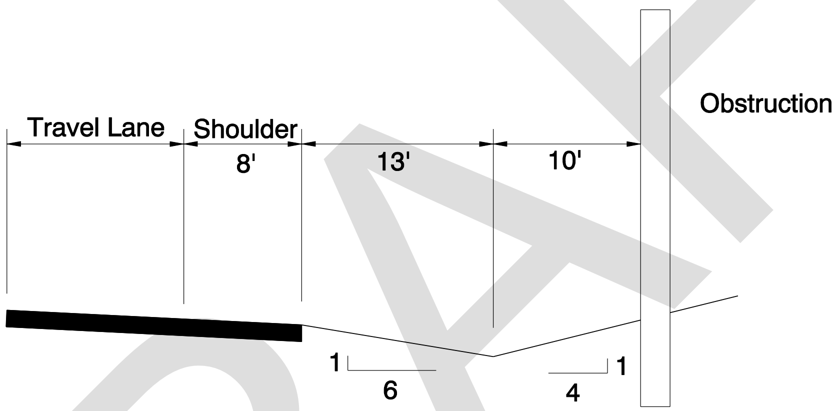
Example:

Design ADT: 7000

Design Speed: 60 mph

Recommended clear zone for 1:6 slope (fill): 30 to 32 feet from Table 400-1

Recommended clear zone for 1:4 slope (cut): 24 to 26 feet from Table 400-1



Discussion: Since the example is within the preferred channel cross section, Table 400-1 can be used to determine the clear zone. However, when the suggested clear zone exceeds the available recovery area for the foreslope, the backslope may be considered as additional available recovery area. The range for the suggested clear zone for the foreslope of 30 to 32 feet extends past the slope break into the backslope. Since the backslope has a suggested clear zone of 24 to 26 feet which is less than the foreslope the larger of the two values should be used. In addition, fixed objects should not be located near the center of the channel where the vehicle is likely to funnel. An appropriate clear zone range for this example is 30 to 32 feet.

For further information and more detailed procedures it is recommended all designers read the AASHTO *"Roadside Design Guide - 2011"*.

Design exceptions for clear zone on 4R projects are approved by the State Traffic-Roadway Engineer.

Table 400-1: Clear Zone Distances

	Design ADT	Fill Slopes	Cut Slopes

Design Speed (mph)		1V:6H or flatter	1V:5H to 1V:4H	1V:3H	1V:3H	1V:5H to 1V:4H	1V:6H or flatter
≤ 40	UNDER 750 750 - 1500 1500 - 6000 OVER 6000	7 - 10 10 - 12 12 - 14 14 - 16	7 - 10 12 - 14 14 - 16 16 - 18	[b] [b] [b] [b]	7 - 10 10 - 12 12 - 14 14 - 16	7 - 10 10 - 12 12 - 14 14 - 16	7 - 10 10 - 12 12 - 14 14 - 16
45 - 50	UNDER 750 [c] 750 - 1500 1500 - 6000 OVER 6000	10 - 12 14 - 16 16 - 18 20 - 22	12 - 14 16 - 20 20 - 26 24 - 28	[b] [b] [b] [b]	8 - 10 10 - 12 12 - 14 14 - 16	8 - 10 12 - 14 14 - 16 18 - 20	10 -12 14 - 16 16 - 18 20 - 22
55	UNDER 750 [c] 750 - 1500 1500 - 6000 OVER 6000	12 - 14 16 - 18 20 - 22 22 - 24	14 - 18 20 - 24 24 - 30 26 - 32 [a]	[b] [b] [b] [b]	8 - 10 10 - 12 14 - 16 16 - 18	10 -12 14 - 16 16 - 18 20 - 22	10 - 12 16 - 18 20 - 22 22 - 24
60	UNDER 750 [c] 750 - 1500 1500 - 6000 OVER 6000	16 - 18 20 - 24 26 - 30 30 - 32 [a]	20 - 24 26 - 32 [a] 32 - 40 [a] 36 - 44 [a]	[b] [b] [b] [b]	10 - 12 12 - 14 14 - 18 20 - 22	12 - 14 16 - 18 18 - 22 24 - 26	14 - 16 20 - 22 24 - 26 26 - 28
65 - 70	UNDER 750 [c] 750 - 1500 1500 - 6000 OVER 6000	18 - 20 24 - 26 28 - 32 [a] 30 - 34 [a]	20 - 26 28 - 36 [a] 34 - 42 [a] 38 - 46 [a]	[b] [b] [b] [b]	10 - 12 12 - 16 16 - 20 22 - 24	14 - 16 18 - 20 22 - 24 26 - 30	14 - 16 20 - 22 26 - 28 28 - 30

Notes:

a) When a site-specific investigation indicates a high probability of continuing crashes or when such occurrences are indicated by crash history, the designer may provide clear-zone distances greater than the clear zone shown in this table. Clear zones may be limited to 30 ft for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

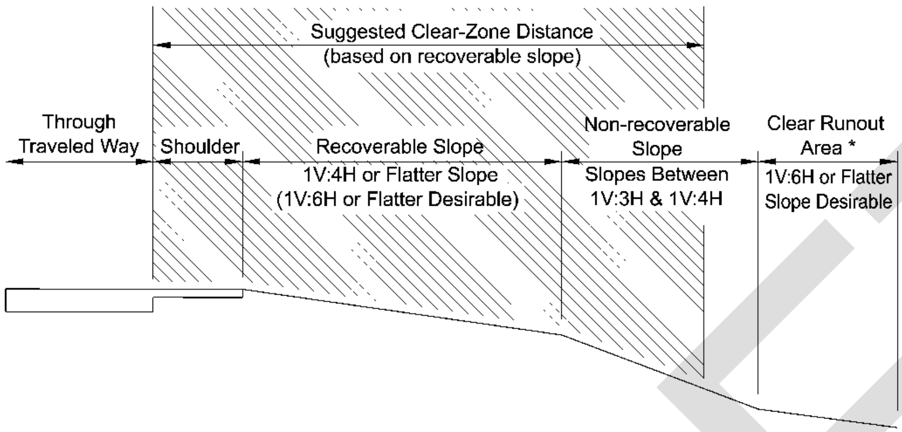
b) Because recovery is less likely on the unshielded traversable 1V:3H fill slopes, fixed objects should not be present in the vicinity of the toe of these slopes.

Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should consider right-of-way availability, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the through traveled lane and the beginning of the 1V:3H slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the foreslope parameters that may enter into determining a maximum desirable recovery area are illustrated in Table 400-2. A 10-ft recovery area at the toe of slope should be provided for all traversable, non-recoverable fill slopes.

c) For roadways with low volumes it may not be practical to apply even the minimum values found in this table. Refer to Chapter 12 in the AASHTO's "*Roadside Design Guide - 2011*" for additional considerations for low-volume roadways and Chapter 10 for additional guidance for urban applications.

♦ Clear Zone on Freeways

Of specific importance for both rural and urban freeways is the safety slope located at the back of curb or from edge of travel lane. In order to provide a recommended ditch section, the 1:6 rock foreslope and ditch section must be followed by a 1:4 for a minimum of 10 feet. A variable backslope can then be used. This type of safety slope is also required for urban freeways with ditch sections or curb. Typically, an urban freeway has a curbed section that is followed by 2% slope for 4 feet. The 2% slope must then be followed by a 1:4 or flatter back safety slope for a minimum of 10 feet. The backslope adjacent to the 1:4 safety slope can then be varied. This urban treatment will meet the recommended ditch section requirements of the "Roadside Design Guide - 2011". These standards should also be followed when designing center medians. In a curbed median section a 4 foot (2%) slope shall be followed by the 1:4 back safety slope.



* The clear runout area is additional clear-zone space that is needed because a portion of the suggested clear zone (shaded area) falls on a non-recoverable slope. The width of the clear runout area is equal to that portion of the clear-zone distance that is located on the non-recoverable slope.

Reference: AASHTO *"Roadside Design Guide – 2011"* Figure 3-2 and Table 3-2

♦ Horizontal Curve Adjustments

Table 400-2: Horizontal Curve Adjustments

Degree of Curvature	Design Speed (MPH)					
	40	45	50	55	65	70
2°	1.1	1.1	1.1	1.2	1.2	1.2
2°30′	1.1	1.1	1.2	1.2	1.2	1.3
3°	1.1	1.2	1.2	1.2	1.3	1.4
3°30′	1.1	1.2	1.2	1.3	1.3	1.4
4°	1.2	1.2	1.3	1.3	1.4	1.5
4°30′	1.2	1.2	1.3	1.3	1.4	-
5°	1.2	1.2	1.3	1.4	1.5	-
6°	1.2	1.3	1.4	1.5	1.5	-
7°	1.3	1.3	1.4	1.5	-	-
8°30′	1.3	1.4	1.5	-	-	-
11°30′	1.4	1.5	-	-	-	-
17°30′	1.5	-	-	-	-	-

$CZ_c = (L_c)*(K_{cz})$

Where:

$CZ_c =$ Clear zone on outside of curvature, feet

L_c = Clear zone distance, feet (see) AASHTO *"Roadside Design Guide – 2011"* Table 3-1

K_{cz} = Curve correction factor

Note: The clear-zone correction factor is applied to the outside of curves only. Corrections are typically made only to curves with a degree of curvature greater than 2°.

Section 404 Curbs and Their Placement Ditches

Figures 300-18, 300-19, and 300-22, outline the typical ditch section for rural highways, and urban and rural freeways. These typical sections create a standard roadside ditch flow-line that is 0.5 feet below the subgrade elevation. The peak discharge, longitudinal slope, and ground cover for each ditch affect the ditch capacity. On steep slopes shear stresses on the ditch bottom should be evaluated to assure the ditch does not erode. The discharge contributing to ditches runs off from areas from within the right of way, but this area is often small compared to runoff from outside the right of way. Evaluate each ditch for significant flows from off-site.

The standard traversable ditch should be used on all projects unless the calculated peak flows indicate insufficient capacity or instability. A ditch is considered traversable when the sum of the horizontal components of the ditch foreslope and the ditch backslope is equal to or greater than 10. When the design speed is greater than 45 mph, the designer needs to give stronger consideration to the configuration of the ditch. Contacting the foreslope of the ditch with the rear bumper can cause the vehicle to roll, and contacting the backslope the ditch with the front bumper can cause an excessive deceleration of the vehicle.

The use of a flat bottom ditch may be appropriate in locations to satisfy water quality treatment requirements. Flat bottom ditches are recommended to be at least 4 feet wide at the ditch bottom with standard surfacing slopes. The 4 foot wide bottom typically allows a vehicle to safely traverse the ditch. Flat bottom ditches may also be appropriate in open freeway medians. Additional information on ditches is provided in Part 1200, Section 1211.

Section 405 Roadside Barriers

Where right side roadside barriers are used, the standard right shoulder width will be increased to provide a 2 foot shy distance. This applies to all divided arterial locations, freeway (including ramps), or non-freeway. Studies show that drivers tend to leave extra room on the right side of the vehicle when near a vertical obstruction. The shy distance or "E" allows a horizontal distance for the driver to shy away from the vertical obstruction. When the right hand shoulder is 12 feet or greater, the 2 foot "E" is not required, since a 12 foot right side shoulder is adequate to park a disabled vehicle and drivers do not tend to require extra width when vertical obstructions are 12 feet or more horizontally from the traveled way. The 2 foot shy distance applies to both concrete barrier and guardrail.

The 2 foot "E" is not added to the left side shoulder except under the following conditions:

1. On freeways only, when the standard shoulder is 10 feet. (This occurs on 6 lane minimum facilities). The minimum edge line to edge line distance in this configuration is 26 feet.
2. Four lane mainline section of all roadway types using concrete median barrier when the left side shoulders (6 feet or less) of the opposing lanes is separated by only barrier. Shoulders that are 6 feet in width require an edge line to edge line distance of 18 feet in this configuration.

This standard does not require the additional 2 foot "E" for the left shoulder at spot roadside barrier locations such as bridges and interchange areas unless the above criteria is met. Interchange ramps with left side roadside barriers do not require the 2 foot "E" on the left side.

For more information on roadside barrier design and location refer to 405.1.

405.1 Guardrail and Concrete Barrier

♦ General

This section provides information to the designer concerning guardrail and concrete barrier. Information on offsets, single slope barrier, cast in place, and slip form barrier is provided. The AASHTO *"Roadside Design Guide - 2011"* shall be used to determine guardrail and concrete barrier locations. Exceptions to this guide are to be approved by the State Traffic-Roadway Engineer. Standard Drawings in the RD400 series deal with guardrail while Standard Drawings in the RD500 series deal with concrete barrier. Barrier treatment in rural areas should consider impacts to animal crossings and the designer should contact the region environmental representative for assistance.

Regardless of the type of the barrier system used, when a median is proposed to be closed with a barrier system discussion with the Oregon State Police needs to occur to discuss cross over locations for emergency access.

Existing barrier systems used to mitigate lack of clear zone at a minimum shall meet NCHRP Report 350 crash testing criteria. No design exception will be granted to leave existing hardware that does not meet the minimum crash testing requirements on 3R and 4R projects.

405.2 Guardrail

This includes transitions to bridge rail, longitudinal runs of guardrail, and guardrail end terminals.

♦ Upgrades and Height Adjustments

- The MGS guardrail (with splice between the posts) passed MASH testing at 28". The previous standard – NCHRP 350 29" guardrail (measured to the top of the rail with the splice on the post) marginally passed MASH testing with steel posts, but failed with wood posts. This means the previous standard is right at the Pass/Fail limit. Therefore, it is reasonable to upgrade to 31" MGS on 4R projects when NCHRP 350 29" guardrail is impacted by the project. NCHRP 350 tested guardrail may remain in place on 1R and 3R preservation projects. Where the height is 28" or less, it should be adjusted to a minimum of 29" – See Standard Drawing RD400. On 4R projects, NCHRP 350 tested guardrail may remain place if it is not impacted by the project

4R Projects:

- Upgrade all unconnected and unprotected bridge rail end treatments within the project limits.
- All NCHRP 230 or older guardrail within the project limits must be upgraded to MGS guardrail.
- All NCHRP 350 guardrail that is impacted by the project must be upgraded to MGS guardrail.
- Existing MGS guardrail that is 28" or lower must be raised to 31".
- A transition for height and splice location may be used for NCHRP 350 guardrail runs that extend more than 250 ft. beyond the project limits (see Oregon Standard Drawing RD481). Where Pre-NCHRP 350 guardrail is impacted, replace the entire run.
    - Consider replacing the entire run of NCHRP 350 guardrail if the run extends more than 250 ft. beyond the project limits if:
        - it is cost effective,
        - the guardrail is disrepair, for example, rotten posts.

3R Projects:

- Upgrade all unconnected and unprotected bridge rail end treatments within the project limits.
- MGS guardrail that is 28" or lower must be raised to 31"
- NCHRP 350 guardrail may remain in place. Where the height is 28" or lower, adjust to a minimum of 29".
    - Note: There is no objection to raising NCHRP 350 guardrail to 31" if practical. However, this does not result in a MASH compliant barrier (since the splice will still be on the post) and it may not be possible to raise some NCHRP 350 end terminals higher than 29".

The entire run of Pre-NCHRP 350 guardrail must be upgraded to the current standard.1R Projects

- Upgrade all unconnected and unprotected bridge rail end treatments within the project limits.
- Guardrail height adjustment is not required for resurfacing treatments that do not impact guardrail height.

    - Grind/inlays and chipseals are assumed to have no impact on guardrail height.
- For projects that impact rail height (i.e. overlays):
    - MGS guardrail that is 28” or lower must be raised to 31”
    - NCHRP 350 guardrail may remain in place. Where the height is 28” or lower, adjust to a minimum of 29”.
    - Upgrading pre-NCHRP 350 guardrail is not required; however, the functionality of the existing guardrail must be maintained.
        - Seek additional funding to upgrade pre-350 guardrail
        - If no additional funding is available - adjust guardrail as high as possible up to 29”.

♦ Guardrail Design and Length of Need

On any project where guardrail or barrier is being proposed, the length of need calculation is required. This will assure that the fixed objects within the clear zone are shielded as intended. Chapter 5 in AASHTO’s “Roadside Design Guide - 2011” contains information and details on length of need calculations.

Designers need to understand where and what the length of need point is on the terminal. The critical impact point of the angled crash test is the length of need point. This is the point where a vehicle should begin to be redirected along the length of the barrier instead of passing through the barrier. For most W-beam terminals this is located at 12’-6” from the impact head unit. Any length of guardrail upstream from the length of need point is not included in the distance provided by the length of need calculation.

$$\boxed{X = \frac{L_A + \left(\frac{b}{a}\right)(L_1) - L_2}{\left(\frac{b}{a}\right) + \left(\frac{L_A}{L_R}\right)}}$$

Example:

Given: ADT = 7,500 vpd

Speed = 50 mph

Select: $\frac{b}{a}$ = 0 – non flared terminal

L_A = Lateral Extent of Area of Concern – Designer selects 15 ft.

L_R = Runout Length – 190 ft.

From table 5-10(b) page 5-50 AASHTO *"Roadside Design Guide - 2011"*.

L_1 = Tangent Length of Barrier upstream from the Area of Concern.

If Barrier is installed with no flare, L_1 becomes zero.

(See page 5-51 AASHTO *"Roadside Design Guide - 2011"*)

L_2 = Lateral Distance – 4 ft shoulder and 2 ft "E" distance = 6 ft.

Solution: For a parallel installation (i.e., no flare rate), the equation reduces to the following:

$$\boxed{X = \frac{L_A - L_2}{\left(L_A / L_R\right)}}$$

$$X = \frac{15 - 6}{\left(15/190\right)} = \frac{9}{.0789} = 114 \text{ ft.}$$

♦ Guardrail Terminals

Guardrail terminals are protective systems that prevent errant vehicles from impacting hazards, by either gradually decelerating the vehicle to a stop when the terminal is hit head-on, or by redirecting the vehicle away from the hazard when struck on the side. These systems are connected to the ends of runs of guardrail and work in concert with the guardrail run to shield rigid objects or hazardous conditions that cannot be removed, or relocated, or break away.

Some terminals utilize W-Beam rail and breakaway timber posts, which are set in two steel foundation tubes for ease of replacement. Some end terminals utilize hinged breakaway steel posts. The rest of the breakaway posts are drilled. All systems establish the third post from the end as length-of-need point, referred to in the AASHTO *"Roadside Design Guide - 2011"*.

Approved end terminals are listed in the Qualified Products List (QPL). Also available are terminals that are designed for a lower speed impact (under 45 mph) that are called Test Level 2 terminals. They are shortened versions of the standard terminals. With the competition as it is, all products undergo routine adjustments to design that make it impractical to list current models. The designer should refer to the QPL, as the QPL stays abreast with all changes and regularly posts updates.

♦ Grading at Guardrail Terminals

In order to create predictable outcomes in actual crashes, conditions that existed during the crash testing should be duplicated as closely as possible. This means that an adequate width of approach at the end post of terminals is essential. This is so an impacting vehicle will be in the same plane as the roadway surface and not dropping off the edge at the instant of impact. A width of 5 feet from the back of the end post to the hinge point should be provided where possible (see RD19).

♦ Establishment of Variable-Sized Recovery Areas

In addition to the grading at guardrail terminals that is needed to provide a relatively flat approach, an adequate recovery area should also be provided where possible. A recovery area consists of traversable slopes (1:3 or flatter) and is free of obstructions. Often, the recovery area can be provided by extending the guardrail run to a location where the desired dimensions can be achieved without extensive grading.

Desired recovery area dimensions:

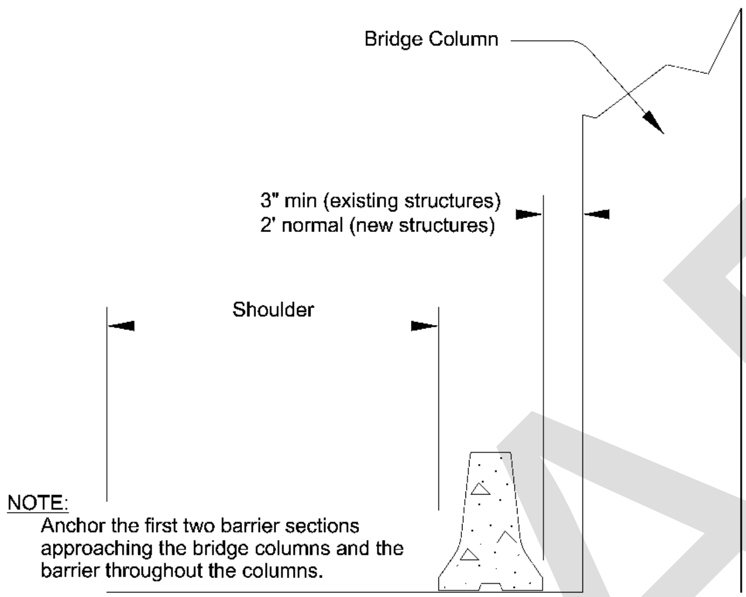
DESIGN SPEED (MPH)	WIDTH (FT.)	LENGTH (FT.)
50 +	20	75
35-45	18	50
< 35	16	40

405.3 Concrete Barrier and Bridge Columns

When the design shoulder width is not encroached upon by placement of the concrete barrier, the concrete barrier should be placed as shown in Figure 400-3. For existing structures, the minimum clearance between the bridge column and barrier is 3 inches. For new structures, the normal clearance between the bridge column and barrier is 2 feet. The roadway designer should consult with the bridge designer to determine the appropriate clearances.

Where the clearance from the traffic face of barrier and the face of the bridge column is at least 3.25 feet, use pinned 42” portable concrete barrier (see Oregon Standard Drawings RD500 series). Where the clearance from the traffic face of barrier to the face of the bridge column is less than 3.25 feet, a 42” MASH crash tested TL5 rigid barrier is required. One option is to use

42” type F bridge rail (see Oregon Standard Drawings BR200 series) installed on a moment slab. The moment slab must be designed in accordance with AASHTO LRFD.



When the design shoulder width is encroached upon by the placement of the concrete barrier, the designer should consult with the bridge designer to develop the best solution to protect the bridge columns.

405.4 Tall Precast Concrete Barrier

See Oregon Standard Drawings RD500 series. This 42 inch high safety shape is available only as precast, with segments 12.5 feet long, matching the length of ODOT’s standard precast barrier.

The tall barrier does not replace the standard, but it is to be used in the medians of interstates and on the State Highway Freight System where median barrier is justified or where existing barrier is to be replaced. The tall barrier is not to be used in the Columbia River Gorge National Scenic Area on Interstate 84. Standard concrete barrier can be used in the median in the Columbia River Gorge National Scenic Area (color approved by USFS).

Use the tall barrier on shoulders of any highway system as needed where adverse geometrics may occur such as curves with a degree of curvature greater than that specified in Tables 300-27, 300-31, 300-33 herein, or where severe consequences at specific locations might occur with penetration of a barrier by a heavy vehicle.

♦ Overlays and Concrete Median Barrier Vertical Face

For relatively straight forward overlay projects, the 3 inch vertical face on concrete median and shoulder barrier may be utilized without adjustment of the barrier. The overlay shall not exceed the vertical face height.

Tapering an overlay so the vertical face height will not be exceeded must be investigated to ensure that recommended slopes adjacent to the median barriers are not exceeded. Chapter 6 in the AASHTO's *"Roadside Design Guide - 2011"* provides additional information on terrain effect and barrier placement.

♦ Concrete Barrier End Treatment

Any barrier end exposed to the flow of traffic must be protected in some manner. Impact attenuators are recommended by AASHTO. Burying ends in the cut slope is another approved method. Sloped ends may be used, but only when the design speed is less than 45 mph and the end is outside of the clear zone. In light of crash tests indicating potential launching hazards, earth mounds are not approved for use.

♦ Concrete Barrier Upgrades

On 4R and 3R projects, barrier that does not meet NCHRP-Report 350 criteria must be replaced except at locations where the backside of the barrier is supported. Backside support can include a cut slopes or retaining wall. Backside support must be strong enough to prevent vehicle penetration of the system at the connection point between segments. 1R projects can include barrier replacement with other funding sources. No design exceptions will be given in the case of 4R or 3R projects.

405.5 Cable Barrier

Cable barrier can be used in medians and on outside shoulders. Though cable barrier has been successfully tested on a 1:4 slope, optimum performance can be achieved by placing on a transverse slope of 1:10 or flatter.

♦ For Median Use

Cable barrier is very effective to use in medians as long as there is at least 8 feet deflection room on both sides of the barrier. The deflection limit is measured from the taut cable to each adjacent fog line. Having less than 8 feet of deflection requires a design exception.

Care must be taken on interstate highways and freight routes where truck mix tends to be higher than the norm, to account for the fact that no cable system has been tested against semi-trucks. A semi-truck can stretch cable many times more than the design-tested deflection, and will usually hold the cable at maximum deflection until the truck and cable are untangled from each other. The designer should account for extra deflection if there is a site-specific history of truck cross-over incidents. For extra measure of protection the designer should consider use of a NCHRP Test Level 4 system in cases like this.

Cable barrier use can be considered on Interstate Highways and designated Freight Routes with a median width of 30 feet without an increase in the post spacing. Cable barrier installations in median widths less than 30 feet require consultation with the Senior Roadside Design Engineer.

♦ For Shoulder Use

Cable barrier works well on shoulders as long as the designer ensures at least 8 feet deflection distance is provided between the cable barrier system and the face of any obstruction. As with median application, account for extra deflection if there is a site-specific history of truck run-off-road incidents.

405.6 Barrier Systems on Retaining Walls

Drop-offs greater than six feet in height at the top of retaining walls shall be protected with a traffic barrier system. As a minimum, barrier located at the top of retaining walls on ODOT projects shall meet Test Level 3 (TL-3) requirements. A higher Test Level may be required for high speed freeways, expressways, and interstates where traffic includes a mix of trucks and heavy vehicles, or when unfavorable conditions justify a higher level of rail resistance. Barrier options for protection of retaining wall drop-offs include:

1. Fixed Bridge Rail on Self Supporting (Moment) Slab: This option consists of a Type "F" 32" Bridge rail (BR200) on a self supporting (moment) slab. The Type "F" 32" railing has been crash tested and satisfies TL-4 test criteria in AASHTO LRFD Chapter 13 Railings. The moment slab must be designed in accordance with AASHTO LRFD and ODOT Geotechnical Design Manual (GDM), and must be strong enough to resist the ultimate strength of the railing. The moment slab must also be designed to resist overturning and

sliding by its own mass when subjected to a 10 kip static equivalent design load in accordance with AASHTO LRFD 11.10.10.2. ODOT also has a Type "F" 42" railing that has been crash tested and satisfies TL-5 criteria, but the static equivalent design load has not been determined.

2. Anchored Precast Wide Base Median Railing: Where TL-3 traffic railing is acceptable, anchored precast wide base median barrier (Oregon Standard Drawing. RD500) may be used when designed in accordance with AASHTO LRFD and the GDM. Anchored precast barriers shall be located at least 3.0 feet clear from the back of the wall face, and each precast section shall be anchored with four vertical anchors as shown on the "Median Installation" option on Oregon Standard Drawing RD515 and RD516.
3. Guardrail: Where TL-3 traffic railing is acceptable, standard guardrail (Oregon Standard Drawing RD400) may be used when designed in accordance with AASHTO LRFD and the GDM. Locate guardrail posts at least 3.0 ft clear from the back of the wall face, drive or place posts at least 5.0 ft below grade, and place at locations which do not conflict with retaining wall elements and components.

405.7 Freeway Median Barriers Warrant

For warranting median barrier on Interstate freeways and Non-Interstate freeways use the following:

1. Any open median 100 feet in width or less shall be closed with an appropriate barrier. The median width is measured between the inside fog lines of opposing directions of traffic.
2. For freeway medians greater than 100 feet wide, regions should evaluate site specific conditions and crash data to determine if the median should be closed. Regions are also encouraged to identify and evaluate any other sections of divided highways that they determine look and feel like interstate and non-interstate freeways to determine if the median should be closed.

Table 400-3: Interstate/Freeway List

Hwy	Route	Highway Name	Begin MP	End MP	
1	I-5	Pacific	0.00	308.38	Interstate
2	I-84	Columbia River	0.00	167.58	Interstate
6	I-84	Old Oregon Trail	167.58	378.01	Interstate

61	I-405	Stadium Freeway	-0.04	4.21	Interstate
64	I-205	East Portland Freeway	0.00	26.56	Interstate
70	I-82	McNary	0.00	11.21	Interstate
227	I-105	Eugene-Springfield	0.00	3.49	Interstate
30	OR 22	Willamina-Salem	24.03	26.18	Freeway
47	US 26	Sunset	53.62	73.75	Freeway
69	OR 569	Beltline	4.37	13.00	Freeway
92	US 30	Lower Columbia River	0.95	1.86	Freeway
144	OR 217	Beaverton-Tigard	0.00	7.52	Freeway
162	OR 22	North Santiam	1.68	13.74	Freeway
227	OR 126	Eugene-Springfield	3.49	9.04	Freeway

There are five barrier systems appropriate for use in the medians of freeways in Oregon. They are listed below. The minimum median widths listed in Table 400-4 are to be used as the minimum median width needed in order to use a specific barrier type. Standard median widths are covered in Part 300, Section 309.12 4R Urban and Rural Freeway Medians. Refer to 405.1 for concrete barrier guidance and AASHTO's Roadside Design Guide for barrier deflection.

Table 400-4: Median Barrier Systems

Barrier Type	Test Level	TL 3 Tested Deflection	Minimum Median Width	Comments
42-inch F-Shape Precast Concrete Barrier	NCHRP 350 TL 4	30 inches (unanchored)	8'-4"	Anchored deflection estimated to be 0 – 6 inches. Requires asphalt pad for placement.

Barrier Type	Test Level	TL 3 Tested Deflection	Minimum Median Width	Comments
Modified Thrie-Beam for Medians	MASH TL3	TBD	8′-4″	Installed system approximately 42 inches wide
High Tension/ Low Maintenance Cable Barrier	MASH TL3, 4	Variable 6 – 9 feet	30 feet	Only system that can be placed on a 1:6 up to a 1:4 slope. Easy to maintain. Consider using TL 4 if trucks are a known problem.
32-inch F-Shape Concrete Barrier	MASH TL 3	30 inches	8′-4″	
Metal Median Guardrail	TBD	24 inches	24 feet	

Median barrier should be installed on a transverse slope of 1:10 or flatter. In medians wider than 30 feet it is preferred to use cable barrier placed near the center of the median. If placed away from the center, ensure that there is enough room for deflection to the closer side. For help in determining how to install barrier in a variable median see Sections 5.6 and 6.6 of "AASHTO's Roadside Design Guide - 2011"

405.8 Impact Attenuators

Place holder

Section 406 Roadside and Median Trees

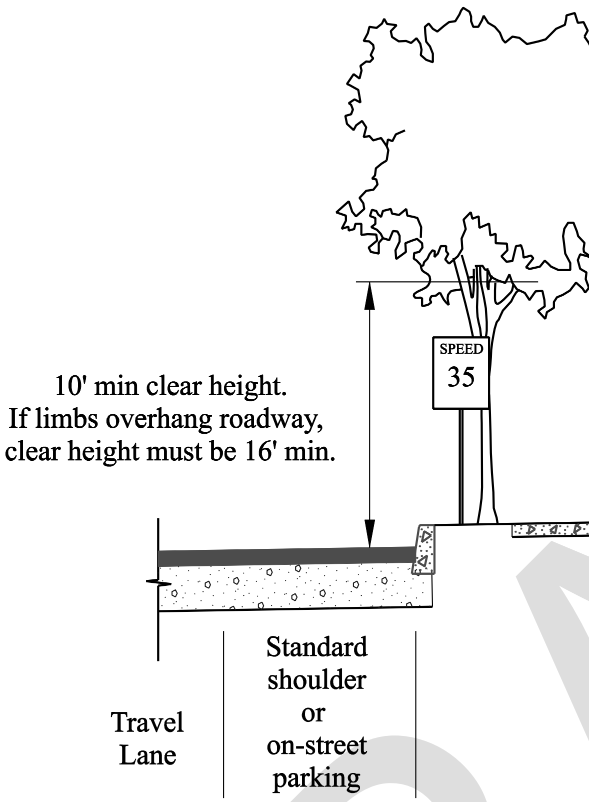
406.1 Roadside Trees

The following is intended to provide for the placement of street trees at the discretion of project teams where the criteria are met. If street trees are to be placed in a location where any of the criteria are not met, a design exception is required. (See Part 300, Section 308 Median Design for the placement of trees in the median.)

Standard criteria to allow roadside trees:

1. Design speed of 45 mph or less.
2. Trees located behind a positive (physical) delineation, i.e. curb.
3. The section is urban, suburban or a rural to suburban transition zone.
4. Trees may be located in the planter strip between the curb and sidewalk where the posted speed is 35 mph or less and there is a standard shoulder or on-street parking.
5. A minimum clear height of 10 feet from the pavement to the bottom of the branches not overhanging the roadway. This requirement allows for clear height of pedestrian use on sidewalks and allows sight distances to be clear. If the limbs overhang the roadway, a minimum clear height of 16 feet must be provided to prevent high loads from striking the branches.

Figure 400-3: Roadside Tree Clearance

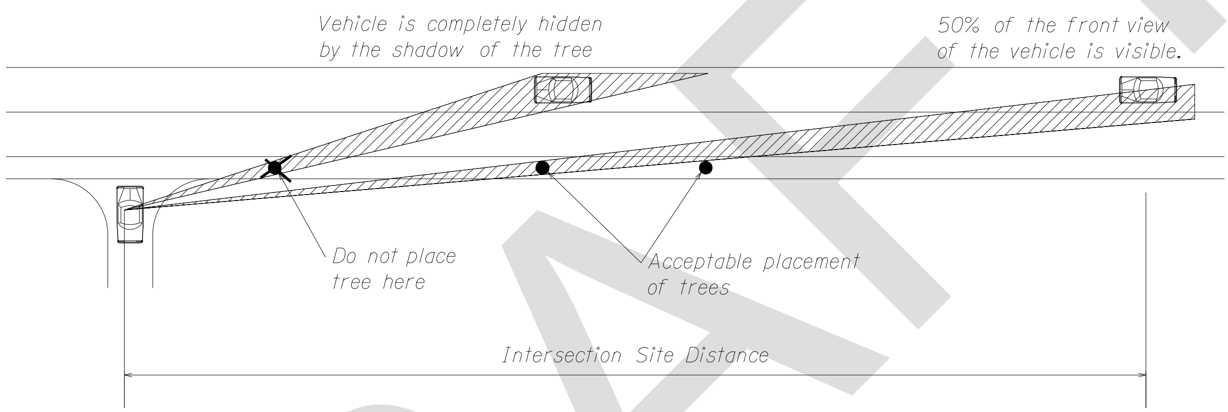


1. When the design speed is 45 mph or less and if the shoulder is nonstandard, or if there is no on-street parking, trees should be located such that there is at least 6 feet from the edge of travel to the trunk of the tree at maturity.
2. Where the posted speed is greater than 35 mph, trees should be located behind the sidewalk or at least 6 feet beyond the curb to the trunk of the tree at maturity.
3. If there is no positive delineation such as a curb, or if the design speed is greater than 45 mph, trees should only be located beyond the clear zone recommended in the AASHTO "*Roadside Design Guide - 2011*".
4. Trees may only be placed within the Intersection Sight Distance Triangle (ISD) such that at least 50 percent of an approaching AASHTO defined "P-vehicle" remains visible at all times and at all approaches when the tree reaches maturity. Fifty percent visibility is measured against what would otherwise be visible if there were no sight obstructions from trees, street furniture, utility poles, vertical curves, etc. For example, if 25 percent of the vehicle is hidden behind a vertical curve, street trees could only block an additional 25 percent of the vehicle. If 50 percent or more of the vehicle were hidden behind a vertical curve, it would not be appropriate to further reduce visibility by planting trees.

5. Consideration must also be given to pedestrians and bicyclists visibility at intersections when selecting tree species and placement. Nearer to the intersection increases the importance of clear visibility lines for drivers to see all users.

The illustration below is only a sample of a shadow diagram. Because of the many variables, shadow diagrams must be drawn on a case-by-case basis. Note that ISD applies equally to all approaches and shall be determined by a design professional. Refer to the AASHTO Green Book for the procedure to determine ISD.

Figure 400-4: Roadside Tree Placement



If the above criteria are met, then the combined effect of the following factors should be considered to determine if street trees are appropriate:

- **Access control** – When the number of approaches is reduced, a greater area is generally available for trees. If there are frequent approaches, it may not be possible to provide trees and at the same time provide adequate visibility at road approaches.
- **Crash history** – Trees should not be placed where there is a history of run-off-the-road accidents or a high potential for such accidents.
- **Environmental value** – Aesthetics, air quality, etc.
- **Clear zone guidelines** – Recognize that if trees are located within the clear zone recommended in the AASHTO *"Roadside Design Guide - 2011"*, they pose a hazard to errant vehicles.
- **Traffic calming** – Tall trees may have a slowing effect on drivers as they provide a tall vertical element on the side of their field of vision.
- **Horizontal alignment** – Run-off-the-road accidents occur more frequently on curves. Trees should not be placed in high-crash locations.

- **Vertical alignment** – If visibility is already compromised due to a poor vertical alignment, street trees may compound the problem.
- **Shy distance to tree** – A minimum of 6 feet from the edge of travel to the trunk of the tree is desirable, when the design speed is 45 mph or less.
- **Signing** – Landscaping plans should show the location of all signs ensuring that trees do not interfere with visibility.
- **Other roadway uses** – Trees need to coexist with utilities, miscellaneous street furniture, etc.
- **Transportation system plans and city ordinances** – Roadside trees are often identified as desirable or required within cities or urban unincorporated areas.

If street trees are included in a project, an appropriate species needs to be selected taking into consideration the dimensions of the tree at maturity, the planter width required to support the root system, etc. An ODOT roadside development professional should be contacted for further information.

406.2 Median Trees

The following is intended to provide for the placement of median trees at the discretion of project teams where the criteria are met. If median trees are to be placed in a location where any of the criteria are not met, a design exception is required.

Standard criteria to allow median trees:

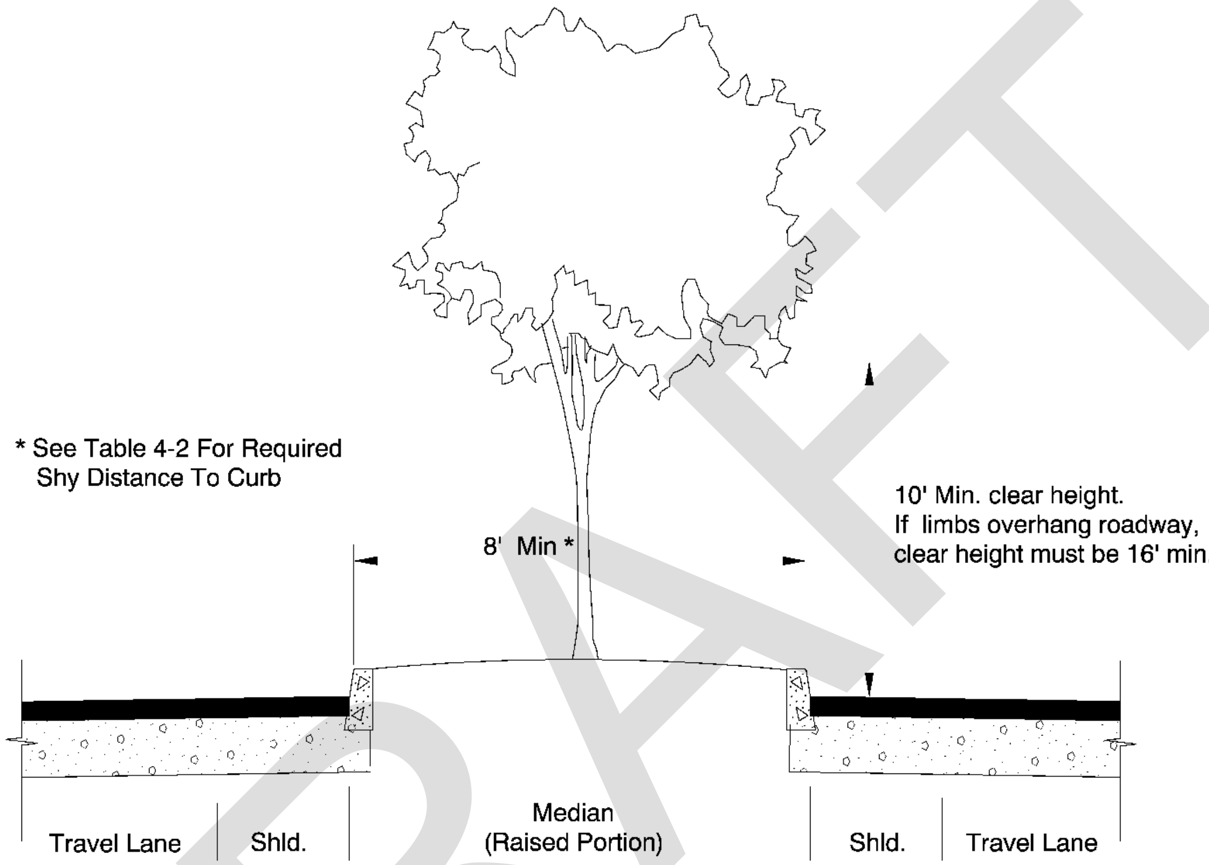
1. Posted speed of 35 mph or less
2. Trees located behind a positive (physical) delineation (i.e. curbed – raised median).
3. The section is urban, suburban or in a rural to suburban transition zone.
4. A minimum clear height of 10’ from the pavement to the bottom of the branches. If the limbs overhang the roadway, a minimum clear height of 16’ must be provided.
5. A minimum median width of 8’ from curb to curb.
6. Trees may only be placed within the Intersection Sight Distance Triangle (ISD) such that at least 50% of an approaching AASHTO defined “P-vehicle” remains visible at all times when the tree reaches maturity. 50% visibility is measured against what would otherwise be visible if there were no sight obstructions from trees, street furniture, utility poles, vertical curves, etc. For example, if 25% of the vehicle is hidden behind a vertical curve, median trees could only block an addition 25% of the vehicle – If 50% or more of the vehicle were hidden behind a vertical curve, it would not be appropriate to further

reduce visibility by planting trees. Note that ISD applies equally to all approaches & should be determined by a design professional.

If the above criteria are met, then the combined effect of the following factors should be considered to determine if median trees are appropriate:

- **Access Control** – When the number of median openings is reduced, a greater area is generally available for trees. If there are frequent openings, it may not be possible to provide trees and at the same time provide adequate visibility between left turning vehicles, oncoming traffic, and other roadway users.
- **Crash history** – Trees should not be placed where there is a history of run-off-the-road accidents or a high potential for such accidents.
- **Pedestrian use** - where the median is expected to provide a refuge for crossing pedestrians, there should be frequent open areas where visibility is good. Trees can hide the pedestrian or cause the driver to believe there is a pedestrian crossing, thus taking emergency action.
- **Environmental value** - aesthetics, air quality, etc.
- **Clear zone guidelines** – recognize that median trees are generally within the clear zone recommended in the AASHTO *"Roadside Design Guide - 2011"* and pose a hazard to errant vehicles.
- **Traffic calming** - tall trees may have a slowing effect on drivers as they provide a tall vertical element on the left side of their field of vision.
- **Horizontal alignment** – run-off-the-road accidents occur more frequently on curves. Trees should not be placed in high crash locations. See AASHTO's Roadside Design Guide 2011 Table 3-2 for Horizontal Curve Adjustment Factors for clear zone widths.
- **Vertical alignment** – If visibility is already compromised due to a poor vertical alignment, median trees may compound the problem.
- **Shy distance to tree** – a minimum of 6' from the edge of travel to the face of the tree is desirable.
- **Other Roadway uses** – Trees need to coexist with utilities, signs, misc. street furniture, etc. Need to consider future needs.

If median trees are included in a project, an appropriate species needs to be selected taking into consideration the dimensions of the tree at maturity, the median width required to support the root system, etc. An ODOT roadside development professional should be contacted for further information.



Section 407 Fences

407.1 Right Of Way Fence

There are two types of fence typically used as access control or right of way fences. A Type 1 fence is a barbed wire fence with 4 or 5 strands of barbed wire. A Type 2 fence uses a woven wire fabric with 3 strands of barbed wire above the woven wire fabric. When determining the type of fence to use, consideration for the type of livestock present may be a factor.

For all freeways, fence will be placed at the access control line. In other situations fencing shall be a consideration in the right of way agreement and installed when required by that agreement.

407.2 Chain Link Fence

The installation of chain link fence, located in clear zones, should be done without the use of the top rail. FHWA has reviewed the use of top rail installations and considers the use of top rail or pipe rail hazardous. They do not recommend using this type of support for chain link fences or pedestrian hand rails where they can be struck by an errant vehicle. In the event of a crash, the rails can penetrate the passenger compartment of vehicles. Chain link fences with top rails are particularly poor as vehicle impact on the fabric tends to pull the rail down onto the hood of the vehicle and into the windshield. Top rails, or other rigid horizontal rails or members, metal or wood, should not be used within the clear zone on projects.

407.3 Snow Control

On the Cascade and Siskiyou Mountain passes and east of the Cascades, drifting snow may be a serious problem. Snow fencing can eliminate the need for snow removal, lower pavement maintenance costs, and increase visibility and safety on the road. The following factors should be considered:

♦ Investigation

The direction of the prevailing winter winds must be determined before effective measures can be taken to prevent snowdrift problems. Personal observations, interviews with persons familiar with the local winter conditions, including the ODOT maintenance foreman, and reviews of local records may be of value.

♦ Grade

Highway grades above the surrounding ground are much less subject to drifting because of wind action. A cut section of highway may act as a natural fence, impeding the steady flow of wind, resulting in snow being deposited on the roadway.

♦ Cross-Section

It may be possible to reduce or eliminate drifting snow problems by streamlining the roadbed. Steep slopes and obstructions to air movement cause snow drifts. Any flattening of the slopes will reduce the areas where snow is deposited on the road. Guardrail is particularly objectionable and wherever feasible should be eliminated by flattening fill slopes. In cut sections the intersection of the cut with natural ground should be back of a 1:6 slope measured from the edge of the shoulder. Widening the cross section through cuts may be desirable to provide for snow storage.

When considering the use of flat slopes for reducing snowdrift problems, the impacts on the safety and aesthetics of the highway should also be considered.

♦ Control with Snow Fences

Snow fences may be required where control cannot be obtained by other methods. It is necessary that any snow fence be properly located and placed. Snow fences are generally placed parallel to the roadway if the prevailing wind is within 25 degrees of being perpendicular to the roadway otherwise the snow fence is placed perpendicular to the prevailing wind direction and at a distance from the roadway centerline that is equal to 35 times the fence height. If a higher than required fence is used the distance from the roadway centerline can be reduced to 18 times the fence height. Snow fence placement depends on a study of conditions at the site, particularly the direction of prevailing winds. A snow fence, in order to function properly, must have an adequate distance behind it to allow for the piling of snow, called snow storage room. The fence itself impedes the wind flow, thereby creating a swirling action behind the fence resulting in the snow being deposited. Ordinarily snow fences should be placed so that the distance from the fence to the top of cut or bottom of fill is 10-15 times the height of the snow fence. If a snow fence is too close to a highway, or a cutbank exists without adequate snow storage room, it can be more of a problem than a solution. A minimum snow storage distance is based on the site conditions.

Two or more parallel rows of fences may be required, but these should be placed far enough apart so the resulting drifts do not overlap, generally 25 times the height of the fence between the snow fences allow non-overlapping snow drifts to form. Snow fences should not be placed any closer than 16 feet to right of way fences or natural parallel barriers.

♦ Control with Landscaping

Trees and shrubs planted at the appropriate location may also provide a permanent and effective type of snowdrift control. An ODOT roadside development professional should be contacted.

Additional information may be obtained from the *ODOT Inspector's Manual* and the *ODOT Maintenance Manual*.

Part 500 Intersection Design

Section 501 Introduction

Part 500 covers the design criteria, guidelines, and processes for designing road approaches, signalized and unsignalized at-grade intersections and roundabouts for all road classifications and contexts on the State Highway system. For information on general design considerations not fully covered in this chapter, or other parts of this manual, refer to AASHTO's most recent version of "*A Policy on Geometric Design of Highways and Streets*" Chapters 9 and 10; the ODOT research report "*Modern Roundabouts For Oregon, Report 98-SRS-522*" and "*NCHRP Report 672, Roundabouts an Informational Guide*", second edition. In addition, supplemental information can be found in National Association of City Transportation Officials (NACTO) publications, including Urban Street Design Guide, Urban Bikeway Design Guide and Don't Give Up at The Intersection.

The Technical Services, Roadway Unit can provide design assistance in the areas of intersection design, channelizations, road approaches, roundabouts, large vehicle accommodation, and alternative mode accommodation. Consult the Technical Services, Roadway Unit about complex intersection designs that cannot meet the criteria contained in this design manual. Information on traffic volumes and requirements can be found in Part 1200, Sections 1205 and 1206 of this manual or further information can be obtained from Region Traffic Units and the Analysis Procedures Manual published by the Transportation Planning Analysis Unit (TPAU) of the Transportation Development Division of ODOT.

501.1 Definitions

Access Control Line - A line established along the state highway where the right of access between a property abutting the highway and the highway has been acquired by the department or eliminated by law.

Alternate Access - The right to access a property by means other than the proposed approach. It may include an existing public right of way, another location on the subject highway, an easement across adjoining property, a different highway, a service road, a local road, or an alley, and may be in the form of a single or joint approach. The existence of alternate access is not a determination the alternate access is "reasonable" as defined in ORS 374.310.

Approach - A Legally constructed public or private connection that provide vehicular access to or from a state highway that has written permission under a Permit to Operate issued by the department, the department has recognized as grandfathered, or the department does not rebut as having a presumption of written permission.

Grandfathered approach - An approach that the department has recognized in documentation dated prior to January 1, 2014 as having grandfathered status under the rules in effect on the date of the documentation.

Grant of Access - The Conveyance of a right of access from the department to an abutting property owner.

Section 502 Road Approaches and Intersections

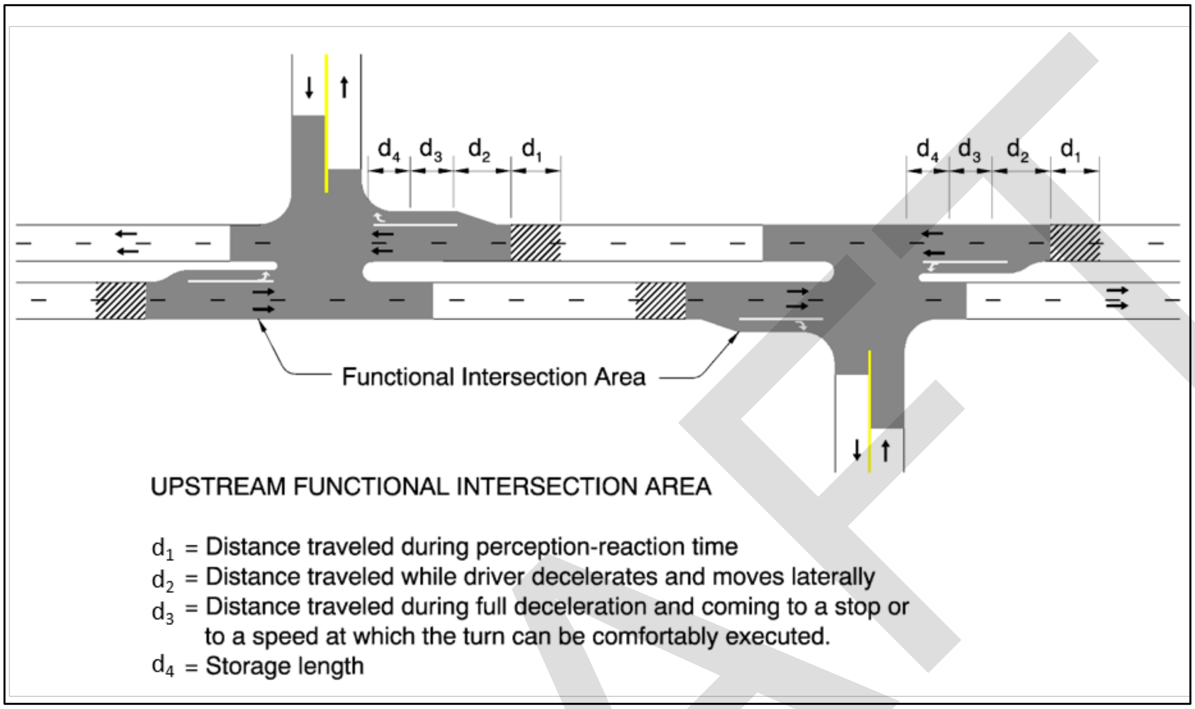
502.1 General

The location and spacing of road approaches should be in conformance with the Access Management standards as described in the Oregon Highway Plan, Appendix C. The decision for placement and design of a road approach must be consistent with the function of the highway and optimize the safety and operational efficiency for vehicles as well as all users of the roadway no matter their modal choice. The road approach design must accommodate the turning movements of the appropriate design vehicle. All road approaches, public and private, require a construction permit from the appropriate District Maintenance Office. The District Manager and Region Access Management Engineer and/or Access Management sub-team should be involved early in any road approach discussion and decisions.

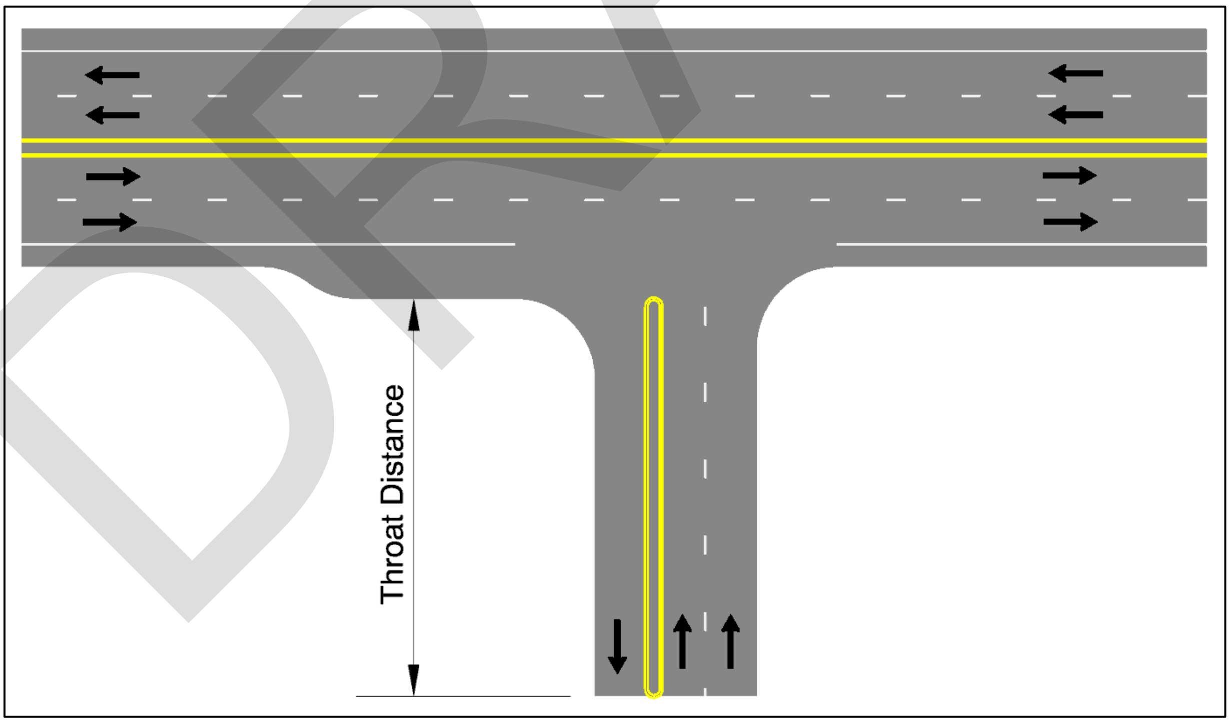
Road approaches can be classified as either private or public. Private approaches connect private property with a state highway across the highway right of way. Public approaches are at-grade intersections of public roadway right of way with a state highway.

Both its physical area and its functional area define an intersection or approach. The physical area is the fixed area of the intersection itself from curb-to-curb confined within the corners of the intersection. The functional area of an intersection extends both upstream and downstream from the physical area and includes any auxiliary lanes or channelizations. The functional area includes the Perception-reaction distance, the deceleration maneuver distance, the full deceleration distance and the storage length. Ideally, approaches to the highway are not constructed within the functional area of an adjacent intersection. Realistically, however, there are many factors that enter decisions regarding placement of approach connections. The roadway designer must consider all aspects and constraints when designing roadway approaches and provide the best overall connections possible. Figure 500-1 displays the functional area of an intersection.

1 Figure 500-1: Functional Intersection Area



3 Figure 500-2: Throat Distance at Approaches

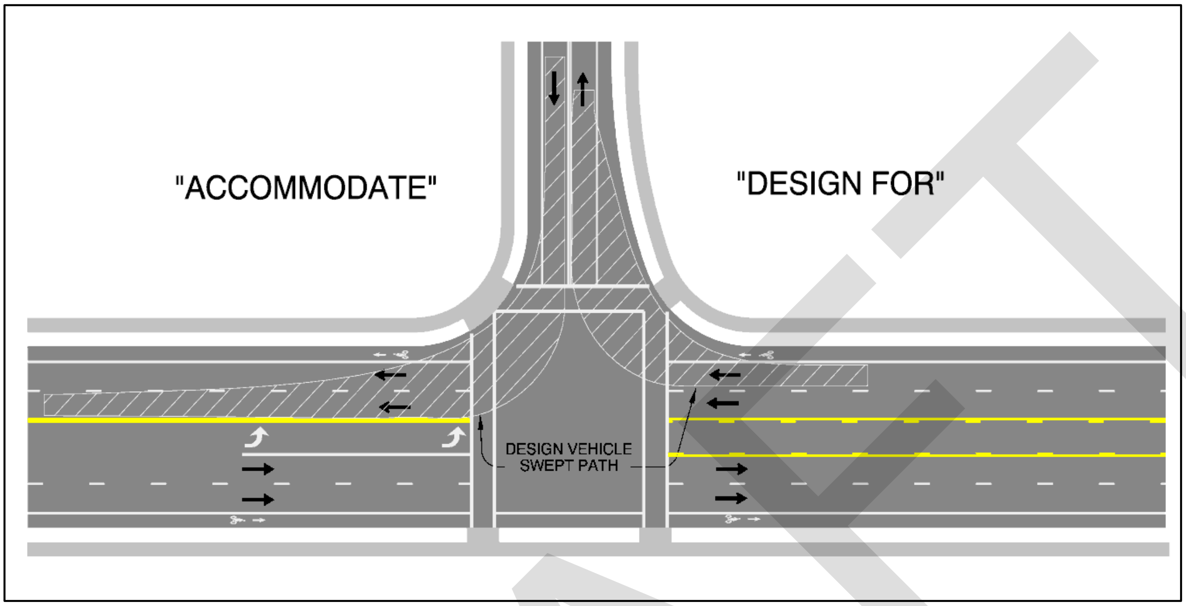


For approach connections from properties adjacent to the highway, the corresponding site circulation plan should specify the entry/exit throat distance. This throat distance is critical in order to provide an efficient and functional connection between the highway and the adjacent property. Throat lengths are critical for commercial and industrial type land use approaches. The Transportation Planning Analysis Unit or the Region Access Management Engineer can assist with determining the appropriate throat distance. Figure 500-2 depicts the typical throat distance concept.

An important concept concerning the design vehicle when designing an intersection or road approach is the concept of "accommodating" the design vehicle or "designing for" the design vehicle. When an intersection is designed to accommodate the design vehicle, the intent is to provide enough physical space for the design vehicle to maneuver and turn through the intersection, but may not be able to do so within the confines of a single lane. When an intersection is designed for the design vehicle, the design provides appropriate turning and maneuvering space to allow the design vehicle to remain within one lane. While it is advantageous to design for the largest vehicle using the approach, often real world constraints make it difficult or impossible to achieve. Designing all approaches for a WB-67 type vehicle certainly provides a level of comfort for the variability of vehicles using the approach. However, not all approaches have a high need for WB-67 access. Freight distribution centers and industrial locations will most certainly need approaches and access designed for WB-67 type vehicles. However, most commercial and retail locations may only need access designed for single axle (SU) type delivery vehicles with accommodation for the occasional WB-67 type vehicle.

The designer must realistically consider the needs of the approach and design accordingly. Being judicious and fully analyzing the needs of an approach connection to create a design specific to the location can improve roadway conditions overall for all modal users of the state highway system. Providing too large an approach than necessary is not only inefficient in cost, but can also have detrimental effects for other roadway users. Figure 500-3 illustrates the "Accommodate" and "Design For" concept.

Figure 500-3: Accommodating and Designing for a Design Vehicle



Section 502.1 is not intended to be a detailed discussion of approach road design. For more detail on approach road or median design refer to Section 506, and Parts 200 and 300.

502.2 Legal Considerations for Road Approaches

The legal issues involved with approaches are specialized and complicated. Refer to the "Access Management Manual" for access rights and road approach issues. This manual includes information from "Oregon Administrative Rules, Chapter 734, Division 51 – Access Management," that defines legal criteria relating to road approach permitting and design. Additional information on access management can be found in Section 503.

502.3 Intersections and Interchanges - Expressways

Connections to both urban and rural expressways can be either at-grade intersections or grade separated interchanges. At most rural expressway locations, the preferred connection type is grade separation. However, there are many factors to consider in the design of these types of connections. For urban and Rural interchange spacing (crossroad to crossroad) and other design criteria see Part 600. Table 600-2 provides information for spacing criteria.

Section 503 Access Management and Access Control

503.1 Access Management

Access management is a tool available to designers, planners, and other transportation professionals to improve traffic safety, capacity, and efficiency while promoting economic development. The benefits of managing access to highways are well documented. Good access management techniques and strategies when designed properly along state highways will reduce the overall number of crashes and increase the highway's capacity. This section is not an exhaustive description of all the rules, laws, and techniques related to access management, but outlines some of the basic concepts, definitions, and appropriate tools for use on Oregon State Highways.

Access management is an important tool for maintaining the safety and functionality of a highway segment. In rural environments, access spacing should conform to the standards contained in OAR 734 Division 51.

There are several documents that designers, planners, and field staff are encouraged to review to get a big picture understanding of access management. These include:

1. OAR 734 Division 51 – These are the administrative rules that the Department must comply with in carrying out the access management in permitting, planning, and project delivery.
2. Project Delivery Leadership Team Operational Notice PD-03 describes the accountabilities and deliverables for access management during project development.
3. Access Management Manual - This manual consists of three volumes covering legal, technical, and procedural information and resources for the department's access management program. Volume 1, Chapter 3 entitled Guidelines and Resources for Access Management in Project Development provides guidance for implementation of project delivery operational notice PD-03. Volume 2 of the manual houses technical papers on various aspects of access management such as sight distance, access spacing, interchange management, functional intersection areas, and medians. Volume 3 is a user's guide for the Central Highway Approach/Maintenance Permit System (CHAMPS). CHAMPS is a computer-based system that is used by department staff to document the permitting process and issue approach permits.

503.2 Access Management - Expressways

Access management is critical to retaining the efficiency, safety, and function of an expressway. The expressway designation implies higher mobility along the corridor over access to individual properties. In general, private land access is limited where the property has alternative access. Expressways should discourage private access and focus connections at public roads. In some cases this may require building alternate access to the property or the purchase of access rights. Existing private accesses should be eliminated when possible during project development. Additionally, public road connections that do not meet the spacing standards should be eliminated where possible during project development and in accordance with any adopted access management plans for the highway. If possible, full access rights should be purchased along the length of the expressway with access points only allowed at public roads that meet the spacing standards contained in Appendix C of the Oregon Highway Plan. The spacing standards can also be found in OAR 734-053-4020. Breaks in the access control line should only be given for those roadways that are connected during construction. All other future connections must obtain a grant of access to be connected. (See Section 503.7 for more information on the Grant of Access process.) The intent of this access control is to manage the number and locations of vehicular access to the expressway and to minimize potential conflict points along high speed, mobility centric highways. Where a multi-use pathway is provided along the expressway, connections for bicyclists and pedestrians to the local road system are strongly encouraged. These types of connections should be designed so that motorized vehicles are precluded from using them. For specific information regarding access management and Expressways, see the Oregon Highway Plan and OAR 734, Division 51.

503.3 Access Management Plans

An access management plan is a useful management tool. An access management plan can be done as part of an ODOT STIP project or during a coordinated planning study. Access management plans developed in a coordinated planning process establish a plan for accessing properties in the future. An access management plan essentially is a detailed plan outlining how adjoining properties are to be accessed during project development.

503.4 ODOT Permit Process

The ODOT Permit Process is also outlined in OAR 734 Div. 51. See OAR734-051-1070(30) for information on "Grandfathered" accesses. All approaches to a state highway must have department permission to be considered legal. Through the permitting process ODOT can negotiate access designs, approach configurations, turn movement restrictions, and even shared approaches. Properties with multiple approaches can be modified to provide the minimum number needed. Again, designers should work closely with the Region Access Management Engineers when making approach permit type of decisions. The authority for issuing permits resides with the District Manager or designee.

503.5 Access Control

Access Control is a term established in Oregon Right-of-Way and Access Rights statutes. A property that is access controlled has no right of access between the property abutting the highway and the highway. Interstate highways and freeways are access controlled with access only through grade- separated interchanges at public streets and highways. There is no access provided to adjoining private properties. Generally, expressways with grade-separated interchanges are access controlled. However, expressways with at-grade intersections may or may not have access control lines established. Preference is to establish access control on urban and rural expressways, but it may not always the case.

Acquiring the access rights from properties abutting a state highway provides a high level of protection to the highway. However, acquiring access control is not justifiable in all conditions. The Department has developed guidelines for access management decisions during project development. These guidelines are contained in Transportation Operations Bulletin PD-03a. They attempt to focus the Department's limited resources for projects that really need access control. Additional guidance can be found in OAR 735, division 51.

503.6 Access Control - Expressways

Maintaining access control on rural expressways is critical to retaining the safety and efficiency of the facility. No private approaches should be allowed on rural expressways. When an expressway is established along a highway, or if there are existing private approaches, a long term plan should be established to eliminate them or provide alternative access as opportunities occur. Public road connections are controlled and spaced according to the access management spacing standards contained in the Oregon Highway Plan, Appendix C. Spacing standards can also be found in OAR 734-053-4020. Traffic signals are not recommended on rural expressways, and modernization of expressways that have traversable medians will typically result in non-traversable medians.

503.7 Grants of Access

A Grant of Access is a transfer of a property right to a property owner for a right of access at a particular location. The Department must follow the requirements of OAR 734 Div. 51 when issuing Grants of Access. Obtaining a Grant of Access can be a complex process. Before even considering a Grant of Access as part of a project, the designer should contact the Region Access Management Engineer.

Section 504 Access Management Design Tools

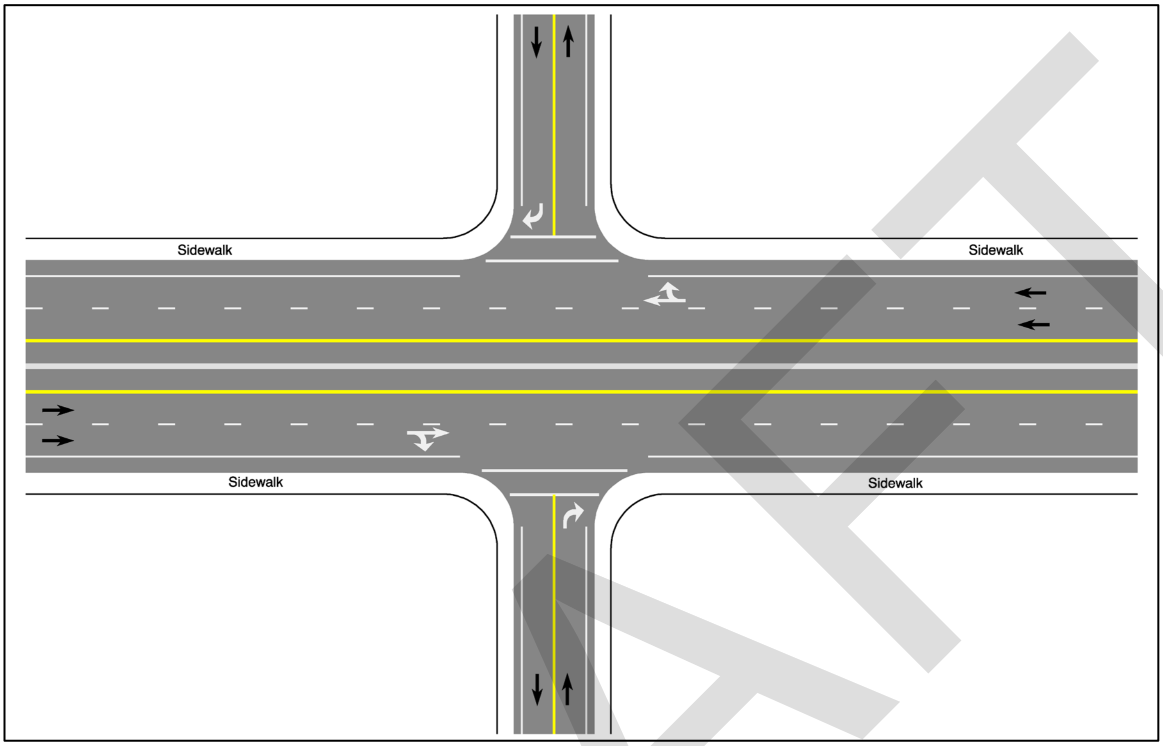
504.1 Right In – Right Out Only

Restricting an approach road to right turns in and out only is accomplished by the installation of a non-traversable median. In urban environments this median should be a raised curb style. In more rural environments the median could be raised curb, median barrier, or depressed median. Controlling the median with a non-traversable design is the only design that provides a positive reinforcement of the turn restrictions. Figure 500-4 and Figure 500-5 show some examples of median designs limiting approach roads to right turns only. Figure 500-6 shows the benefits of median control involving pedestrians. For more information on median design, refer to Part 300, Sections 308 through 312. For more information on approach road design, refer to Section 101 and Section 506.

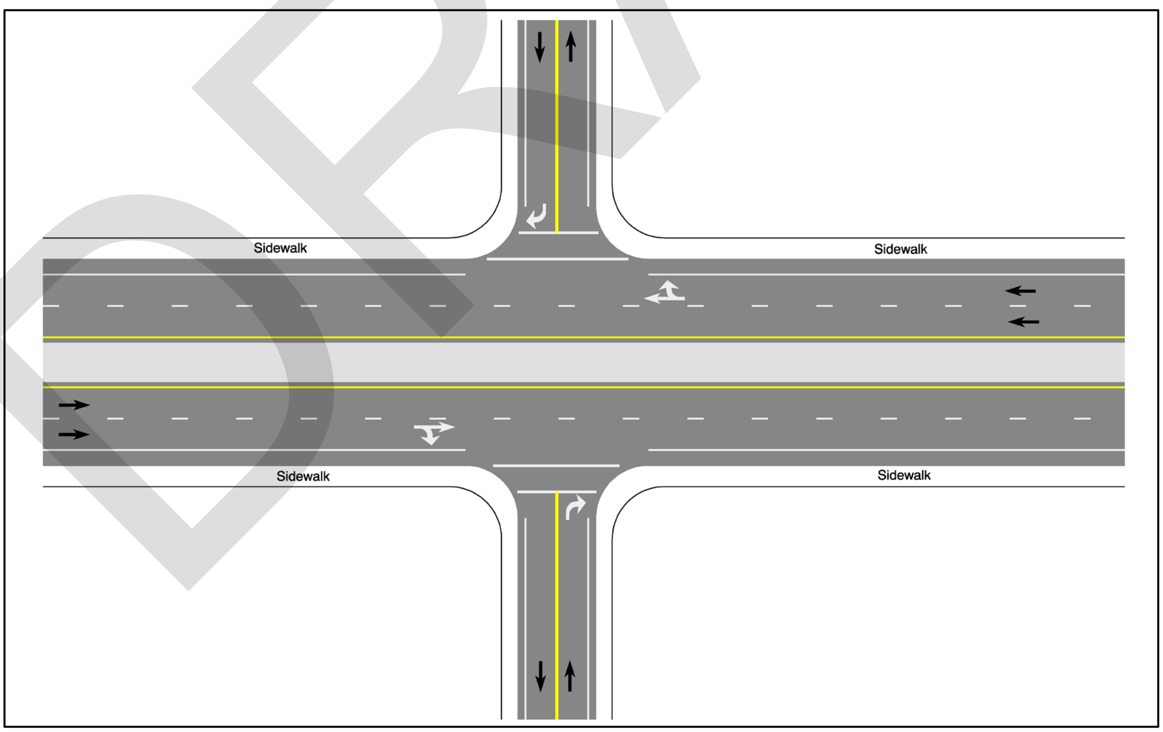
Note: The addition of any median treatment will need to be investigated for freight mobility issues and comply with ORS 366.215, Creation of state highways; reduction of vehicle-carrying capacity. For guidance in complying with ORS 366.215, see ODOT guidance document "*Guidelines for Implementation of ORS 366.215, No Reduction of Vehicle-Carrying Capacity and the ODOT Highway Mobility Operations Manual*".

Another design option that may be considered in some situations is the use of a “pork chop” design. A pork chop design consists of a channelization island, usually raised curb that directs traffic in the intended direction. The channelization island tries to discourage turn movements by angling the entry and exit so that left turn movements are uncomfortable. The problem with the pork chop design is that passenger vehicles are still physically able to make left turn movements. Most pork chop designs that do not include a non-traversable median design have a very high rate of non-compliance for the restricted movements. Therefore, a pork chop design should still include a non-traversable median design as well. Where a non-traversable median is not practical or is unacceptable, the designer should attempt to maximize the entry and exit angles to make left turn movements as difficult as possible. Figure 500-7 shows a “pork chop” design concept with median control.

1 Figure 500-4: Median Detail: Right-In Right-Out



3 Figure 500-5: Raised Median Detail: Right-In Right-Out



1 Figure 500-6: Benefits of Median Control for Pedestrians

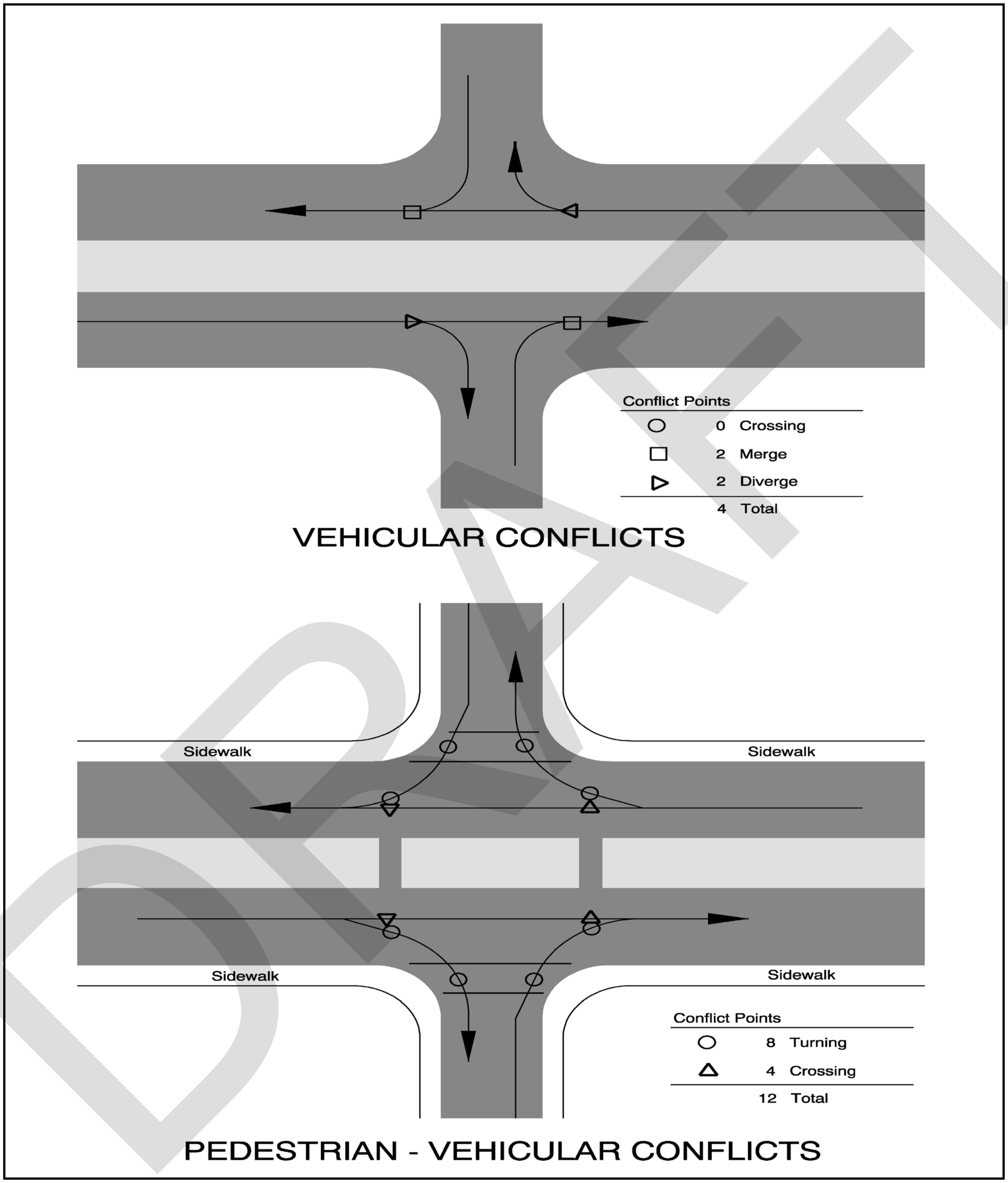
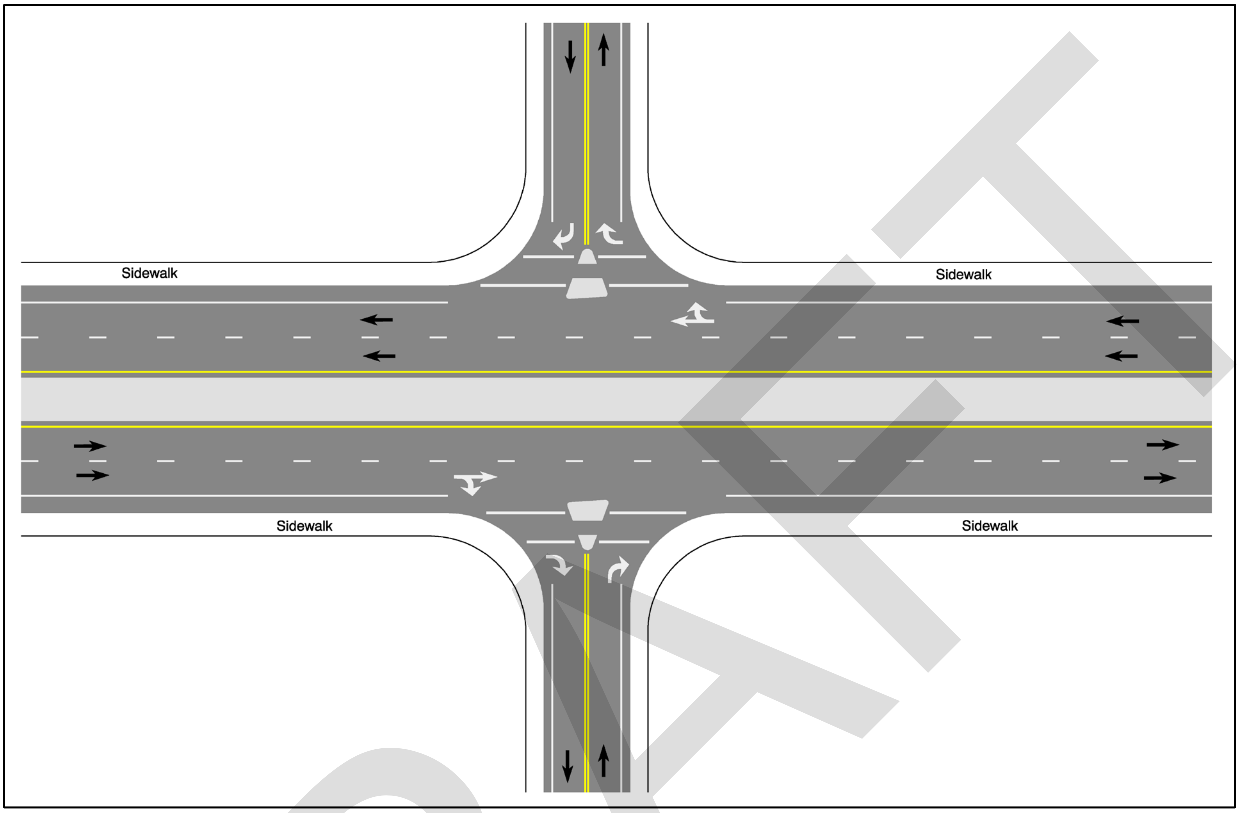


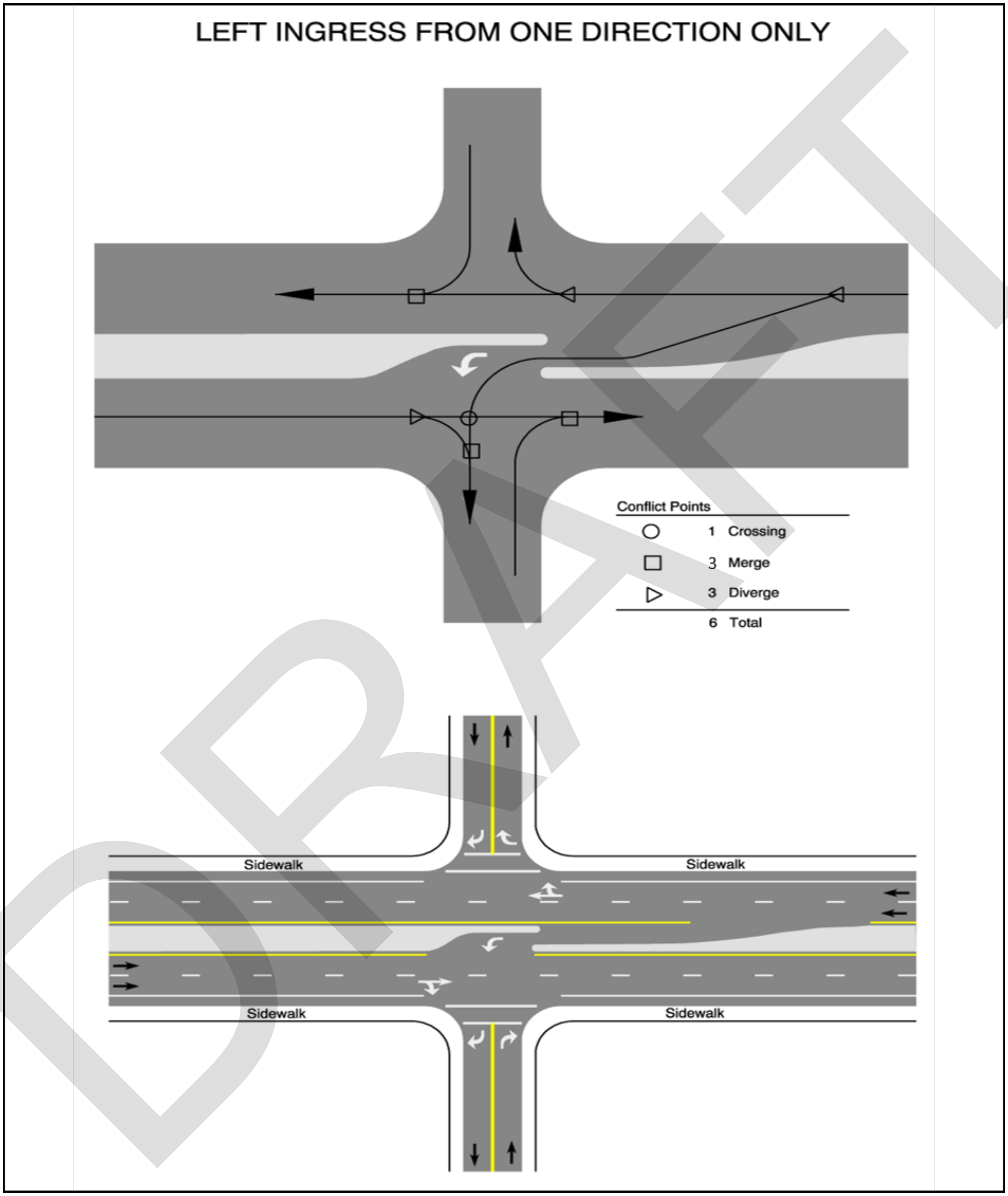
Figure 500-7: "Pork Chop" with Non-Traversable Median



504.2 Right In – Right Out with Left In

From a traffic analysis perspective, the left turn out movement from approach roads usually operates worse than all other movements. This is because in the hierarchy of turn movements, the left turn out from an approach road is the last priority. In addition, the left turns from an approach road usually experience a higher number of accidents than the other movements. Because of these factors, there are several situations where eliminating a left turn out movement from an approach road is the preferred design solution. The only effective design option for this technique is a non-traversable median. Generally the preferred median style is raised curb. Median barrier is not applicable to this design technique. When designing this type of median it is critical to physically exclude the left turn out movement. The basic concept of this design is to extend a traffic separator along the right edge of the left turn entering traffic. This separator should extend back away from the approach road far enough so that passenger vehicles cannot physically turn left from the approach road. The design still must accommodate the appropriate design vehicle. Figure 500-8 illustrates this design concept.

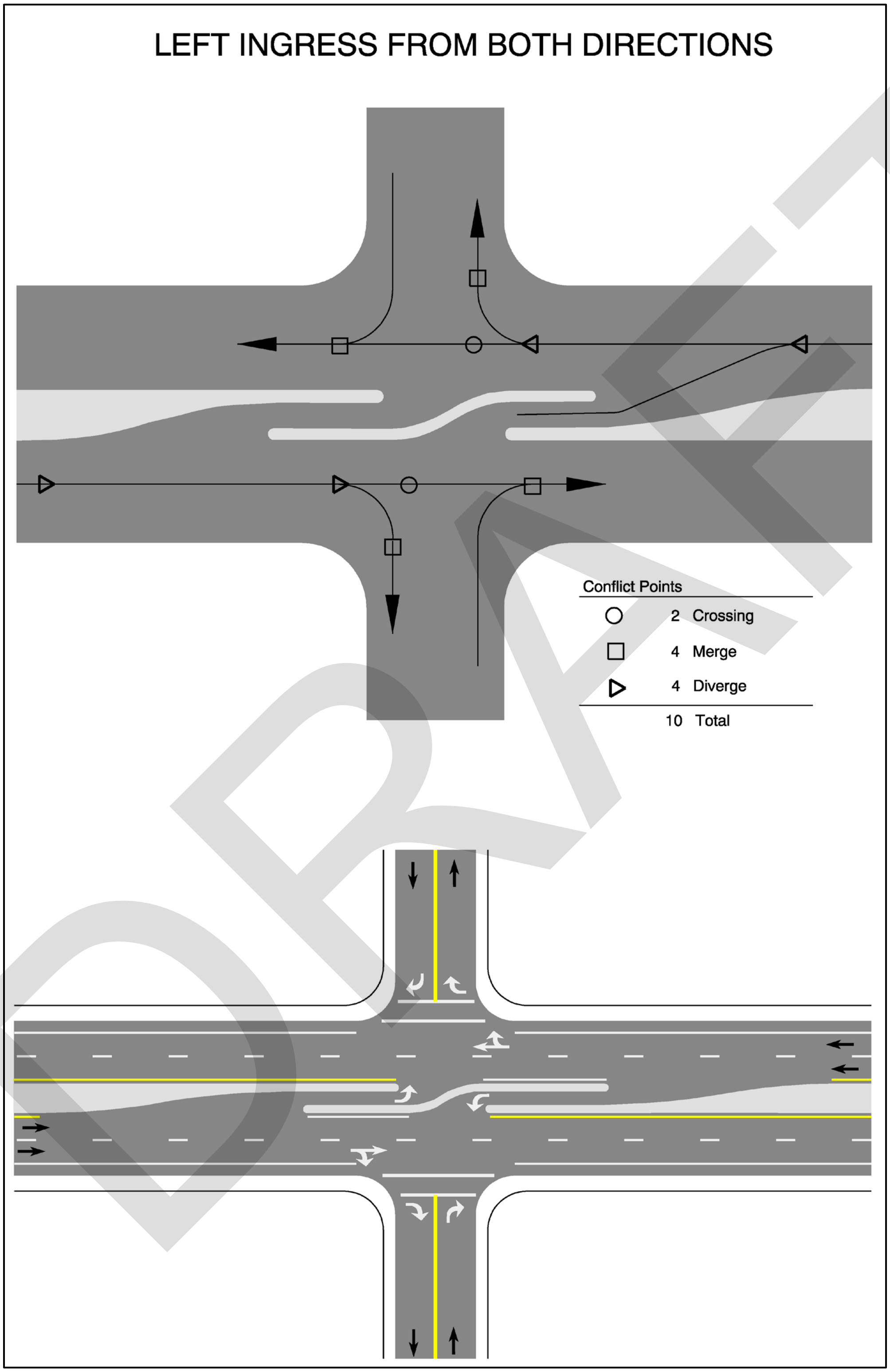
1 Figure 500-8: Right-In, Right-Out, Left-In (One Direction)



504.3 Opposing approaches with Left In

In many urban environments, approach roads will be directly opposite from each other. In some situations, eliminating left turns out of the approaches is desired. In these cases, the appropriate design is very similar to the design described in "Right Out with Left In" for a single approach restricting left turns out. The difference is the median design now accommodates opposing left turn traffic. The concept remains the same however, physically eliminate the ability for vehicles to make a left turn out movement. The difference is the traffic separator must now "snake" through the intersection transitioning from one side of the median to the other using reversing curves. The curvature is determined by the design vehicle. It is preferred with this technique to obtain additional width of the traffic separator in the middle of the median. This will provide additional visual guidance through the intersection. Figure 500-9 illustrates the use of this design concept.

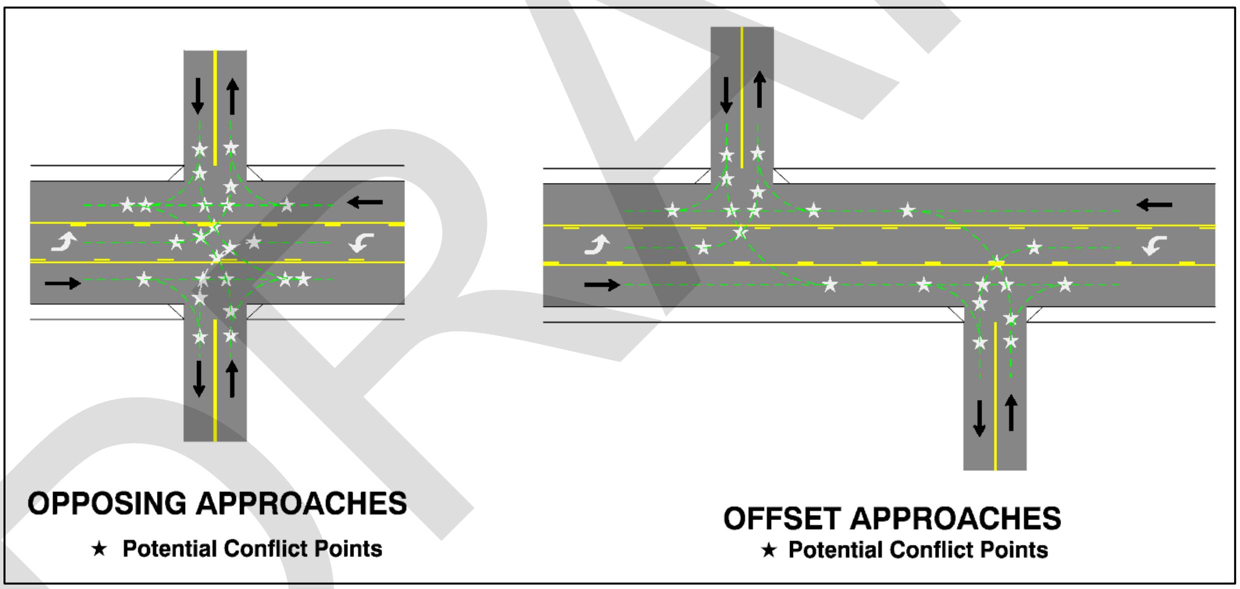
1 Figure 500-9: Opposing Approaches, Right-In, Right-Out, Left-In (Both Directions)



504.4 Offset Approaches

Primarily, this design option is used in rural or fringe areas where spacing between approach points is large. This design tool is implemented where a four-leg intersection is experiencing significant operational and safety problems. By separating the intersection into two individual intersections, the number of conflicts is reduced which should improve the safety of the intersections. If this design option is chosen, the intersection needs to be split in the correct direction. The approaches should be offset to the right in order to eliminate the back to back left turn queue conflict. The amount of the offset will vary depending upon the highway volume, approach road volume, surrounding land uses, speed of the highway, and direction of the offset. The designer considers the functional area of each intersection and the amount of weaving traffic. In addition, contact the Region Access Management Engineer and the Traffic-Roadway Section when considering offset approaches. For more information on offset approaches/intersections refer to Figure 500-10.

Figure 500-10: Conflict Points - Opposing Approaches and Offset Approaches

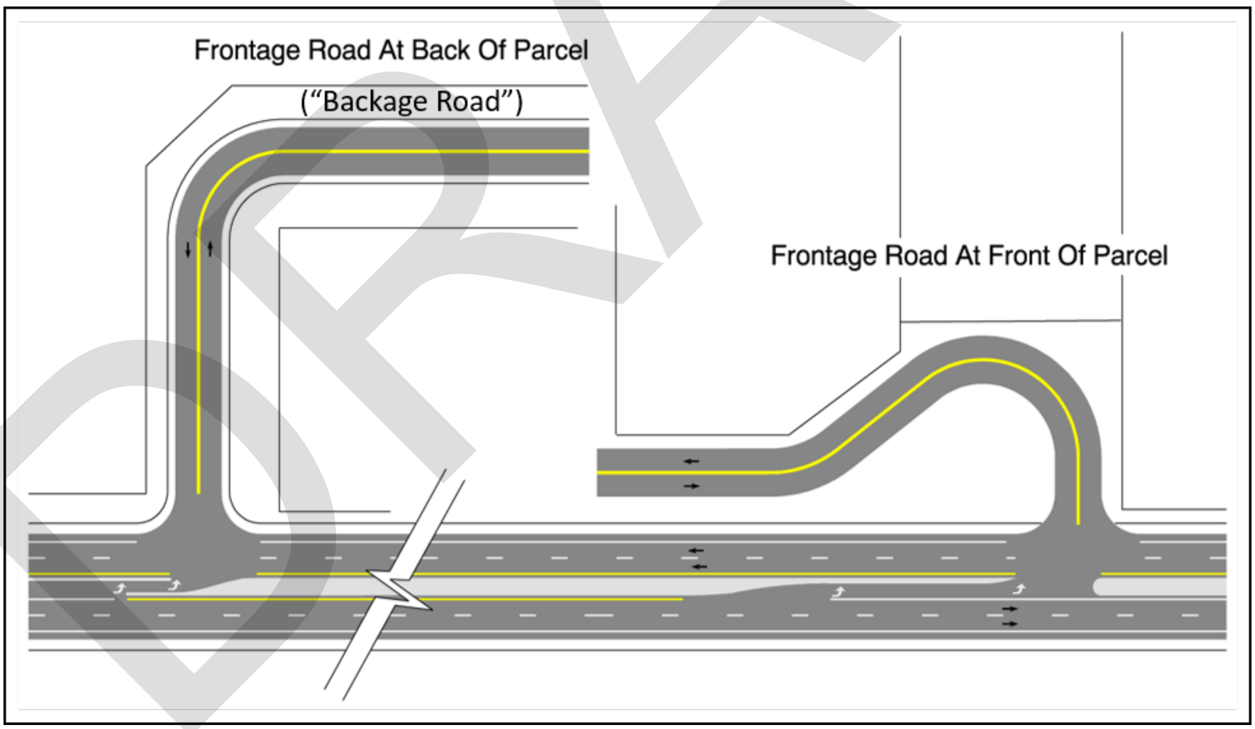


504.5 Frontage Roads

Frontage roads are a very useful design to eliminate or restrict direct highway access from a section of highway. Design frontage roads to accommodate the volume and type of traffic anticipated. Two of the most important elements of the frontage road design are the connection to the highway and turning roadway. The connection needs to be designed to accommodate the allowable turning movements for the appropriate design vehicle. If trucks are to use the frontage road, they must be considered in the design. Secondly, the design of the connection to the frontage road is critical. Usually, this connection is a turning roadway, but may be an intersection. The connection needs to provide off-tracking room for trucks using the frontage road. The design needs to consider the roadway alignment and width to make sure trucks can physically make the turns required. Finally, frontage roads should be offset from the highway so as to not interfere with highway operations. The frontage road must be physically separated from the highway by use of barriers, fencing, or ditches. The separation between the highway and frontage road edges of pavement must be at least 40 feet, but preferably 50 feet or more. The design also needs to consider clear zone requirements and the effect of headlight glare on both roadways.

Another option involving the location of the frontage road is to locate the frontage road on the back side of the adjacent properties. This is often called a “backage” road. This option may be more appealing from a visual standpoint allowing the properties to front the mainline roadway while the parking lot and frontage road are located further away from the mainline roadway. This option may also provide for better mainline/frontage road traffic operations. See Figure 500-11 or frontage road examples.

Figure 500-11: Examples of Frontage Road Locations



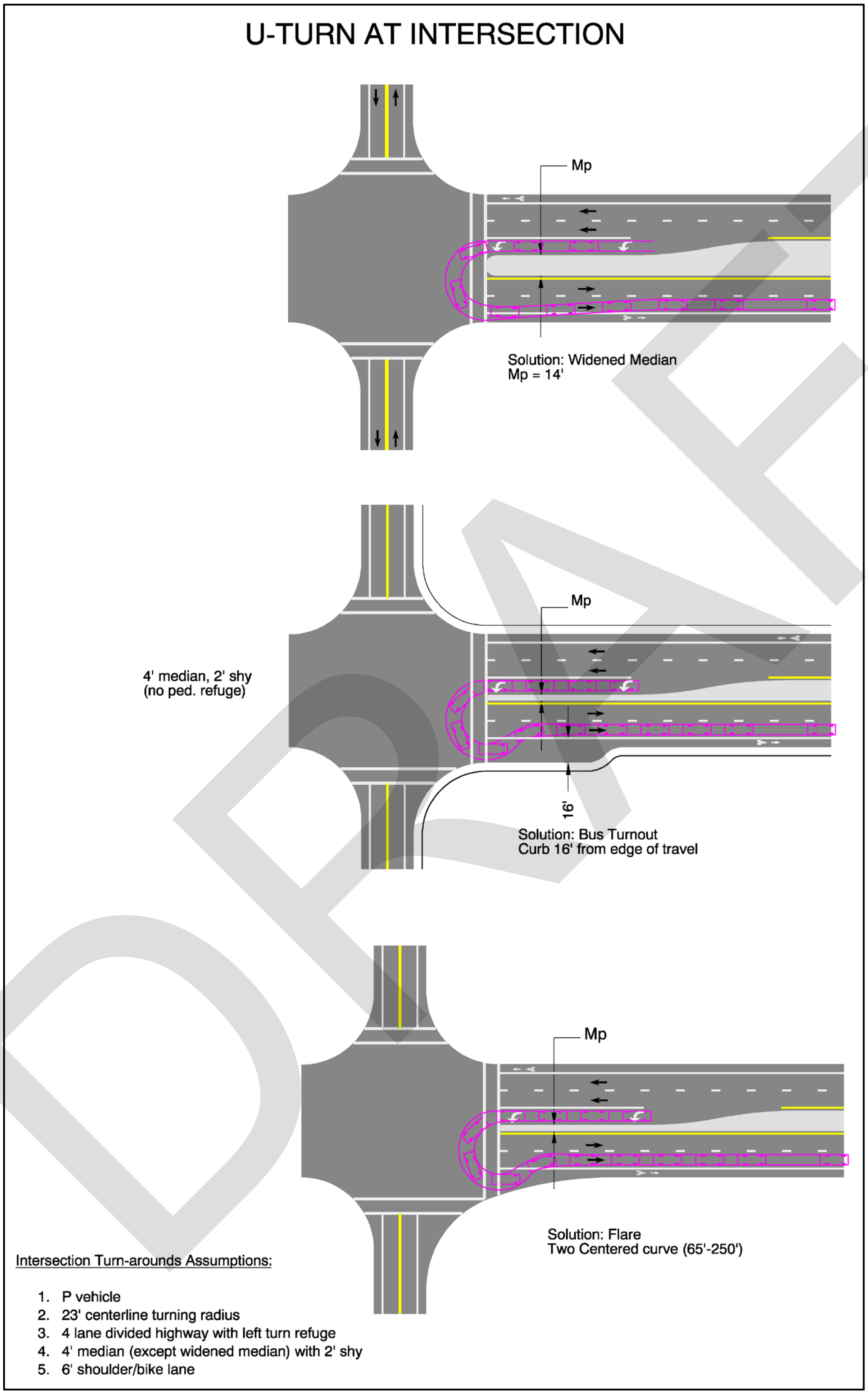
504.6 U-Turns

Where a section of highway contains a non-traversable median for an extended length, there may be a need to accommodate U-Turning traffic. There are several design techniques available to accommodate U-Turns. The first option is at an intersection without a jug-handle. This design option generally requires widening the highway in one quadrant of the intersection to accommodate the required turning space of vehicles. Designs need to consider the type of vehicle using the U-Turn. In many situations, trucks will be prohibited from using this style of U-Turn. The widening can make use of a far side bus stop, or can be tapered. All U-Turns using this type of design technique at a signalized intersection must have the approval of the State Traffic-Roadway Engineer.

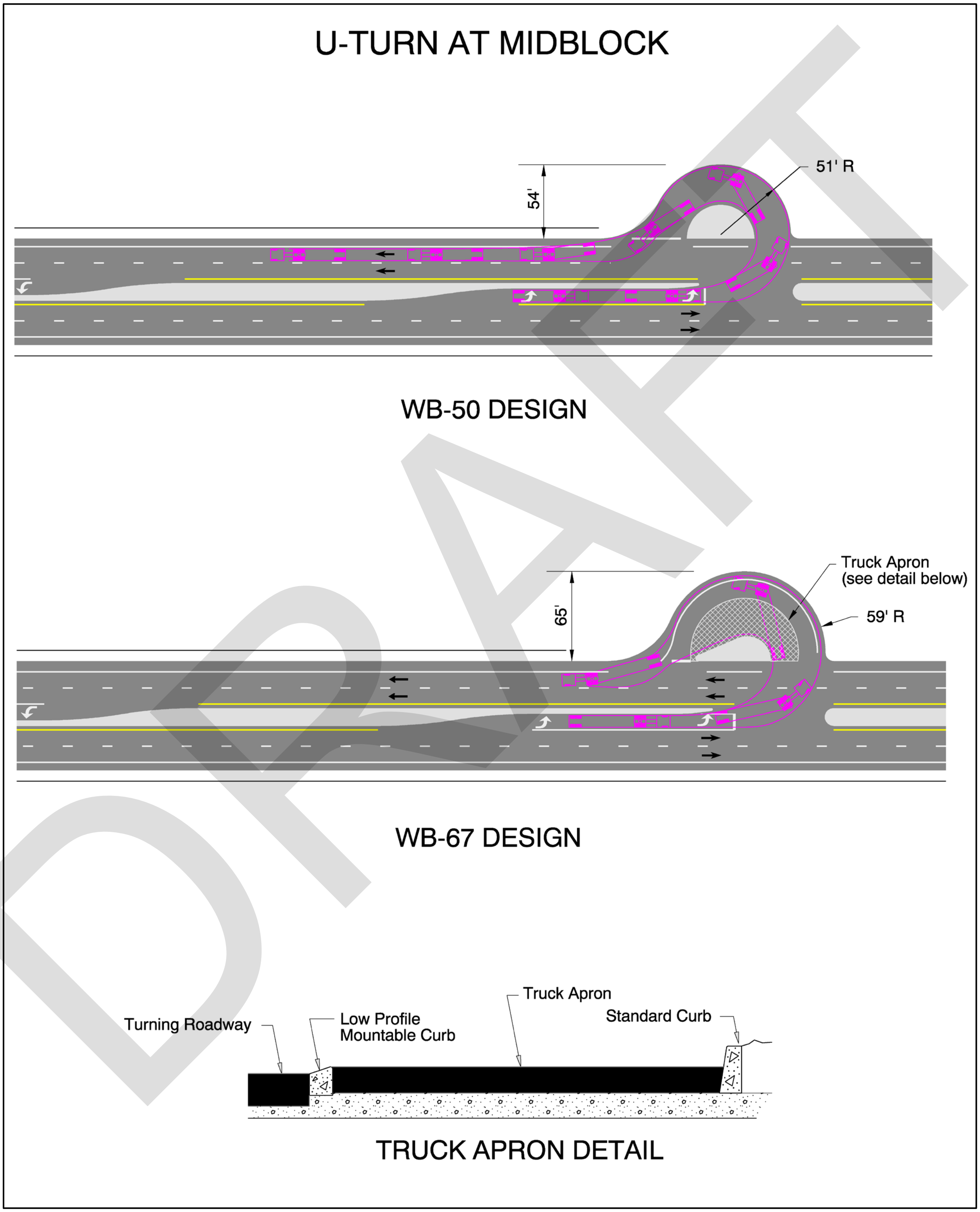
A second design option for accommodating U-Turning traffic is the use of a jug-handle. There are two options for jug-handle U-Turn designs. One option is the left side jug-handle. The left side jug-handle is a turning roadway alignment located on the left side of a highway. U-Turning traffic makes a left turn from the highway into the jug-handle. The jug-handle circulates the traffic back to the highway where vehicles re-enter the traffic stream as right turns through normal gaps in traffic flow. This style of jug-handle can be used at an existing "T" intersection or mid-block. The jug-handle is only compatible with a right side "T" intersection, which may or may not be signalized.

The other jug-handle design option is the right side jug-handle. The right side jug-handle is located on the right side of the highway. U-Turning traffic makes a right turn off the highway into the jug-handle, and then loops around to the left. The vehicles then make a left turn across the highway. This movement may or may not be signalized. As with the left side jug-handle, the right side jug-handle is only compatible with a "T" intersection. In this case, however, the intersection is only on the left side of the highway. Additionally, this type of jug-handle can be used at a mid-block location. The major disadvantage of this style is traffic must make a left turn across both directions of highway traffic and is therefore less efficient and may also have additional safety risks. See Figure 500-12 and Figure 500-13 for U-Turn treatments.

1 Figure 500-12: U-Turns at Intersections



1 Figure 500-13: U-Turns at Mid-Block



504.7 Indirect Left Turns

One tool available is indirect left turns at intersections. In some situations for capacity or safety reasons, it may be desirable to remove left turning traffic. The left turns are accomplished by other connections. The first option available is the use of a right side jug-handle just like the one described for U-Turns above. Vehicles wishing to turn left actually leave the highway on the right side then cross the highway. Generally these designs are signalized to facilitate the crossing movement. Again this particular type of jug-handle is only compatible with a left side "T" intersection.

A different type of indirect left turn design uses connecting roadways. This design concept is similar to the jug-handles described in the U-Turn section. Within this type of design are several options. These include the single quadrant and double quadrant. The single quadrant design provides one connecting roadway that provides for two way traffic operation. Location of the connecting roadway is dependent upon traffic flow characteristics, adjacent roadside development, need for intersection spacing, and signalization needs. The concept of the single quadrant design is to remove all left turning traffic from a specific intersection. The traffic uses the connecting roadway to gain access to the particular street. Location of the connecting roadway is critical to the operation on the highway, particularly if both intersections are to be signalized. The designer should make sure the Traffic Management Section and TPAU have reviewed and approved this design concept prior to actual installation.

As mentioned previously, another option is the double quadrant design. This design is very similar to a jug-handle style interchange, except that the intersecting roadways are not grade separated. Again, turning traffic, generally left turns, use the connecting roadways. The roadways may provide for all movements or may be right in/out only depending upon traffic capacity and safety needs. Again, the Traffic Management Section and TPAU should review and approve this type of design prior to installation. In addition, there may be access management issues on these connecting roadways. The Region Access Management Engineer should be consulted to identify and address these issues. In many situations, these last two design alternatives may be a phased approach towards grade separation in the future.

Section 505 Driveway Design

505.1 Design Requirements for Private Road Approaches

Private approaches are connections to adjacent businesses, residences, or other private roadways. Generally, private approaches provide access to/from the highway and an adjacent property across the highway right of way. These approaches service all land use types including residential, commercial, and industrial. Typically, private approaches in urban areas will use a 'dust pan' style approach. This style drops the curb and possibly the sidewalk to highway grade to allow vehicular access. Use Standard Drawings RD725 through RD750 when designing "dust pan" style private approach roads. For high volume driveways or driveways that are part of a signalized intersection, use a radius design style similar to that used by a public approach. Refer to Table 500-1 to determine the style of approach to be used. The Signal Design Manual, Section 5.1.6 has additional information for driveways at signals.

There are three general types of private road approaches. These are:

- Type A Non-curbed, ditch section highway with radius style approach.
- Type B Curbed highway section with "dust pan" style approach.
- Type C Curbed highway section with radius style approach.

Design Type C private approaches in accordance with Section 506 General Intersection Design. The design of Types A and B are described below.

The design of private road approaches is affected by many factors. The type of access, volume of vehicles, type of vehicles, grades, alignment, and adjacent land use all influence the design. The spacing of approach roads should be consistent with the spacing guidelines specified in the Oregon Highway Plan, Appendix C. The designer is encouraged to read the Access Management Policy contained in the OHP and Oregon Administrative Rule (OAR) 734, Division 51 for clarification of spacing guidelines and other guidance pertaining to access management.

1. All road approaches should be placed so that intersection sight distance is provided. The vehicle entering the traffic stream should have a view along the highway equal to the intersection sight distance for the design speed of the highway. At a minimum, stopping sight distance for the design speed of the highway must be provided at all approaches. For more information on intersection and stopping sight distances refer to the AASHTO Green Book and HDM, Part 200, Section 217.4 for Intersection Sight Distance. Any proposed approach that cannot provide sight distance as required by Oregon Revised Statute (OAR) 734, Division 51 must obtain an approval from the Region Access Management Engineer (RAME). For more information related to access management deviations, see Section 503. Cut slopes may need to be widened and roadside vegetation removed in order to provide required sight distance.

2. Both public and private road approach grades should be designed so that drainage from the approach does not run on or across the traffic lane, shoulder areas, or sidewalk. In no case should the normal slope of the shoulder be altered. In urban areas where the drainage is along a curb and gutter, only the paved approach area to the right of way line may drain into the gutter. In the case of an approach below the street grade, a short vertical curve should be used to confine the drainage in the gutter line. In some

instances inlets may be required on each side of the approach to collect runoff without ponding or to ensure that roadway drainage does not leave the right of way. The approach road should provide a flat landing area for vehicles entering the highway for at least 20 feet from the edge of the shoulder. A grade of two percent is desirable for these landings and four percent is the maximum. Approach grades steeper than four percent should be carefully evaluated by the Designer.

3. The maximum grade break between highway shoulder and approach is eight percent for Type A and B approaches. In addition, a 20 foot landing area should be provided. In some situations, the maximum break cannot be met. When this is the design condition, the designer should attempt to achieve a roadway-to-approach transition as smooth as possible. This may require using a short vertical curve. The approach must at least accommodate the appropriate design vehicle. Generally, commercial accesses are designed for at least a Single Unit (SU) truck design vehicle. Vehicles larger than an SU are not to be treated as the design vehicle unless 3 or more WB-40 or larger trucks are anticipated between 7:00AM and 7:00PM. Anytime the design vehicle is larger than a SU, the approach is designed as a radius style. When vehicles larger than an SU are anticipated, but are not the design vehicle as described above, the approach must accommodate the larger vehicle. ('Accommodation' only refers to the physical ability to make the maneuver including encroaching on other lanes, whereas 'designed for' means that design elements do not require encroachment. A site visit and discussion with maintenance personnel along with information gathered from property and business owners will help determine the appropriate design for an approach. (See Figure 500-3 for more detail concerning "design for" and "accommodate for".)

4. All approaches must be designed to aid in the longitudinal crossing of pedestrians. It is preferable to maintain sidewalks at a continuous grade. However, without a buffer strip or set back to provide a ramp down area to street grade, this is nearly impossible. Route continuity is also important to pedestrians. If a curbside sidewalk cannot be set back for a significant longitudinal distance, it is best to leave it curbside rather than break up the pedestrian continuity. For ADA compliance, sidewalk cross-slope must be maintained at 2 percent or less. To meet this requirement approaches may need to be designed with more than one slope to transition from roadway grade to final approach grade. Roadway standard drawings in the RD700 series provide information and various design options for curb, sidewalk, and driveway design at approaches.

5. All curbs and delineators used at approaches on highways without continuous curbs should be placed at the normal shoulder width from the edge of the traveled way to provide adequate shoulder adjacent to the approach.

6. Approaches on opposite sides of the highway should be located across from each other whenever possible. However, under high speed and high traffic volume conditions, approaches may need to be separated to reduce the complexity and number of conflicts (see Figure 500-10). In addition to reduction in conflict points, separating approaches

breaks the crossing maneuvers into distinct steps and isolates them reducing driver tasks and anxiety. When designing, the approaches need to be separated far enough that they operate independently outside their functional areas (see Figure 500-1). Although this situation is possible at some high volume private approaches, this treatment is generally only appropriate for public road approaches. Not all intersection locations are good candidates for separated approaches. The Technical Services, Roadway Engineering Unit and the Region Access Management Engineer should be contacted when considering separation of private approach roads. Major public roads with large volumes of through traffic should generally not be separated.

7. Approach roads should not be constructed within the functional area of an adjacent intersection. Refer to the Access Management Policies from the Oregon Highway Plan and OAR 734, Division 51 for more information on functional area (see Figure 500-1).

8. Where a private approach serves a high volume of traffic, additional design and/or traffic controls may need to be incorporated into the design. High volume approaches often will require channelization along the highway. Refer to Section 506 for details on left and right turn lanes. In some instances, the approach may require a traffic signal in order to operate safely and efficiently. A private approach located opposite of a signalized intersection forms an additional approach to the intersection and all approaches to a signalized intersection must be signalized. It is best to avoid this type of driveway configuration. However, when it is necessary, see the Signal Design Manual, Section 5.1.6 for guidance. The designer should work with the Region Access Management Engineer to determine solutions for high volume private approaches and potential private approaches opposite signalized intersections. Private approaches are not allowed directly opposite interchange ramp terminals.

1. NOTE: All traffic signals must be approved by the State Traffic-Roadway Engineer prior to installation. Generally, only public road approaches should be considered for signalization. Avoid signalizing private approaches.

9. Type A approaches need to be designed to minimize the pedestrian longitudinal distance. This may require the design to incorporate a two-centered curve rather than a single radius when accommodating design vehicles larger than a Single Unit (SU) truck.

10. The approach design and corresponding site circulation plan should specify the entry/exit throat distance. This throat distance is critical in order to provide an efficient and functional connection between the highway and adjacent property. Throat lengths are critical for commercial and industrial type land use approaches. The Transportation Planning Analysis Unit or the Region Access Management Engineer can assist with determining the appropriate throat distance. See Figure 500-2.

1 Table 500-1: Typical Private Approach Style and Width

Land Use Type	Approach Peak Hour Volume	Approach Style	Typical Throat Width[1]
SF Residential[2]	0 – 10	Dust Pan	16′
SF Residential[2]	11+	Dust Pan	24′
MF Residential	0 – 10	Dust Pan	16′
MF Residential	11 – 150	Dust Pan	24′ – 28′
MF Residential	151 – 300	Dust Pan[3]	36′ – 40'
MF Residential	301 – 399	Radius[4]	Variable[5]
MF Residential	400+	Radius	Variable[5]
Commercial	0 – 20	Dust Pan	24′
Commercial	21 – 150	Dust Pan	28′ – 32′
Commercial	151 – 300	Dust Pan[3]	36′ – 46′
Commercial	301 – 399	Radius[4]	Variable[5]
Commercial	400+	Radius	Variable[5]
Industrial		Dust Pan/Radius[6]	Variable[5]
Special Uses[7]		Radius	Variable[5]

1 The typical throat widths are only to be used as guides to the designer or permit specialist. The throat width needs to be checked to ensure traffic movements are accommodated acceptably.

2 Generally, multiple single-family residences don't share a single approach unless they are on a public road.

3 The dust pan style designs are primarily to be used. However a radius style may be used if the traffic composition at the driveway contains a substantial number of recreational vehicles, buses, and single unit trucks, and the highway posted speed is greater than 35 mph, or access spacing each side is 660 feet or more.

4 The radius style design should generally be used. However, a dust pan style may be considered where the highway posted speed is 30 mph or less and access spacing is 165 feet or less.

5 The typical width is variable dependent upon approach style, design vehicle, and number of lanes.

6 Special care should be used when determining the appropriate style. Some industrial uses operate similar to commercial uses and should use commercial style approaches and dimensions. Heavy industrial/warehouse uses that serve significant truck volumes should use a radius style.

7Special Uses include developments such as truck stops, amusement parks, stadiums, distribution centers, etc.

Section 506 General Intersection Design

506.1 General Design Considerations

This section describes the standards and guidelines for the geometric design of traditional at-grade intersections including lane widths, shoulders, superelevation, skew angles, turning radii, left turn lanes, right turn lanes, channelization islands, curb extensions, and bicycle and pedestrian needs. Context of the roadway and roadside is important to the final intersection design. Contextual factors in the design of intersections include the adjacent land use, urban or rural condition, vehicle speeds, traffic volumes and highway operation. The ODOT Practical Design Policy of Safety, Corridor Context, Optimize the System, Public Support and Efficient Cost (SCOPE) can aid in applying context design to a project. (See Practical Design Policy)

Specific design issues and concerns related to signalized and unsignalized intersections are discussed in Section 507 and Section 508 respectively. The design standards and considerations for modern roundabouts are contained in Section 509.

506.2 Approach Grades

There are two types of approaches to state highways. Public road connections are one type of approach and private approaches such as driveway connections are the second category. For public roads, the approach grades of intersecting roadways with a state highway should be kept to a minimum. It is undesirable to have road connections along superelevated curved sections of state highway and these connections are discouraged. When this type of connection can not be avoided, special care must be taken by the designer to provide an adequate connection. It is preferable to have a relatively flat or slightly elevated roadway connecting with a state highway. This helps improve the visibility of the intersecting roadway and can also help control highway drainage.

In order to effectively match intersecting roadway grades with state highway grades, vertical curve alignments should be used on all approach connections. Generally the intersecting roadway’s vertical alignment should match with the cross slope of the highway as long as the cross slope is less than 3 percent. Where the cross slope is equal to or greater than 3 percent a small break in the grade or vertical curve at the outer edge of shoulder not exceeding 2 percent may be acceptable. In addition, a 20 foot paved landing should be provided to aid an entering vehicle transition to the highway. The goal is to provide a connection that does not require vehicles to stop and enter the highway from a steep grade. The flatter the approach, the better, particularly for large vehicles. Due to acceleration and deceleration characteristics of various vehicle types using public roadways, grades of public road approaches at state highway connections greater than 3 percent should be avoided. However, in many locations due to existing terrain or right-of-way constraints, constructing approach grades less than or equal to 3 percent may be costly or infeasible to accomplish. In these locations, a more practical threshold would be to provide a maximum grade on the connecting road of 6 percent. In locations where the connecting approach grade exceeds 6 percent, special care needs to be taken by the designer to provide adequate vertical transition from the steep road approach to the highway grade.

Due to typically expected operating conditions, driveway approaches to state highways can be constructed with greater differential changes in grade than public roadway connections. Figure 500-14 and Figure 500-15 provide design and layout information for an approach with sidewalk and without sidewalk. Additional information and options about the design and layout of sidewalks and driveway approaches is available from Oregon Standard Drawings. Pertinent standard drawings include RD715, RD725, RD730, RD735, RD740, RD745 and RD750.

Regardless of roadway connection type, where a marked or unmarked crosswalk exists, the cross slope should be held to 2 percent or less to meet ADA requirements. Figure 500-16 provides information about sidewalk ramps. In addition, adequate sight distance must be provided at all road connections.

<u>NOTE</u>: Crosswalks, whether marked or unmarked, exist across each approach to an intersection unless specifically closed by the road authority.

Figure 500-14: Driveway Approaches With Sidewalks

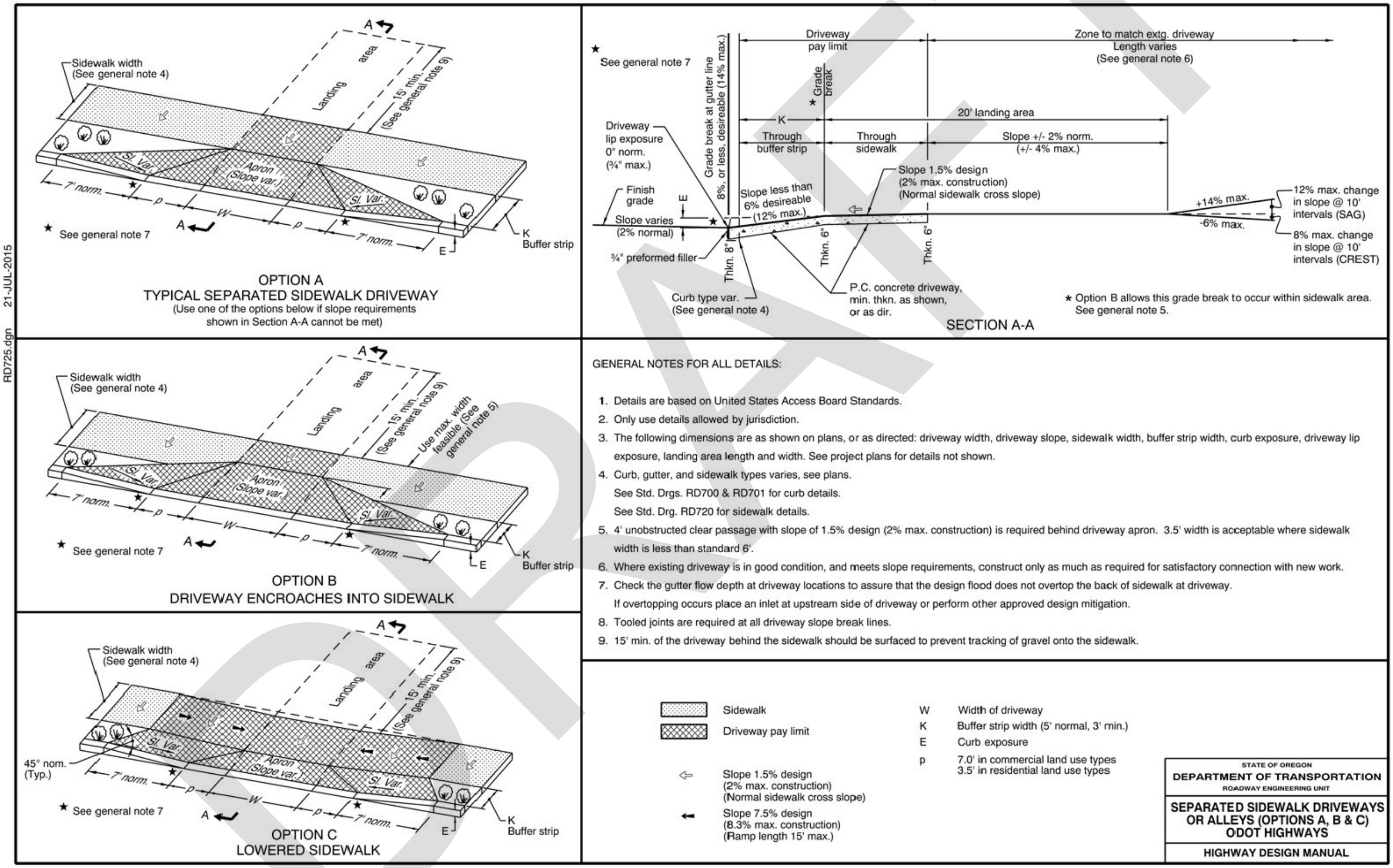


Figure 500-15: Driveway Approaches Without Sidewalks

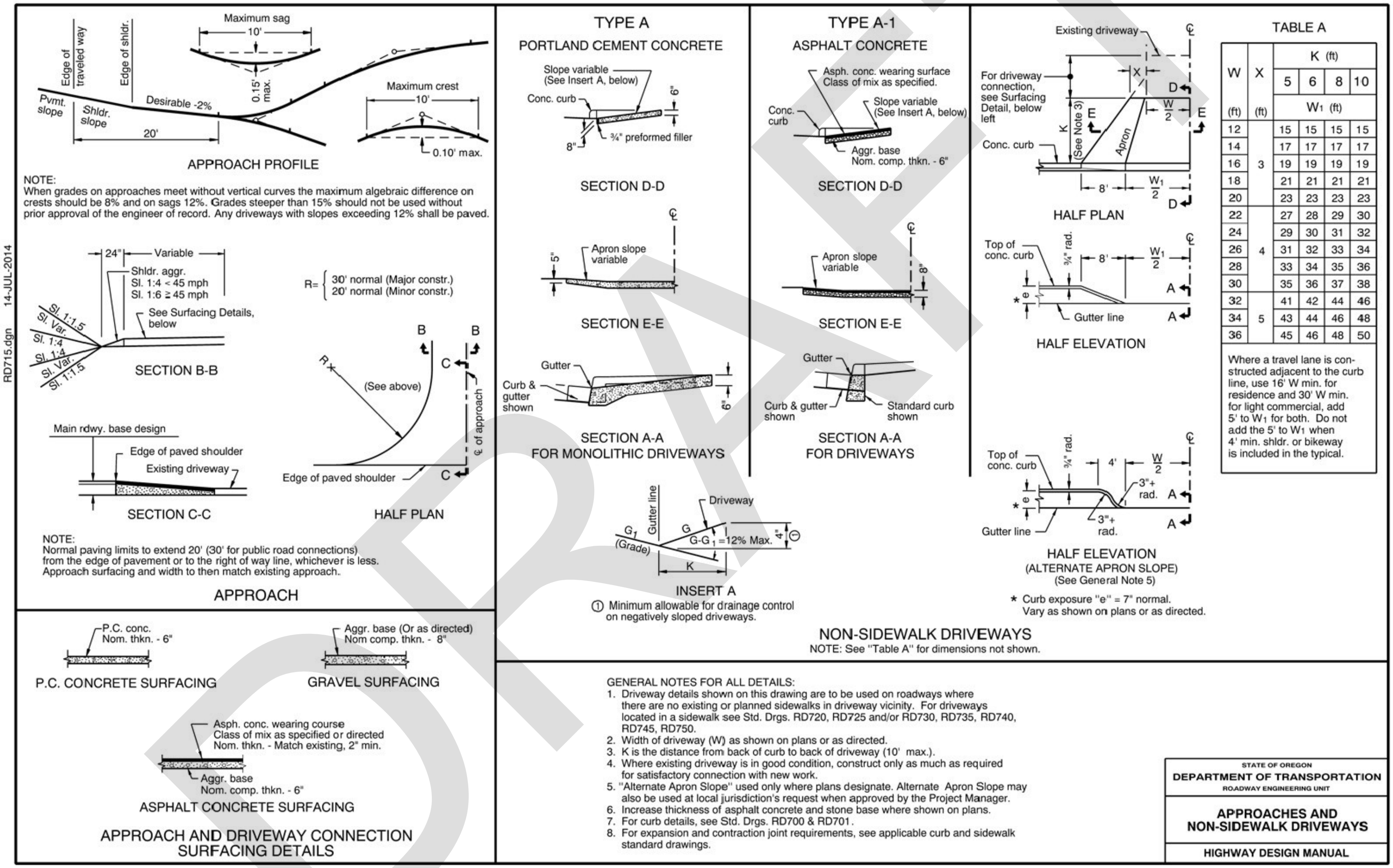


TABLE A

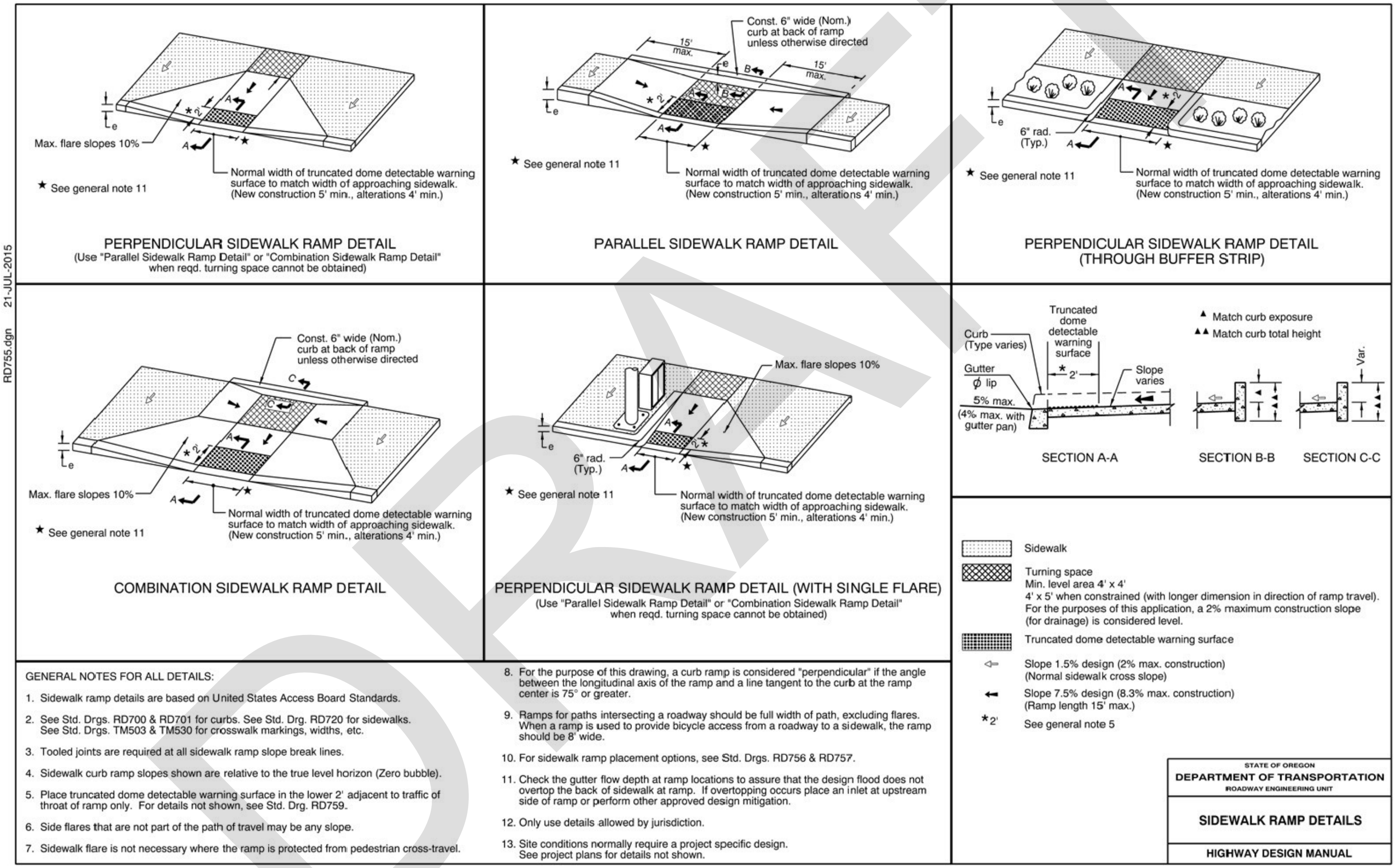
W	X	K (ft) 5	6	8	10
(ft)	(ft)	W1 (ft)			
12	3	15	15	15	15
14		17	17	17	17
16		19	19	19	19
18		21	21	21	21
20		23	23	23	23
22	4	27	28	29	30
24		29	30	31	32
26		31	32	33	34
28		33	34	35	36
30		35	36	37	38
32	5	41	42	44	46
34		43	44	46	48
36		45	46	48	50

Where a travel lane is constructed adjacent to the curb line, use 16' W min. for residence and 30' W min. for light commercial, add 5' to W_1 for both. Do not add the 5' to W_1 when 4' min. shldr. or bikeway is included in the typical.

GENERAL NOTES FOR ALL DETAILS:

1. Driveway details shown on this drawing are to be used on roadways where there are no existing or planned sidewalks in driveway vicinity. For driveways located in a sidewalk see Std. Drgs. RD720, RD725 and/or RD730, RD735, RD740, RD745, RD750.
2. Width of driveway (W) as shown on plans or as directed.
3. K is the distance from back of curb to back of driveway (10' max.).
4. Where existing driveway is in good condition, construct only as much as required for satisfactory connection with new work.
5. "Alternate Apron Slope" used only where plans designate. Alternate Apron Slope may also be used at local jurisdiction's request when approved by the Project Manager.
6. Increase thickness of asphalt concrete and stone base where shown on plans.
7. For curb details, see Std. Drgs. RD700 & RD701.
8. For expansion and contraction joint requirements, see applicable curb and sidewalk standard drawings.

Figure 500-16: Sidewalk Ramp Details



506.3 Travel Lane Widths

Travel lane width through an intersection needs to remain constant. In general, the through travel lane width at rural and high speed, channelized intersections is 12 feet as shown in Figure 500-19 For specific locations, the appropriate travel lane width is determined by the location (rural or urban), design speed, volume of trucks, highway designation and alignment. Use the rural or urban highway design chapters of this manual determine the appropriate through lane width. In most urban locations and Special Transportation Area (STA) designated roadway sections, 11 foot travel lane width is preferred, depending on functional classification, volume and nature of traffic, pedestrian mobility, freight mobility and accessibility goals. In other urban locations with significant constraints, 11 foot travel lane width may be allowable. See Part 200 and Part 300 for guidance on the use of lane widths less than 12 feet. However, travel lane widths shall not be reduced through an intersection. Lane width approaching an intersection is to be maintained through the intersection.

When an intersection is a part of or connecting to a turning roadway, the lane widths may need to be increased to allow for large vehicle off tracking. Refer to chapters 3 and 9 of the AASHTO Green Book for more details of turning roadways.

Any reductions in existing lane widths will need to be investigated for freight mobility issues and comply with ORS 366.215, Creation of state highways; reduction of vehicle-carrying capacity. For guidance in complying with ORS 366.215, see ODOT guidance document "*Guidelines for Implementation of ORS 366.215, No Reduction of Vehicle-Carrying Capacity" and the "ODOT Highway Mobility Operations Manual*".

506.4 Travel Lane Alignment

Similar to through travel lane width, travel lane alignment should remain constant through an intersection. If a proposed design creates misalignment of lanes across an intersection, rather than introducing angle points that create abrupt deflections to vehicle pathways across the intersection, a better design option would be to incorporate slight alignment and striping changes upstream and downstream of the intersection to better transition lanes smoothly, thereby effectively reducing or eliminating the lane shift. The alignment changes upstream and downstream should provide curvature to smooth the transition. This is particularly true with intersections on curves. Shifting of lanes through signalized or stop controlled intersections is strongly discouraged and should only be done when site constraints make it infeasible to keep lane alignment consistent. Travel lanes on the mainline highway shall not be shifted at uncontrolled intersections.

At signalized intersections, lane lines should line .up through the entire intersection and not be offset. This helps to not only discourage actual lane changes through the intersection area, but also minimizes the possibility of a driver inadvertently encroaching on the adjacent lane. However, in cases where it is deemed necessary to shift a lane through a signalized intersection, refer to the following guidance provided in the remainder of Section 506.4 and Figure 500-17 (Travel Lane Offset Layout) for discussion of potential lane offset.

Posted Speed Limit Less than 30 mph:

- Maximum Offset – 4 feet

Posted Speed 30 mph to 35 mph:

- Maximum Rate of Change Across Intersection – 1ft. lateral in 20 ft. longitudinal
- Maximum Offset - 4 feet

Posted Speed 40 mph to 45 mph:

- Maximum Rate of Change Across Intersection – 1ft. lateral in 30 ft. longitudinal
- Maximum Offset – 3 feet

Posted Speed Greater Than 45 mph:

- No Offset Permitted Across Intersection

Shifted travel lane rate of change is measured in the direction of travel between marked crosswalks by projecting a line along the center of the entering travel lane from the closest crosswalk stripe entering the intersection to the farthest crosswalk stripe exiting the intersection. If no crosswalk is present, then project a line perpendicular from the end of the lane striping to the center of the travel lane entering the intersection to determine a beginning measuring point for the lane shift and rate of change distance. Since most controlled intersections without a marked crosswalk should have a stop bar present, the stop bar with respect to the travel lane center could also be used as an alternate method to determine a starting point. In either method, the ending point is the intersection of the projected entering lane center and the intersection of the furthest crosswalk stripe exiting the intersection. If no crosswalk is present on the exiting side of the intersection, then project a perpendicular line from the beginning of the lane striping leaving the intersection to the center of the shifted lane to determine the end point. In all cases the rate of change shall be applied evenly across the entire distance along the projected center of the entering travel lane.

Travel lane offset is measured from the center of the travel lane entering the intersection to the center of the shifted travel lane exiting the intersection. For multi-lane roadways, all travel lanes in the same direction shall be offset equally and remain parallel to one another unless site specific constraints make this infeasible. For locations where lanes cannot be shifted equally or cannot remain parallel to one another, contact Region Roadway and Traffic staff or Technical Services Traffic-Roadway Engineering staff for guidance.

For stop-controlled intersections, the maximum offset that may be applied is 4 feet across the intersection.

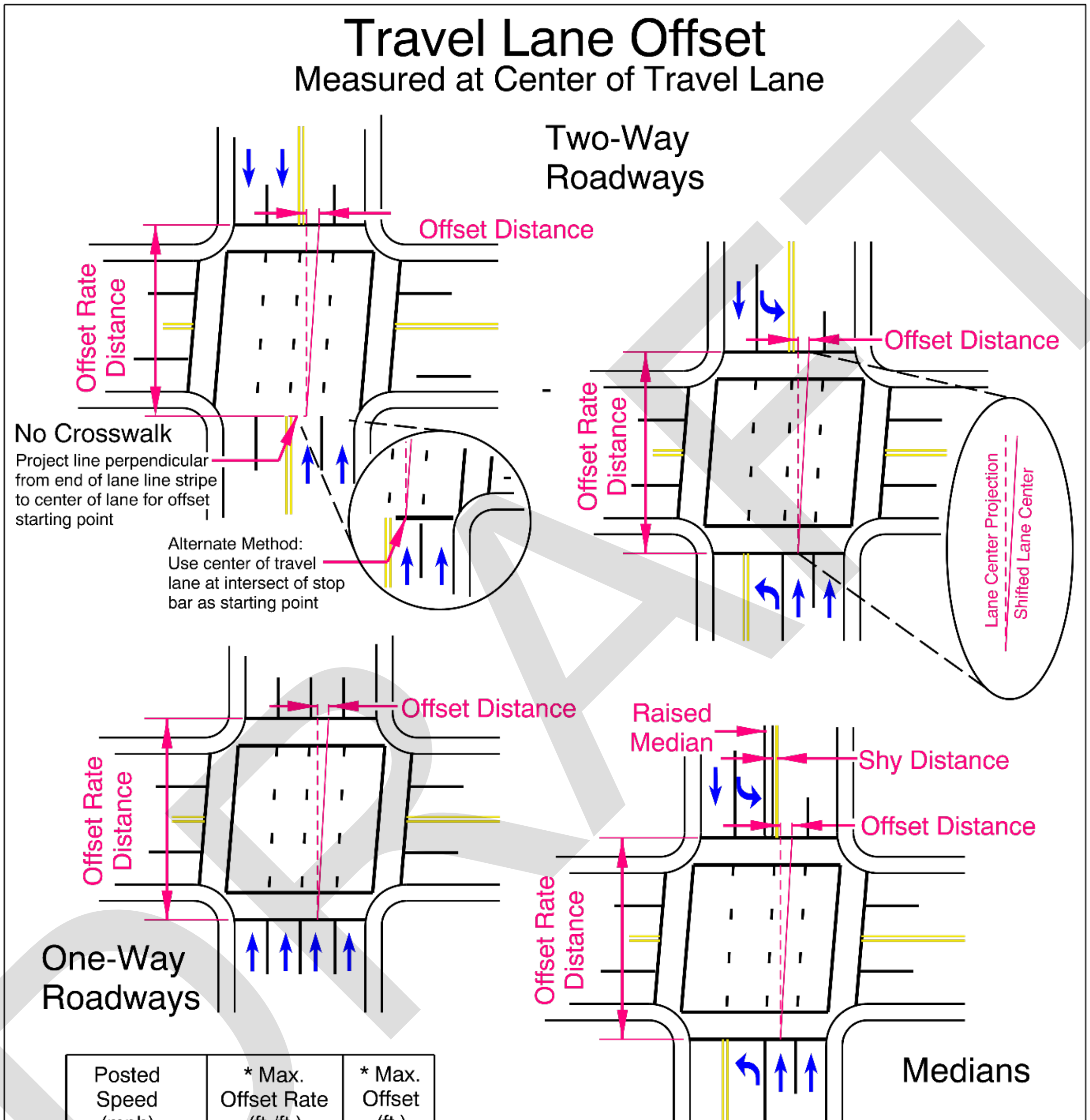
When lanes are shifted through an intersection, care must be taken to ensure that adequate space is maintained between travel lanes and roadway features like curbs; raised median islands, signs, illumination or signal poles, etc. All proposed lane shift designs must be reviewed by appropriate staff in the Region Traffic and Region Roadway sections as well as appropriate Traffic and Roadway staff in the Technical Services Traffic-Roadway Engineering section regardless of proposed lane shift amount. Agreement for the lane shift is required from the Region Roadway Manager/Engineer, the Region Traffic Manager/Engineer and the Technical Services Traffic-Roadway Section.

At signalized intersections, excessive shifting of lanes may cause signal head misalignment with their respective lanes. Signal heads should be shifted to match the lane shift. If this cannot be accomplished, then lane shift shall be limited to a maximum of two feet with agreement from the Region Traffic Engineer.

If shifting lanes through a signalized intersection is necessary, it is advantageous to carry some form of lane marking, generally dotted striping, through the intersection to inform drivers of the shift and help keep them aligned with the lanes. Contact the Region Traffic Section for appropriate use of lane markings through the intersection.

Providing guidance for layout of lane offset at intersections in this manual does not imply agreement to any specific design proposal. It is the designer's first responsibility to provide a design that transitions a vehicle from one side of an intersection to the other smoothly. Only after it has been demonstrated and determined through the review process that a smooth transition is not feasible will a design incorporating a lane shift be considered as a viable option. Figure 500-17 Illustrates travel lane offset layout when a shift of the travel lane is necessary.

Figure 500-17: Travel Lane Offset Layout



Posted Speed (mph)	* Max. Offset Rate (ft./ft.)	* Max. Offset (ft.)
less than 30	—	4
30-35	1 in 20	4
40-45	1 in 30	3
Over 45	Not Permitted	

* All Lane Offset Proposals Shall be Reviewed for Agreement by Appropriate ODOT Staff. See Text, Section 506.4

Note:

1) Drawings on this page reflect general layout of lane offset measurement for illustrative purposes. For intersections that include other conditions such as curved alignments, varying lane widths, or other site specific design elements, it is the designer's responsibility to follow as closely as possible the travel lane offset parameters outlined in section 506.4. Contact Region Roadway staff or Technical Services Roadway staff for guidance.
2) Lane shift parameters apply to both left or right offsets of the travel lane.

506.5 Travel Lane Continuity

Lane continuity is also important for effective traffic flow at an intersection. When a through lane drops downstream of an intersection, adequate length of the lane being eliminated needs to be established to allow the two traffic streams to merge safely and effectively as well as to allow for standard signing and striping of the lane drop. This distance may vary by location due to specific intersection operation, number of downstream access points, on-street parking or other constraints. Each location needs to be thoroughly investigated and an appropriate length determined. Failure to provide adequate length for necessary maneuvers may impact intersection operation and expected capacity due to uneven lane balance. Anticipated lane utilization through the intersection may not occur if it is too difficult to merge downstream. Drivers familiar with the intersection may be reluctant to use the lane that is dropping if they have had difficulties merging downstream in the past and they may choose to merge into the other through lane prior to the intersection. This is particularly true for locations where a through lane is added just prior to the intersection to increase intersection capacity and then immediately dropped downstream of the intersection. Consult the Region Traffic Engineering Unit and the ODOT Transportation and Analysis Unit (TPAU) to provide information about appropriate merge length.

506.6 Shoulder Widths

As with travel lanes, the width of shoulders should generally remain constant through an intersection. However, two-lane highways that are flared to provide left turn channelization may require shoulder width modifications. Urban and rural design criteria will determine appropriate shoulder width at specific locations. Standard shoulder width should be utilized through rural and higher speed intersections. In constrained locations where left turn channelization is being considered, the shoulder width may be reduced, but shall be no less than 4 feet in rural locations. Reduction of shoulder width below the design criteria width may require a design exception. For urban shoulder width, See Part 200 and Part 300 for design criteria.

When only a minimum 6-foot bicycle lane is provided adjacent to the highway, reducing shoulder width requires discussion about bicycle accommodation needs. Part 900 and the Oregon Bicycle and Pedestrian Design Guide provide information about shoulder widths and consultation with ODOT Bicycle and Pedestrian staff may provide additional appropriate design options. Shoulder widths will also require modifications where the intersection includes a right turn lane. If the design is providing only a minimum 6-foot bicycle facility adjacent to the highway, then shoulders should be designed to match the dimensions of Figure 500-18. This would provide only a minimum level of design. However, the goal of highway projects is to provide the highest appropriate level of bicycle and pedestrian facilities possible within project scope and funding. Consider separated and protected bicycle facility design options. On projects where funding categories limit project scope to specific items, there may be other sources of funding that can be allocated to include bicycle and pedestrian improvements. Contact the region Active Transportation Liaison to determine bicycle and pedestrian facilities appropriate for the project and to determine if alternate funding sources are available for even greater improvements to the bicycle and pedestrian networks along the highway.

Figure 500-18: Right Turn Channelization

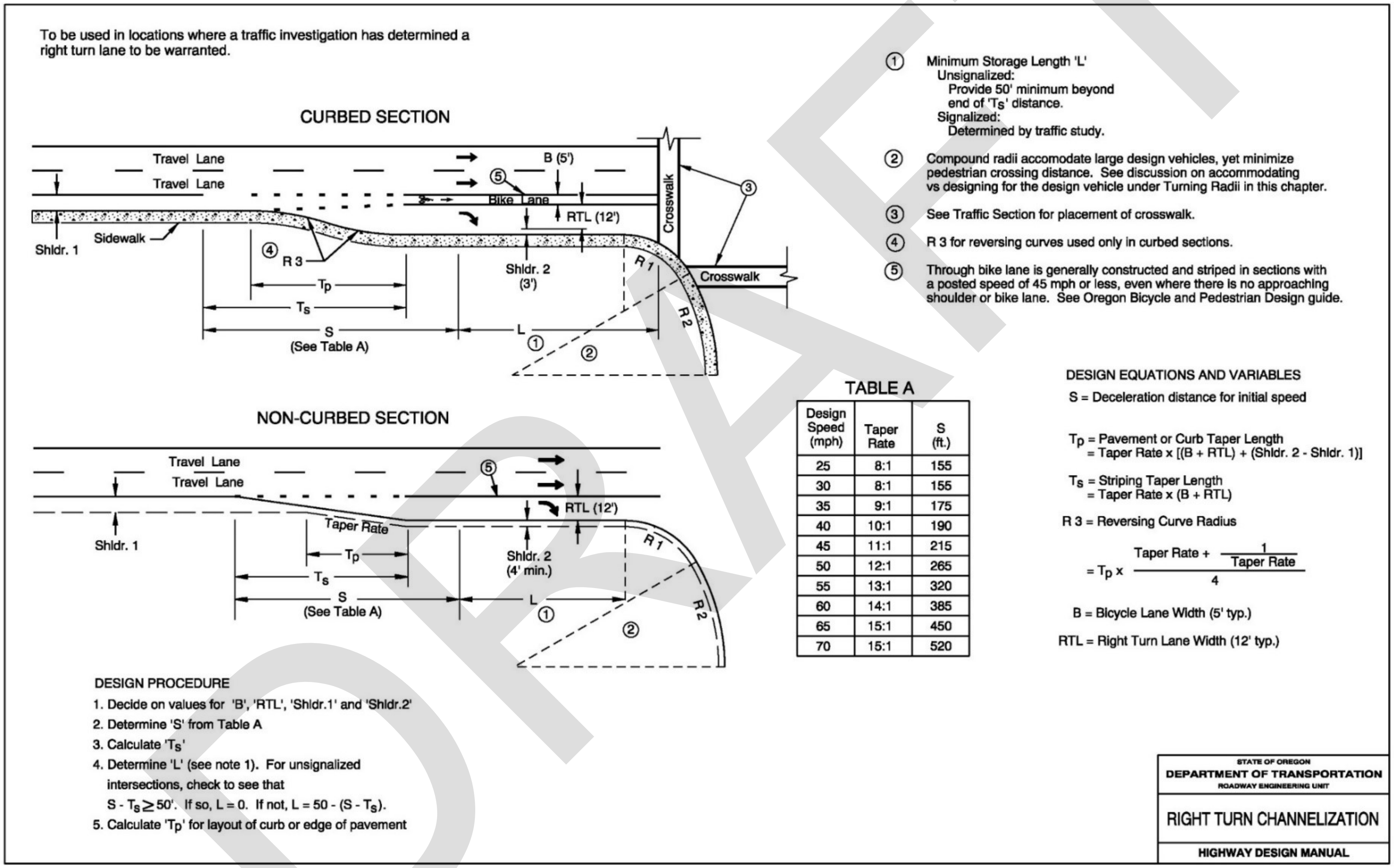


TABLE A

Design Speed (mph)	Taper Rate	S (ft.)
25	8:1	155
30	8:1	155
35	9:1	175
40	10:1	190
45	11:1	215
50	12:1	265
55	13:1	320
60	14:1	385
65	15:1	450
70	15:1	520

506.7 Intersections on Curves and Superelevation

It is undesirable to have an intersection located within a horizontal curve and the practice should be avoided. Intersections on curves present design challenges that affect superelevation, sight distance, driver comfort and vehicle stability. However, in many existing situations, intersections are present within highway curves and in many of these locations, these connections cannot be effectively relocated. Signalized intersections in curves compound operational problems, as well. Stopping traffic on steep cross slopes determined by main line design superelevation needs is undesirable due to the potential for slippage under ice conditions or potential load shifting on trucks. Intersection Sight Distance (ISD) should be achieved at all intersections. However, Stopping Sight Distance (SSD) is the minimum requirement.

When an intersection occurs within a highway curve, the highway superelevation should be kept to a minimum. However, the highway still needs to provide for safe movement of traffic through the intersection at highway speeds. As a result, the designer must balance the superelevation need of traffic on the main line in free flow conditions with operational issues of the intersection. In these types of locations, some designers prefer to merely limit maximum superelevation to 4%. However, in some cases, trying to hold the superelevation to 4% or less may result in design speeds less than desirable for a specific highway. A better solution is to determine an appropriate superelevation for a specific location based on needs at that location.

At a minimum, the superelevation at an intersection should provide speeds determined from the Comfort Speed matrix shown in Part 300 equal to the desirable design speed. This means that if the design speed for the highway segment is 45 mph, then the comfort speed for the curve at the desired superelevation must be at least 45 mph.

> Example:
>
> Using the Suburban Superelevation & Spiral Lengths in Part 300 and a design speed of 45 mph with an 8 degree curve, the design superelevation would be 6%. This may be an undesirable condition with a signalized intersection on a curve. An alternative is to use the Comfort Speed values. Entering the table for an 8 degree curve and following across the row until the column for 45 mph is reached returns a 4% superelevation. This would reduce the design superelevation by 2% and may be an acceptable option.

When using an alternate superelevation design, care must be taken to determine that reducing superelvation does not compromise the overall geometry of the alignment and subsequently create a new problem while attempting to solve a current one. A design exception will be required to utilize an alternate superelevation design based on Comfort Speed in relation to Design Speed. It is critical to ensure that connections on the high side of a superelevated highway curve provide an approach with adequate sight distance. Ideally, intersection sight distance should be provided. Where this is not feasible or practical, as a minimum, stopping sight distance must be provided.

Another important consideration in designing a road connection on the high side of a horizontal main line curve is the comfort factor for side road traffic. Operation of the main line is the first concern, but it is important to create a comfortable transition across the superlevation for the traffic entering onto the main line. Where possible, keeping superelevation to a minimum on the main line while establishing grades on the connecting road to minimize vertical and lateral movement inside the vehicle entering onto the main line is desirable.

In addition to consideration of vehicles entering from the side road to the main line, main line traffic turning dynamics at intersections on curves must be evaluated as well. Main line turning vehicle dynamics and driver comfort also benefit from minimum superelevation when making turns onto side roads. Main line vertical grade can have great effect on turning dynamics. Negative (downhill) grades in conjunction with horizontal curvature and its respective superelevation can exacerbate turning forces acting on a vehicle. Not only can these forces be uncomfortable for drivers and passengers, in the case of trucks or other vehicles with higher centers of gravity like RVs and buses, these forces can cause loads to shift or, in extreme cases, cause roll over crashes.

When it is necessary to design or improve an intersection located on a horizontal curve, it is important to carefully analyze the interaction of the horizontal curvature and superelevation with all intersecting grades, grade breaks and vertical alignments on both the side road and the main line in relation to anticipated vehicle turning movements and dynamics. It is important to keep these forces and reactions to a minimum and within acceptable levels to ensure safe and effective operation of the intersection.

In addition to geometric considerations, intersections on horizontal curves can produce problems for pedestrians as well. Care must be taken to ensure sight lines to crosswalks provide ample vision for drivers to see pedestrians.

506.8 Skew Angles

Roadway connections with a state highway should intersect at a 90 degree angle. 90 degree intersections maximize sight distance, improve safety, increase efficiency, and improve operations and safety of bike and pedestrian movements. In some situations however, obtaining a 90-degree intersection is impractical or excessive in cost. Where this is the case, skewed intersections may be unavoidable. Skew angles of up to 30 degrees from perpendicular may be justified. However, the amount of skew should be held to a minimum. Figure 500-27 shows an intersection with excessive skew and the intersection reconfigured to improve skew. Figure 500-28 shows skew configuration with right turn lanes and islands to accommodate pedestrian movements. The presence of large trucks needing to negotiate this type of intersection can have direct effect on the final design layout.

Several factors can help determine the amount of skew that is acceptable for any particular intersection. Intersections with all or most of the following characteristics might justify allowing a skew angle of up to 30 degrees.

1. Highway speeds are low, generally 35 mph or less;
2. Volumes on both the highway and intersecting roadway are low (at or below left or right turn channelization warrant limits);
3. Large vehicle turning movements are minimal;
4. Intersecting roadway has a functional classification of minor collector or below, and
5. Intersection sight distance is available.

For all other intersections not meeting criteria on this list, the maximum skew should be held to 15 degrees from perpendicular. Refer to the AASHTO 2018 Green Book, pages 9-31 through 9-33, for possible alignment solutions to skewed intersections.

506.9 Turning Radii

Turning radii are one of the most important design elements of intersections. The operations, safety, and efficiency of an intersection are controlled by the turning movements. If the turning vehicles are geometrically limited from completing the maneuver properly, the intersection may break down, capacity is limited, and accident potential may increase.

The appropriate design vehicle must be identified prior to designing the intersection turning movements. Selection of the appropriate design vehicle can sometimes be difficult. Issues to take into consideration in choosing a design vehicle include number and type of trucks, functional classification of the intersecting roadways, surrounding land use, consideration of future changes in land use and traffic, freight route designation, etc. See Part 200 and Part 300 for additional information on design vehicle selection. After determining the appropriate design vehicle, a decision needs to be made as to the level of design accommodation to be made. In other words, is the intersection radii to be designed for the design vehicle or merely to accommodate the design vehicle? The concept of designing for the design vehicle is to provide a path for the vehicle that is free of encroachments upon other lanes. Providing a design that only accommodates the design vehicle means that some level of encroachment upon other lanes is necessary for the vehicle to make a particular movement (see Figure 500-3). An example of an intersection that would need to be designed for trucks with no encroachment into adjacent lanes would be a stop controlled intersection with a state highway, the highway being two lane or multi-lane with higher speeds and/or high traffic volumes. If a traffic study concludes that finding a gap in multiple traffic flows is not possible, the intersection would need to be designed for the design vehicle so that the truck driver can turn from his lane into a single lane. Other factors to consider in turning radii are the affects on pedestrians and bicycles. Large radii create long crossing distances with increased exposure times. These conditions negatively impact pedestrian and bicyclist safety and may add time to signal timing cycles. Large radii also encourage motorists to take turns at higher speeds that can have an effect on intersection safety as a whole. In general, large vehicles are a small percentage of the vehicle types and users of an intersection. Designing intersections for large vehicle maneuverability may be of benefit for the large vehicle, but it tends to make the intersection less safe for the majority of the users of the intersection. Therefore, in consideration of the overall safety of the intersection, the design should only accommodate large vehicle operation in most cases. When it is necessary to design the intersection with large radii for larger vehicles, a balance needs to be obtained between the necessary radii and impacts to all intersection users.

Another item that must be decided is the turning radius of the design vehicle. The turning radius of the design vehicle determines the ease and comfort of making the turning maneuver. The smaller the turning radius, the larger the off-tracking of the vehicle and the slower the speed. Forcing large vehicles to use very small turning radii forces the driver to perform a very slow maneuver that may not be in the best interests of the operation of the intersection. Generally the radius chosen is in line with the surrounding culture. Tighter radii are chosen for low and/or urban speeds, while larger radii are selected for higher speeds and rural intersections.

Once the design vehicle is selected and the level of design accommodation determined, then the intersection radii can be designed. Intersection radii should be kept as small as possible to minimize the size of the intersection and the pedestrian crossing distance. Any time the design vehicle is larger than a Single Unit (SU) truck or a bus, the designer may need to consider using a two-centered curve. Off-tracking templates or automated off-tracking programs should be used to determine the vehicle path. Once this path is identified, a two-centered curve can be developed which closely emulates this path. The designer may need to look at a range of vehicle turning radii and the subsequent intersection designs. This allows the designer to select the best design for the design vehicle while minimizing the size of the intersection.

Designers are encouraged to keep the size of intersections to a minimum. Often when accommodating large trucks, the intersection radii become very large. This can substantially increase the size of the intersection. Larger intersections generally have greater accident potential, are difficult to delineate, can be confusing, require more right-of-way, and significantly increase pedestrian and bicycle crossing times and distances.

506.10 Left Turn Lanes

On some higher volume and higher speed highways, left turning traffic can become a major safety concern, especially on two-lane highways. On rural highways, left turn lanes should generally only be considered at public road intersections. The Analysis Procedures Manual (Transportation Planning and Analysis Unit) discusses citing criteria for installing left turn lanes. When these criteria are met, a left turn lane should be considered in the design. Generally, left turn lanes are not to be constructed for private accesses in rural areas unless the siting criteria are met and installation of a left turn lane will not create additional safety concerns on the highway. A major concern regarding left turn lanes for private access is that successive accesses may require installation of a section of a continuous two way left turn lane (CTWLTL). Using CTWLTLs in rural environments should be discouraged. CTWLTLs may be considered where needed specifically for safety in short sections or within the boundaries of a rural community.

As stated above, providing left turn lanes at multiple locations that are spaced closely may create a need for a CTWLTL. It is undesirable to provide a typical section that creates an hour glass shape. This is where a highway is widened to provide a left turn lane, then narrowed back to the original typical, only to be immediately widened again. This situation should be avoided. Left turn lanes in rural areas should be selected where adequate spacing exists to avoid this hour glass problem.

Providing a left turn lane at an intersection will significantly improve the safety of the intersection. Eliminating conflicts between left turning vehicles decelerating or stopping and through traffic is an important safety consideration. A left turn lane must be provided at all non-traversable median openings and they are strongly recommended to be installed at other intersections meeting the installation criteria. The left turn lane installation criteria are different for signalized and unsignalized intersections. Refer to Section 507 for Signalized Intersections and Section 508 for Unsignalized Intersections for the appropriate siting criteria. For additional information about siting criteria for left turn lanes, see the ODOT Analysis and Procedures Manual (APM). (https://www.oregon.gov/odot/Planning/Pages/APM.aspx)

Left turn lanes for rural and higher speed locations shall be 12 feet wide plus the appropriate traffic separator width and shy distance when required. For urban locations, see Part 200 and Part 300 for left turn design criteria.

The installation of a traffic separator at urban left turn lane locations is critical when there are access points to adjacent properties along the length of the left turn lane. The separator will protect the left turn lane operation and safety by eliminating the opportunity for vehicles to cross it when entering and exiting adjacent accesses. The width of the traffic separator is determined by several factors. If the median includes a raised curb design, the traffic separator width shall be a minimum of 4 feet I higher speed locations. However, when pedestrians are to be accommodated on the raised portion of the median with separate phases for the crossing maneuver, the raised traffic separator width shall be 6 feet minimum. Medians that use raised curb also need to provide the appropriate shy distance from the curb and adjacent through travel lanes. The width of striped traffic separators is determined by the design speed of the highway and the type of land use area. For design speeds of 55 mph or less, the striped separator shall be 2 feet and 4 feet for design speeds of 60 mph or greater. For more information on median design, refer to Part 300, Cross-Section Elements.

Development of left turn lanes should be in conformance with Figure 500-19. However, where the median width is developed non-symmetrically, a reversing curve may be used in lieu of the straight speed tapers. The reversing curve option can reduce the overall widening thereby saving construction costs and possibly saving right of way or significant features. Figure 500-19 depicts the standard left turn channelization design. Figure 500-20 depicts the reversing curve channelization option.

Left turn lanes should be striped in accordance with the ODOT Pavement Marking Design Guidelines. Essentially this means that the reversing curve entry taper shall be used for:

1. All dual left turn lanes;
2. All left turn lanes developed from sections without medians or with narrow medians, and
3. All left turn lanes located within wide median sections or CTWLTLs that have design speeds greater than 45 mph.

It is critical to the operation of intersections to provide adequate storage length for left turning vehicles out of the through traffic lanes. At a minimum, the turn lane should provide 100 feet of storage. The Region Traffic Engineering Unit and the Analysis Procedures Manual (APM) should be consulted to determine the appropriate storage length for specific intersections. For specific analysis procedure questions or interpretation of the APM or for complex projects requiring additional study, contact the ODOT Transportation and Analysis Unit (TPAU) for guidance or technical help on the particular project or methodology.

In some instances, dual left turn lanes may need to be considered. When designing dual left turn lanes, there must be dual receiving lanes on the connecting roadway with adequate length downstream prior to any merge points. The designer must determine the appropriate design vehicles to use for side-by-side operation through the turning movement. In rare locations, like at freeway ramp terminals leading to truck stops or warehousing districts, the design may need to be two WB-67 vehicles making the turn simultaneously. However, in most locations, a WB-67 and an SU vehicle side-by-side is adequate for design. In other locations where truck volumes are low, an SU vehicle and a passenger vehicle may be sufficient.

Figure 500-19: Left-Turn Channelization

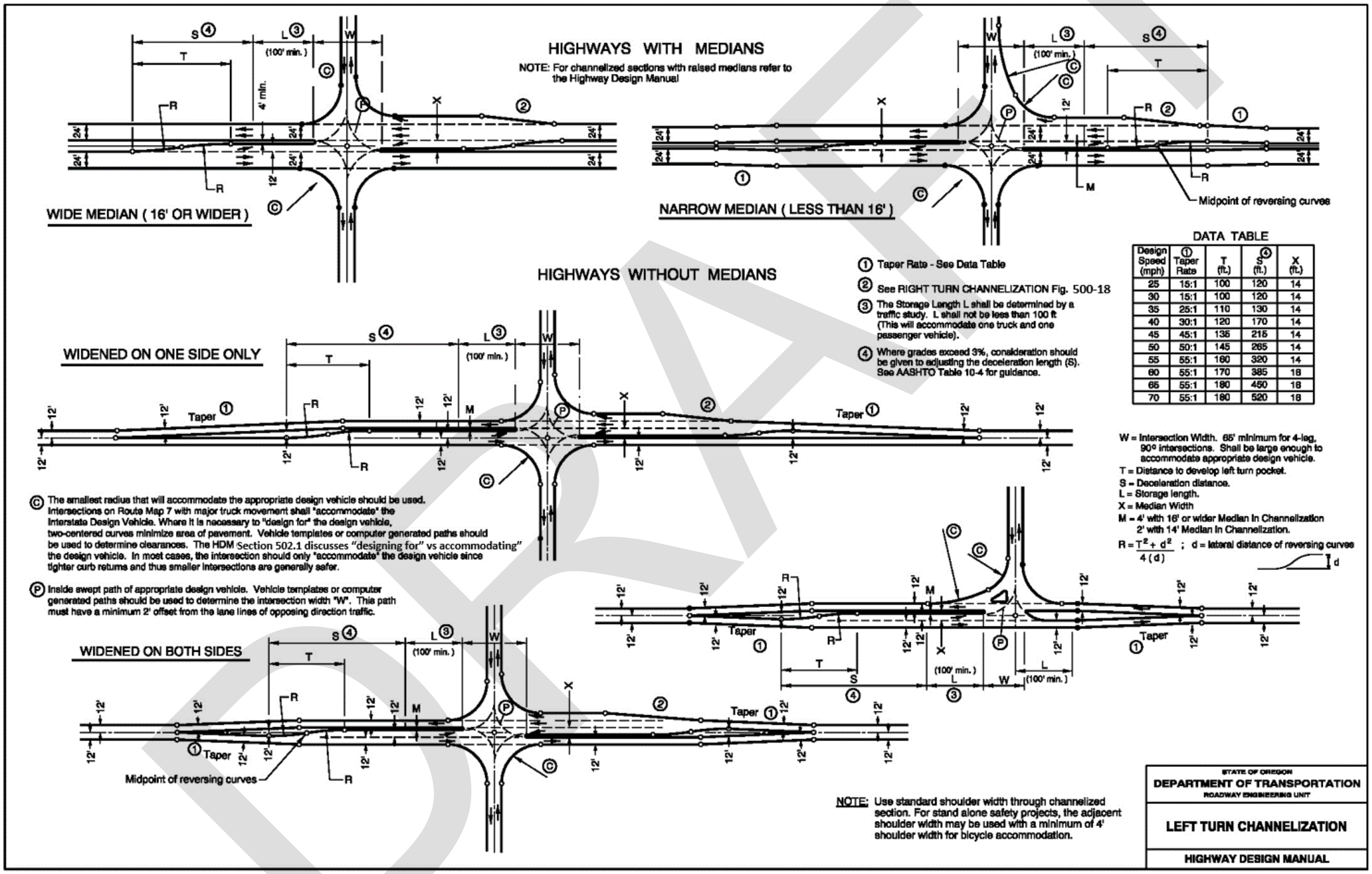
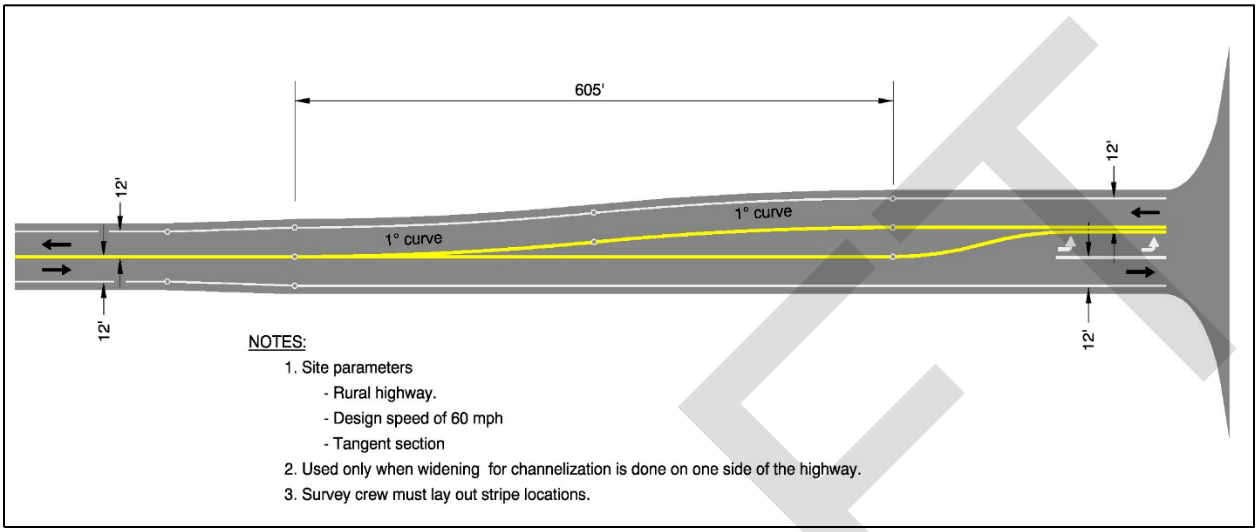


Figure 500-20: Reversing Curve Option for Left-Turn Channelization



506.11 Right Turn Lanes

Similar to left turns, right turning traffic may sometimes create a safety issue at some intersections. However, right turn traffic does not normally need to come to a complete stop and wait for an opposing gap to complete the maneuver, except in the case of a pedestrian crossing. Therefore, the safety implications are not as significant as with left turning vehicles. However, at some intersections, the volumes on the highway and the right turning traffic may be significant enough to create a safety problem. The Analysis Procedures Manual (Transportation Planning and Analysis Unit) discusses siting criteria for installing a right turn lane. A right turn lane should be considered only at public road intersections that meet these criteria. Right turn lanes should not be used for private drives unless the access has significant turning volume, a specific accident problem could be corrected by utilizing a right turn lane, or the access is within a rural community area and meets the criteria from the Analysis Procedures Manual.

Speed differential between right turning traffic with through traffic can create significant safety problems at intersections. To reduce this conflict, installation of right turn lanes may be appropriate at some intersections. Right turn lanes also help improve traffic operations and mobility standards at some intersections. Installation of right turn lanes should be considered at intersections that meet the siting criteria. For information about siting criteria for right turn lanes, see the ODOT Analysis and Procedures Manual (APM).

(https://www.oregon.gov/odot/Planning/Pages/APM.aspx)

Not all intersections that meet the siting criteria should have right turn lanes installed. In urban situations, only significant public roads and large private approaches should be considered for installation of a right turn lane. A proliferation of right turn lanes along an urban arterial is undesirable for bicycles and pedestrians, creates an aesthetically unpleasing typical section, and may not improve safety throughout the section. Multiple right turn lanes could, in effect, create a continuous right turn lane, which is not desirable on state highways.

Right turn lanes should be designed in conformance with Figure 500-18. Preferably, a right turn lane should be 12 feet wide with a shoulder of 3 feet or 4 feet for curbed or non-curbed sections respectively. This allows for additional space for larger turning vehicles. In some instances right turn lanes could be considered a turning roadway. Turning roadways are usually thought of in relation to interchange ramps. However, according to AASHTO, turning roadways include interchange ramps and intersection curves for right-turning vehicles. The AASHTO publication, "*A Policy on Geometric Design of Highways and Streets - 2011*" has extensive information on turning roadway design including sections on minimum radii, control radii, corner islands, minimum edge of traveled way, lane configuration and swept paths. However, in urban locations where space is constrained by the built environment, flexibility is necessary when laying out right turn lanes. See Part 200 and Part 300 for urban right-turn lane design criteria.

When designing an urban right turn lane, bicyclist movements need to be accommodated. The goal for highway projects is to provide the highest appropriate level bicycle and pedestrian facilities possible within project scope and funding at a given location. It is desirable to connect new and existing networks while projects are being constructed. Contact the region Active Transportation Liaison to determine bicycle and pedestrian facilities appropriate for the project and to determine if alternate funding.

Where minimum bicycle lanes adjacent to the travel lane are existing or proposed, adding a bike lane to the left of the right turn lane helps reduce conflicts between right turning vehicles and through cyclists. In addition, providing the bike lane between the through travel lane and the right turn lane better aligns the cyclist with the downstream shoulder or continuation of the established bike lane. However, creating a bike lane between the through lane and the right turn lane establishes a conflict point further back from the intersection where the paths of right turning vehicles and cyclists must cross. Care must be taken to balance bicycle speeds, right turning vehicle speeds and operational queue lengths in the right turn lane to establish the appropriate bike and motor vehicle crossing location. Part 900 provides guidance for designing bicycle facilities. In this conflict area, the bike lane is generally marked with short skip striping. However, more recently, the MUTCD and FHWA have allowed this area to be colored green as an experimental condition to draw more attention to the conflict area. Region Traffic and Roadway sections, ODOT bicycle and pedestrian coordinators and the ODOT, Technical Services, Traffic-Roadway section should be consulted for current guidance if it is determined that using this treatment in this location would be beneficial.

The standard width for a bike lane between a through travel lane and a right turn lane is 5 feet. This width is narrower than a standard bike lane against a curb. However, it is a minimum width and if the bike lane is too wide, it may appear to vehicle drivers as an added lane. Also, width added to a bike lane increases the overall width of the roadway section that must be crossed by pedestrians. Width of the right turn lane is critical as well. The preferred width is 15 feet (12' lane, 3' shoulder) from the adjacent travel lane or bike lane to curb for an urban right turn lane. The additional 3 feet provides space for truck off-tracking and minimizes the need for a right turning truck to encroach on the adjacent lane when making the turn. In some instances, a 3 foot shoulder may not be adequate and additional width might be needed. However, that additional width has consequences. Right turn lane width in conjunction with bicycle lane width is a balance between providing enough space for the respective vehicle's lane use, but minimizing the crossing distance for pedestrians at an intersection within the space available. Part 200 and Part 300 provide design criteria for urban cross-sections and urban right-turn lanes.

In some instances, dual right turn lanes may need to be considered. When designing dual right turn lanes, there must be two lanes on the connecting roadway to turn into and there must be adequate length provided downstream before any lanes merge. The designer also must determine the appropriate design vehicles to use for side-by-side operation through the turning movement. In rare locations, like at freeway ramp terminals leading to truck stops or warehousing districts, that may need to be two WB-67 vehicles making the turn simultaneously. However, in most locations, a WB-67 and an SU vehicle side-by-side is adequate for design. In other locations where truck volumes are low, an SU vehicle and a passenger vehicle may be sufficient. When considering dual right turn lanes as an option, consult the Region Traffic Section for input. Dual right turn lanes are also difficult for pedestrians and bicyclists to navigate. Part 900 and the Oregon Bicycle and Pedestrian Design Guide provides information in regards to dual right turn lanes. Consult the ODOT Bicycle and Pedestrian coordinator for guidance as well.

506.12 Deceleration & Acceleration Lanes

Deceleration lanes are encouraged at intersections and required at interchanges. Deceleration at an interchange can look similar to a standard right turn lane or a freeway exit ramp. Each situation must be evaluated and analyzed to determine the appropriate treatment. Figure 500-18 should be used for all right turn deceleration lanes. The information contained in Part 600 can be used to determine acceptable exit ramp designs.

Acceleration lanes should generally only be used at interchanges on rural expressways. Acceleration lanes at at-grade accesses or intersections may not be appropriate. Acceleration lanes should only be used where they will not be influenced by downstream intersections or accesses. At-grade intersections and access locations may include acceleration lanes only where access management spacing standards are met, the type of turning movements are considered, and where an engineering analysis shows they will operate safely. Design guidance and criteria for at-grade intersections are found in Section 506.13 and Section 506.14.

For freeway style interchanges, freeway type acceleration lanes are necessary. For jug handle and at-grade acceleration lanes, the parallel type shown in Section 506.13 may be most appropriate. Part 600 and the AASHTO Green Book provides guidance for determining the appropriate acceleration lane length. The length may need to be increased when a significant volume of truck traffic is using the merge lane or where high volumes are merging into a single lane.

506.13 At-Grade Right Turn Acceleration Lanes

At-grade intersections generally should not have short tapers or acceleration lanes constructed for vehicles entering the state highway from a crossroad or another state highway. Acceleration lanes are generally only provided at grade separated facilities. However, in some situations acceleration lanes may be justified. The following criteria outlines where at-grade right turn acceleration lanes can be considered. All of the criteria must be satisfied and requires joint approval from the State Traffic-Roadway Engineer through the design exception process.

1. The posted speed on the main highway shall be 45 MPH or greater.
2. The V/C ratio of the right-turn movement without the acceleration lane shall exceed the maximum value listed in Tables 6 and 7 of the OHP for the corresponding highway category and location.
    a. Exception 2a: If trucks represent at least 10% of all right-turning vehicles entering the highway, then the V/C criteria may be waived.
    b. Exception 2b: If substandard sight distance exists at an intersection or right-turning vehicles must enter the highway on an ascending grade of greater than 3%, then the V/C criteria may be waived.
    c. Exception 2c: If crash data in the vicinity of the intersection shows a history of crashes at or beyond the intersection attributed to right-turning vehicles entering the highway, then the V/C criteria may be waived.
3. The peak hour volume of right-turning vehicles from the side street onto the state highway shall be at least 10 vehicles/hour for Rural Expressways and 50 vehicles/hour for all other highways.
4. No other access points or reservations of access shall exist on both sides of the highway within the design length, taper, and downstream from the end of the taper within the decision sight distance, based on the design speed of the highway.

a. Exception 4a: If positive separation between opposing directions of traffic exist such as raised medians or concrete barriers, then access control is only needed in the direction of the proposed acceleration lane.

The State Traffic-Roadway Engineer shall determine if a right-turn acceleration lane proposal meets the above criteria. Proposals are submitted to the State Traffic-Roadway Engineer from the region and include an engineering investigation with data supporting the above criteria and a drawing encompassing the intersection and design length of the acceleration lane showing all access points and reservations of access to the highway. Only proposals for right-turn acceleration lanes from public streets will be considered. All right-turn acceleration lane proposals shall require the approval of the State Traffic-Roadway Engineer.

Special consideration should be given to cyclists and pedestrians. Acceleration lanes create an unexpected condition for both pedestrians and cyclists. Every reasonable effort should be made to create conditions that make the crossing safer and easier for pedestrians and cyclists. The acceleration lane shall be designed in accordance with Figure 500-21 “Right Turn Acceleration Lane from At-Grade Intersection”.

Free-flow acceleration lanes may be considered in rural or suburban areas provided the turning radius is tightened and the angle of approach is kept as close to a right angle as possible. These combined elements will force right-turning drivers to slow down and look ahead, where pedestrians and bicyclists may be present, before turning and accelerating onto the roadway.

Figure 500-21: Right Turn Acceleration Lane from at Grade Intersection

RIGHT TURN ACCELERATION LANE FROM AT GRADE INTERSECTION

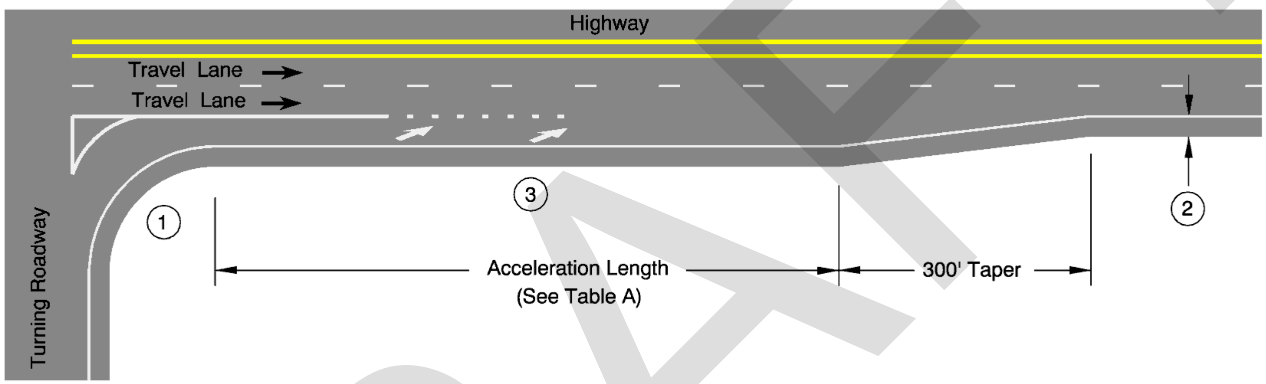


TABLE A
MINIMUM ACCELERATION LENGTH

Design Speed of Highway (mph)	Design Speed of Turning Roadway: Stop Condition	Design Speed of Turning Roadway: 15 mph
50	720	660
55	960	900
60	1200	1140
65	1410	1350
70	1620	1560

TABLE B
MAINLINE GRADE AJUSTMENT FACTORS

Design Speed of Highway (mph)	% Grade	Upgrade	Downgrade
50	3% to less than 5%	1.3	0.65
55		1.35	0.625
60		1.4	0.6
65		1.45	0.6
70		1.5	0.6
50	5% and over	1.5	0.55
55		1.6	0.525
60		1.7	0.5
65		1.85	0.5
70		2.0	0.5

NOTES:

1. Radius shall accomodate design vehicles, yet minimize pedestrian crossing distance. Compound radii are recommended for larger design vehicles. Radii are measured to the edge of travel lane or face of curb.
2. Design shoulder width as required per Highway Design Manual
3. Use Table B to determine acceleration lenght adjustment due to grade.

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RIGHT TURN ACCELERATION LANE FROM AT GRADE INTERSECTION

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506.14 Median Acceleration Lanes

For ODOT purposes, a median acceleration lane is a lane added to the median of a roadway at an un-signalized intersection to allow left turning vehicles from a side road to gain speed and merge with main line traffic. Median acceleration lanes may seem like a reasonable solution to left turn problems onto busy, high speed roadways and, in some locations, they may be an acceptable feature. However, their use should be reserved for locations with specific needs. Improper installation of a median acceleration lane may create unanticipated problems greater than the problems the installation is attempting to solve. Any location where a median acceleration lane is proposed must be analyzed carefully before a median acceleration lane is considered to be appropriate. Overall, there is little definitive research or information available on the use or effectiveness of median acceleration lanes. What does seem to be known, however, is that location is of critical importance to the effective function of a median acceleration lane. Therefore, site specific analysis is paramount in determining the appropriateness of installing a median acceleration lane.

Median acceleration lanes function best on rural, multi-lane, free flowing roadways with ample median width and decision sight distance to accommodate not only the turning movements of all vehicle types, but to also provide the acceleration lane itself. Median width must be provided over a long enough distance to allow the accelerating driver to choose a gap in the traffic stream and merge smoothly prior to the end of the median acceleration lane. Median acceleration lane length will likely need to be longer than typical right side acceleration lane length in order to ensure adequate, comfortable and safe merge maneuvers into the traffic stream. Additional run-out length should be provided downstream of the median acceleration lane taper. This will provide a “bail out” area or escape route in the event that no adequate gap is available for the accelerating vehicle in the main line traffic stream. Median acceleration lanes are not appropriate for two lane roadways on the state highway system and shall not be installed on such facilities in either rural or urban locations. Figure 500-22 and Figure 500-23 provide information about Median Acceleration Lane layout.

Although not recommended, it may be possible to install a median acceleration lane on some limited access, divided, urban arterials or expressways with posted speeds of 45 mph or greater. However, this type of installation must be considered carefully. Median width and intersection spacing must be appropriate to allow the acceleration lane to function. In addition, there shall be no right side access points to the main line highway along the length of the median acceleration lane or within decision sight distance of the left side merge taper. Right side accesses along a section of roadway with a median acceleration lane on the left side create the scenario of the main line traffic being impacted from both sides of the roadway at the same time. Median acceleration lanes shall not be installed in locations with posted speeds below 45 mph. When speeds are below 45 mph, the differential of an accelerating vehicle and the traffic stream are not as great and a median acceleration lane does not provide added benefit.

As discussed in the preceding paragraphs, in limited situations, a median acceleration lane may provide an incremental improvement to a multi-lane expressway by providing left turning vehicles an opportunity to accelerate and reduce speed differential before entering the traffic stream. This is particularly true where there are large numbers of left turning trucks. Where sufficient gaps exist in the main line traffic stream, a median acceleration lane is not needed and the cost of installation as well as potential environmental impacts of adding new impervious surface may not be justified. However, where there are few gaps in the main traffic stream and there is a high demand for left turning trucks or other large vehicles like RVs, motor homes or buses from the side road, a median acceleration lane may serve as an acceptable interim solution. A median acceleration lane is not a typical design. Contact Technical Services Roadway staff for information regarding the installation of median acceleration lanes. Before any median acceleration lane can be installed on the state highway system, approval from the State Traffic-Roadway Engineer must be obtained.

Consideration may be given to install a median acceleration lane when all of the following criteria are met:

1. A multi-lane, divided expressway or arterial highway with a posted speed of 45 mph or greater
2. Adequate Median width to allow for desirable dimensions as shown in Figure 500-22 and Figure 500-23
3. Large left turning volume from side road – particularly truck volumes and recreational vehicle
4. Insufficient gaps or inadequate intersection sight distance (Particularly AASHTO B1, Right Side)
5. No right side accesses onto main line along the length of the acceleration lane or within decision sight distance of the end of the taper
6. Significant crash history – particularly truck crashes

Table 500-2: Desirable Length of Full Width Median Acceleration Lane

Posted Speed (mph)	2/3 of Posted Speed (mph)	Desirable Length of Full Width Median Acceleration Lane, Rounded (ft.)
45	30	810
50	34	995
55	37	1203
60	40	1435
65	44	1680
Desirable Length Based on 200lb/hp Truck Accelerating to 2/3 posted speed Minimum Median Acceleration Lane Length – 810′		

The 200 pound per horsepower truck equates to the 85% truck in the national fleet based on studies reported in NCHRP Report 505, Review of Truck Characteristics as Factors in Roadway Design published in 2003. Table 29 in NCHRP Report 505 lists average acceleration capabilities for several different weight to power ratio classes of trucks. For the 200 pound per horsepower vehicles, the average acceleration listed is 1.22 ft/s2. The following formula for uniform acceleration was used to determine the desirable lengths for Median Acceleration Lanes listed in Table 500-2.

$$\boxed{V_f^2 = V_i^2 + 2AS}$$

Where:

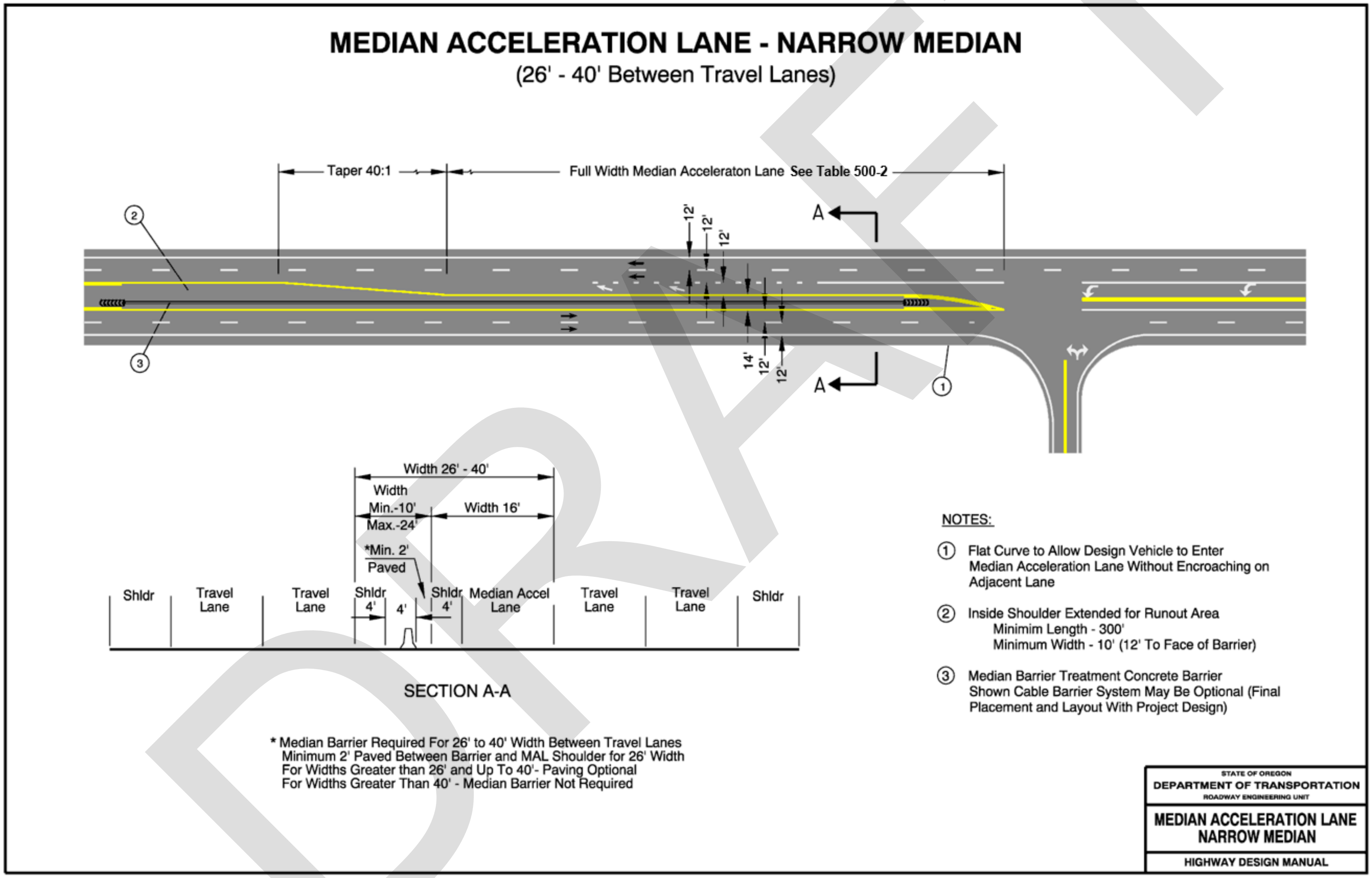
V_f = Final speed achieved at the end of distance S, ft/sec.

V_i = Initial speed, ft/sec. for Table 500-2, $V_i = 0$

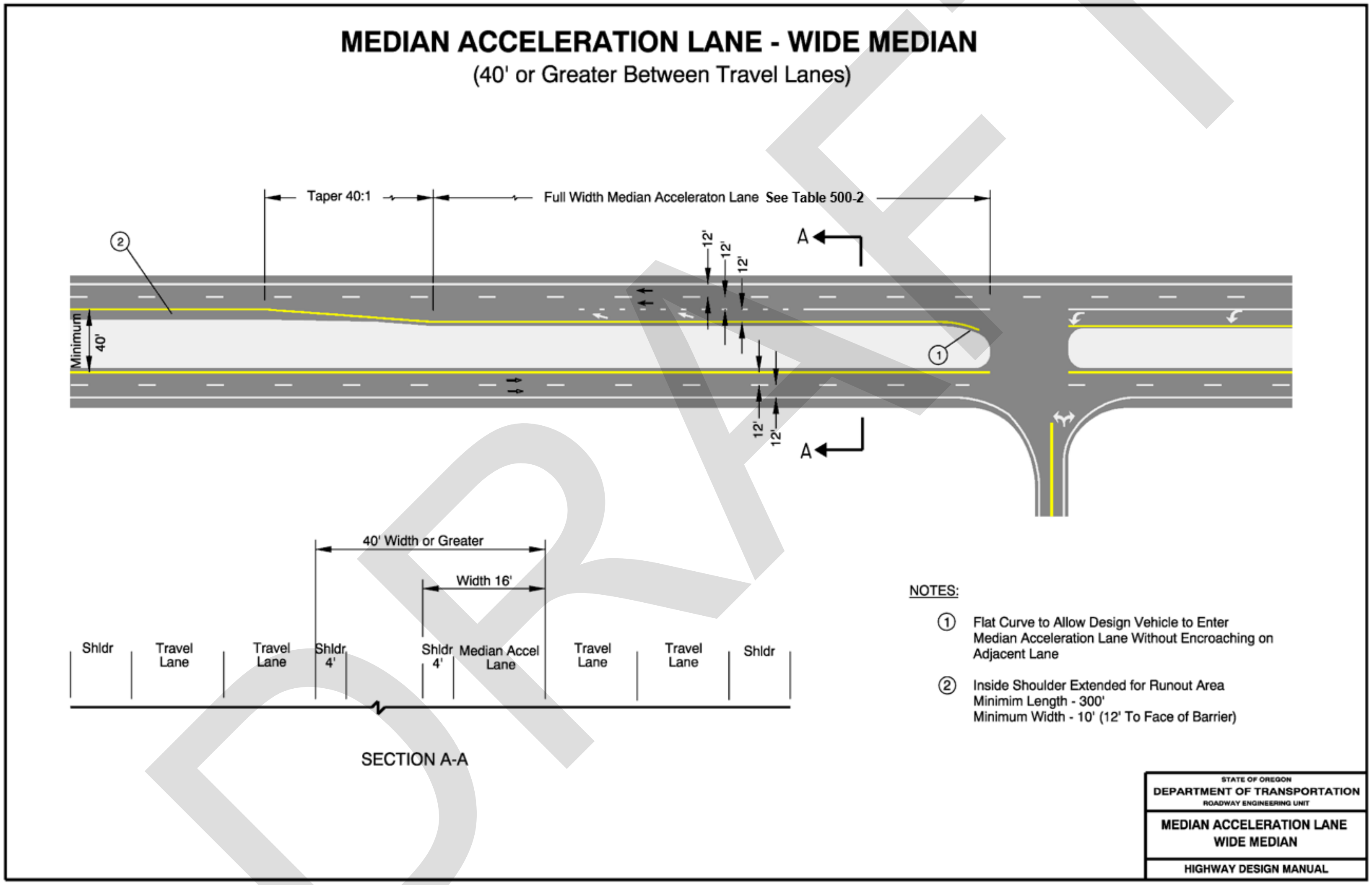
A = Acceleration, ft/sec^2. A=1.22 ft/sec^2

S = Distance to accelerate to 2/3 of posted speed, Ft.

Figure 500-22: Median Acceleration Lane - Narrow Median



1 Figure 500-23: Median Acceleration Lane - Wide Median



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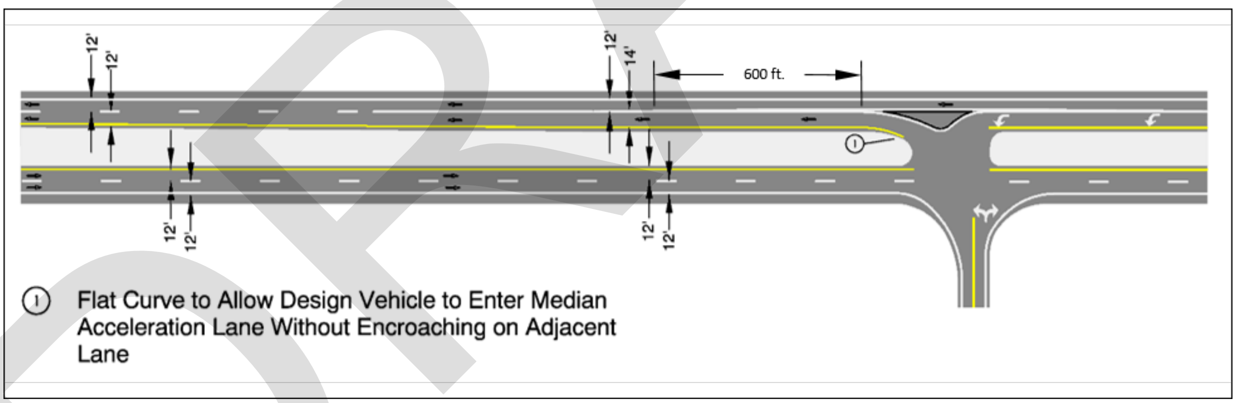
506.15 Left Turn Add Lanes

A left turn add lane is a lane provided for vehicles turning left from a side road to accelerate and enter the main line traffic stream in a designated through lane. A left turn add lane should not be confused with a median acceleration lane. Although they may serve similar functions, there is a distinct difference. A median acceleration lane requires the left turning vehicle to merge into the through lane of the main line traffic stream. Whereas, a left turn add lane creates a new and separate through lane for the left turning vehicle to enter that is independent of the existing through travel lane on the main line highway. This eliminates the need for the turning vehicle to merge into the existing through lane and creates a completely different operational characteristic from a median acceleration lane that reduces impacts on traffic in the existing through lane. Some form of physical separation between the add lane and the existing through travel lane should be provided for a length necessary to minimize speed differential between travel lanes. The first 600 feet should be a positive physical separation in the form of a raised separator or barrier, while the remaining length can be less physically separating in the form of rumble strips or a wide, solid paint stripe. Figure 500-24 illustrates a left turn add lane configuration.

Figure 500-24: Left Turn Add Lane



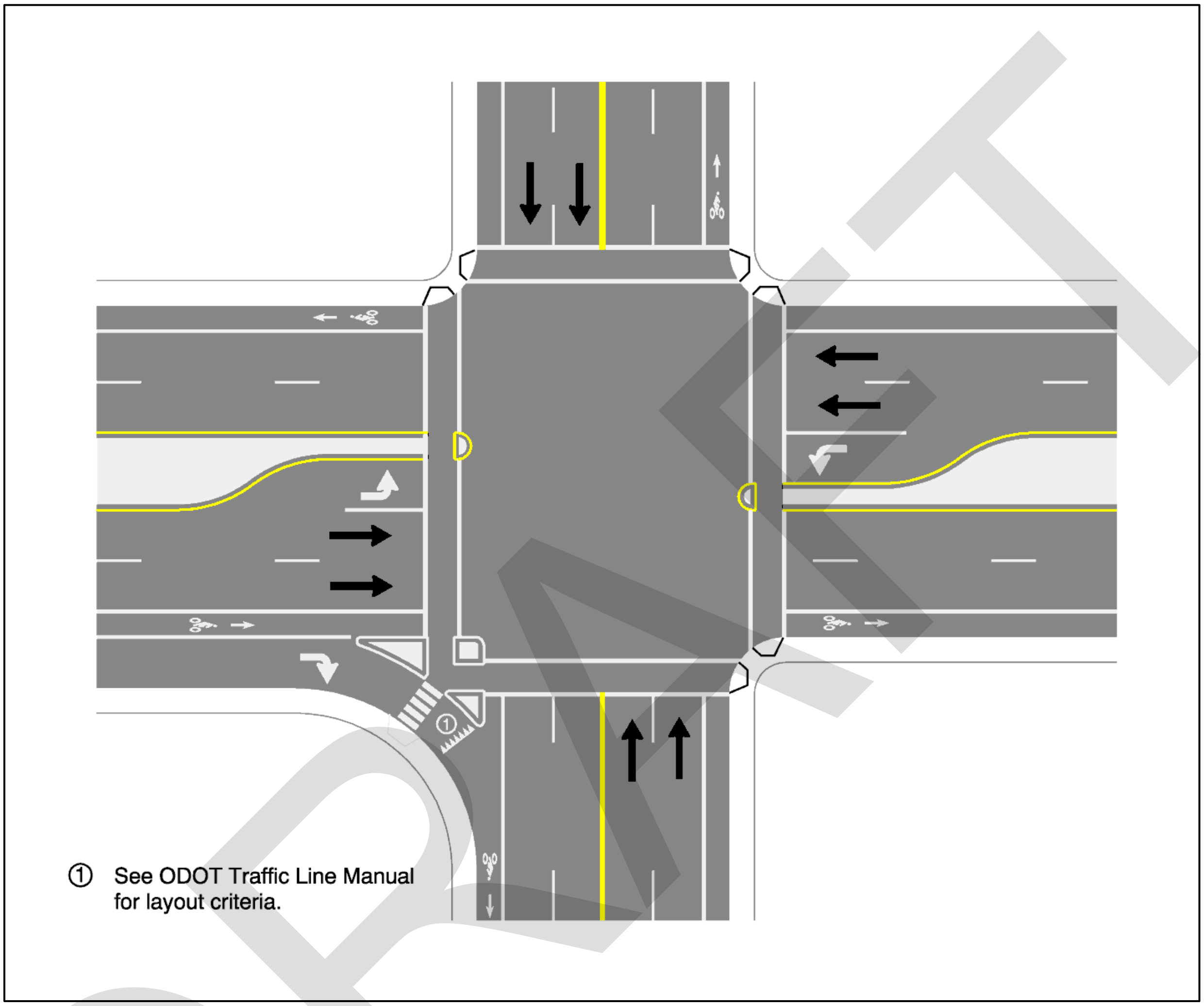
506.16 Channelization Islands

Channelization islands help to direct turning traffic through an intersection. Channelization islands are a tool to help decrease the exposed crossing area of very large intersections. These islands can provide a refuge area for crossing pedestrians and offer a location for signal poles and sign posts. Where channelization islands are to accommodate poles or sign posts, the island should ideally have an area of at least 100 square feet. The minimum area shown on RD710 is 75 square feet.

Channelization islands are also useful for decreasing the crossing distance of pedestrians. When intersections are very wide, pedestrians must cross very long distances which increases their exposure time to traffic, reduces safety, and reduces efficiency of the signal due to the time necessary to cover the crossing maneuver. The designer should consider using channelization islands where crossing distances are greater than 6 lanes wide. (Section 308 discusses raised medians and Section 506.16 provides additional guidance on channelization islands for bicyclists and pedestrians). Channelization islands should be designed in conformance with Figure 500-25 provides additional information regarding pedestrian crossings and channelization islands.

In some rural locations, it may be advantageous to provide a moderate to higher speed right turn movement at major intersections. However, care must be taken at these locations to adequately provide facilities that protect pedestrians. Channelization islands could also be used in these instances. When channelization islands are installed at high speed, rural locations, care must be taken to place these islands with adequate offset distance from the through travel lane. Figure 500-32 provides layout details for channelization islands. Adding raised channelization islands to intersections must be in compliance with ORS 366.215 and freight mobility needs. See ODOT guidance document "*Guidelines for Implementation of ORS 366.215, No Reduction of Vehicle-Carrying Capacity*" and the "*ODOT Highway Mobility Operations Manual*".

Figure 500-25: Typical Multi-Lane Channelized Intersection



506.17 Curb Extensions

Curb extensions, also known as “bulb-outs,” are good tools to help reduce the pedestrian crossing distances in areas with on-street parking. Curb extensions also increase pedestrian visibility, help control vehicular speeds, and give a “downtown look” to an urban area. Curb extensions are generally appropriate within slower speed compact areas, such as Special Transportation Areas (STAs) or Traditional Downtown/Commercial Business Districts. Curb extensions are generally considered at intersections, but they can also be utilized with great benefit at mid-block pedestrian crossings as well.

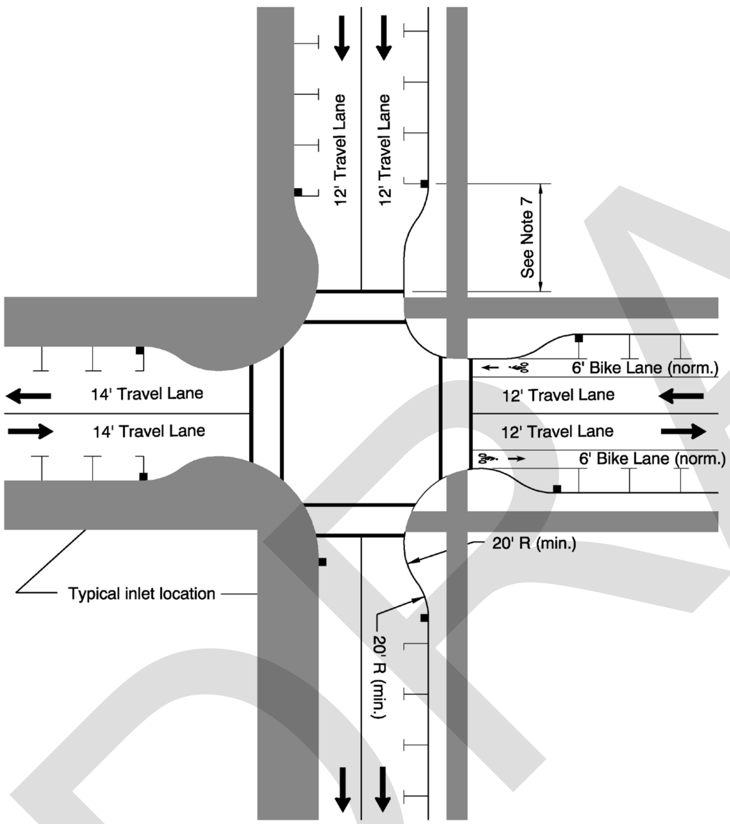
The curb extensions still must be designed to accommodate the appropriate design vehicle. However, due to the speed, traffic characteristics, and importance of alternative modes in these areas, the level of accommodation of large vehicles is expected to be minimal. Curb extension design at proposed locations must meet the process and criteria outlined in ORS 366.215 and must meet freight mobility needs. See ODOT guidance document "*Guidelines for Implementation of ORS 366.215, No Reduction of Vehicle-Carrying Capacity*" and The "*ODOT Highway Mobility Operations Manual*".

Curb extensions should generally be constructed to the full width of the on-street parking. However, when no bike lane is present, the curbside travel lane should be at least 14 feet wide from the left side lane line to the face of the curb at the maximum extension point. Each curb extension design is different. Figure 500-26 contains several design concepts for consideration. Special consideration is required in many situations for addressing drainage in conjunction with curb extensions, especially in retrofit situations. Curb extensions should not block or narrow bicycle lanes and must provide adequate drainage along the curb line with no ponding of water at the sidewalk ramp entrance. For additional information on curb extensions, see Part 800 for pedestrian design guidance.

ORS 811.550(17) requires parking to be 20 feet from a marked or unmarked crosswalk and the MUTCD indicates parking should be 30 feet from the crosswalk at signalized intersections. Curb extensions can be used to provide the pedestrian benefits listed previously in this section as well as provide compliance for the required distance from crosswalks to on street parking.

Figure 500-26: Curb Extensions

CURB EXTENSIONS



General Notes

1. Intersections on state facilities should be designed to accommodate the appropriate design vehicle with the SU as the minimum. Corner curb radii are normally no less than 33' in cases where vehicles are turning right onto a roadway without a bike lane. The introductions of bike lanes, one-way streets and different combinations of turning movements may reduce the curb radius requirements to as low as 16'. These radii should be confirmed by the appropriate vehicle turning template or computer-generated turning paths.

2. Other curb radii should be no less than 20' to accommodate street maintenance equipment. This radius may be reduced if approved by local authorities.

3. Sidewalk ramps should be designed in accordance with Standard Drawing RD 755. Ramps should be located at the normal crosswalk location.

4. Storm water inlets should be placed at the point where the curb extension matches into the normal street section. Normally, 2 inlets are required, one at each end of the curb extension. Drainage may be required in the sidewalk area, depending on slopes and sidewalk design. Drainage may also be provided through the use of a slotted drain or a pipe through the curb extension.

5. Curb extension should be kept clear of obstructions that could obscure sight distance.

6. Curb extensions should not narrow bikelanes.

7. ORS 811.550(00) requires parking to be 20 feet from crosswalk for unmarked or marked crosswalks. MUTCD - 30 feet from crosswalk at Signalized intersection

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506.18 Bicycle and Pedestrian Needs

The design of intersections takes into account the needs of bicyclists and pedestrians. The level and amount of design effort required to ensure adequate design for these modes will vary among different areas.

Intersection designs should try to keep the crossing distances and pedestrian exposure to a minimum. Pedestrians and motorists must be able to see each other clearly and understand how the other will proceed through the intersection. This can sometimes be difficult at major intersections that accommodate multiple turn lanes. When intersections become excessively large and complex, pedestrian safety is often at a higher risk. The roadway designer provides mitigation measures to reduce the crossing distance to balance impacts for roadway users.

Providing pedestrians with a crossing that can be completed in one movement can improve crossing impacts. However, when pedestrians must cross an excessive number of traffic lanes or a combination of excessive traffic lanes and a large skew angle, consider an appropriately sized pedestrian median refuge to enable pedestrians to cross the street in two phases. A right turn channelization island can also be considered to reduce the pedestrians' exposure to both through and right turning vehicles. Curb extensions are a tool available to reduce the crossing distance for roadways with on-street parking. Median refuges and right turn channelization islands may be more appropriate in suburban locations, and curb extensions may be a more appropriate tool in more compact areas such as STAs or Commercial Business Districts. However, any of these tools could apply in a multitude of situations. A general rule of thumb is to consider pedestrian crossing remediation when the crossing distance exceeds 90 feet in typical urban environments such as Urban Business Areas (UBAs) and 72 feet in compact densely developed areas such as STAs.

Use Protected Intersection design to provide safer intersection operations for all users. See Part 900 for guidance on Protected Intersections.

ADA requirements shall be met in every intersection design. Issues such as proper ramps, location of pedestrian and signal poles, obstructions, fixed objects, drainage, etc., need to be reviewed and designed to be compliant with ADA design requirements and accommodate all roadway and intersection users. Part 800 for Pedestrian Design and Part 900 for Bicycle Facility design has additional information on intersection accommodation.

506.19 Intersection Design Affecting Pedestrians

There are several aspects of intersection design that impact the safety, comfort or access needs of pedestrians. For each identified issue, measures that can be used to mitigate these effects will be proposed.

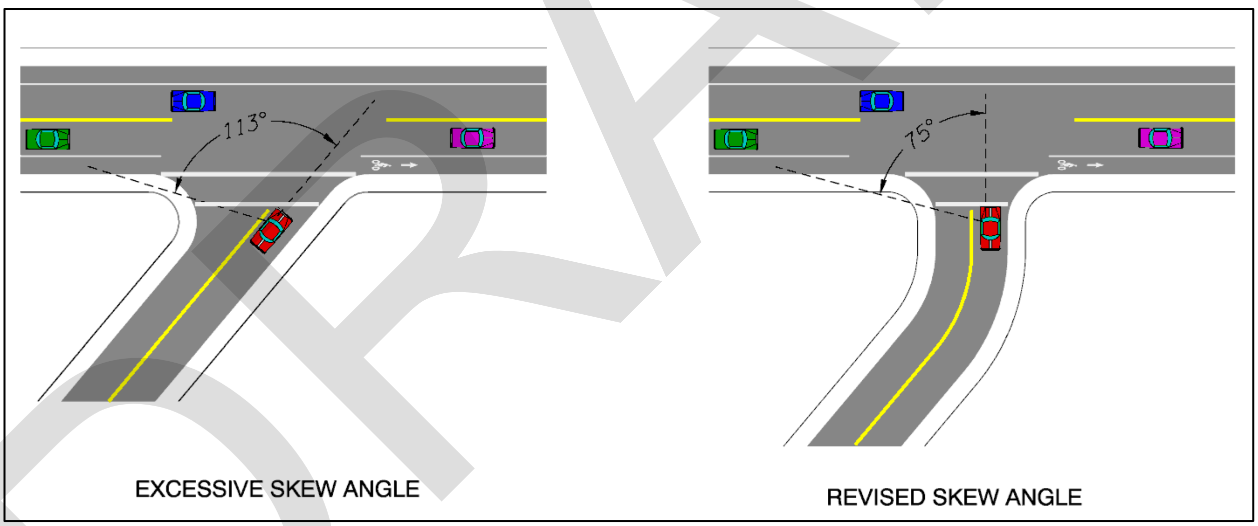
506.20 Excessive Skews

Skewed approaches have several negative effects for pedestrians:

1. They make the crossing longer;
2. They enable motorists to make a turn at high speeds;
3. They force entering motorists to look backwards for conflicts, so that a pedestrian approaching from the other direction is out of sight, and
4. They place crossing pedestrians with their backs to approaching traffic.

The best way to mitigate for a skew is to reconfigure the intersection at or close to a right angle. If sufficient right of way is not available for total reconfiguration, the negative effects can be mitigated with a curb extension in the flat-angle corner(s). Figure 500-27 shows an example of an intersection with excessive skew and the intersection reconfigured with improve skew angle. If a curb extension isn't feasible, then use the tightest possible radius in the flat-angle corner(s).

Figure 500-27: Skew Angle and Field of View



506.21 Long Crosswalks

Long crosswalks are a problem for all road users for several reasons:

1. The pedestrian is exposed to conflicts longer;
2. It is difficult for some people to see pedestrian signals if they are too far away, and

3. The capacity of the intersection is reduced if the signal cycle is governed by the pedestrian crossing time. However, operational needs must be balanced against pedestrian access needs and pedestrian safety.

Several methods may be considered, individually or jointly, to reduce crosswalk lengths:

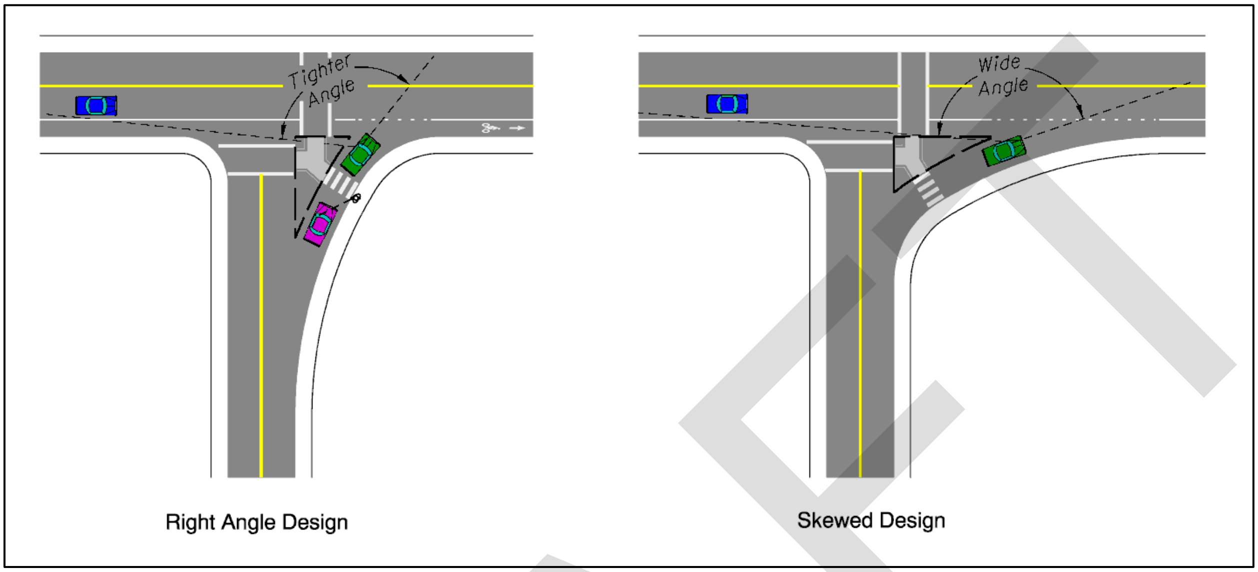
1. Narrow the cross-section;
2. Provide curb-extensions on streets with parking;
3. Reduce the skew of the intersecting street, and
4. Minimize curb radius.

If the overall crosswalk length cannot be reduced, or the above techniques still do not provide sufficient reductions, then consider placing a refuge island(s) to enable the pedestrian to cross in two or more phases. Pedestrians should not be forced into a two-phase crossing; rather, the option should be available should they be stranded on a refuge island. Always provide a pedestrian push-button on islands. Pedestrian median refuges are strongly recommended when crossing more than 6 lanes. The Signal Design Manual can provide guidance for crossings at signalized intersections. Consult the Region Traffic Section and the Technical Services Traffic Unit when considering the installation pedestrian refuge islands.

506.22 Island Geometry

An island placed between a slip lane and through traffic can offer pedestrians a refuge, but if it is poorly designed, the geometry can encourage drivers to make turns at high speeds without looking for pedestrians. This can be mitigated by a design that brings the motorist to the intersecting street at close to a right angle, rather than a skew. This forces the driver to slow down, and enables the driver to see the crossing pedestrian. Figure 500-28 shows an example of a reconfigured right angle design skewed flat angle design. The type of design chosen varies depending upon the right turn vehicle accommodation. In many cases the presence of large trucks creates challenges for the use of this treatment. See Section 502.1 and Figure 500-3 for more information on large vehicle accommodation and design. Also see ODOT guidance document "*Guidelines for Implementation of ORS 366.215, No Reduction of Vehicle-Carrying Capacity*" and the ODOT "*Highway Mobility Operations Manual*".

Figure 500-28: Island Geometry



506.23 Corner Radii

Large corner radii present several problems for pedestrians:

1. They make the crossing longer;
2. They enable motorists to make a turn at high speeds, and
3. They make it very difficult to line up the sidewalks, crosswalks and curb cuts.

Designers should try every possible technique to minimize the corner radii at intersections in urban areas. Refer to the techniques described in Section 506.9, Design Considerations, Turning Radii.

Choosing the appropriate radius is often dependent on factors other than strict interpretation of design parameters. For example, it may be acceptable to design to a tight radius on approach streets with very little truck traffic, even if that means that the occasional truck may have to encroach into traffic to make a turn. Where there is a higher volume of truck traffic turning, a balance needs to be maintained between a large enough radius to accommodate truck turning, but a small enough radius to keep speeds of smaller turning vehicles low; thereby, minimize impacts to pedestrians and bicyclists.

506.24 Crosswalk and Ramp Placement

Crosswalk and ramp placement becomes a concern when an intersection is skewed, or if the corner radii are too large, especially with curb-tight sidewalks. The pedestrian expects the sidewalk, the curb ramp and the crosswalks to be in a reasonably straight line. The natural crossing point will be a continuation of the sidewalk.

Again, large corner radii create very long crosswalks. The designer may then be tempted to move the crosswalk away from the intersection, where the crossing is shorter, and crosswalks and curb ramps are perpendicular to the curb. This creates a new problem, as the crosswalk is offset from the intersection. The crossing pedestrians may not be visible to turning motorists, or pedestrians may ignore the crosswalk markings and walk where they are less inconvenienced. In other circumstances, squaring up the crossing may be the appropriate treatment. The best solution is to tighten up the intersection as much as possible.

In most instances, the best design will be arrived at through an iterative process. Imagining the natural path a pedestrian will take, while anticipating the various vehicle turning movements that may conflict with a pedestrian will help a designer reach optimal visibility of pedestrians and reasonable crossing distances. Examining driver and pedestrian expectations where pedestrian/vehicle conflicts may occur will help a designer better accommodate pedestrian crossings.

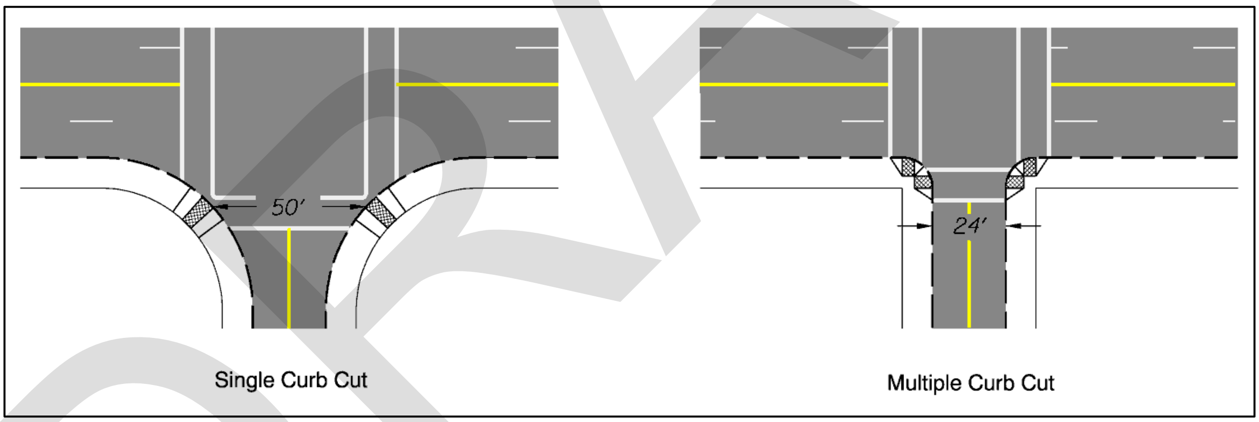
Another consideration is trying to ensure that sidewalks are separated with a buffer strip. This has two advantages: the extra separation will place the sidewalks between the offset crosswalk and the curb-tight crosswalk described above, and a curb ramp traced through the buffer strip will more effectively channel pedestrians to the right crossing point. For additional information, Part 800 provides guidance for pedestrian design.

506.25 Curb Ramps - Placement and Number

U.S. Access Board guidance on compliance with the Americans With Disabilities Act (ADA) recommends two curb ramps at each corner of an intersection on new construction, and reasonable efforts should be made to install two on retrofit projects. Two curb ramps enable people in wheelchairs and other mobility aids to enter a crosswalk directly, without having to turn 45° in the roadway. Two curb ramps also make it easier to construct them perpendicular to the curb, as required. An additional advantage to utilizing two curb ramps is they better line up between the crosswalk and the adjacent sidewalk than a single curb ramp does. This allows vision impaired pedestrians a straight path to follow to reach the sidewalk, rather than having to deviate from the crosswalk alignment to find the single ramp located away from the crosswalk to sidewalk path. However, on corners with larger radii, generally radii greater than 30 feet, placing two curb ramps may make it difficult to align everything correctly. In these situations, after other mitigation has been tried, placing one diagonal ramp may work better. Figure 500-29 is an example of number of curb ramps based upon radius size, crossing distance and location. However, regardless of radius, the designer should strive to place two ramps for each corner when it is feasible. The use of only a single ramp on a corner may require a design exception.

The drawings in Figure 500-29 are for illustrative purposes for discussion about ramp number and placement. Actual ramp design requires greater detail. Whatever the final design, the designer needs to provide the most effective method available to ensure continuity for people with disabilities to traverse the distance between the crosswalk and the sidewalk. See applicable ODOT Standard Drawings for accessible island, accessible sidewalk and accessible ramp options and design. Additional information about providing acceptable access to public rights-of-way can be found in the publication, Special Report: Accessible Public Rights-of-Way, Planning and Designing for Alterations that was produced by the Public Rights-of-Way Access Advisory Committee (PROWAAC) as well as the publication, Public Right of Way Accessibility Guidelines (PROWAG). See Part 900 for additional information about compliant ADA design and ODOT design practices.

Figure 500-29: Crosswalk Ramp Placement



506.26 Signal Pole Placement

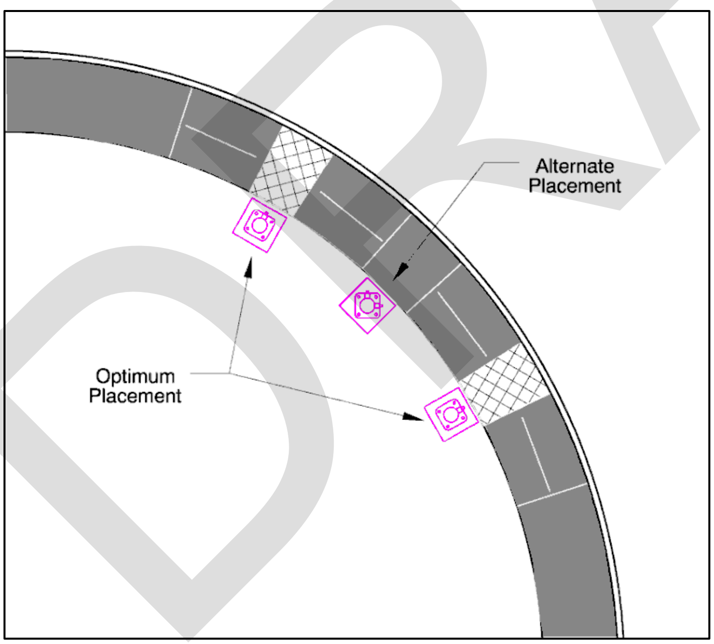
Signal poles must be placed in a location where they do not interfere with pedestrians' path of travel. But, they must be placed in a manner that all pedestrians are able to conveniently reach the signal control push-buttons. There are special placement criteria for accessibility that must be followed to be in compliance with the Americans with Disabilities Act. The designer should work with the Region Traffic Unit and the Technical Services, Traffic-Roadway Section concerning placement of signal poles. The Signal Design Manual provides extensive detailed information and guidance for signal pole, pedestal, and push button placement.

In general, placing the poles correctly is made easier with tight corner radii, sidewalks separated with a buffer strip, and two curb ramps per corner. As the radius increases, it becomes more difficult to place the pole out of the ramps and out of the walking area, but still within reach. The best location for a signal pole is between the two ramps. If that is not feasible, the pole can be placed in the back of walk. This may make it difficult for pedestrians to reach the push-buttons. In this situation, consider placing a pedestrian pole at a more convenient location, preferably between the two curb cuts. In all locations, signal poles and pedestrian buttons must be installed to meet accessibility requirements.

On corners with one curb ramp, it may be best to place the pole at the back of curb, while ensuring that there is a minimum 4 foot (4.5 foot design) level area between the pole and the top of the ramp. Under no circumstances shall poles be placed in a curb cut, or in the level landing at the top of a ramp. Figure 500-30 provides a general example of signal pole placement with parallel style sidewalk ramps.

This section is a general overview for signal pole placement and needs to help the roadway designer understand conflicts and ADA requirements. See the ODOT Signal Design Manual as well as the MUTCD, 4E.08 for additional detailed information on signal pole placement. Signal pole placement is a specialized design consideration. Consult Region Traffic and the Technical Services, Traffic Signal staff for appropriate placement of signal poles and equipment.

Figure 500-30: Signal Pole Placement



506.27 Free-Flow Acceleration (Add) Lanes

This type of intersection treatment should be avoided in urban areas. Free-flow acceleration lanes are generally not allowed for at-grade intersections. They create an unexpected condition for both pedestrians and cyclists. Free-flow acceleration lanes are different than at-grade right-turn acceleration lanes described in Section 506.13. A free-flow acceleration lane provides a lane for traffic to make the turn and enter the acceleration lane without stopping. This implies priority for the turning vehicle over other roadway facility users and is generally not appropriate in urban locations. Use of free-flow lanes is strongly discouraged where pedestrians and bicyclists are expected to cross the lane.

If a free-flow acceleration or add lane is provided for capacity reasons, then every reasonable effort should be made to create conditions that make any adjacent crossings safer and easier for pedestrians and cyclists. Crossings should occur prior to vehicle acceleration locations where vehicle speed is low and adequate sight distance must be provided for a driver to see pedestrians and bicyclists crossing the lane.

Most of the design principles offered in previous sections on right turn lanes would apply to free-flow lanes also: tighten the turning radius, narrow the lane, and keep the angle of approach as close to a right angle as possible. These three elements combined will force drivers turning right to slow down and look ahead, where pedestrians and bicyclists may be present, before turning and accelerating onto the roadway.

Section 507 Signalized Intersections

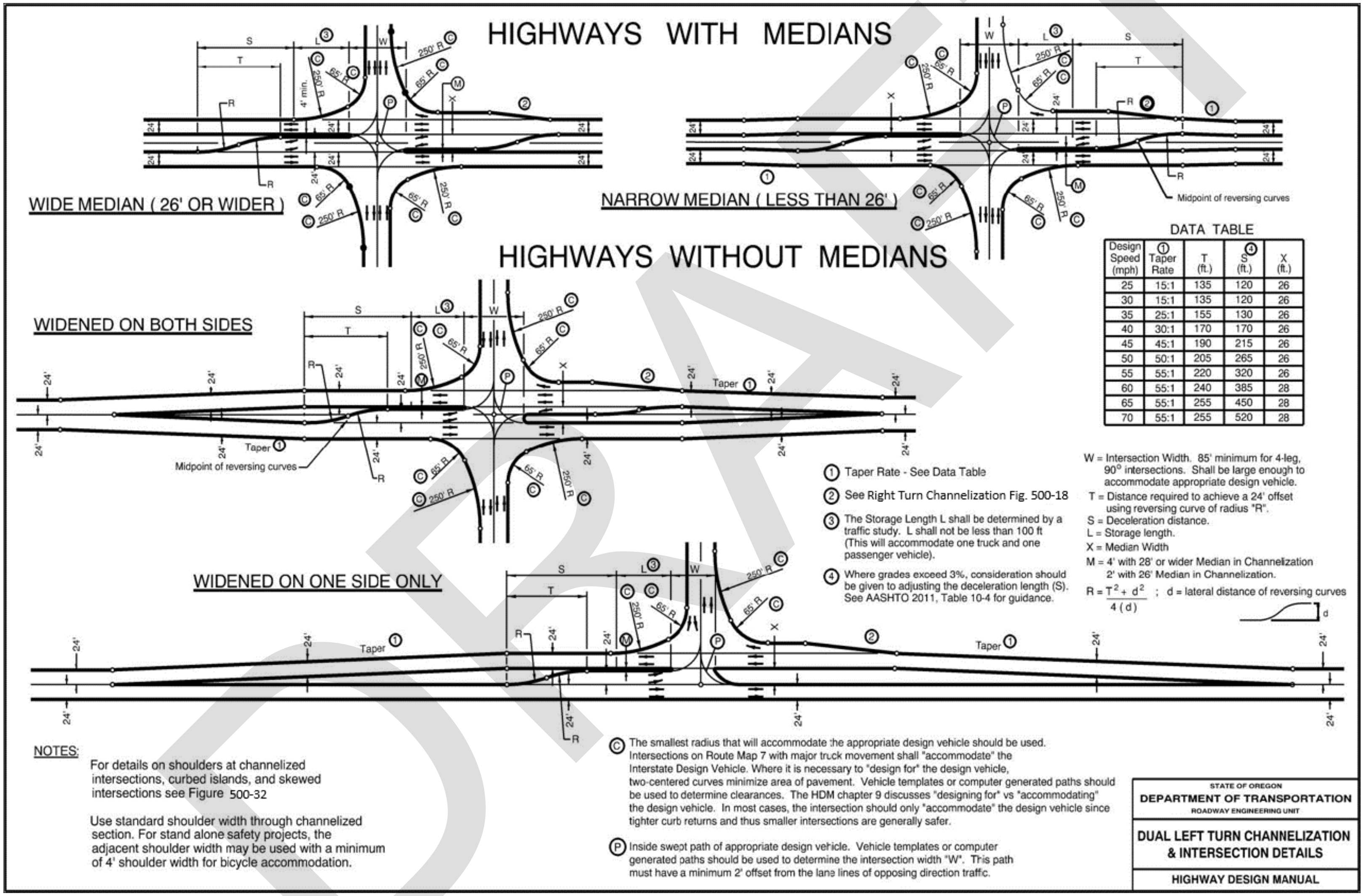
Signalized intersection design will need to consider the following issues in addition to the design standards for general intersection design that were discussed in Section 506. Specific roadway design items of interest at signalized intersections include left turn lanes, right turn lanes, bicycle accommodation and pedestrian needs. It will be necessary for the designer to coordinate with the Region Traffic Unit and the Traffic-Roadway Section of Technical Services to meet these specific design needs.

507.1 Left Turn Lanes

Most signalized intersections will have left turn lanes. When left turning traffic is allowed from a two way highway at a signalized intersection, a left turn lane should be provided. Providing a traffic signal phase for left turning traffic is determined by the Traffic Engineering Section (see "*ODOT Traffic Signal Policy and Guidelines*").

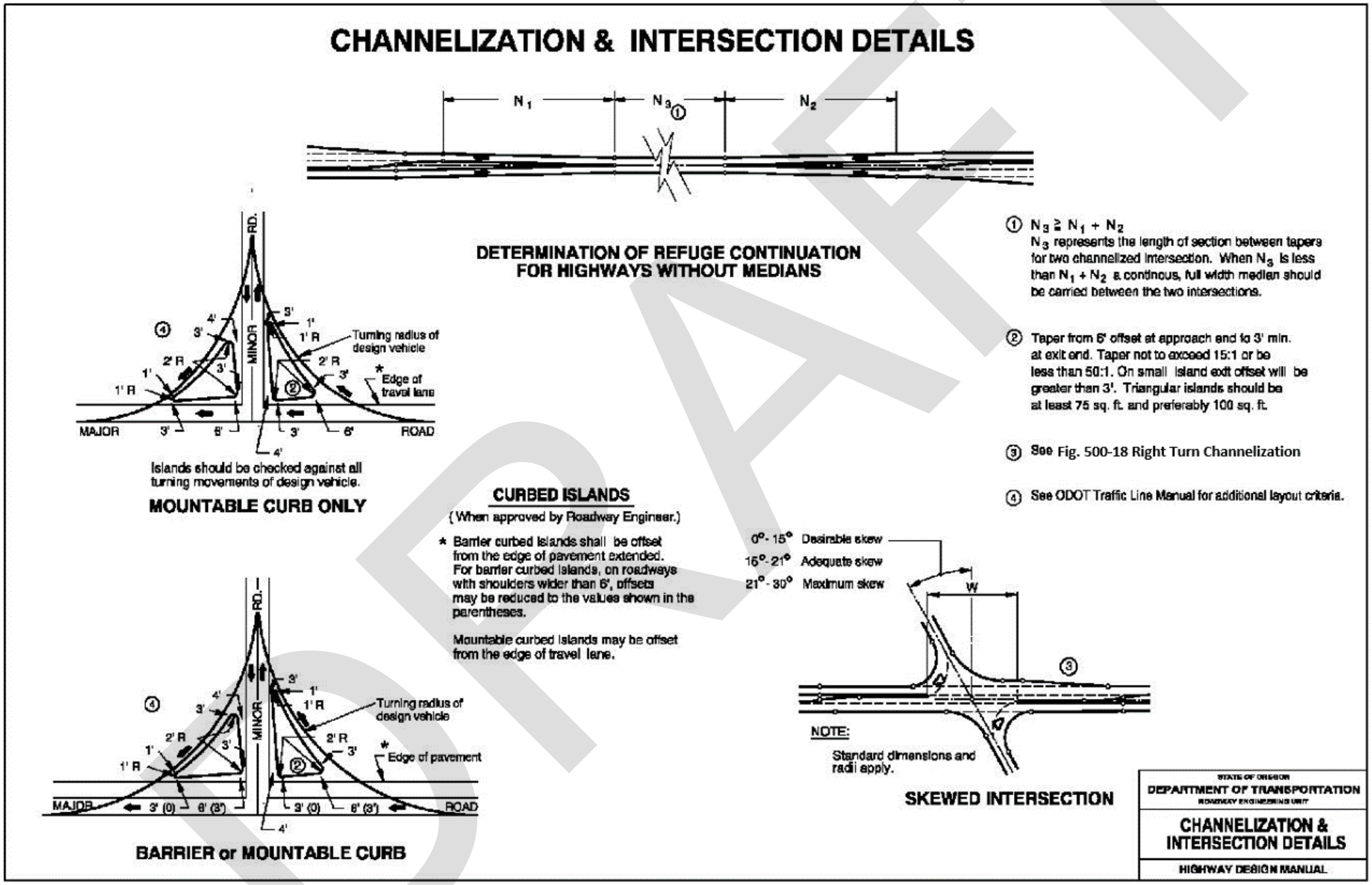
When the left turning volume is very large, a single left turn lane may not be able to operate at an acceptable level. In these instances, a dual left turn lane may be needed. Requests for dual left turn lanes must be approved by the State Traffic-Roadway Engineer (see OARs 734-020-0135 and 0140 for criteria). When designing dual left turns lane, there must be dual receiving lanes on the connecting roadway with adequate length downstream prior to any merge points. The designer must determine the appropriate design vehicles to use for side-by-side operation through the turning movement. In rare locations, like at freeway ramp terminals leading to truck stops or warehousing districts, that may need to be two WB-67 vehicles making the turn simultaneously. However, in most locations, a WB-67 and an SU vehicle side-by-side is adequate for design. In other locations where truck volumes are low, an SU vehicle and a passenger vehicle may be sufficient. Dual left turn lanes should be designed in conformance with Figure 500-31. Consult the Region Traffic Section when considering the design of a dual left turn lane as well. Figure 500-32 illustrates channelization, island and intersection details.

Figure 500-31: Dual Left Turn Channelization



Design Speed (mph)	(1) Taper Rate	T (ft.)	(4) S (ft.)	X (ft.)
25	15:1	135	120	26
30	15:1	135	120	26
35	25:1	155	130	26
40	30:1	170	170	26
45	45:1	190	215	26
50	50:1	205	265	26
55	55:1	220	320	26
60	55:1	240	385	28
65	55:1	255	450	28
70	55:1	255	520	28

1 Figure 500-32: Channelization & Intersection Island Details



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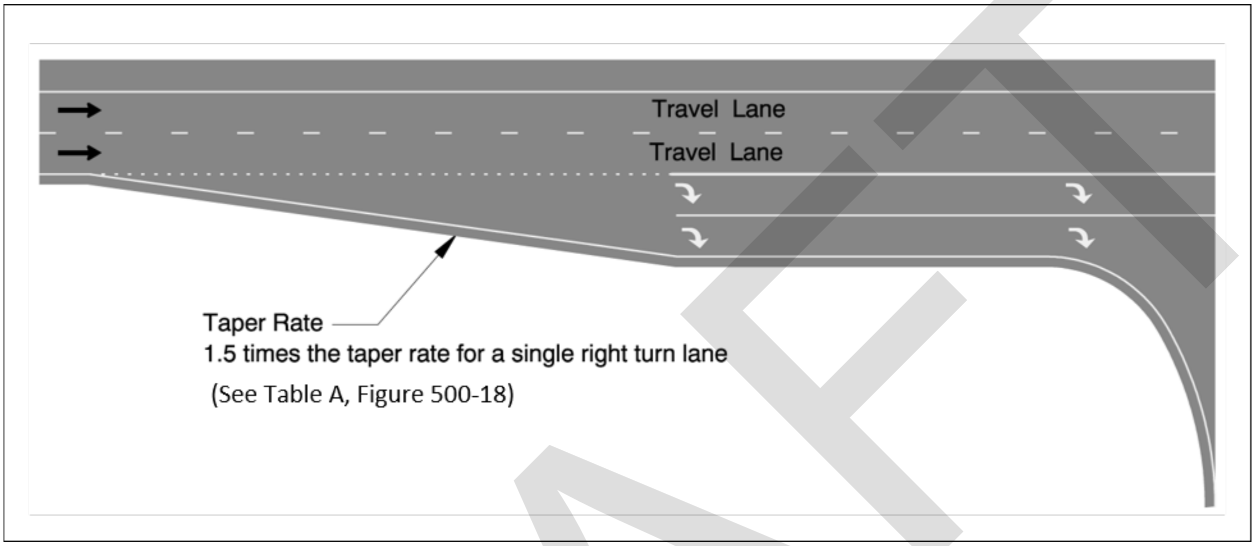
507.2 Right Turn Lanes

There are no specific warrants for installation of a right turn lane at a signalized intersection. A rule of thumb is to install a right turn lane when peak hour right turn volume is 200 or more. However, adding a right turn lane increases pedestrian crossing distances and adds complexity for bicycle facilities. Installation of a right turn lane at signalized intersections should be justified by engineering analysis. Consult the Region Traffic Section and the Transportation Planning Analysis Unit (TPAU) when considering addition of a right turn lane. In some instances, removal of an existing right turn lane may be preferred for overall operation of a signalized intersection for all road users.

When a right turn lane is installed, it is critical to the operation of signalized intersections that adequate storage length for right turning vehicles (out of the through traffic lanes) be provided. The storage length needs to accommodate the 95% queue distance through the design life of the project. The 95% queue length means that there is only a 5% probability that the actual volume of vehicles will exceed the storage available. In areas where obtaining the 95% queue distance is impractical, the designer should provide as much storage as possible. Consider shortening the entrance taper to lengthen the available storage if possible. Any exceptions, however, will require an approval from the State Traffic-Roadway Engineer. For individual intersection or operational projects, contact the Region Traffic Engineering Unit to determine the appropriate storage lengths needed. For complex or environmental study projects, the Transportation Planning Analysis Unit (TPAU) can be contacted to help determine the appropriate storage lengths or give guidance or technical help on the particular project or methodology. At some intersections, right turn demands might be so large that dual right turn lanes may be necessary. The Analysis Procedures Manual, Region Traffic, and the Technical Services Traffic Engineering Section must be consulted and the approval of the State Traffic-Roadway Engineer obtained prior to installation of dual right turn lanes (see OARs 734-020-0135 and 0140). Where dual right turn lanes are required, follow the guidelines shown in Figure 500-33. Dual right turn lanes can create additional crossing issues for bicycle and pedestrian movements. When dual right turn lanes are proposed, bicycle and pedestrian movements must be considered and adequately addressed. Contact the ODOT Bicycle and Pedestrian Facility Specialist for information about providing appropriate facilities.

In addition to bicycle and pedestrian considerations at dual right turn lane locations, the designer also must determine the appropriate design vehicles to use for side-by-side operation through the turning movement. In rare locations, like at freeway ramp terminals leading to truck stops or warehousing districts, that may need to be two WB-67 vehicles making the turn simultaneously. However, in most locations, a WB-67 and an SU vehicle side-by-side is adequate for design. In other locations where truck volumes are low, an SU vehicle and a passenger vehicle may be sufficient. When considering dual right turn lanes as an option, consult the Region Traffic Section for input. When designing dual right turn lanes, there must be two lanes on the connecting roadway to turn into and there must be adequate length provided downstream before any lanes merge.

Figure 500-33: Dual Right Turn Channelization



507.3 Bicycle and Pedestrian Needs

Signalized intersections need to provide marked pedestrian crossings at all approaches and provide bicycle connectivity and continuity. There may be some locations where full access may not be appropriate. Locations where exceptions to full access may be considered are:

1. Intersections that include multiple left or right turn lanes,
2. Intersections with one or more legs being one way roadways, and
3. Intersections that are a 'T' configuration.

However, even at these locations, bicycle and pedestrian needs and movements must be addressed and some level of accommodation is expected. The idea is to only close a crossing where there is a safety concern for pedestrians. Only the State Traffic-Roadway Engineer can close a legal pedestrian crossing and it should only be requested when there is no other option or solution. Contact the Region Traffic Section and the Traffic Engineering Section of Technical Services early in the project to determine the appropriate pedestrian crossing locations.

Section 508 Unsignalized Intersections

This section covering unsignalized intersection design is intended to enhance the discussion about general intersection design criteria covered in Section 506. Left turn lanes, right turn lanes, bicycle access and pedestrian movements will need to be specifically considered and accounted for when designing unsignalized intersections. The level and amount of design effort required to ensure adequate design for these modes will vary among different areas. Because of the complexity of urban areas, a higher level of effort is needed to ensure that these design needs are adequately addressed.

508.1 Left Turn Lanes

Left turn lanes at unsignalized intersections must meet the siting criteria to justify installation. Regardless of the funding source, the Region Traffic Engineer must approve all unsignalized channelized left turn lanes. The designer consults with the Region Traffic Unit in locations where left turn lanes are being considered. For information about siting criteria for left turn lanes, see the ODOT Analysis and Procedures Manual (APM).

https://www.oregon.gov/odot/Planning/Pages/APM.aspx

508.2 Right Turn Lanes

Unsignalized intersections and private approach roads must meet the installation criteria prior to constructing a right turn lane. Regardless of the funding source, the Region Traffic Engineer must approve all unsignalized right turn lanes.

Since the right turning vehicles only have to yield to pedestrians and bicyclists at unsignalized intersections, there is no need to provide vehicle storage at an unsignalized right turn lane. The one exception is where vehicular storage may be required where the right turn lane is next to an at grade railroad crossing. For information about siting criteria for right turn lanes, see the ODOT Analysis and Procedures Manual (APM).

https://www.oregon.gov/odot/Planning/Pages/APM.aspx

508.3 Bicycle and Pedestrian Needs

Bicycle movements must be considered at all unsignalized intersections. There are a variety of methods available to provide adequate bicycle connectivity and continuity at these types of locations. For information, see the "*Oregon Bicycle and Pedestrian Design Guide*". Part 900 provides guidance for bicycle facility selection and bicycle access requirements.

By law, every intersection is a legal crossing location for pedestrians. This is true whether the crossing is marked or unmarked. Therefore, it is important to ensure that pedestrian needs are included in the intersection design, particularly in urban areas. See the ODOT Traffic Manaul for standards, guidelines, and processes related to marking crosswalks. Part 800 provides guidance on pedestrian design requirements and ADA compliance.

Section 509 Modern Roundabouts

509.1 General

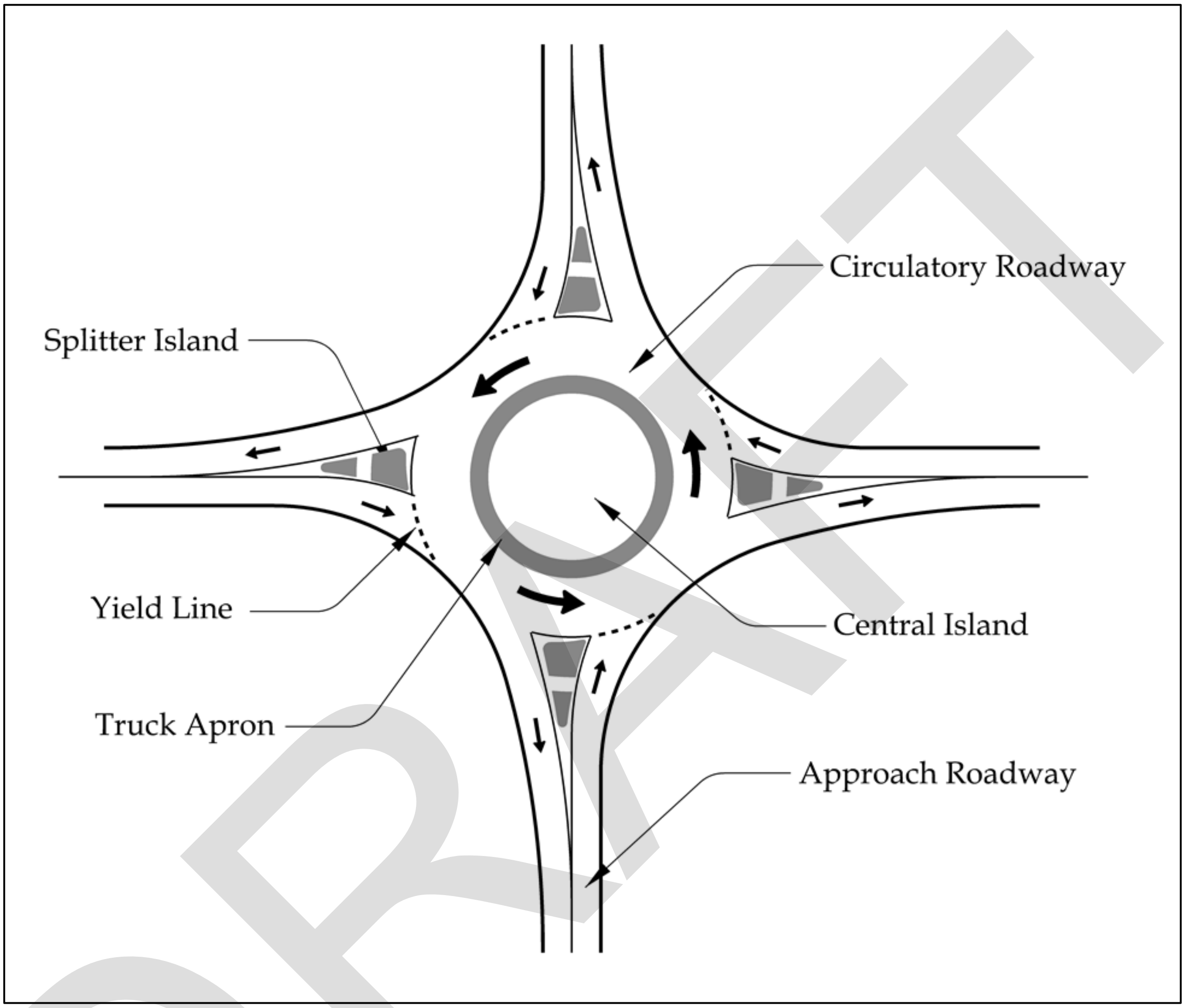
This section provides basic information and site criteria on both single lane and multi-lane roundabouts. Please contact the Technical Services, Traffic-Roadway Section for additional design criteria and recommendations.

Traffic signals, stop signs and modern roundabouts are all forms of intersection control. Signal control and stop control are more established forms of intersection control and are well known to motorists, pedestrians and bicyclists. Signal control and stop control function by separating out individual traffic movements at an intersection. Each road user takes a turn or is delegated time and reasonable opportunity to move through the intersection. However, intersections controlled by signals and signs do not always afford the most efficient or most safe operation. When traffic volumes are low, signals can cause unnecessary delay by stopping traffic flow when conflicts do not exist. When traffic volumes are high, stop signs can cause long queues and extended delay. In addition, when motorists, pedestrians or bicyclists make mistakes or push the limits at signalized or stop controlled intersections, the results often cause severe injury crashes or fatal crashes. Modern roundabout controlled intersections have the potential to function much more efficiently and safely than signal controlled or stop controlled intersections and they do not stop traffic flow unnecessarily. By design, roundabouts allow for more consistent flow by slowing all vehicles through the intersection. By reducing delay, they improve vehicle fuel efficiency and reduce overall vehicle emissions at the intersection as well. Modern roundabouts can also be safer than signalized or stop controlled intersections. By reducing speeds and keeping traffic flowing in the same direction, both crash frequency and severity have been shown to be reduced when compared to other intersection control types. Roundabouts have been shown to be safer for pedestrians and bicyclists as well.

However, roundabouts are not as prevalent as signals or stop signs and some people, including motor vehicle drivers, pedestrians, and bicyclists, are unsure how to use them. As a result, they approach roundabouts with concern, both when discussing proposed installations and when encountering one on the highway. In some cases, drivers remember circular intersections of the past that were called “traffic circles” or “rotaries”. Many of these older circular intersections did not function well. As a result, many drivers have negative impressions of circular intersections that carry over to the present. By their design, however, modern roundabouts eliminate the undesirable design features of older traffic circles or rotaries and create an efficient and effective intersection control option with specific characteristics. The distinctive characteristics of a modern roundabout that separate it from a traffic circle or rotary include a raised central island with a circulatory roadway, raised splitter islands at the entry to introduce deflection to the vehicle path, and yield control for approaching vehicles, rather than having the circulating traffic yield to the entering traffic as was the case with older style traffic circles or rotaries. In various locations around the United States, operations at many of the original traffic circles and rotaries have been improved by incorporating some of the modern roundabout concepts into them where feasible. In some locations, the older style traffic circles have been removed entirely. Figure 500-34 details several major roundabout elements.

Studies have shown, even in communities where the initial majority viewpoint concerning the installation of roundabouts was negative, once roundabouts were installed and the community became used to driving them, the roundabouts have become a popular form of safe and effective intersection control and the community viewpoint changed to positive for the installation of roundabouts.

Figure 500-34: Elements of a Roundabout



509.2 Overview

Roundabouts have been proven as a viable alternative to traffic signals at many intersections. Several studies comparing roundabouts to traffic signals or two-way stop controlled intersections have demonstrated consistent results in determining that roundabouts can provide significant safety improvements. Their combined findings indicate:

1. Reduction of fatalities by more than 90%;
2. Reduction of injuries by up to 75%;
3. Reduction of all crashes by a third or more; and

4. Increases in pedestrian and bicyclist safety due to slower vehicle speeds.

Additional information concerning roundabouts and their safety performance can be found through information provided by the Federal Highway Administration website "*FHWA Safety – Roundabouts*" and through research results from the Insurance Institute for Highway Safety (IIHS).

All roundabouts greatly reduce conflicts at intersections and increase safety when compared to signal controlled or stop controlled intersections. However, due to differences in inherent characteristics of single lane and multi-lane roundabouts, there are differences in the potential safety improvements between them. Both single lane and multi-lane roundabouts reduce fatal and serious injury crashes. Single lane roundabouts have greater reduction in intersection conflict points than multi-lane roundabouts and, therefore, tend to have greater reduction in overall crash rates than multi-lane roundabouts. Since there is more than one travel lane in a multi-lane roundabout, multi-lane roundabouts have the potential for sideswipe crashes that single lane roundabouts do not have. However, since speeds are slow, these crashes are generally less severe than the higher speed "T-bone" and head-on crash types that occur at signalized or stop controlled intersections. Therefore, even though multi-lane roundabouts may have a greater preponderance of side-swipe crashes than a single lane roundabout, they are still a safer alternative than a multi-lane signalized intersection because severity of crashes is greatly reduced, while providing the necessary intersection capacity.

There are three conflict types that can occur at multi-lane roundabouts that do not occur at single lane roundabouts and they can lead to sideswipe crashes. They are categorized as:

1. Driver fails to maintain lane position through the roundabout (Note: ORS 811.292 and ORS 811.370 have provision for "commercial motor vehicles" to operate outside a single lane in a multi-lane roundabout when necessary.)
2. Entering driver fails to yield properly and enters next to a vehicle exiting the roundabout
3. Driver turns or exits from the incorrect lane and crosses the path of a vehicle in the outside lane

These types of driver error are not unique to roundabouts and similar errors can also occur at conventional intersections. However, with good roundabout geometric design consistent with appropriate entry and exit angles, vehicle deflection and sight distance as well as effective striping and signing, the first two can be minimized thereby further improving safety over conventional, multi-lane intersections.

Along with the potential safety benefits they provide, roundabouts can also reduce congestion and delay. They have been shown to be efficient during both peak and non-peak hours. Other distinct advantages of roundabouts include the following:

1. Reduced pollution and fuel use through smoother flow and fewer stops;

2. Significant life-cycle cost savings when compared to traffic signals due to no signal equipment installation and reduced maintenance costs; and
3. Can provide traffic calming and general speed reduction, while supporting urban and rural community values through quieter operation and by providing a traffic control solution that is both functional and aesthetically pleasing.

As stated earlier in this section, some features of multi-lane roundabout design are significantly different from single lane roundabout design and some techniques used in single lane roundabout design may not directly transfer to multi-lane roundabout design. However, several principal objectives should be achieved when designing any roundabout. The following principles are the goal of roundabout designs:

1. Provide slow entry speeds and consistent speeds through the roundabout utilizing vehicle path deflection.
2. Provide the appropriate number of lanes and lane assignments to achieve adequate capacity, lane volume balance and lane continuity for necessary vehicle movements.
3. Provide smooth channelization that is intuitive to drivers that results in vehicles naturally using the intended lanes.
4. Provide adequate design and accommodation for all vehicle types expected to use the roundabout, including freight and transit vehicles.
5. Design to include the needs of pedestrians and bicyclists.
6. Provide appropriate sight distance and visibility for driver recognition of the intersection and potential conflicts with other roadway users both motorized and non-motorized.

The Transportation Research Board (TRB) and the FHWA have published a useful guidance document entitled [Roundabouts: An Informational Guide, Second Edition]() that is also NCHRP Report 672. It can be found on the TRB/NCHRP website.

For proposed roundabouts on state highways in Oregon, staff should familiarize themselves with FHWA guidance documents, the Oregon Highway Design Manual, including this section, Section 509 Modern Roundabouts, the Roundabout Selection Criteria And Approval Process (Section 509.3 of the HDM and Section 403 (Roundabouts) of the ODOT Traffic Manual) as well as pertinent sections of the Analysis and Procedures Manual (APM) published by TPAU.

Before proceeding to the Roundabout Selection Criteria and Approval Process, a thorough alternatives analysis should have been completed in the form of an Intersection Traffic Control Study showing that a roundabout is a viable alternative when compared to other types of intersection traffic control. Refer to the Intersection section of the ODOT Traffic Manual for more detail on how to conduct this type of analysis. Capacity for the proposed roundabout should be analyzed for the appropriate peak hour flow(s).

509.3 Roundabout Selection Criteria and Approval Process

Roundabouts are proposed for a variety of reasons including, safety improvements, operation improvements, community livability, traffic calming, aesthetic gateway treatments, etc. The State Traffic-Roadway Engineer has been delegated the authority to approve the installation of roundabouts on State Highways. Requests for roundabout evaluations are a collaborative process between the Region Traffic Unit and Region Roadway Unit. All roundabout requests sent to the State Traffic-Roadway Engineer for consideration shall be jointly sent by the Region Traffic Manager and Region Roadway Manager, accompanied by an Engineering Investigation that includes purpose, need and intent of installation of the proposed roundabout. In addition, the Engineering Investigation shall address the considerations as described in the following discussion.

Once the State Traffic-Roadway Engineer receives a request, the Traffic-Roadway Section will coordinate a review with other technical staff from Technical Services and the Transportation Planning Analysis Unit (TPAU) to make a recommendation to the State Traffic-Roadway Engineer. If the information provided is insufficient or not appropriate in methodology (as determined by the Department) the State Traffic-Roadway Engineer may request further analysis.

The approval process for Roundabouts is divided into two phases: Conceptual Approval and Design Approval. The State Traffic-Roadway Engineer will make the decision whether Roundabouts will receive Conceptual Approval and move to the Design Approval phase. The State Traffic-Roadway Engineer will make the final decision on the approval of the geometric design in the next phase. Conceptual Approval must follow ODOT procedures that assure the roundabout can accommodate freight movement on the highway and this requires the Region to have conversations with the freight industry through the freight mobility committee review process (*ORS 366.215; OAR 731-012*). The State Traffic-Roadway Engineer will make the final decision on the approval of the geometric design in the Design Approval phase.

Conceptual Approval will constitute official approval under the Delegated Authorities of the State Traffic-Roadway Engineer for a roundabout to be used as traffic control at a particular intersection. For Conceptual Approval, an Intersection Traffic Control Study addressing all pertinent considerations described in this section will be required. In addition, a Conceptual Design of the intersection shall be submitted to the State Traffic-Roadway Engineer for review by Traffic-Roadway Section staff. Conceptual Approval will not be granted until Traffic-Roadway Section staff verifies that Region has followed the ODOT procedures related to vehicle carrying capacity (*ORS 366.215; OAR 731-012*).

Design Approval will constitute the final approval phase of the roundabout at a particular intersection. The geometrics of roundabout designs (including channelization plans) must be submitted to the State Traffic-Roadway Engineer for review and approval.

The Department has developed a list of considerations that should be addressed in the Engineering Investigation that is submitted for proposed roundabout locations. These considerations should not be interpreted as roundabout warrants nor should they be considered pass/fail criteria for installation of a roundabout. Rather, they have been identified as important considerations to take into account when proposing roundabout intersections on state highways.

1. Freight Mobility needs should be sufficiently defined and addressed prior to Conceptual Approval.

2. Motorized user mobility needs must be balanced with the mobility needs of non-motorized road users. The ability for bicyclists and pedestrians to safely move through the roundabout intersection is equally important as the mobility needs of motorized vehicles. Bicyclists should be given the option to use either the circulating roadway with other vehicles or the pedestrian crossings outside the circulatory roadway. Special design considerations should be given for the pedestrian crossings at the entrances and exits on all legs of the roundabout where vehicles are either decelerating to enter the roundabout or accelerating to exit the roundabout. Multi-lane roundabouts, like other multi-lane intersections, have potential for “multiple threat” conflicts between vehicles and pedestrians, particularly vision impaired pedestrians. The Public Rights-Of-Way Accessibility Guide (PROWAG) has identified the need for pedestrian-activated crossing capability at multi-lane roundabouts. Although not explicitly required at this time, rulemaking is proposed and it is prudent to design a multi-lane roundabout for easy installation of the necessary equipment in the future. Crosswalk placement, striping, installing conduit as well as identifying and reserving necessary equipment locations even though final installation of all the equipment is not necessary at this time, is good design practice and can save money in the future. Additional information can be obtained by reviewing the PROWAG document available from the FHWA Civil Rights website under Programs/ADA/Section 504.

3. Roundabout design should consider the needs and desires of the local community including speed management and aesthetics.

4. Intersection safety performance should be a primary consideration when pursuing a roundabout for intersection control. Predicted reductions in fatal and serious injury crashes should be compared with other types of intersection control such as traffic signals or other alternatives supported by crash modification factors (CMF) from the AASHTO Highway Safety Manual.

5. Roundabout entrance geometry, circulating geometry and exit geometry should be designed to allow the design vehicle to traverse the roundabout in a reasonable and

expected manner commensurate with best design practices as shown in NCHRP Report 672, Roundabouts: An Informational Guide, Second Edition and the HDM. This design should utilize a representative template of the design vehicle and the vehicle path should be demonstrated through the use of computer generated path simulation software.

6. Roundabouts should meet acceptable v/c ratios for the appropriate Design Life. (See the Design Life subsection for possible exceptions to this consideration.)
7. Roundabouts proposed for the state highways with posted speeds higher than 35 mph will require special design considerations (e.g. longer splitter islands, landscaping, possibly reversing curve alignments approaching the roundabout, etc.) to transition the roadside environment from higher to lower speeds approaching the roundabout intersection.
8. For Roundabouts with more than 4 approach legs, special design considerations should be made for the layout of the approach legs.
9. Roundabout proposals should address how roundabout operations would impact the corridor immediately upstream and downstream from the roundabout intersection. (If the proposed roundabout is in a location where exiting vehicles would be interrupted by queues from signals, railroads, draw bridges, ramp meters, or by operational problems created by left turns or accesses, these problems should be addressed by the Engineering Investigation.

For brevity, the following is summarized from the ODOT Traffic Manual, Section 403, Roundabouts, and is included in a bulleted, step-wise listing. For the full text, reference the [ODOT Traffic Manual].

Steps in the Roundabout Selection Criteria and Approval Process include:

1. Perform an engineering Investigation including a comprehensive Intersection Traffic Control Study. In addition to site specific intersection data, the investigation should include comparisons of intersection control types (i.e. stop controlled, signal controlled, roundabout, etc.)
2. Determine design Life – generally 20 years for STIP projects and 10 years for development review.
3. Submit a scaled Conceptual Design of the proposed roundabout to the State Traffic-Roadway Engineer for approval including roundabout type, geometry, topography, influence area, approximate right-of-way required as well as other pertinent design information and impacts. Figure 500-34 illustrates major design elements of a roundabout.

4. After Concept Design Approval has been obtained, submit a refined Design Package to obtain Design Approval from the State Traffic-Roadway Engineer. This Design Package should include:
    a. Channelization plans, completed per the Department's guidance for roundabout striping found in the Traffic Line Manual and for splitter islands found in the Highway Design Manual.
    b. A summary of the documented design decisions including how the requirements of ORS 366.215 and OAR 731-012 (Reduction of Vehicle Carrying Capacity) are being met.
    c. Identified deviations from design standards where design exceptions might be needed.
    d. Roundabout geometric data, including:
        - Approach, entry, exit, and circulating design speeds for all approach legs including any bypass legs for right-turning vehicles. Bypass legs should be designed for speeds no more than 5 mph greater than the design speed of the circulatory roadway in order to accommodate bicycles and pedestrians crossing the bypass leg;
        - The design vehicle for each movement and accommodations for other special vehicles (e.g. permitted loads, farm equipment, etc.);
        - A table or drawing summarizing the roundabout design details, including inscribed diameter, central island diameter, truck apron designed to accommodate the appropriate design vehicle for the roundabout, and cross slope of the circulating roadway;
        - Detailed drawings showing the fastest path for each movement, with speed and radius for each curve;
        - A table summarizing stopping and intersection sight distance on each leg; and
        - Computer generated paths showing design vehicle and largest oversize vehicle movements (freight routes will help identify the oversized loads that could be expected).
5. Detailed drawings of the splitter islands on each leg. These should include pedestrian and bicycle accommodation, ramps, etc.
6. Preliminary signing and illumination plans.

509.4 Design Considerations

It is the intent of the Department to ensure that the geometric design of roundabouts adheres to principals that encourage lower speeds, where appropriate, and improves safety for all users. These principals will also have traffic-calming benefits on the road system. It must be recognized that the design of a roundabout is an iterative process. Geometric layout may need to be refined several times before capacity and safety requirements can be achieved. Engineering judgment will be required to refine the layout.

The following discussion points present some basic design considerations for modern roundabouts. Additional design details and layout considerations can be obtained through consultation with the Traffic-Roadway Section of Technical Services. Roundabout designs on the state highway system shall use NCHRP Report 672, Roundabouts: An Informational Guide, Second Edition and the HDM to determine design criteria and compliance with design standards. Where design considerations may conflict, the ODOT Highway Design Manual criteria will be used to resolve the conflict.

509.5 Design Vehicle

When designing intersections on the state highway system, ODOT makes a distinction between "designing for" and "accommodating for" large vehicles. The typical design vehicle for intersections on state highways is the WB-67 class Interstate Truck also known as the Interstate Design Vehicle. Vehicles larger than the WB-67 class are accommodated as necessary. In the design of roundabouts, as with other highway facilities, layouts should provide accommodation for the largest vehicles likely to use the facility. The primary consideration for designing a roundabout to allow large vehicles to satisfactorily traverse it is to select both the appropriate design vehicle and, if necessary, the appropriate accommodation vehicle. Once the vehicles have been selected, the necessary design for entrance geometry, circulating geometry and exit geometry can be provided.

When designing a roundabout on the state highway system, the designer:

1. Shall coordinate with ODOT Commerce and Compliance Division and appropriate highway user groups to determine type and frequency of large vehicle traffic expected to use the roundabout.

2. Shall use a WB-67 Interstate Truck as the design vehicle, unless it has been determined through coordination with ODOT Commerce and Compliance Division and appropriate highway user groups that a smaller vehicle is acceptable.

3. Shall consider and accommodate as necessary, based on conversations with ODOT Commerce an Compliance Division and appropriate highway user groups, the need of over-dimensional vehicle passage through the roundabout.

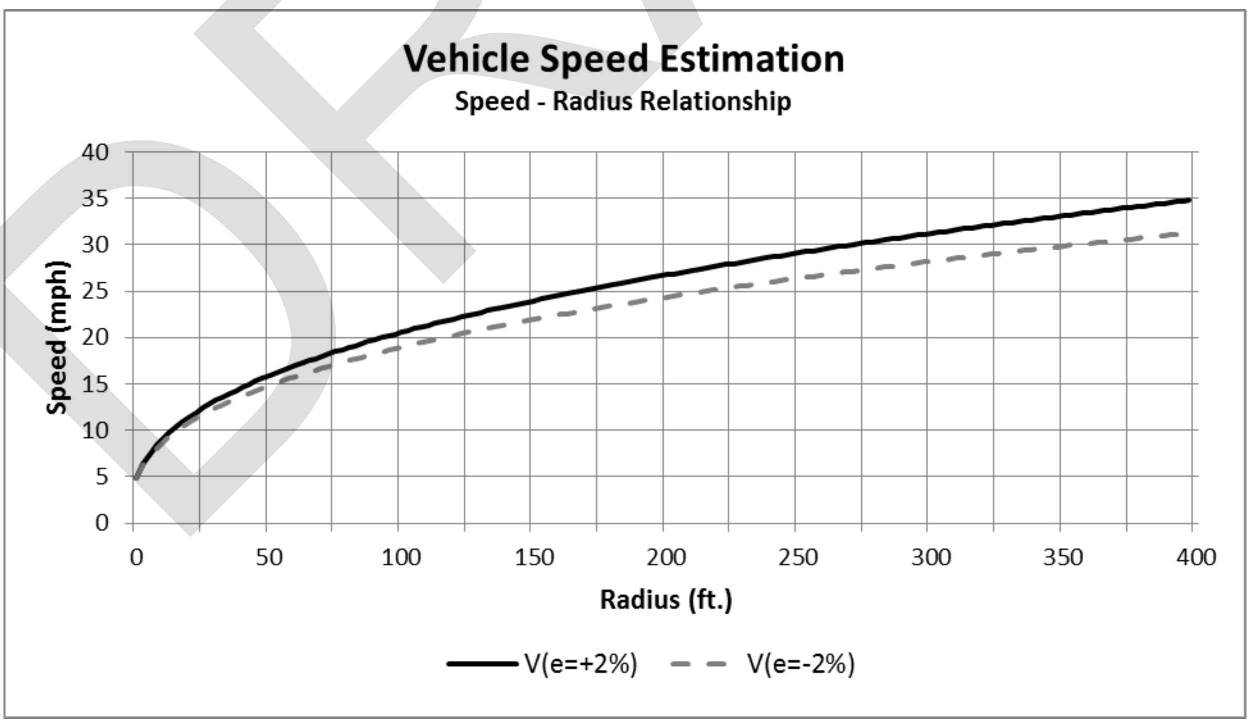
4. Shall design entrance geometry, circulating geometry and exit geometry for all roundabouts, single lane and multi-lane, to allow the design vehicle to traverse the roundabout in a reasonable and expected manner commensurate with best practices as shown in NCHRP Report 672, Roundabouts: An Informational Guide, Second Edition and the HDM. It is also important to remember that ORS 811.292 and ORS 811.370 have provision for “commercial motor vehicles” to operate outside a single lane in a multi-lane roundabout when necessary.

5. Shall design the roundabout using representative templates for the design vehicle and for any vehicles being accommodated with the design. This design will utilize the representative templates to demonstrate vehicle accommodation and vehicle pathway through the roundabout by using computer generated path simulation software.

6. Shall coordinate with ODOT Commerce and Compliance Division and other highway user groups throughout the design process to ensure all roundabout user expectations are being considered, including bicycle and pedestrian needs.

509.6 Design Speed and Target Speed

Figure 500-35: Estimated Vehicle Speed and Radius Relationship – Fastest Path



Highway designers generally use a selected design speed when designing roadway elements for a project. However, in the traditional sense of highway design, the term design speed doesn't necessarily relate well to roundabouts. Controlling speed plays an important part for safety at roundabouts. Roundabouts are purposely designed so that traveling speeds are restricted to a low and consistent speed through the roundabout. Figure 500-35 demonstrates estimated vehicle speeds based on the relationship of path geometry in the terms of radius and superelevation to corresponding theoretical velocity when calculating fastest paths through a roundabout. Superelevation for the path through a roundabout is considered to be a typical positive two percent at entrance and exit and a typical negative two percent along the circulating roadway. Table 500-3, is a tabular form of the path speed/radius relationship based on 25 foot increments in radius and the typical positive and negative two percent superelevation. The vehicle speed values shown on the graph in Figure 500-35 and in Table 500-3 are determined by utilizing the simplified equations shown in [TRB Report 672, Roundabouts: An Informational Guide, Second Edition] where:

V=3.4415R0.3861 for e= +2%

and

V=3.4614R0.3673 for e= -2%.

These simplified forms are derived from the basic equation for velocity and minimum radius from the AASHTO Green Book;

$$\boldsymbol{V} = \sqrt{\boldsymbol{15R(e+f}}$$

They are only valid for superelevation values (e) of +2% and -2%. Side Friction Factor (f) varies with speed as shown in Figure 3-6 (Side Friction Factors Assumed for Design) in the AASHTO Green Book and is accounted for in the equations. In an actual design, if superelevation is greater or less than the assumed positive and negative two percent shown in Figure 500-35 or Table 500-3, then theoretical fastest path speeds for the specific design will need to be calculated using the AASHTO minimum radius equation, design superelevation (e) and friction factor (f) values from the 2011 AASHTO Figure 3-6, Side Friction Factors Assumed for Design.

Table 500-3: Speed, Radius Relationship

Radius (ft.)	V(+2%) (mph)	V(-2%) (mph)
25	12	11
50	16	15
75	18	17
100	20	19
125	22	20
150	24	22
175	25	23
200	27	24
225	28	25
250	29	26
275	30	27
300	31	28
325	32	29
350	33	30
375	34	31
400	35	31

Speed (V), Radius (R) Relationship Equations:

Equation 500-1 $\boldsymbol{V = 3.4415R^{0.3861}}$ For e= 2% (NCHRP Report 672)

Equation 500-2 $\boldsymbol{V = 3.4614R^{0.3673}}$ For e= -2% (NCHRP Report 672)

Equation 500-3 $\boldsymbol{V = \sqrt{15R(e+f)}}$ (AASHTO Minimum Radius)

The design speed of the roundabout intersection should not be confused with the design speed of the highway. In many cases, the design speed of the approaching roadway may be greater than the speed for which the roundabout will be designed. Therefore, it is advantageous to use the term target speed when designing the roundabout layout. This will eliminate confusion with the approach road design speed. Target speed is considered the speed of the "fastest path" of a vehicle through the roundabout. There are five critical path radii used to determine fastest path movements through a roundabout. The fastest path of a vehicle is a theoretical analysis of entrance radius (R_1), the circulating radius (R_2), exit radius (R_3), left turn radius (R_4) and right turn radius (R_5). Figure 500-366, denotes the five critical radii that determine fastest path calculations for a roundabout. Figure 500-37 and Figure 500-38 demonstrate the method and assumptions used to calculate a fastest path through a roundabout. On the state highway system, maximum theoretical entry approach speeds for single lane roundabouts should be 25 mph. For multi-lane roundabouts maximum theoretical entry approach speeds should be limited to 30 mph. Target speeds for single lane roundabouts should be between 15 and 20 mph and between 20 and 25 mph for multi-lane roundabouts. Theoretical speeds through the roundabout (entry, circulation, exit) should be kept consistent with no greater differential than 10 mph to 15 mph maximum between entry and exit. For smaller diameter roundabouts found on local jurisdiction highways, these theoretical speeds may need to be reduced to fit the smaller design.

A safely designed roundabout should have geometry that accommodates all traffic movements at the chosen approach and target speeds, thereby maximizing safety benefits and minimizing the area needed for installation.

Figure 500-36: Five Critical Path Radii for Fastest Path Analysis

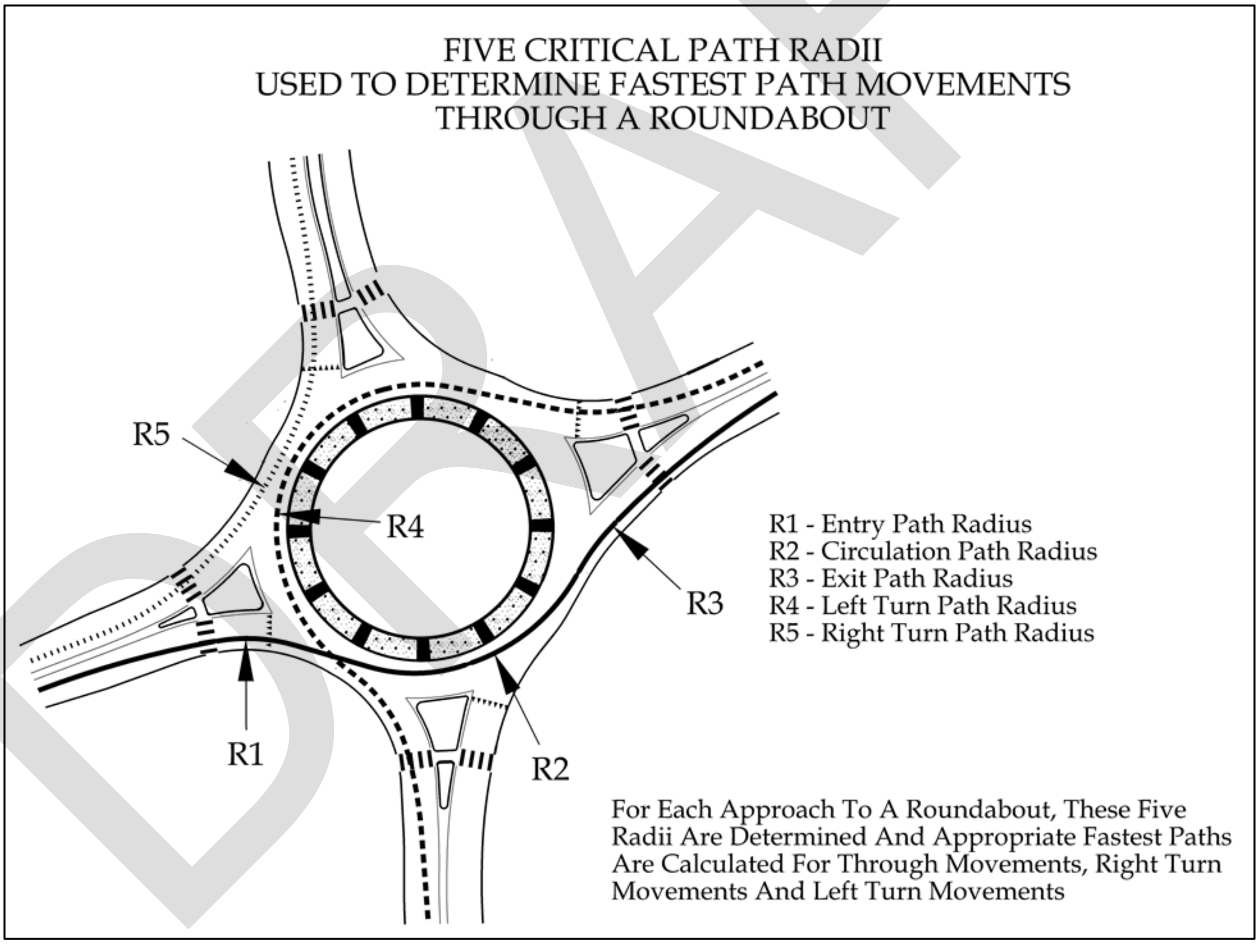


Figure 500-37: Fastest Vehicle Path through a Single Lane Roundabout

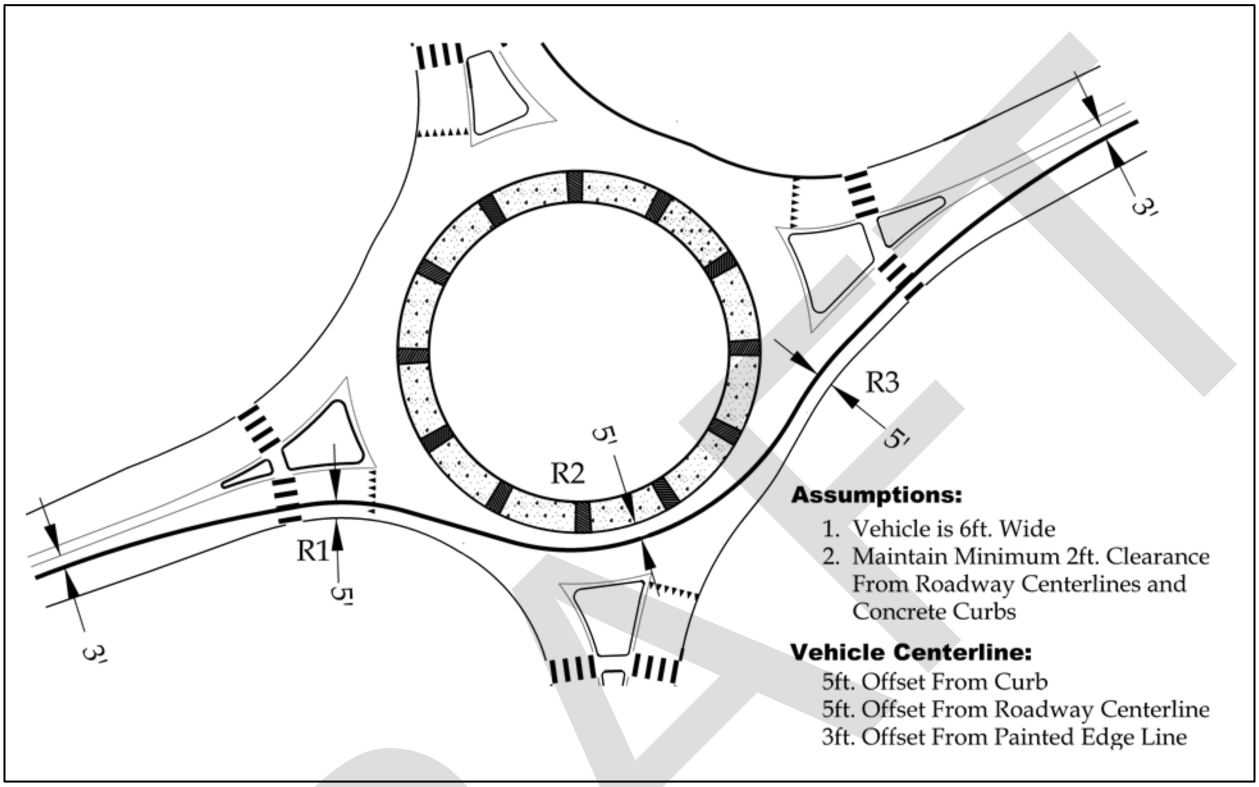
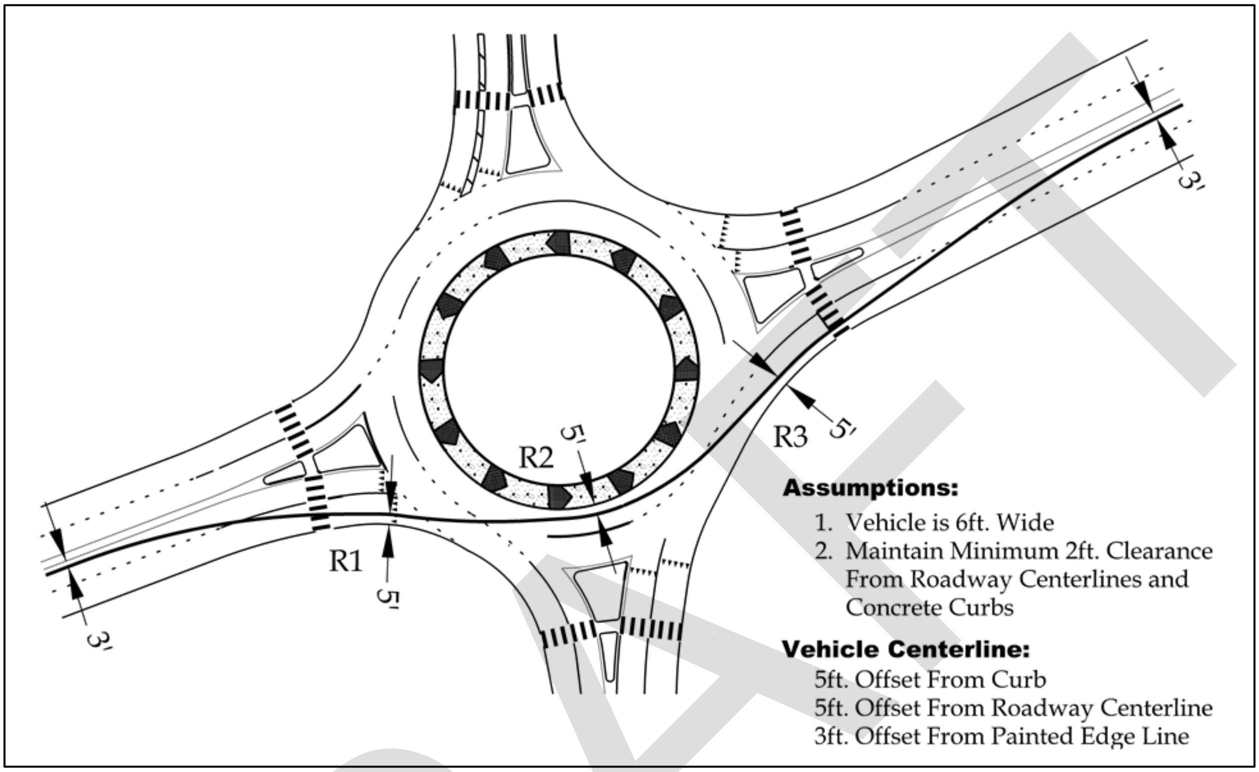


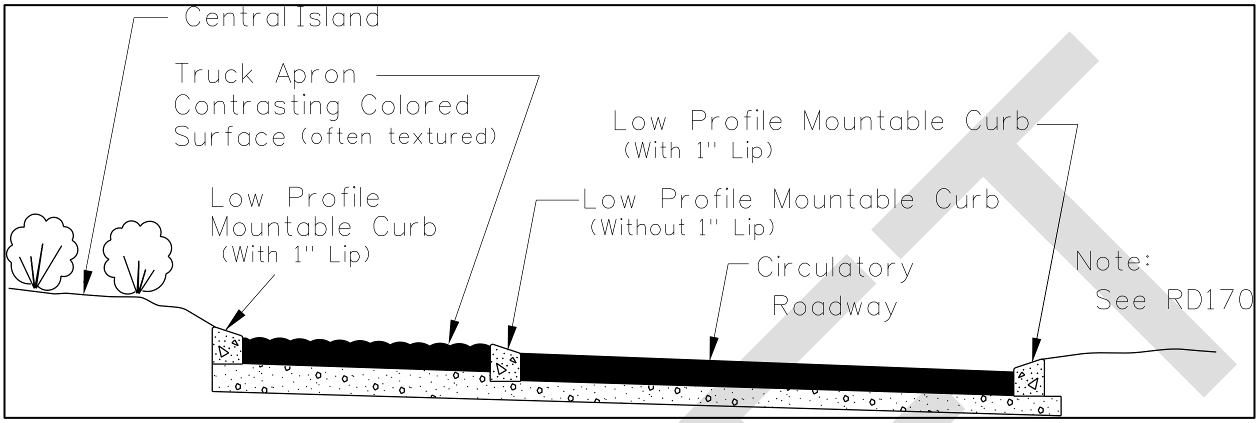
Figure 500-38: Fastest Vehicle Path through a Multi-Lane Roundabout



509.7 Inscribed Circle and Central Island

The inscribed circle is the outside edge of travel of the circulatory roadway. The central island is the raised area surrounded by the circulatory roadway. There are two areas of a central island, the mountable truck apron and the non-traversable, center, raised area. Figure 500-39 shows a typical cross-section of a roundabout including the truck apron, circulating roadway and central island.

Figure 500-39: Roundabout Cross-Section



The Interstate Design Vehicle (WB-67 class truck) is the standard design vehicle for roundabouts on the state highway system. Vehicles larger than a WB-67 vehicle will be accommodated at roundabouts where necessary as determined through conversation with ODOT Motor Carrier Transportation Division and appropriate highway user groups. The truck apron is a key roundabout design element to provide passage and accommodation of the design vehicle and larger vehicles through the roundabout. Encroachment onto the truck apron is permitted and encouraged in order for large vehicles to effectively traverse a roundabout; however, vehicles smaller than the Interstate Design Vehicle may be accommodated without encroachment. To minimize circulatory roadway width for single lane roundabouts, some states use the design philosophy that the circulatory roadway should be only wide enough to allow passage of a standard bus without using the truck apron and therefore, all larger vehicles would use the truck apron for off-tracking. This is a good "rule of thumb" for initial design to minimize the circulatory roadway width if deemed necessary. However, design each roundabout to provide the most appropriate design elements for the traffic stream expected to use it. In some locations where high proportions of heavy vehicles are expected, the design of adequate circulatory roadway width with minimal use of the truck apron may be appropriate. It is anticipated that these locations would be the exception and few in number, since increasing circulatory roadway width or inscribed diameter to accommodate large vehicles within the circulatory roadway will generally increase the fastest path speeds through the roundabout for smaller vehicles, thereby potentially negating some of the safety benefits afforded by roundabouts. A balance must be maintained between accommodating large vehicles and the safe, effective passage of general traffic for which the roundabout is intended.

NCHRP Report 672, Roundabouts: An Informational Guide, Second Edition lists ranges of acceptable inscribed diameters for both single lane and multi-lane roundabouts. For a WB-67 vehicle and a single lane roundabout, suggested inscribed diameters are from 130 feet to 180 feet and for multi-lane roundabouts the suggested range is from 165 feet to 220 feet for 2-lane roundabouts and up to 300 feet for 3-lane roundabouts. However, NCHRP Report 672 was written to cover roundabouts in all applications including national highways, state highways and local jurisdictions. Therefore, the entire range of diameters may not be appropriate for state highways. For general design parameters on the state highway system, the minimum inscribed circle diameter for a single lane roundabout accommodating the Interstate Design Vehicle is 165 feet and the minimum inscribed circle diameter for a multi-lane roundabout accommodating the Interstate Design Vehicle is 200 feet. If a smaller vehicle than a WB-67 class vehicle has been deemed the appropriate design vehicle, a smaller inscribed diameter may be acceptable. Use of inscribed diameters smaller than the minimums described above require design concurrence and/or design exceptions. Contact the Technical Services, Traffic-Roadway Section for guidance.

Table 500-4: Inscribed Diameters

	INSCRIBED DIAMETER				
	NCHRP Report 672			**ODOT Minimum**	
Design Vehicle	**Single Lane**	**Multi-Lane**		**Single lane**	**Multi-Lane**
		2-Lane	**3-Lane**		
WB-67	130 ft - 180 ft	165 ft - 220 ft	up to 300 ft	*130 ft -180 ft	*180 ft – 220 ft

* Design Exception Required For Smaller Inscribed Diameters

In addition to design vehicle considerations, there are many other factors to consider when determining the inscribed diameter for a proposed roundabout. There may be locations where a smaller inscribed diameter is appropriate to accomplish overall intersection control goals. These locations should be considered on a case-by-case basis and designed accordingly to achieve the necessary intersection control. These designs may be based on a smaller design vehicle if deemed appropriate through conversation with ODOT Commerce and Compliance Division and the requisite highway user groups. If a WB-67 class vehicle is the design vehicle and a smaller diameter is proposed, then the truck apron may need to be widened for accommodation. However, widening the truck apron will reduce the central Island diameter and may create undesirable visibility and sight lines across the roundabout.

In addition to the inscribed diameters shown in Table 500-4, there are inscribed diameter ranges of smaller diameters that can be utilized in certain locations to meet operation and safety needs with minimal to no right-of-way acquisition. Depending on diameter and agency terminology, these types have been termed “mini-roundabout” or “compact roundabout”. In general, mini-roundabouts fall into a diameter range of 45 ft. to 90 ft. and compact roundabouts are considered in the 90 ft. to 130 ft. range. These are generally used on city or county roadways with minimal or no large vehicle traffic. For the needs and vehicles that utilize the state highway system, there are fewer places where these smaller diameter roundabouts would be appropriate. However, there may be some locations where a mini or compact roundabout would work well on the state system and these two additional types of roundabouts should not be arbitrarily dismissed. If a smaller, non-standard inscribed diameter roundabout is proposed for a design, contact the Technical Services, Traffic-Roadway Section for guidance. In the right location and with proper design, mini and compact roundabouts can provide safe and efficient intersection traffic control for minimal cost.

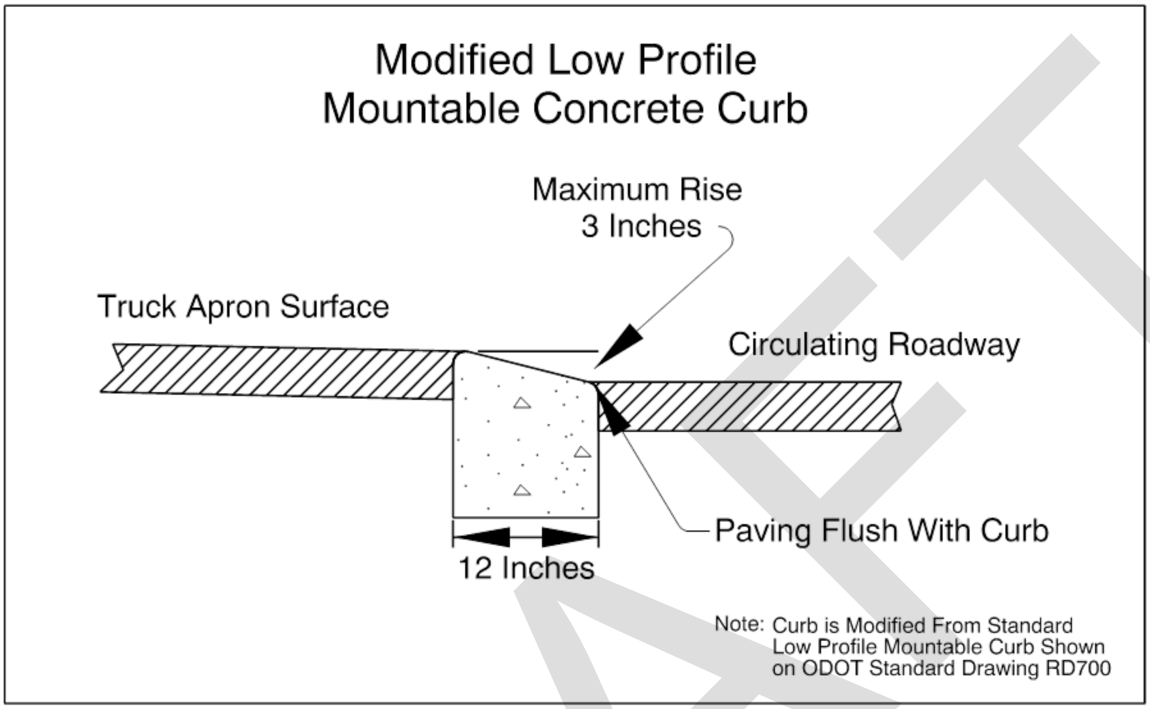
509.8 Roundabout Cross Section

Once the inscribed diameter has been established, circulatory roadway width and truck apron width can be determined. The circulatory roadway is the area between the outside curb and the truck apron. This is the area where the majority of traffic will traverse the roundabout. For single lane roundabouts, circulatory roadway widths should provide adequate width for most vehicles to comfortably maneuver through the roundabout, provide for some off-tracking of larger vehicles up to the design vehicle, but not be so wide that drivers may feel there is more than one lane in the roundabout.

For all roundabouts, circulatory roadway width is based on the number of entering lanes and the turning requirements of the design vehicle. Generally, the circulating width should be at least as wide as the maximum entry width and in some cases it may be appropriate to increase the width up to 120 percent of entry width. The recommended circulatory roadway width for a single lane roundabout on the state highway system is 21 feet, excluding the truck apron width. For multi-lane roundabouts, the suggested circulating width is 14 feet to 16 feet per lane or 28 feet to 30 feet for a two-lane roundabout on the state highway system. The suggested circulatory roadway widths are based on general design characteristics. Circulating widths for specific designs should be checked using design vehicle turning characteristics and overall intersection control parameters governing the intended need for the roundabout installation. Circulatory roadway width should not jeopardize intended speed control of a roundabout.

Central island truck aprons are an integral design element of a roundabout that provides accommodation for large vehicles while maintaining deflection and design controls for general traffic to achieve effective roundabout design at an intersection. A truck apron should be designed in such a way that mounting over by a passenger car would feel uncomfortable but not unsafe. Truck aprons shall be designed to allow for efficient transition to and from the circulatory roadway for large vehicles. Modified, low profile curbs no higher than 3 inches shall be used for delineation and transition between the circulatory roadway and the truck apron. Curbs for the truck apron shall be installed flush with the circulatory roadway. See Figure 500-40. For full curb design at roundabouts. (See Standard Drawing RD170.)

Figure 500-40: Truck Apron Low Profile Mountable Concrete Curb



Truck apron width is determined by turning requirements of the design vehicle and other large vehicles being accommodated through the roundabout. Vehicle paths can be simulated using computer software to determine off-tracking needs.

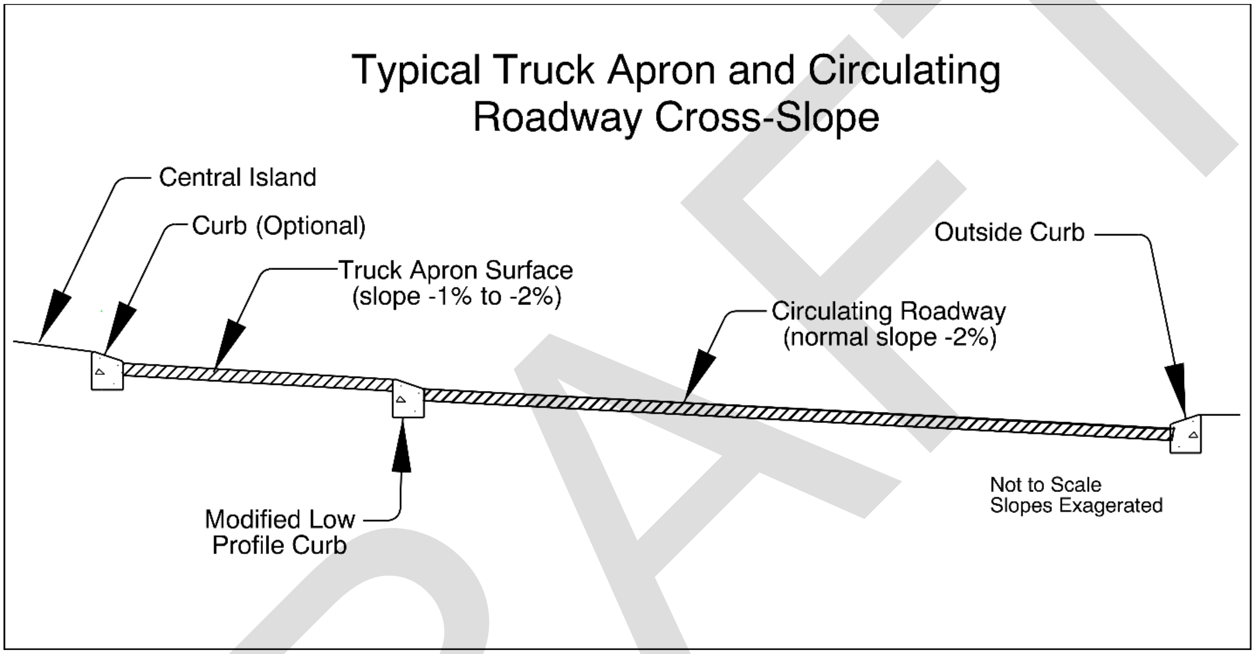
In general, past design practice set cross-slope of the truck apron at 2% from the roundabout center to the apron curb (-2%). However, more recent design philosophy is leaning to utilizing a 1% cross-slope to better accommodate specific large vehicle combinations. Truck apron cross-slope needs to be carefully determined in order to not introduce undesirable dynamics to large vehicles as they traverse the apron. This is particularly true when accommodating low–boy trailers, oversize loads, loads with high centers-of-gravity or loads that can shift, like bulk liquid loads. Low-boy trailers can pose particular problems with the vertical profile between the apron and the circulating roadway. Some low-boy trailers have only six inches of clearance from the ground to the bottom of the trailer frame. Truck apron cross-slope should be only as steep as necessary to provide adequate drainage. Smooth transitions between the circulating roadway and the apron are crucial to effective design and in most all cases should not be greater than 2% in differential slope.

Cross-slope of the circulating roadway is also usually at 2% outward (-2%) keeping the truck apron and circulating roadway relatively parallel with each other. Figure 500-41 Illustrates typical truck apron and circulating roadway cross-slope. Advantages to this cross-slope design include:

1. Raising the central island and improving its visibility,

2. Lowering circulating speeds by introducing adverse superelevation,
3. Minimizing breaks in the cross-slope of the entrance and exit lanes. And
4. Helping drain surface water to the outside of the roundabout minimizing the drainage system.

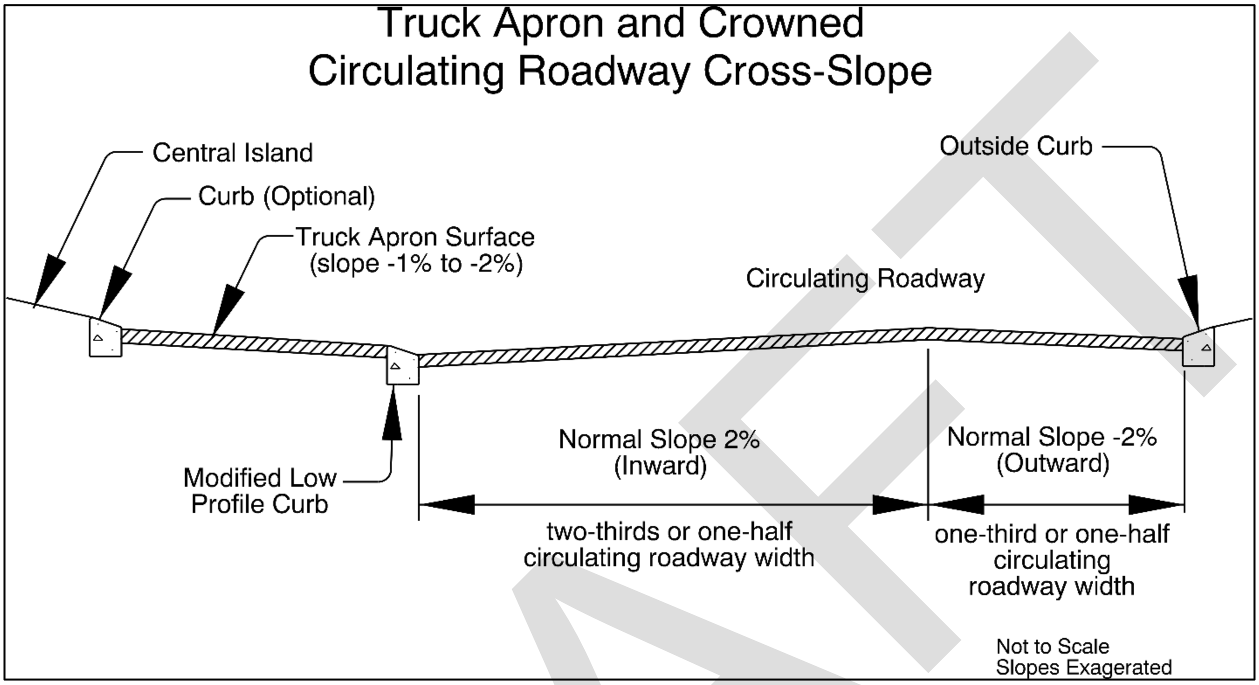
Figure 500-41: Typical Truck Apron and Circulating Roadway Cross-Slope



In the past, significantly altering the cross-slope relationship between the truck apron and the circulating roadway was generally not an accepted practice. However, more recent research and analysis investigating varying this relationship from the typical -2% across the truck apron and circulatory roadway has shown there may be some benefit to certain vehicle movements through roundabouts, as well as potential drainage benefits. Some agencies have opted to slope the truck apron inward toward the central island. In locations subjected to high incidence of precipitation, this option can reduce runoff across the circulating roadway. This can also have a beneficial effect of less ice buildup on the circulating roadway in colder climates. Depending on adjacent geometry of a particular roundabout, sloping the truck apron inward can also have a positive effect in minimizing the potential for load shifting.

Some agencies are developing roundabout geometries that include a crown section on the circulating roadway. In this option, the inner portion of the circulating roadway is sloped inward towards the truck apron and the outer portion is sloped outward away from the truck apron. The crown section is usually divided into two-thirds of the circulating roadway width sloping inward and one-third sloping outward. The roadway width could also be divided in a half inward and a half outward scenario. Figure 500-42 illustrates the crowned circulating roadway concept.

Figure 500-42: Truck Apron and Crowned Circulating Roadway Cross-Slope



Agencies that are developing these alternative cross-sections feel they may be of benefit in accommodating oversize and overweight vehicles at roundabouts. The theory is to minimize vertical movement as a large vehicle transitions on and off the truck apron. Disadvantages to using a crowned circulating roadway section are;

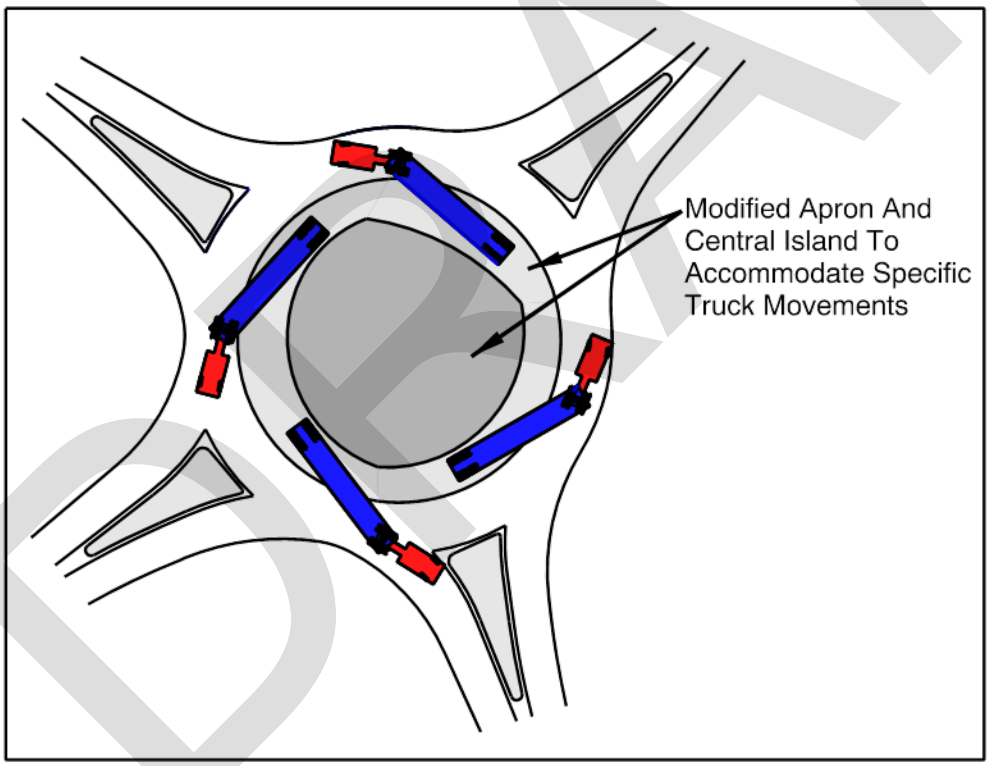
1. More inlets are required to handle the drainage and the drainage system is more complex with the potential for increased maintenance.
2. The crown section introduces a break point in the vehicle path at entrances and exits that must be adequately blended for both comfort and vertical clearance problems
3. Sloping the circulating roadway inward reduces or eliminates the adverse superelevation of the fastest path through the roundabout. This can increase vehicle speeds on the circulating roadway.

The alternative roundabout cross-sections discussed in this section are not the preferred cross-section for roundabouts on the state highway system in Oregon. They are discussed here because some agencies are using them and they seem to have benefits in certain locations. However, their use is not wide spread and more information is needed to understand if there are unforeseen negative impacts.

However the cross-section of a roundabout is designed, the vertical profile that a vehicle traversing a roundabout follows is a critical piece of the overall roundabout design. Designers must analyze the design profile for the paths of all vehicles that will be using the roundabout. This is particularly important for large vehicles that will need to utilize the truck apron and for low-boy trailers with limited ground clearance. The vertical clearance can be checked by drawing a chord across the truck apron in the position of the trailer's swept path. It is also important to analyze vertical clearance along the circulatory roadway itself. In some cases, the warping of the profile to blend transitions at exits and entrances can create high spots that a turning trailer may contact under dynamic loading or twisting of the trailer frame.

There is no set truck apron width. It needs to be wide enough to accommodate appropriate vehicle movements. A 10 foot width is a good starting point. Large vehicles making left turns will generally have the greatest off-track. Apron width may need to be increased to accommodate this move for some vehicles. Truck aprons and the corresponding central island do not necessarily need to be round. There are examples of oval shaped central islands and odd shaped aprons that have been used to accommodate specific vehicles. Truck aprons utilizing "cut-out" central island sections have also been employed in order to optimize truck movements at some locations. Figure 500-43 illustrates modifying the truck apron and central island to accommodate truck movements.

Figure 500-43: Modified Truck Apron



Modifying the central island and truck apron can be beneficial in small diameter roundabouts by keeping the footprint small and still provide accommodation for large vehicles. This can also work well at normal sized roundabouts that accommodate oversize vehicles. However, care must be taken in not creating an apron wider than necessary. Widening the truck apron will decrease the remaining raised center area. One important reason for the raised center area is to provide a visual screen using vegetation to restrict visibility from one side of the roundabout to the other. The center area needs to be visible to approaching drivers to indicate to them the existence of the roundabout. If an approaching driver can see across the roundabout, there may be a tendency to think the road continues straight through the intersection and the driver may be unaware of the necessity to deviate and maneuver around the circulatory roadway. Long range approach visibility of the central island is important at all roundabouts, but it is paramount at rural locations where approaching vehicles are traveling at a greater speed differential between normal roadway speed and roundabout entrance speed. A driver needs time to understand and slow down on approach to the entrance.

In a positive sense, wider aprons can increase sight distance to the left for a driver judging a gap when entering a roundabout. Balance needs to be maintained between a truck apron wide enough to accommodate vehicles and aid in entering sight distance, but not create visibility or recognition problems for approaching traffic. If a roundabout's inscribed diameter needs to be in the smaller end of the suggested NCHRP 672 range for design, a wider apron may be necessary to accommodate large vehicles. Designing for these situations needs careful consideration to ensure compromises made do not negatively affect overall roundabout performance.

509.9 Entry/Exit Geometry and Layout

Entrance and exit geometry and layout are critical to effective roundabout design. There are four key considerations when designing roundabout entrances and exits. They include;

1. Approach alignment;
2. Angle between approaches;
3. Entry/exit width, and
4. Entry/exit curve radii.

♦ Approach Alignment

There are three general types of approach alignment. They include;

1. Alignment offset left of center;
2. Alignment with center, and;
3. Alignment offset right of center.

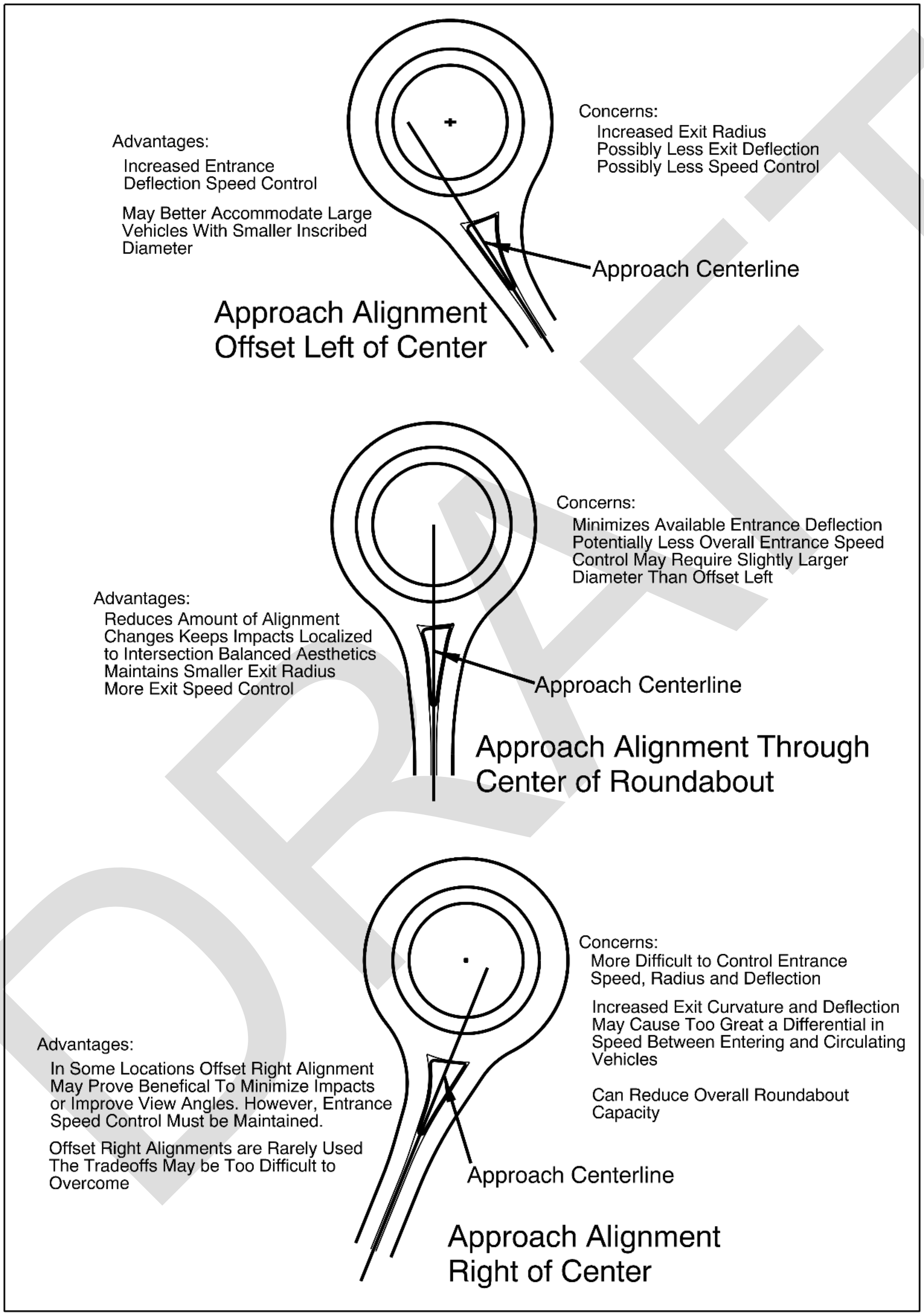
Figure 500-44 illustrates the three alignment types.

1. Alignment Offset Left of Roundabout Center

a. Advantages
   i. Increased deflection for better entry speed control
   ii. Potential for larger entry radii to better accommodate large vehicles with smaller inscribed diameters
   iii. May reduce impacts to right side of approach roadway
b. Disadvantages
   i. Potential for tangential exit or increased exit radii creating less speed control on exit
   ii. May create greater impacts to left side of approach roadway

2. Alignment With Center of Roundabout
   a. Advantages
      i. Reduces alignment changes along approach roadway to keep impacts centered
      ii. May provide for more consistent entry and exit radii and more consistent speed
      iii. Centers approach on roundabout center and may make roundabout more visible to approaching drivers.
   b. Disadvantages
      i. May require a slightly larger inscribed diameter to maintain speed control compared to left offset style
      ii. May be more difficult to control approach speeds
3. Alignment Offset Right of Center
   a. Advantages
      i. May Improve view angles in some locations
      ii. May help in large inscribed diameters, if speed can be controlled
   b. Disadvantages
      i. Less potential for appropriate deflection to control entry speed
      ii. Decreases exit radii creating greater speed differential through roundabout
      iii. Creates potential for uncomfortable forces acting on vehicle occupants

1 Figure 500-44: Approach Alignment



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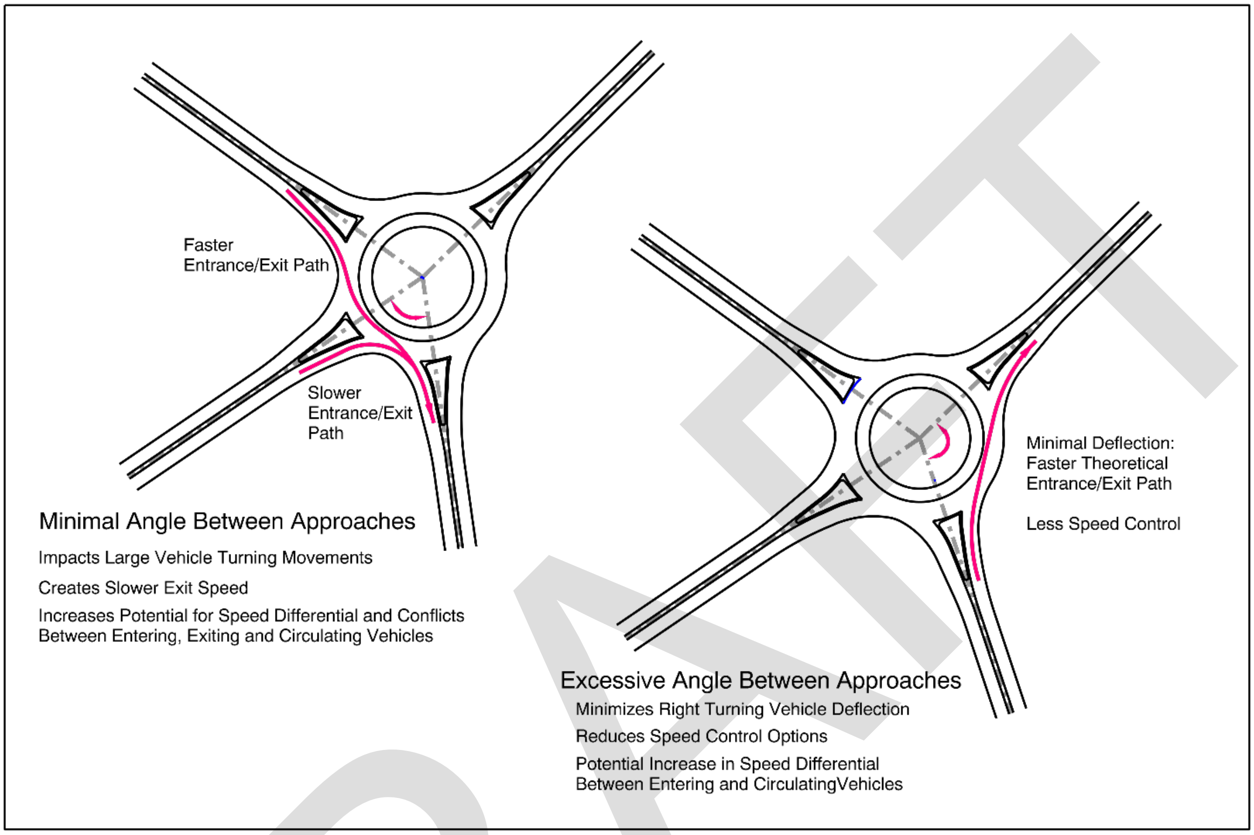
Of the three types of approach alignments discussed, alignments offset left or alignments with the center are preferred for roundabout design on state highways. Approach alignments offset right are discouraged and should not be used. Offset right alignments will require design concurrence through the ODOT Technical Services, Traffic-Roadway Section and the state Traffic-Roadway Engineer.

♦ Angle Between Approaches

As with stop controlled or signalized intersections, the angle between approaches is important to the overall design of a roundabout. All approaches should be designed as perpendicular to each other as possible. This approach design will help ensure sufficient separation between two adjacent legs. Approaches built too close together, can lead to potential traffic conflicts due to the entering driver being unaware of an entering vehicle on the upstream approach leg. In addition, if two successive approaches meet at an angle significantly greater than 90 degrees, it will often result in excessive speed of right turning vehicles. Alternatively, if two successive approaches form an angle significantly less than 90 degrees, then the difficulty for larger vehicles to successfully move through the turn is increased. Figure 500-45 demonstrates difficulties with approach angles too great or too small.

1 Figure 500-45: Angle Between Approaches



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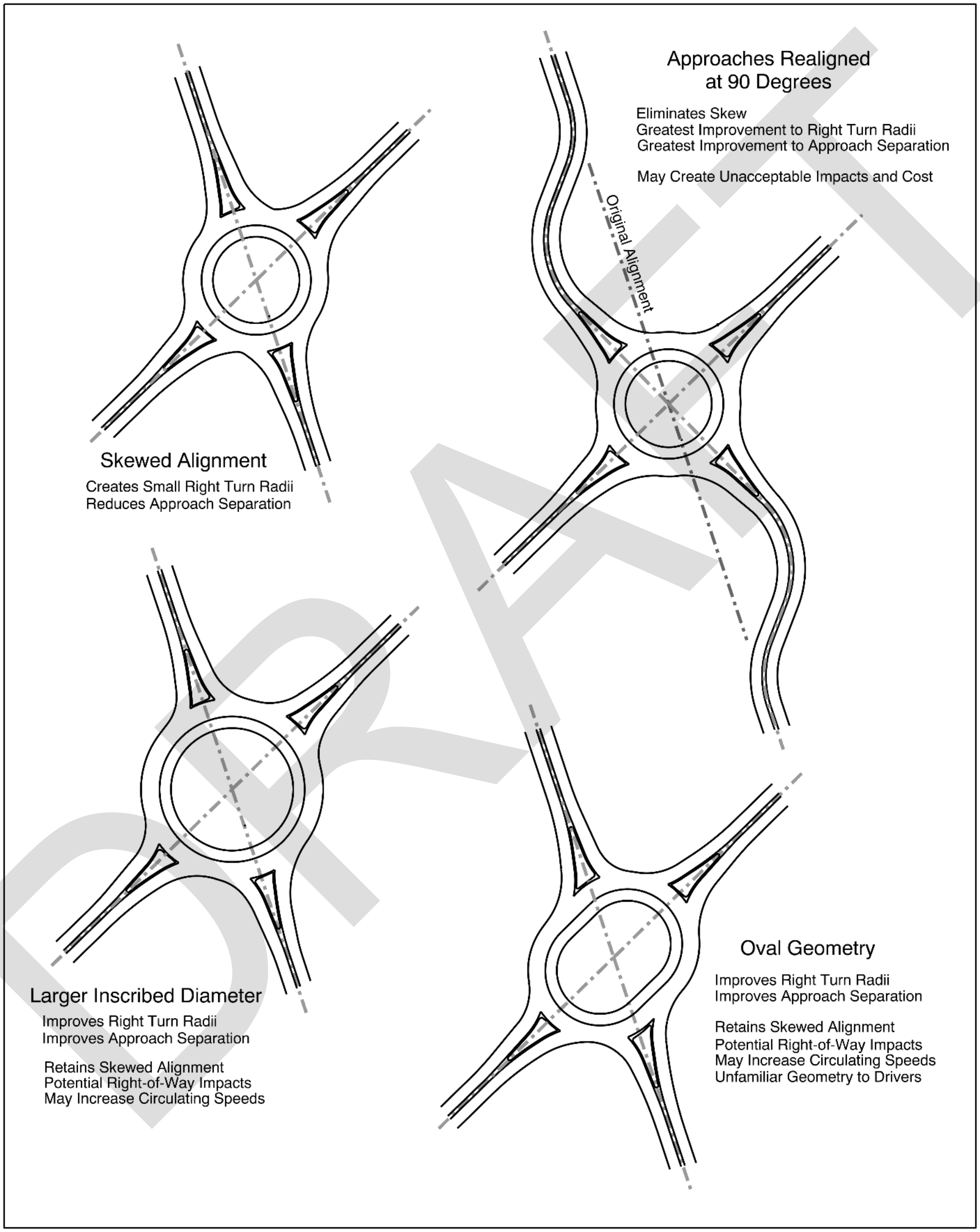
1 Figure 500-46: Skewed Alignments



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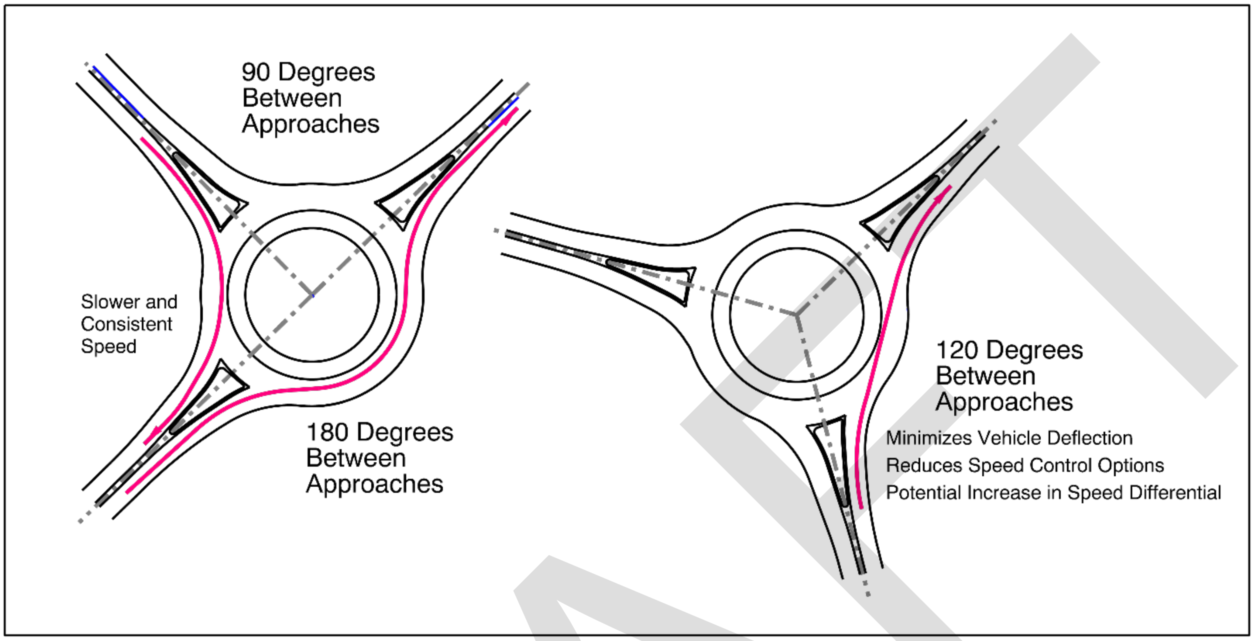
As with designing any intersection improvement, conventional or roundabout, it may be difficult if not impossible to provide perpendicular approach connections. Right-of-way, topography and existing structures are only a few of the potential restrictions and conflicts designers face when trying to improve skewed intersection alignments. When it is not possible to re-align approaches to 90 degrees, it may be possible to increase the inscribed diameter or to change the overall geometry from a circle to an oval to achieve a balance between entry design, exit design and speed control. However, care must be taken to not compromise the overall roundabout design or project parameters. Increasing the inscribed diameter or developing an oval roundabout can improve adjacent approach geometry, but these designs can also increase roundabout speeds to the point of negatively impacting the overall design. Also, an oval geometry may have greater right-of-way impacts as well as being too unfamiliar to drivers, thereby creating the potential for confusion. Figure 500-46 illustrates a skewed alignment and the three options to make approach alignment improvements and the potential trade-offs when using them. A fourth option could be a combination of these design adjustments. Improving the skew with a minor alignment change and a small increase in inscribed diameter may be sufficient to provide acceptable approach geometry, while minimizing impacts to adjacent properties. For simplicity in presenting the concepts, illustrations in the previous figures all have the individual approach alignments meeting at the center of the roundabout. Using approach alignments other than center alignments as shown in Figure 500-44 could also help to create acceptable overall approach spacing at skewed locations. Even though a roundabout contains skewed approaches, it may still provide improved safety and operations over the existing skewed intersection it is replacing.

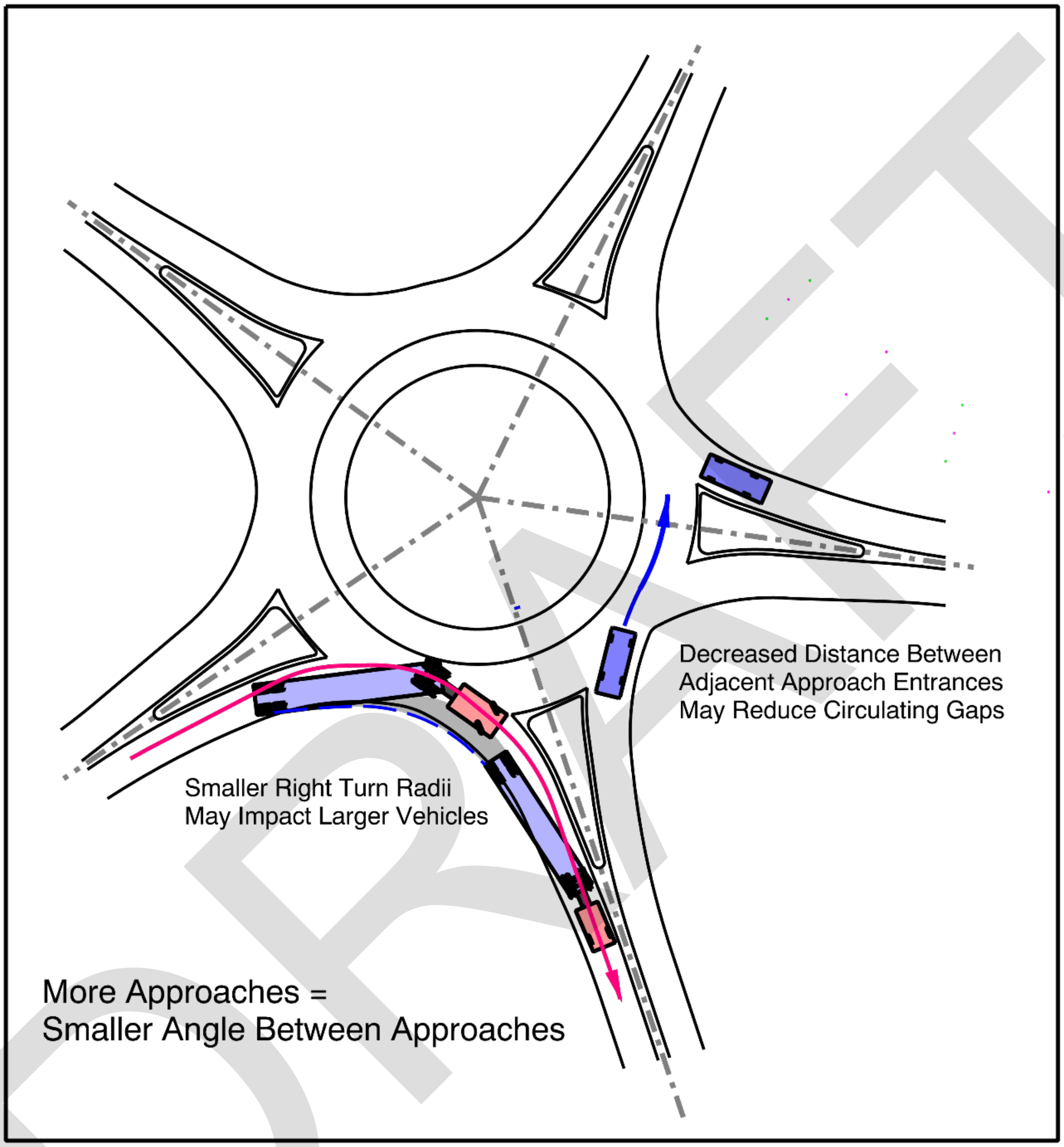
By their nature, roundabouts with 3 or 5 (or more) approaches can be difficult to provide appropriate deflection, speed control and right turning radii. Roundabouts with only three approaches may have large angles between approaches allowing for less deflection and higher entrance and exit speeds. Roundabouts with five or more approaches present challenges not so much in achieving deflection, but in providing sufficient turning radii at some or all right turn movements, as well as challenges providing preferred entry design. For roundabouts with three approaches, in order to achieve appropriate deflection and speed control, it is preferred, as much as possible, to align two of the approaches at 180 degrees with each other and the third approach at 90 degrees with the other two rather than aligning all three at 120 degrees with each other. Figure 500-47 depicts three legged roundabout approach alignment.

1 Figure 500-47: Roundabout with Three Legged Approaches

2 

3 Figure 500-48 portrays a roundabout with five approaches and some of the inherent problems
4 with roundabouts comprised of more than four legs. Roundabouts with more than four
5 approaches present challenges with approach angles and with entry and exit parameters. In
6 general, the more approaches there are, the smaller the angle between the approaches. These
7 roundabouts will need special design considerations to achieve an effective design. Contact the
8 Technical Services Roadway Unit to discuss options when laying out a roundabout with more
9 than four approach legs.

1 Figure 500-48: Roundabout with Five Legged Approaches



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3 # 509.10 Entry and Exit Width

4 Entry width and exit width are also important factors in creating effective roundabout design.
5 These widths are dictated by the needs of the traffic stream based principally on the design
6 vehicle. However, vehicle needs must be balanced against necessary speed management and
7 pedestrian crossing needs. Single lane roundabouts generally employ widths between 14 ft.
8 and 18 ft. Although, in some locations, these widths may be increased if deemed appropriate
9 and flaring the entrance can aid in truck off-tracking. For multi-lane roundabouts, required

entry and exit widths depend on the number of lanes entering or exiting. Typical widths for a two-lane roundabout range from 24 ft. to 30 ft. However, as with single lane roundabouts, these widths may be increased for specific vehicle accommodation when necessary, keeping in mind the balance with other roundabout design needs and parameters.

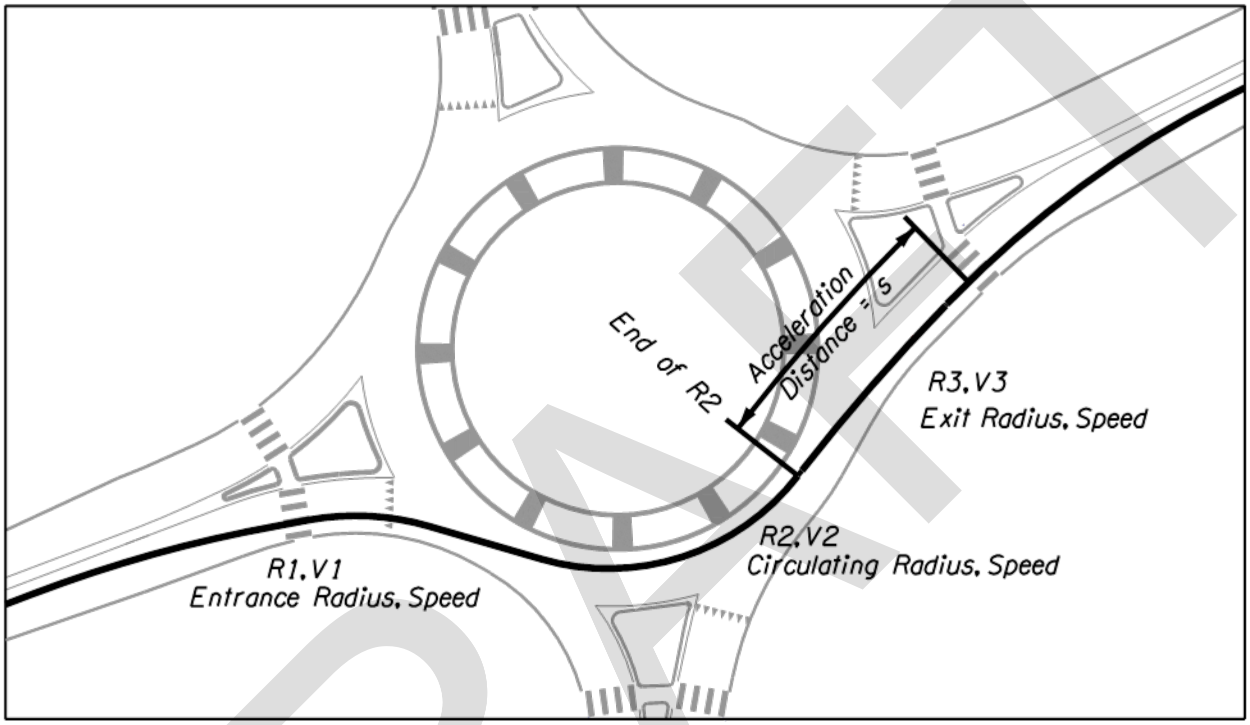
509.11 Entry and Exit Geometry

Along with entry width and exit width, entrance and exit geometry helps control speed in roundabout design. Entrance and exit geometry can have an effect on capacity and safety. Entrance radii designed too small may potentially create single vehicle crashes due to abrupt changes in vehicle path alignment. Entrance curve radii set too large may increase entry speeds and a fastest path greater than desired. Entrance radii are generally in a range from 50 ft. to 100 ft. However, there is no single appropriate radius for all designs. Entrance radius should be appropriate to control entrance speed, but still provide the necessary room for large vehicles to enter the circle without hitting the curb. For some locations, compound radii may be the best solution.

Exit radii are generally larger than entrance radii to allow for consistent or slightly increased flow at the exit. Exit radii should not be designed smaller than entrance radii. When exit radii are smaller than entrance radii, the potential exists for congestion and crashes at the exit. However, if exit radii are too large, speeds may be too great at the downstream pedestrian crossing. Exit pathways must balance exit speed in relation to predicted fastest path speeds from entrance and circulating geometries along with pedestrian crossing needs. Research has demonstrated correlation between observed exit speed and a vehicle's ability to accelerate on the circulating roadway as it approaches the exit to the roundabout. Approach alignments left of center are beneficial for entrance geometry deflection and entrance speed control, but they can also have a tendency to create flatter horizontal exit geometry that may have potential for greater acceleration and higher than acceptable speed upon exiting the roundabout. Roundabout designers must provide a consistent and controlled path for vehicles to enter, traverse and exit a roundabout at an appropriate speed. It may take several design iterations to achieve acceptable entrance and exit geometry for a roundabout location.

The generally accepted method to predict entrance and exit speed for design is to use the speed, radius relationship as previously discussed in Section 509.6. However, research projects from 2004 and 2007 have developed an alternate method of predicting vehicle speeds for entrances and exits of roundabouts. These research projects observed vehicle operation at roundabouts throughout the country and determined that in some locations, the actual vehicle speeds observed did not match predicted speeds. The intent of the two research projects was different, but they both developed an alternate method to match observed speeds with predicted design speeds at roundabout exits. The method is based on the standard Newtonian equation for uniform acceleration. Although equations were developed for both entrance speed and exit speed, it is recommended by [NCHRP Report 672, Roundabouts: An Information Guide, Second Edition] that the standard method using the speed, radius relationship should be used for prediction of entrance speed, while the alternate method may be used for exit speed.

Figure 500-49: Exit Geometry – Alternate Speed Prediction Method



Newtonian Equation for Uniform Acceleration to Predict Roundabout Exit Speed

Equation 500-4 $$V_f^2 = V_i^2 + 2as$$ (Figure 500-49)

Where: V_f = Final R3 Speed, ft/s (V3 – exit speed)

V_i = Initial R2 Speed, ft/s (V2 – circulating speed)

a = Acceleration, ft/s2

S = Distance, ft. (End of R2 to Crosswalk)

Since, as a general rule, larger exit radii will increase the overall roundabout capacity by allowing exiting vehicles to exit faster than entering vehicles, some roundabout designs incorporate a large exit radius that creates an almost tangential alignment for exiting vehicles. The concept is to maximize flow at the exit and, thereby, create greater gaps for entering vehicles. These designs are based on the alternate method of exit speed prediction using uniform acceleration calculations. This may work well to increase capacity and designers who prefer this type of design feel that opening up the exit geometry may provide drivers with a better line of sight to pedestrians and the crosswalk area as well. However, the potential for loss of consistent speed control at the downstream crosswalk is a major disadvantage. Limiting the acceleration distance and determining appropriate acceleration rates are critical to predicting potential exit speed with these types of designs. See Section 510, Analysis for Roundabout Entrance and Exit Geometry, for additional information and discussion about larger radius or tangential roundabout exits and the proposed alternate calculation method.

There is significant discussion between roundabout designers about the best method to determine exit geometry and to control exit speed within design parameters. As a result, currently there is no definitive answer to what is the best method to predict entrance and exit speed when designing a roundabout. Research has shown that in some cases where exit radii are not excessively large and/or acceleration distances are short limiting a vehicle's ability to accelerate prior to the exit crosswalk, opening up exit geometry may not have a great effect on exit speed. However, relaxed exit geometry that increases acceleration distances and acceleration rates can potentially have significant effects on a vehicle's speed at the exit crosswalk thereby impacting pedestrian movements and, potentially, pedestrian safety. This is particularly true for multi-lane roundabouts in off-peak times when a vehicle's fastest path may cross adjacent lanes. In any roundabout layout, it is the designer's responsibility to provide vehicle alignments that consistently control vehicle speeds from entrance to exit in an effective manner for all modes of transportation utilizing the roundabout. For this reason, ODOT's preferred method of design is to use smaller, more radial alignments for entrance and exit layout when predicting vehicle speed into, through and out of a roundabout. There may be some rural locations where pedestrian activity is expected to be low or locations where pedestrian activity is restricted or prohibited that a large radius or tangential exit design might be acceptable. However, for roundabouts designed on the state highway system, appropriate radius values that effectively provide design entrance, circulating and exiting speeds shall be determined using the speed, radius relationship discussed in Section 509.6 of the ODOT Highway Design Manual using Equation 500-1, Equation 500-2 or Equation 500-3, Figure 500-35, or Table 500-3 to determine appropriate fastest paths for roundabout design. For additional guidance on roundabout entrance and exit geometry design, contact the ODOT Technical Services, Traffic-Roadway Section.

509.12 Entrance and Exit Aprons

Depending on overall geometry, large vehicles can have difficulties negotiating entrances and exits to roundabouts. Like aprons added to central islands to aid vehicle off-tracking, truck aprons positioned on the entrance and/or exit curves have been utilized at some roundabout locations to accommodate potential off-tracking needs. While these aprons, sometimes called "blisters", are advantageous for the movement of large vehicles through the roundabout, they can be counter-productive for the roundabout as a whole by providing an alternate fastest path that allows too great a speed for smaller vehicles, thereby, diminishing the overall effectiveness of the roundabout. These types of entrance and exit aprons should not be a general design element included in all roundabout designs. Rather, their design should be approached with caution and should be reserved for when they are needed as a necessity to accommodate specific vehicles. Effective entrance and exit geometry to control speeds of smaller vehicles must be maintained along with the design of truck entrance aprons. However, utilizing entrance and exit aprons can keep the overall size of a roundabout small and still provide space for large vehicles to maneuver through the roundabout. Keeping the overall size of a roundabout small also helps maintain speed control. Figure 500-50 demonstrates an oversize vehicle off-tracking onto an entrance apron.

When entrance or exit aprons are used, they need to be designed to allow access by large vehicles, but designed to discourage their use by smaller vehicles in order to maintain the overall roundabout design parameters and speed control. Entrance and exit apron design is similar to central island truck apron design (See Figure 500-40). Using entrance and/or exit aprons may create potential design compromises that need to be understood and analyzed as appropriate for the overall roundabout design at any specific location. Entrance and exit aprons should only be used when all other design options have been evaluated and they are the only reasonable alternative to provide accommodation for large vehicles through the roundabout. Figure 500-51 demonstrates an oversize vehicle swept path through a single lane roundabout utilizing an entrance apron.

Figure 500-50: Oversize Vehicle and Entrance Apron

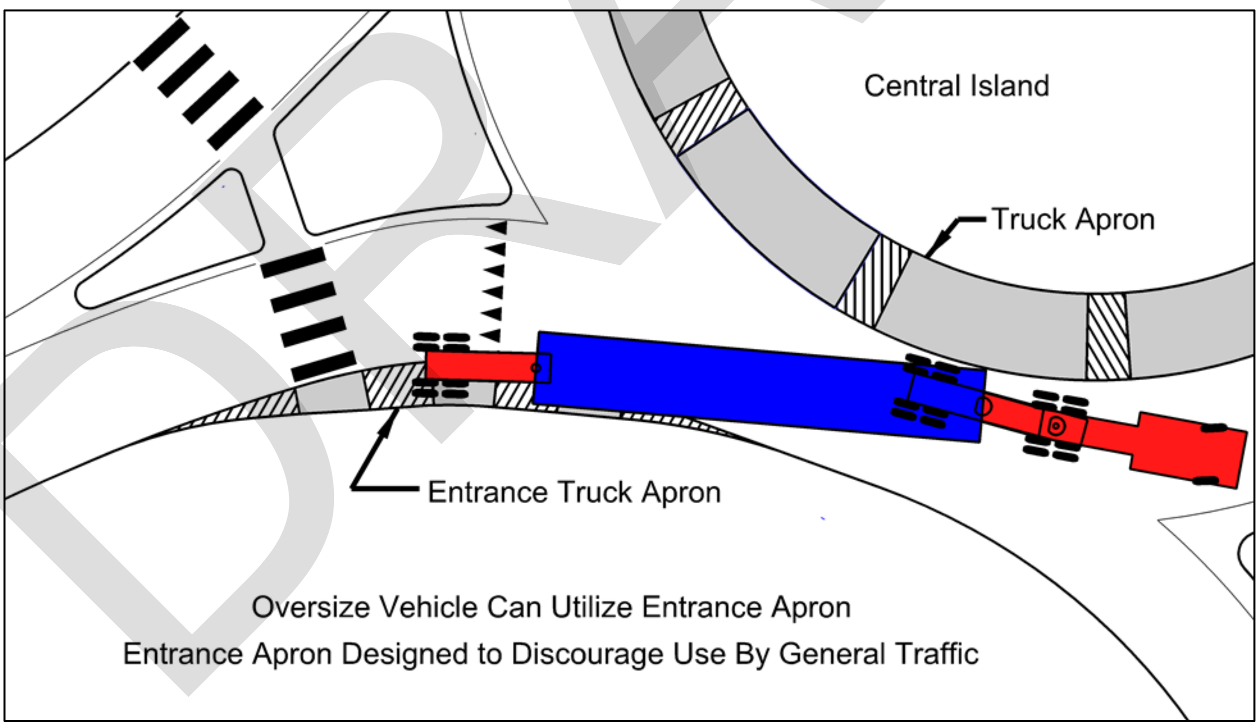
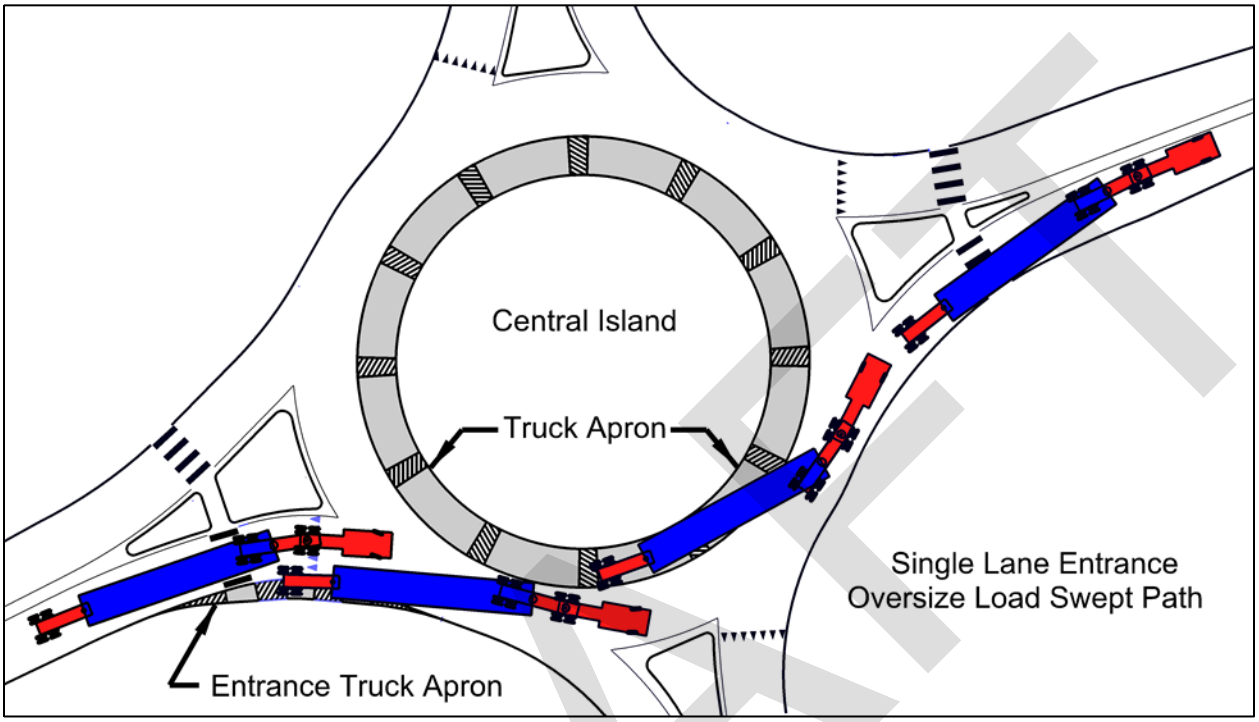


Figure 500-51: Swept Path of Oversize Vehicle Using an Entrance Apron



509.13 Splitter Island

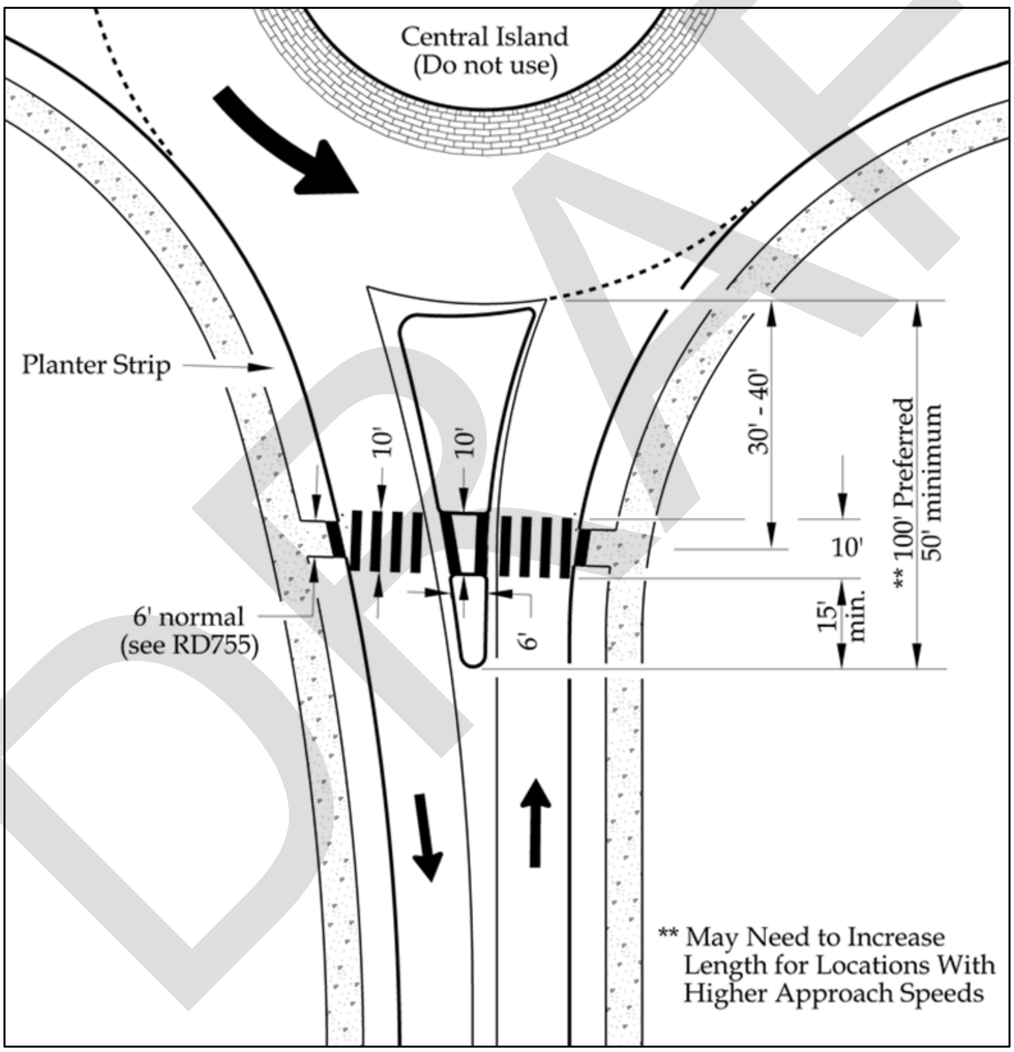
The purposes of splitter islands are to:

1. Help alert drivers of the upcoming roundabout and regulate entry and exit speed;
2. Physically separate entering and exiting traffic, minimize potential for wrong-way movement;
3. Introduce deflection into vehicle paths; and
4. Provide a refuge for pedestrians, and a place to mount traffic signs.

Although a length of 100 ft. is desirable, the minimum length of the island in an urban location measured along the approach should be 50 feet long to provide sufficient protection for pedestrians. Use longer islands or extended raised medians in areas with higher approach speeds. For these locations, base median and splitter island combined length on the distance needed to comfortably decelerate from roadway speed to the desired entrance speed of the roundabout. A separation between the yield line on the circulatory roadway and the pedestrian crossing is crucial to safety and operation. This separation distance helps split up the decision points of yielding to a pedestrian and picking a gap in the vehicular flow of the roundabout. It is recommended that the pedestrian crossing be located at least 35 – 40 feet from the yield line to the center of the crosswalk. The recommended crosswalk width is 10 feet. The opening through the splitter island should be 6 feet in length at the center of the crosswalk. Typically, the splitter island will have a cut through design to accommodate pedestrians. Figure 500-52 shows an example of a splitter island at a single lane roundabout.

For multi-lane roundabouts, entry geometry is typically established first to identify a design that adequately controls fastest-path speeds, avoids path overlap and accommodates large vehicles. The splitter islands are then developed in conjunction with the entrance and exit designs to provide adequate median width for pedestrian refuge and sign placement requirements. For more information specific to overall design of multi-lane roundabouts, refer to the following section, 509.14 specific to multi-lane roundabout design.

Figure 500-52: Minimum Splitter Island Dimensions, Single Lane Roundabout



509.14 Design for Pedestrians

The accommodation and safety of pedestrians at roundabouts is dependent on the following design features:

1. Slow speeds, achieved through sufficient deflection.
2. Separation of conflicts, achieved by placing the crosswalk away from the yield line of the circulatory roadway by 26–40 feet (approx. one car length); and
3. Breaking up the pedestrian crossing movements, achieved by placing a splitter island at each leg.

Sidewalks provide pedestrian accessibility at roundabouts. Standard sidewalk width of 6 feet should be used with greater widths as necessary. Where ramps will provide bicyclists access to use the sidewalks and crosswalks with pedestrians, 10 feet or more is appropriate for sidewalk width. When pedestrians and bicyclists share a sidewalk, appropriate multi-use or shared path guidelines are employed for the design.

Sidewalks should be set back from the edge of the circulatory roadway whenever possible using landscaped buffer zones. Landscape strips provide more benefits than just aesthetic value. They provide increased comfort for pedestrians, an area for snow storage and a buffer to allow for the overhang of large vehicles, if necessary, as they traverse the roundabout. Setbacks also help direct pedestrians to appropriate crosswalks, rather than crossing to the center island or cutting across the circulatory roadway. In addition, vision impaired persons can use the landscape strip to guide them to the crosswalk. Recommended set back widths should be 5 feet. For ODOT design, the minimum set back is 3 feet. Grass or low shrub type vegetation should be the choice for plantings. They provide the visual and tactile delineation, but also allow drivers to see pedestrians on the sidewalk and at crosswalks. Taller plantings may block driver sight distance and mask the presence of pedestrians. Roundabout Signing and vegetation placement must be coordinated in order to ensure signs are not obscured as vegetation grows over time. Legible signs, easily understood by drivers are an important feature of modern roundabouts.

When a buffer zone is not incorporated in the design and a curbside sidewalk must be used, a continuous detectable edge treatment should be included along the street side of the sidewalk to guide pedestrians to the ramps and crossing areas. Examples of edge treatments include chains, fencing or railings. Do not use Detectable Warning Surfaces for edge delineation. For additional information, see the document “Public Rights-of-Way Accessibility Guidelines” (PROWAG), Section R306.3.1.

Research has shown multi-lane roundabouts to be safer for pedestrians than signal controlled, multi-lane intersections. Vision impaired pedestrians may find crossing multi-lane roundabout connections to be difficult, due to limited or masked audible cues to traffic movements. However, this would not be dissimilar to multi-lane, mid-block crossings or multi-lane, uncontrolled intersection crossings as well. When appropriate, multi-Lane Roundabouts benefit from the installation of special traffic control devices (Signals, Pedestrian Hybrid Beacons or Rectangular Rapid Flash Beacons) at crosswalk locations to accommodate pedestrians with vision impairment. NCHRP Report 834, Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities: A Guidebook, provides information for design of pedestrian crossings.

The Public Rights-of-Way Accessibility Guidelines (PROWAG), Section R306.4 published by the United States Access Board indicates that roundabouts with multi-lane street crossings shall have accessible pedestrian signals. Section R209 of PROWAG defines "accessible pedestrian signal". As such, not all traffic control devices meet the criteria shown in section R209 to be compliant with the PROWAG. Currently, the PROWAG has not been officially adopted by the United States Department of Justice. Therefore, at this time, there is some flexibility in terms of absolute requirements for accessibility and types of equipment to provide accessibility when designing a multi-lane roundabout. However, while not actually installing signalization equipment at this time, it would be both beneficial and prudent for potential future signalization requirements to incorporate signalization design criteria to the greatest extent possible with all designs. The designer should consider what would be required to retrofit a signal into the proposed multi-lane roundabout layout. Consideration should be given to signal pole placement, signal head visibility, and controller cabinet location as well as conduit, wiring and operational needs. At the very least, the roundabout design should be as easily adaptable as possible in the future to include the requirements for accessibility as defined in the PROWAG when they become mandatory. Check with the Region Traffic Unit and the Traffic–Roadway Section of Technical Services for applications and acceptable devices. For more information on pedestrian design at roundabouts see Part 800.

509.15 Design for Bicyclists

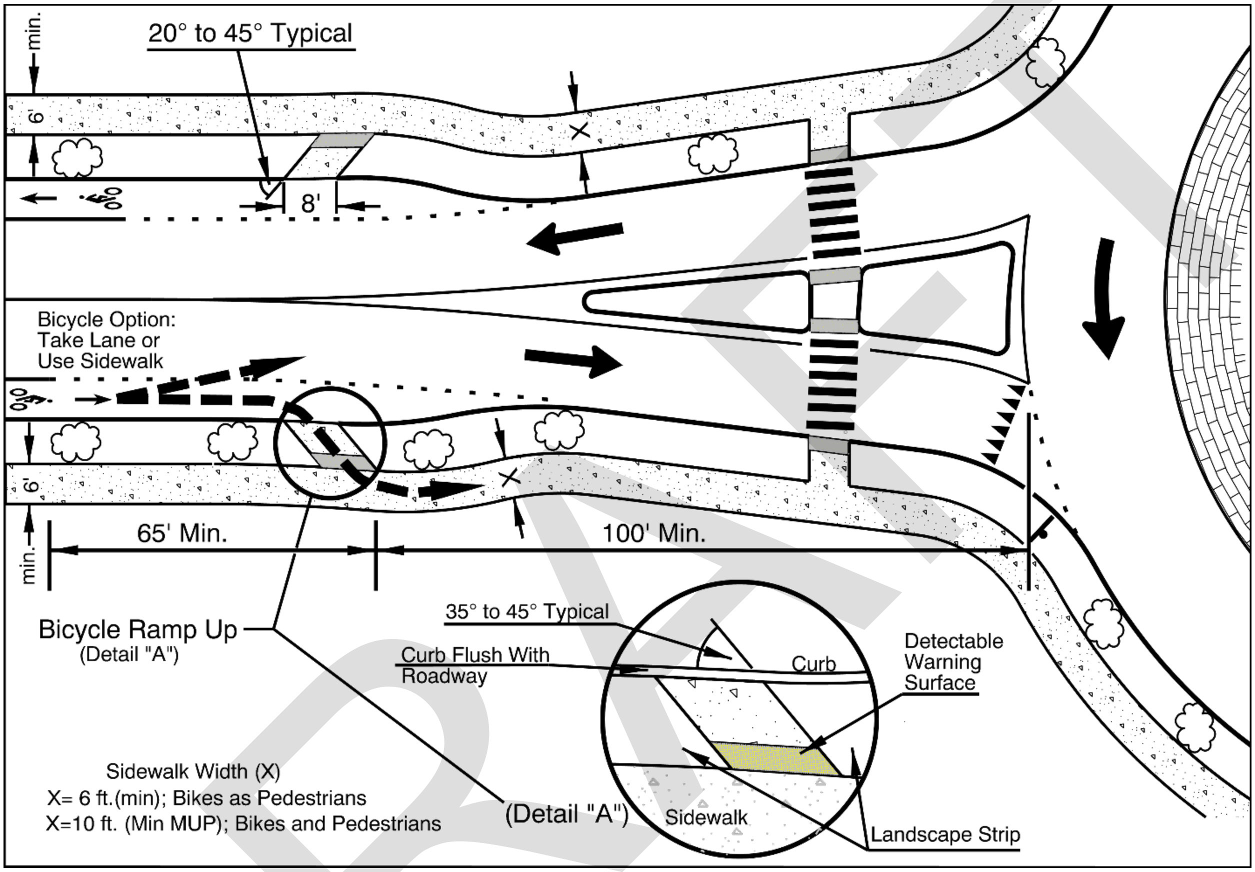
As in general roadway design for bicyclists, greater emphasis is being placed on separated bicycle facilities at roundabouts and that is the preferred method to accommodate cyclists and all efforts should be made to achieve separated facilities. However, not all locations will have the ability it include fully separated designs. When fully separated designs are not possible, bicyclists will be given a choice to enter a roundabout as a vehicle and occupy a lane until exiting the roundabout, or to use the sidewalks and crosswalks with pedestrians. Occupying a lane through the roundabout will, in most cases, be the most expedient method of traversing a roundabout. However, riding with traffic in a roundabout may not be comfortable for many bicyclists. For these bicyclists, a ramp is provided for them to exit the bike lane on approach to the roundabout and use the sidewalk and crosswalks in the manner of a pedestrian. It is generally recommended that only experienced bicyclists, comfortable riding with traffic, use the travel lane through a roundabout.

In single lane roundabouts, occupying a lane through the roundabout is less complicated than occupying a lane in a multi-lane roundabout. With a single lane roundabout, bicyclists will generally be traveling at relative speed to other vehicles on the roadway. Since it is easier to command the lane in a single lane roundabout, there is less chance of a bicyclist being cut off at an exit by a motorist. Also, bicyclists are more visible to motorists in a single lane roundabout, as there is less room and less distraction for vehicle drivers.

Multi-lane roundabouts pose greater challenges to bicyclists when occupying a lane to navigate through them. The greater complexity of multi-lane roundabouts may cause bicyclists to be less visible to motorists. Bicyclists will have a greater challenge in controlling the lanes in a multi-lane roundabout and there is greater potential to be cut off at an exit. Depending on roundabout configuration and bicyclist destination, a bicyclist may need to enter the roundabout in the left lane of a multi-lane roundabout. This may not be familiar or expected by other roundabout users. When considering bicycle access and movement through a multi-lane roundabout, it is important to remember that ORS 811.292 and ORS 811.370 have provision for "commercial motor vehicles" to operate outside a single lane in a multi-lane roundabout when necessary. Like other vehicle drivers traversing a roundabout, bicyclists must not pass or ride beside a commercial vehicle. In Oregon, by statute (ORS811.292), it is a Class C Traffic Violation to drive beside or pass a commercial vehicle in a roundabout.

If bicyclists choose to ride with traffic through any roundabout, single lane or multi-lane, they should be afforded the same roundabout design concepts as motor vehicle drivers. They are expected to be a vehicle and should not be given individual direction to maneuver in a manner unexpected or different than a motor vehicle. They should be provided with efficient, safe and effective means of traversing the roundabout, as are other roundabout users. Bicyclists choosing to use the travel lane through a roundabout should be given ample space and distance to merge into the travel lane prior to the roundabout entry to allow motorists time to recognize them. Under no circumstances should a bike lane be carried into or through a roundabout. Providing a bike lane up to the actual circulatory roadway entrance will compound the merge maneuver for the bicyclist and create a conflict point between the bicyclist and motorist who are both concentrating on entering a gap in roundabout traffic. Providing a bike lane within a roundabout will only increase potential conflicts between vehicles and bikes at roundabout exits creating a potentially less safe condition than if bicyclists use the travel lane. Figure 500-53 provides direction for roundabout approach legs that have a shoulder or bike lane. The shoulder/bike lane should terminate at a distance sufficient to allow bicyclists to merge into traffic before drivers' attention is on roundabout traffic coming from the left. Curb ramps should be placed where the shoulder/bike lane terminates, allowing bicyclists to access the sidewalk should they choose to utilize it and the crosswalks to traverse the roundabout. The bike lane should end 165 feet in advance of the yield line and curb ramp width should be a minimum of 8 feet. General design practice attempts to keep roundabout entrances relatively flat with a suggested maximum grade of 4 percent. However, this is not always possible due to existing topographic conditions. Even a maximum grade of 4 percent sustained over a long enough distance can slow a cyclist. Approach grade and expected cyclist speed in relation to vehicle speed at the lane merge point is an important design consideration when designing for bicyclists to use the travel lane through a roundabout.

Figure 500-53: Bike Accommodation



Bicycle ramps can be confused with pedestrian ramps by vision impaired pedestrians. One option is to include Detectable Warning Surfaces on bicycle ramps. It is preferred to locate bicycle ramps in a landscape strip or buffer area and a detectable warning surface should be placed at the top of the ramp, adjacent to the sidewalk. In these locations, the ramp is considered as part of the traveled way that needs to be detectable. A second option that is gaining popularity is to use Tactile Wayfinding Tiles across the top of the bicycle ramp and sidewalk. This option is relatively new and more direction will be available when the next addition of the AASHTO Bicycle Design Guide is published. Contact the Bicycle and Pedestrian Design Engineer in the Technical Services, Roadway Unit for more information when using Tactile Wayfinding Tiles.

The least desirable location for the bicycle ramp is within the sidewalk itself. When placement of the ramp within the sidewalk is unavoidable, the detectable warning surface is placed at the bottom of the ramp, adjacent to the curb and care must be taken to ensure the ramp is not a tripping hazard in the pedestrian pathway along the sidewalk. Use this design option only if necessary and no other option will work.

Minimum sidewalk width is 6 feet. However, sidewalks that include bicycle traffic mixed with pedestrian traffic should be increased to at least 10 feet in width to allow for a minimum width multi-use pathway condition. If sidewalks are limited to a 6 foot width, then bicyclists should walk their bikes as a pedestrian. In locations where bicycle riding on the sidewalk is prohibited by statute, appropriate signage is necessary to inform bicyclists.

Bicycle ramps up from the roadway to the sidewalk should be placed at a 35 degree to 45 degree angle with the roadway allowing bicyclists to use the ramp, while discouraging them from entering the sidewalk area at too great a speed. Since the bicycle ramp is not a pedestrian ramp, its slope is not limited to a maximum of 1 in 12 (8.33%). If necessary, the slope may be greater than 1 in 12. Ramps steeper than 1 in 12 can be a clue for vision impaired pedestrians to differentiate between the bicycle ramp and the pedestrian ramp. Steeper ramps can also help slow bicycle traffic as it enters the sidewalk zone. In general, ramps should only be as steep as necessary to fit the location with a potential maximum of 1 in 5 (20%) in extreme circumstances. Bicycle ramps from the sidewalk down to the roadway at roundabout exits can be placed with an angle as small as 20 degrees with the roadway since it is not necessary for a bicyclist to slow upon entry to the roadway. A flatter angle can be beneficial in allowing a bicyclist to enter the bike lane or travel lane at a relative speed to traffic. However, some discernible angle is necessary to provide information to vision impaired pedestrians that the bicycle ramp is not the pedestrian ramp.

When roadways leading up to a roundabout location have been designed utilizing a separated or protected bicycle facility like a cycle track, side path or multi-use path, there may be several options for providing accommodation for bicyclists to navigate the roundabout. For guidance in melding the bicycle facility design with the roundabout design, contact the ODOT bicycle and pedestrian facility specialist in the Technical Services, Traffic-Roadway Section. For more information on bicycle facility design at roundabouts, see Part 900.

509.16 Design for Trucks

Freight transport is a vital function of the state highway system. Improperly designed roundabouts can impede freight traffic. Roundabouts proposed on a Reduction Review Route will need to go through a review with ODOT Commerce and Compliance Division and affected highway stakeholders to obtain a "Record of Support". Roundabouts proposed on Non-Reduction Review Routes do not need a Record of Support from stakeholder groups. However, those projects will need to comply with ODOT Directive, DES-02. The DES-02 Directive requires collaboration with industry stakeholders to come to agreement that the proposed roundabout is properly sized for the location.

Roundabouts on the state highway system must be designed to accommodate the necessary movement of freight. The WB-67 class, "interstate" truck will be the basic design vehicle for roundabouts on the state highway system. Larger, permit vehicles will be accommodated as needed on a case-by-case basis. At specific locations, a smaller design truck than a WB-67 might be appropriate on some sections of highway. If a vehicle smaller than a WB-67 is anticipated to be used as the roundabout design vehicle, discussions with ODOT Commerce and Compliance Division and representatives of the trucking industry will be necessary in order to reach a final determination of feasibility.

When oversize/overweight (OSOW) loads may need to move through a roundabout location, these loads will need to be accommodated in an acceptable manner. In order to create an overall roundabout design that will accommodate the anticipated OSOW vehicles at a particular roundabout, discussion between the designer, Technical Services staff, ODOT Commerce and Compliance, and trucking industry representatives will be necessary in order to determine appropriate loads and vehicle configurations to consider and how best to accommodate their movement through the roundabout. Section 509.5 provides general information about roundabout design vehicles and accommodation vehicles.

There may be locations where a smaller diameter roundabout is required that may also need to allow for OSOW vehicle traffic or a location may need to allow for unique or specialized loads to pass through the proposed roundabout. For these situations, there are several alternative design concepts that provide special access and movement through the roundabout. Contact the Technical Services, Traffic-Roadway Section for assistance in designing these unique and special access locations. In most cases, they will require design concurrence and may need additional design approval from the state Traffic-Roadway Engineer, as well as support of highway stakeholder groups.

509.17 Transit Considerations

While it is possible to effectively locate roundabouts on transit corridors, placement of actual transit stops in proximity to roundabouts is problematic for smooth operation of both the transit system and the roundabout. The placement of bus or other transit stops near roundabouts should be consistent with the needs of the users and the desired operations of the roundabout. Stops should be close to passenger generators or destinations, and pedestrian crossings of the roundabout legs should be minimized. A bus or transit stop is best situated:

1. On an exit lane, in a pullout just past the crosswalk; or
2. On an approach leg 60 feet upstream from the crosswalk, in a pullout; or
3. On a single lane entrance leg, just upstream from the crosswalk, if the traffic volume is low and the stopping time is short. This location should not be used on two-lane

entrances (In the interest of pedestrian crossing safety, a vehicle should not be allowed to pass a stopped bus).

Bus pullouts or transit stops shall not be located within the circulatory roadway of the roundabout on the state highway system.

Although rare, there are locations in other jurisdictions where fixed transit lines (light rail, Bus Rapid Transit) have been provided with independent alignment through roundabouts. The best practice for the state highway system is to avoid placing a fixed transit line through a roundabout; however, when it cannot be avoided, care must be taken when establishing the transit alignment so as to not diminish the performance of the roundabout. The design can be successful. However, care must be taken to determine the transit schedule and its impact on the traffic flows at the roundabout. The interaction between the transit vehicles and normal traffic must be considered for present volumes and patterns as well as anticipated future transit and traffic needs.

Figure 500-54: Example of a Light Rail Line through a Roundabout

509.18 Roundabouts Near Railroad Crossings

Locating any intersection near an at-grade railroad crossing is generally discouraged. However, this is often unavoidable and roundabouts have been successfully used to control traffic near railroad crossings in many places around the US. Where an at-grade rail crossing is provided at a roundabout, design consideration should include the provisions of traffic control such as crossing gates and flashing lights at the grade crossing consistent with treatments at other highway-rail grade crossings. The treatment of at-grade rail crossings should follow the recommendations of the MUTCD. Another relevant reference is the FHWA Railroad-Highway Grade Crossing Handbook.

Where roundabouts include or are in proximity to a highway at–grade rail crossing, a key consideration is the accommodation of vehicle queues to avoid queuing across the tracks. The MUTCD requires an engineering study to be conducted for any roundabout near a highway-rail grade crossing to determine queuing effect at the rail crossing and to develop provisions to clear highway traffic from the crossing prior to train arrival. Contact the ODOT Rail Safety Division for more information when considering a roundabout near at-grade railroad crossing.

509.19 Multi-Lane Roundabout Configuration

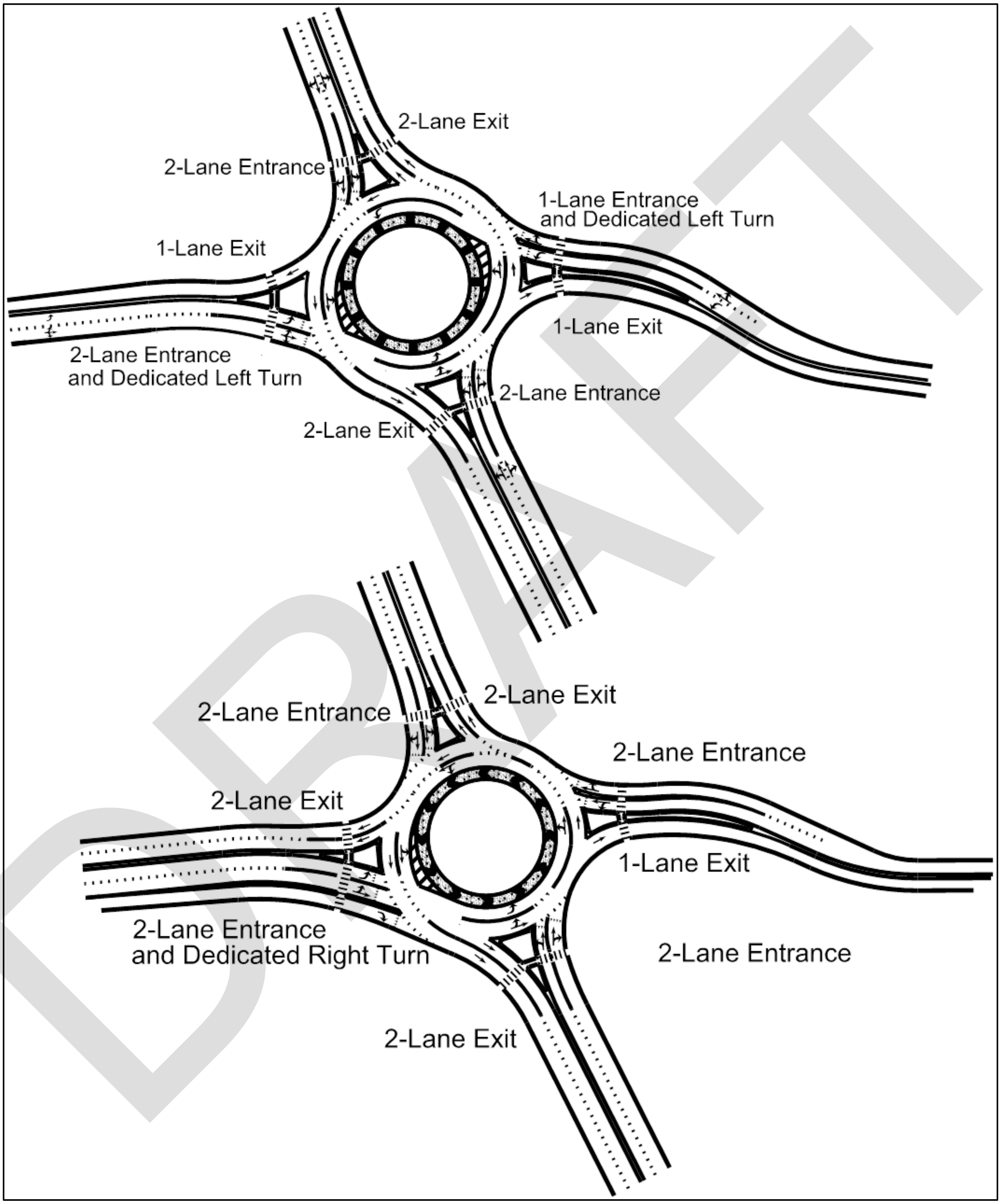
Since many design features of roundabouts are integral to both single lane and multi-lane roundabouts, the previous discussion about roundabout design elements did not specify explicit information about single lane roundabouts or multi-lane roundabouts, but rather discussed the design elements themselves in more general terms for both applications. However, there are a few unique design needs at a multi-lane roundabout that are not shared with single lane roundabouts. As a result, multi-lane roundabout design presents a greater challenge to the designer.

In the past, roundabouts were classified as single lane, double lane and, in extreme cases, triple lane roundabouts. The intent was to have equal lanes entering and exiting assuming balanced flow between intersecting roadways. However, as roundabout design has evolved and a roundabout is just another form of intersection control, general intersection control principles are being applied to roundabout design. In conventional intersection design, it is not required to have an equal number of lanes at each leg. Intersection lane configuration is based on the needs of the traffic movements through the intersection. If one leg has a high volume of left turn traffic, a dedicated left turn lane may be designed for that leg as well as a through lane. This, in effect, creates a two lane entrance, while the through lane may align with only one lane on the opposite leg exiting the intersection. Likewise, if one leg has a high volume of right turn traffic, a dedicated right turn lane or even a "free right" slip lane might be designed to improve operation. The same concepts are now being applied to roundabout design and the term "multi-lane roundabout" has replaced the previous "double lane" or "triple lane" nomenclature. The term multi-lane covers a wider range of various lane configuration options that a design might employ to better tailor the design to the specific intersection control required for a specific location. However, as a result, because lane configuration on entrance and exit may be specific to a particular move at a particular exit, signing and striping of multi-lane roundabouts must convey to drivers which lane they need to be in to negotiate the roundabout successfully. The information contained in the signing and striping must be understood by the approaching driver far enough in advance of the roundabout to safely make the appropriate lane choice. If drivers are positioned in the correct lane for their destination when entering the roundabout, the lane striping and guidance will get them to the appropriate exit.

Some multi-lane roundabout configurations may appear complex to an approaching driver. When examining a design in plan view it may be easy to see how the lanes flow. However, at driver eye level that may not be the case. The designer must keep in mind what drivers see, or don't see, as they approach the roundabout and what must they see to understand how to get to the appropriate exit for their journey. Efficient, effective and well placed signing, striping and lane markings are critical to convey that information to motorists in modern multi-lane roundabout design. Figure 500-55 and Figure 500-56 portray examples of multi-lane roundabout design with various entrance and exit lane configurations. These layouts are hypothetical and are intended to provide guidance and illustration for potential options to meet traffic control needs at a given location.

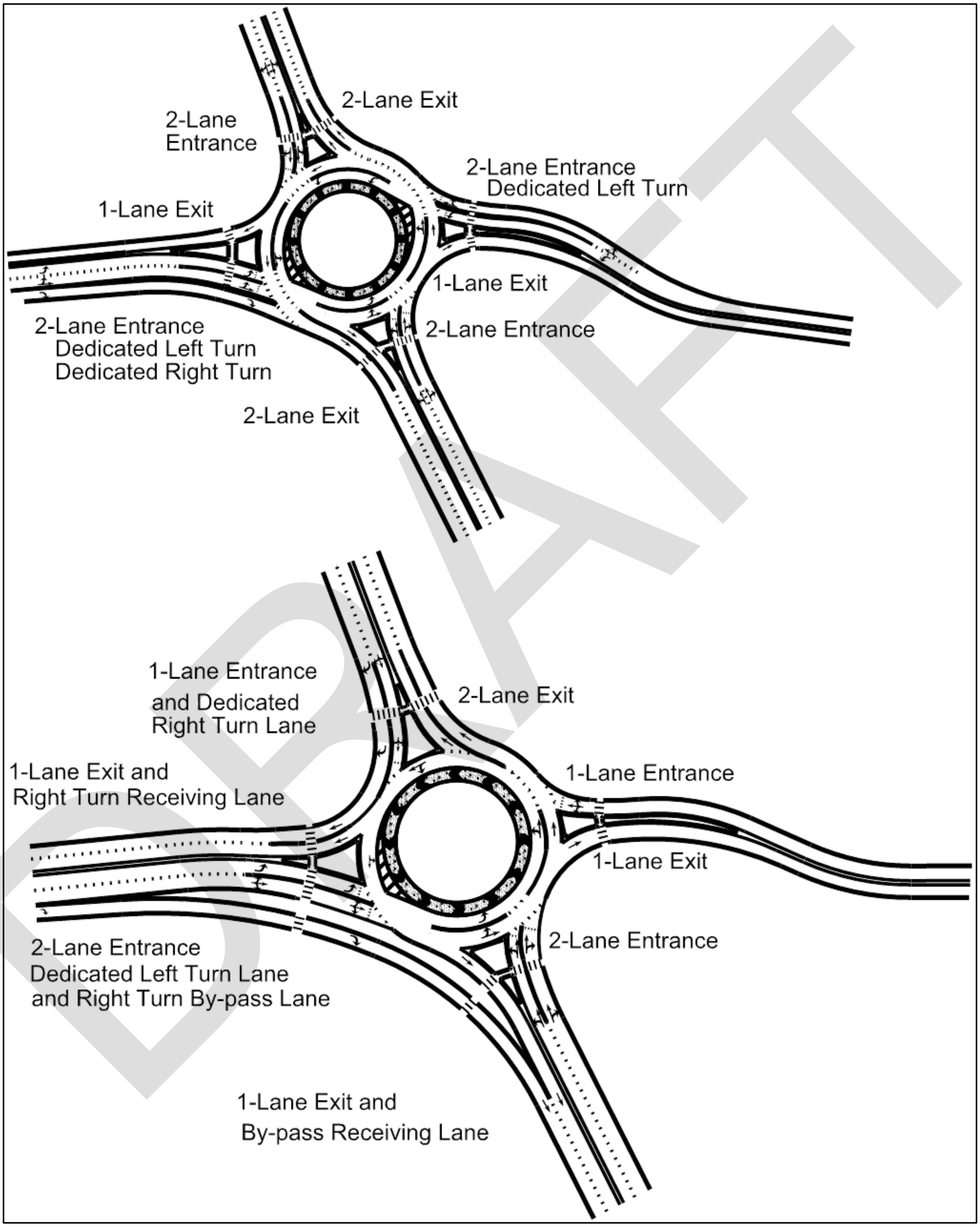
These multi-lane roundabout layouts are not all inclusive and other configurations may fit a particular location better. Individual designers will need to design for the needs of the site for which the roundabout is being designed. Some of the entrance and exit options shown in the figures would only be employed at unique or high volume locations. As with any intersection design, it is important to only provide what is necessary to meet the control needs of the traffic movements. It is good design practice to keep the layout and operation of a multi-lane roundabout as simple as possible, while still providing the necessary control functions to allow smooth, efficient traffic flow. Additional information about roundabout lane configuration and striping can be found in the ODOT Traffic Line Manual and the 2009 Edition of the MUTCD, Chapter 3C Roundabout Markings.

1 Figure 500-55: Various Multi-Lane Roundabout Entrance and Exit Options



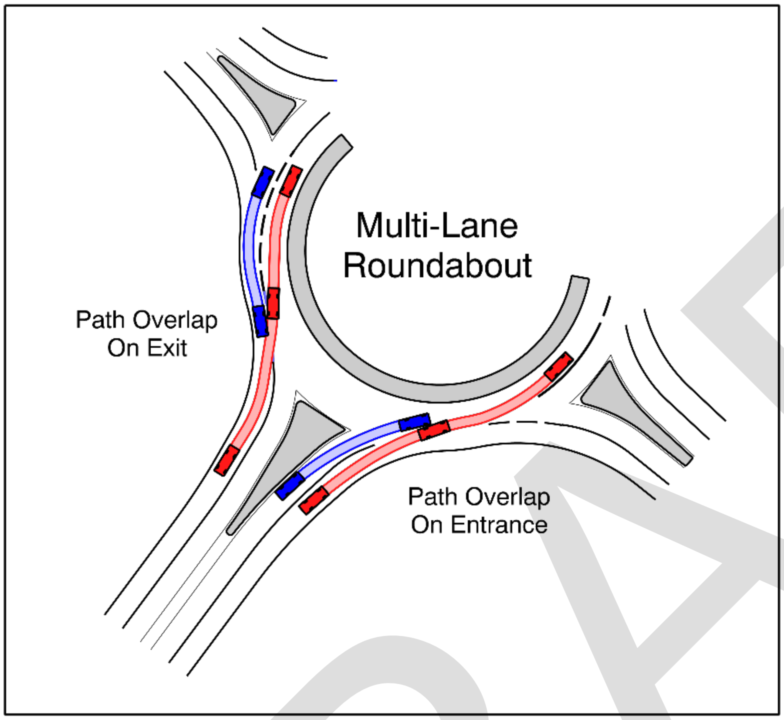
2

Figure 500-56: Additional Multi-Lane Roundabout Entrance and Exit Options



509.20 Path Overlap (Multi-Lane Roundabouts)

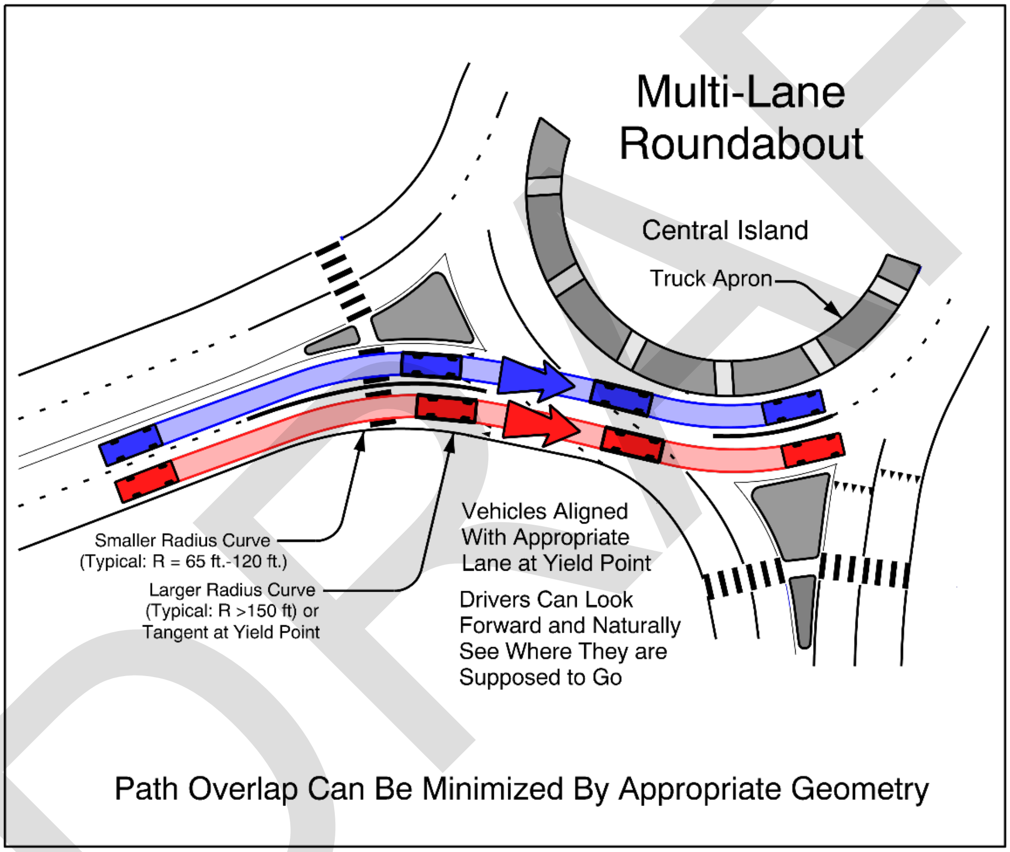
Figure 500-57: Path Overlap - Multi-Lane Roundabout



Path overlap is another unique design concern present with multi-lane roundabouts. Figure 500-57 demonstrates the effect of path overlap at a multi-lane roundabout. Entrance design, central island design and exit design must be balanced to provide a consistent, comfortable flow when designing both single lane and multi-lane roundabouts. Multi-lane roundabouts, however, pose a greater problem with entry and exit design. Because more than one lane enters and exits the circulating roadway at multi-lane locations, a phenomenon known as path overlap can occur. Vehicle path overlap occurs when the natural path of a vehicle crosses into the adjacent lane. It generally happens at entrances to roundabouts, but can also occur at exits or even along the circulating roadway itself. The natural path of a vehicle is the path a driver seeks based on comfort due to the applied forces to the vehicle from the roadway geometry. The natural path is determined by approach geometry, entrance radii and entrance width. To avoid path overlap and potential side-swipe crashes at a multi-lane roundabout, the entry design for the approach lanes must provide a comfortable path for drivers to keep their vehicles in one lane and not encroach on the adjacent lane. While proper entry curvature is a key factor in avoiding path overlap, there is no single method for creating a desirable vehicle path alignment. It may take several iterations of design elements to finalize an appropriate vehicle path to provide a smooth transition from entrance to circulating roadway to exit that eliminates path overlap.

As a general starting point, entrance radii should be greater than 65 feet and less than 120 feet. Compound curve sets or a single curve in series ahead of a tangent may prove beneficial in creating a successful design that balances desired speed constraint, provides large vehicle accommodation and addresses bicycle and pedestrian needs while directing the entering driver to the appropriate lane through the multi-lane roundabout. Figure 500-58 illustrates geometry that can minimize path overlap. The general idea is to create entrance geometry that slows the entering vehicle to the desired entry speed and then comfortably leads it to the appropriate circulating lane with a smooth transition to the circulating roadway and another smooth transition from the circulating roadway to the exit radius out of the roundabout.

Figure 500-58: Minimizing Path Overlap - Multi-Lane Roundabouts



509.21 Large Vehicle Accommodation (Multi-Lane Roundabout)

Large vehicles must be able to negotiate a multi-lane roundabout. As with single lane roundabouts, truck aprons around the central island are used to aid large vehicle movements through multi-lane roundabouts. While ORS 811.292 and ORS 811.370 provide for “commercial motor vehicles" to operate outside a single lane in a multi-lane roundabout when necessary, it is beneficial to design multi-lane roundabouts to allow larger vehicles to remain in one lane as much as possible. However, this need must be balanced with the overall effectiveness of the roundabout and it is acceptable to allow some truck off-tracking into an adjacent lane when necessary for overall design of a roundabout. In Oregon, by statute (ORS 811.292), it is a Class C Traffic Violation to drive beside or pass a commercial vehicle in a roundabout. Providing too large of a multi-lane design may encourage faster path speeds for passenger vehicles when truck volumes are not present

When accommodating larger vehicle, one way to help keep them from encroaching on the adjacent lane at the entrance to a multi-lane roundabout, while keeping entrance width to a minimum is to provide a section of "Gore Striping" between the entrance lanes. Figure 500-59 and Figure 500-60 depicts a WB-67 swept path at a roundabout entrance that utilizes gore striping. The drawings show a truck entering from either lane utilizing the striping to minimize encroachment of the adjacent lane.

Figure 500-59: WB 67 Entering in the inside Lane, Using Gore Striping

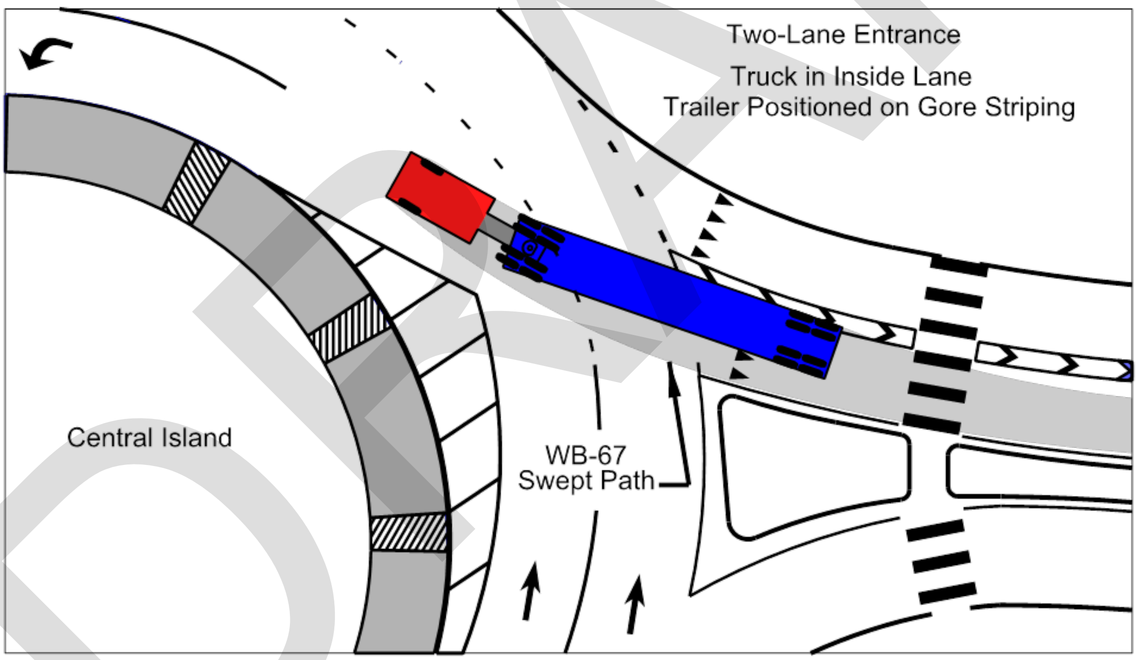
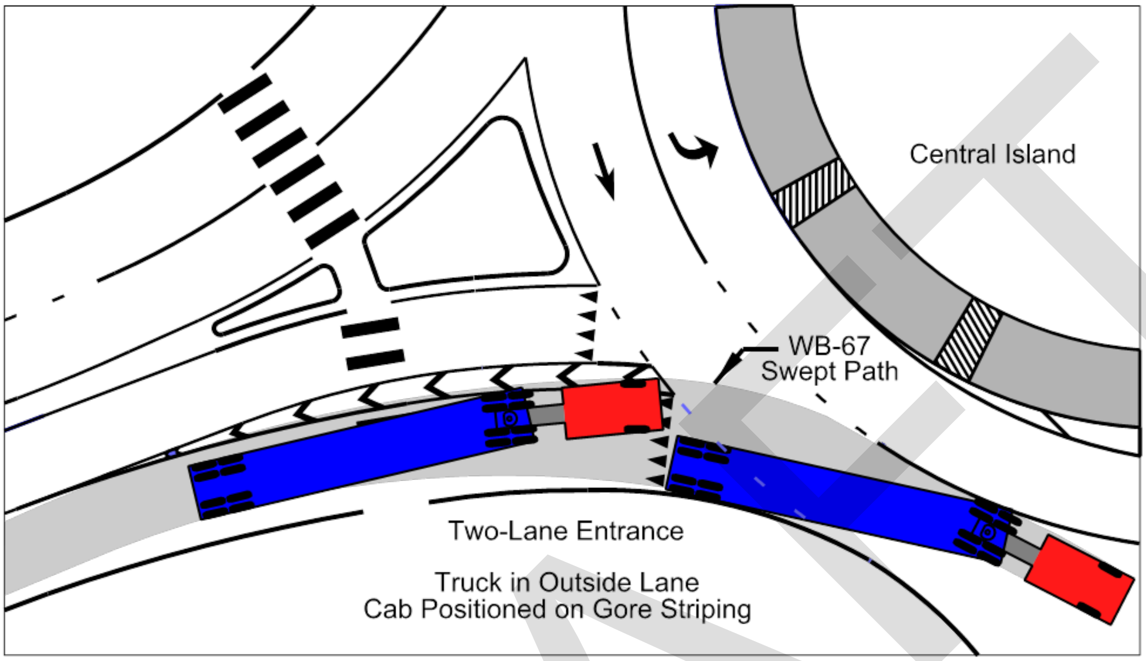


Figure 500-60: WB-67 Entering in the Outside Lane, Using Gore Striping



Section 510 Analysis; Roundabout Entrance and Exit Geometry (White Paper)

Entrance and exit geometries play an important role in controlling speed and movement of a vehicle through a roundabout. In general, providing roundabout alignments that increase flow at the exit may provide increased gaps in the circulating traffic stream and may provide greater opportunities for entering vehicles. Currently, there is significant discussion between roundabout designers about the best method to determine exit geometry and to control exit speed within design parameters. The discussion centers around the prediction of vehicle speed and how to calculate appropriate values for design. The standard method has been to utilize the speed, radius relationship as shown in Figure 500-61. The graph was derived using the basic equation for velocity and minimum radius from the AASHTO Green Book; $V = \sqrt{15R(e+f)}$, where superelevation, e, is held to +2% and -2% with side friction factor, f, values assumed for general design.

Figure 500-61: Estimated Vehicle Speed and Radius Relationship

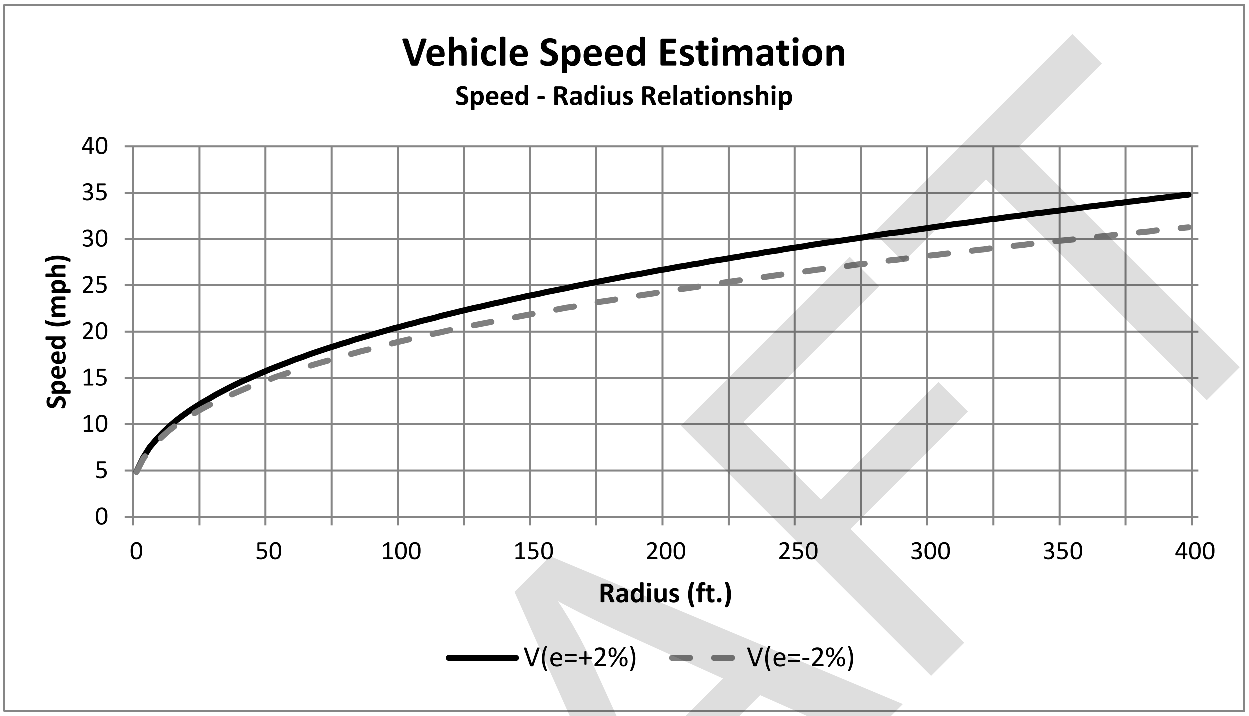


Table 500-5 is a tabular form of the values in Figure 500-61 reported at 25 ft. radius intervals. In addition, NCHRP Report 672 Roundabouts: An Informational Guide, provides simplified equations to calculate speeds for given radii as well. Equation 1 is for +2% superelevation and Equation 2 is for -2% superelevation.

Table 500-5: Speed, Radius Relationship

Radius (ft.)	V(+2%) (mph)	V(-2%) (mph)
25	12	11
50	16	15
75	18	17
100	20	19
125	22	20
150	24	22
175	25	23
200	27	24
225	28	25
250	29	26
275	30	27

300	31	28
325	32	29
350	33	30
375	34	31
400	35	31

Speed (V), Radius (R) Relationship Equations:

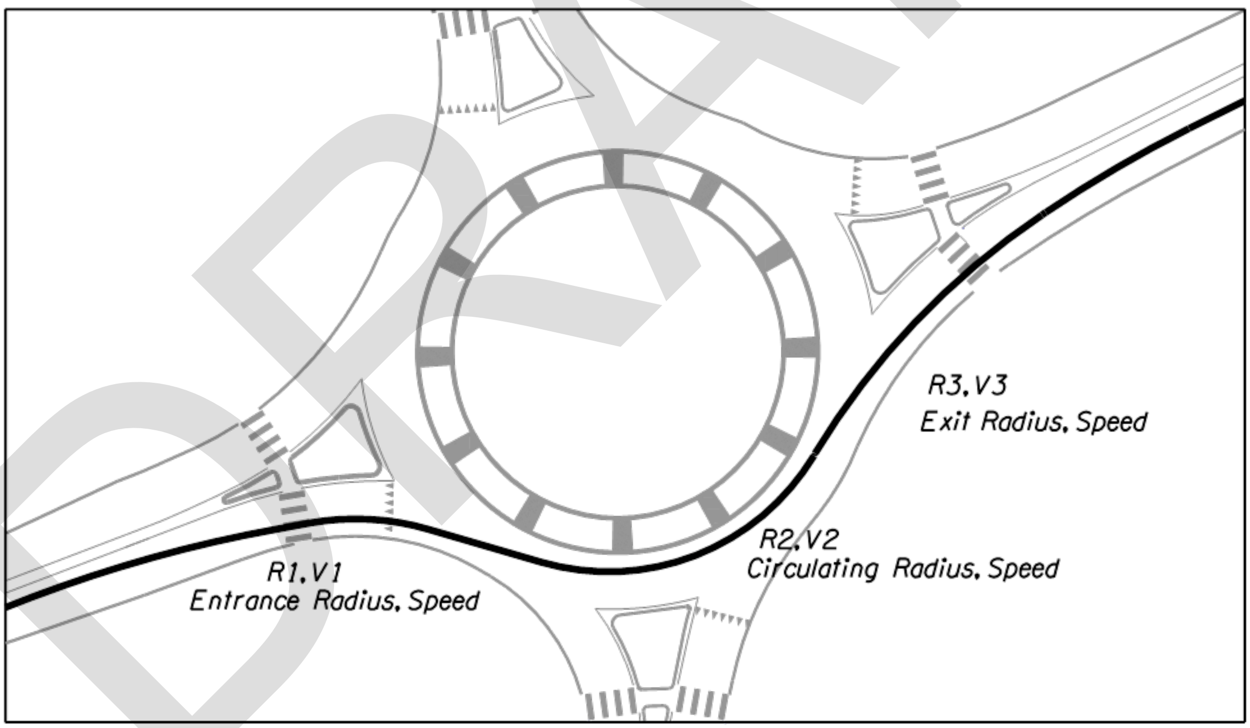
Equation 1 $V = 3.4415R^{0.3861}$ V=3.4415R0.3861 For e= 2% (NCHRP Report 672)

Equation 2 $V = 3.614R^{0.3673}$ V=3.4614R0.3673 For e= -2% (NCHRP Report 672)

Equation 3 $V = \sqrt{15R(e+f)}$ (AASHTO Minimum Radius)

Figure 500-62 illustrates the vehicle path through a roundabout depicting the R_1,V_1; R_2,V_2; and R_3,V_3 locations.

Figure 500-62: Vehicle Path through a Roundabout - Speed, Radius Locations



For superelevation other than +/- 2%, Equation 3, AASHTO Minimum Radius calculations need to be used with an appropriate side friction factor, f.

However, there is thought that exit radii designed too small to reduce predicted exit speed in an attempt to focus on pedestrian safety may unnecessarily limit overall roundabout capacity.

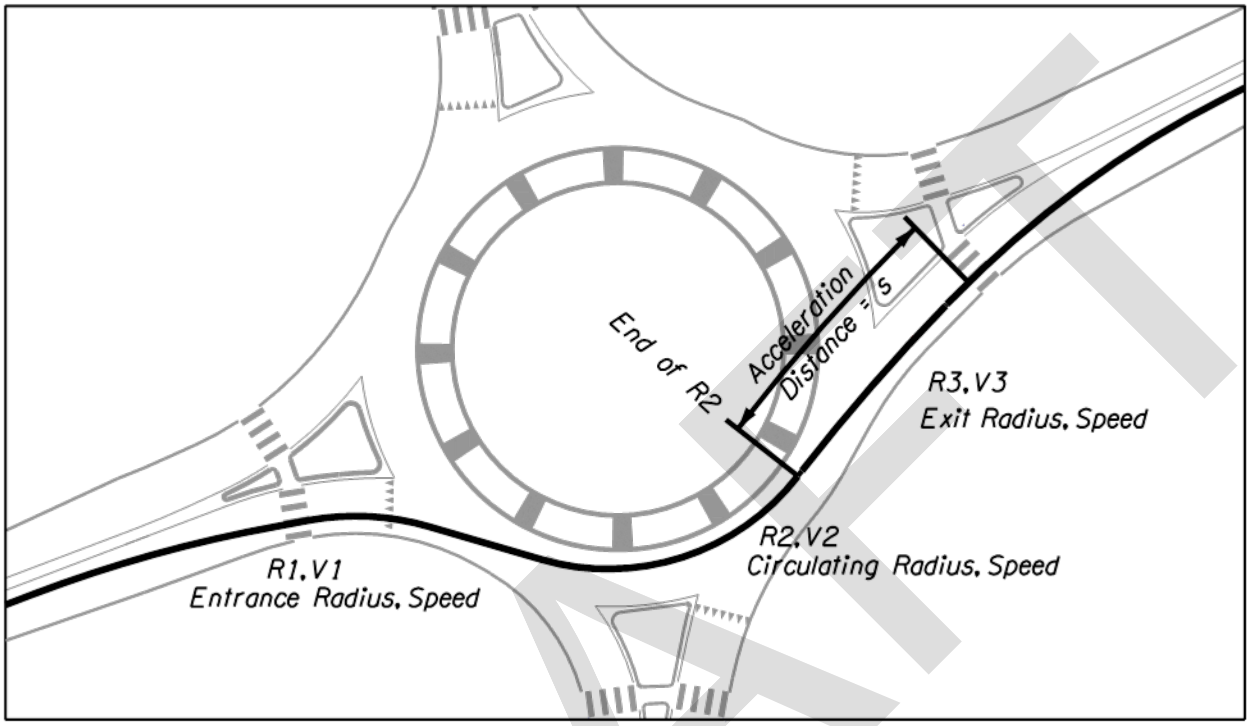
This leads to the question, then, how to calculate appropriate exit radii to maximize capacity and still protect pedestrian movements at the downstream crosswalk?

510.1 Research for Alternate Calculation Method

♦ Report: Alternate Design Methods for Pedestrian Safety at Roundabout Entries and Exits: Crash Studies and Design Practices in Australia, France, Great Britain and the USA Bill Baranowski, Edmund Waddell (2004)

Research done in 2004 by Bill Baranowski of Roundabouts USA and Edmund Waddell of Michigan DOT investigated entrance and exit geometry in order to determine appropriate roundabout alignments to increase capacity without negatively effecting pedestrian safety. The investigation determined that R_1 and R_2 values along with vehicle acceleration from R_2 through R_3 may play more of a role in exit speed than exit radius, R_3, alone. The researchers looked at the circulation radius, speed; R_2,V_2 relationship, the distance from the end of the R_2 radius to the exit crosswalk and the potential acceleration of a vehicle over that distance. Figure 500-63 illustrates the acceleration distance from the R_2V_2 location and the downstream pedestrian crossing.

Figure 500-63: Vehicle Path Through a Roundabout Speed, Radius, Acceleration Distance



The research assumed an exiting vehicle is capable of accelerating along a given R3 radial path with an acceleration rate of 3.5 ft/s2 and also assumed acceleration starts at the end point of R2. The standard Newtonian equation for uniform acceleration was used to compute potential vehicle speeds at the exit crosswalk.

Newtonian Equation for Speed and Acceleration

$$V_f^2 = V_i^2 + 2aS$$

Where: V_f = Final R3 Speed, ft/s (V_3, Exit Speed)

V_i = Initial R2 Speed (V_2, Circulating Speed)

a = Acceleration, (3.5 ft/s^2)

S = Distance, ft (End of R2 to Crosswalk)

After analyzing theoretical roundabout layouts and investigating several existing roundabouts, the researchers concluded that the R_2,V_2 radius, speed relationship and vehicle acceleration from R_2 to the crosswalk as a vehicle exits a roundabout has more effect on the vehicle speed at the exit crosswalk than a tighter exit radius using only the radius, speed relationship for R3 alone. The theory then is that exit geometry (radius) can be relaxed to increase overall capacity and not appreciably affect pedestrian activity or safety at the exit crosswalk by increased vehicle speed. This may prove to be true for small acceleration distance values coupled with relative radius values in order to predict and control maximum potential exit speed. However, effectively controlling this relationship may not always be easily accomplished

While the theory may have validity, it is only one analysis and appropriate application is critical to its effectiveness for speed prediction and control. Two key variables in the calculation are the distance available to accelerate prior to the exit crosswalk and the acceleration rate itself. If available acceleration distance is kept short, the exit speed may not be greatly affected. However, in larger diameter roundabouts, the available distance to accelerate may have an appreciable effect on exit speed. This may be particularly true for multi-lane roundabouts. The acceleration rate chosen for design will also have an effect on the predicted speed. The research used a rate of 3.5 ft/sec^2 for exit speed calculations. This is not a particularly fast rate of acceleration and may be acceptable for a curvilinear acceleration rate for small to moderate radii transitioning to the exit. However, some roundabout designs are utilizing large exit radii that become almost tangential. In these designs, it would be expected that vehicles would be accelerating from R_2 to the exit at a rate greater than 3.5 ft/sec^2. NCHRP Report 672, Roundabouts: An Informational Guide uses 6.9 ft/sec^2 for an acceleration rate in similar equations. This is nearly twice the rate used in the Baranouski/Waddell research and may be a better estimation when considering that the current vehicle fleet is capable of maximum performance, straight line acceleration rates of 9 ft/sec^2 for a four cylinder compact car to over 20 ft/sec^2 for a high performance eight cylinder vehicle with the average (non-weighted for vehicle types) for all vehicles about 13 ft/sec^2. (See Table 500-6 attached, Maximum Performance – Straight Line Acceleration by Vehicle.)

The Baranowski/Waddell research is significant in that it shows the role R_2 can play in controlling exit speed when alignments incorporate smaller curvilinear radii and short acceleration distances between R_2 and the exit crosswalk. However, for a larger R_3 radius or tangential exit, the acceleration rate for predicted speed calculations may need to be increased to better represent conditions as available acceleration distances increase.

♦ NCHRP Report 572, Roundabouts in the United States

Rodegerdts, Blogg, Wemple, Myers, et al (2007)

NCHRP Report 572 was a research project that investigated roundabouts in the United States and analyzed their operation. Authors of NCHRP Report 572 collected data from 103 roundabouts from around the United States. One of their findings indicated that observed entry and exit speeds did not always correlate well to the predicted entry and exit speeds determined for a given roundabout using the speed, radius relationship. The predicted speeds tended to be greater than the observed speeds. This was particularly evident for roundabouts with tangential or large entrance or exit radii. However, the speed, radius relationship did well in predicting observed circulating speeds through the R_2 and the R_4 pathways around the central island. It is unclear as to why the speed, radius relationship is effective to predict speeds for pathways around the central island radius, but is not as effective when predicting speeds in relation to entry and exit radii when correlated to observed speeds at specific roundabouts. From their observations and analysis, the authors developed equations that, in some locations, may better predict entry and exit speeds based on vehicle deceleration and acceleration ability. Like the previous research work done in 2004, these equations include vehicle deceleration and acceleration parameters based on observations and analysis and use the standard equation for uniform acceleration as a basis. These equations are also presented in NCHRP 672, Roundabouts: An Informational Guide, second edition (2010) to calculate predicted values for V_1 and V_3 along a vehicle's fastest path as it enters and exits a roundabout. The guide suggests these equations can be used as an alternative to using values derived from the simplified speed, radius relationships. However, as a cautionary statement, since predicted V_2 values derived from the speed, radius relationship seem to correlate to observed V_2 values, there may be other factors involved like driver behavior, driver expectation, driver familiarity, etc. affecting the correlation of predicted exit speeds and observed exit speeds rather than straight forward correlations to radial path, speed or acceleration.

Equation 4 – Alternative Entrance Speed Calculation, V_1

$$\boldsymbol{V_1 = \frac{1}{1.47}\sqrt{(1.47V_2)^2 + 2a_{1,2}d_{1,2}}}$$

V_1 = entry speed, mph

V_2 = circulating speed based on path radius, mph

$a_{1,2}$ = deceleration between point of interest along V_1 path and mid-point of V_2 path, = -4.2 ft/s^2

$d_{1,2}$ = distance between point of interest along V_1 path and mid-point of V_2 path, ft.

The deceleration rate of -4.2 ft/s^2 for entry speed was developed from the observed driver/vehicle behavior at the researched sites. While this equation had better correlation predicting entry speed with observed speed, the authors also included the following statement in NCHRP 572:

> *"However, given the hesitancy currently exhibited by drivers under capacity conditions, the observed entry speeds may increase over time after drivers acclimate further. Therefore, the research team believes that an analyst should be cautious when using deceleration as a limiting factor when establishing entry speeds for design. Furthermore, the research team believes that a good design should rely more heavily on controlling the entry path radius as the primary method for controlling entry speed, particularly for the fastest combination of entry and circulating path (typically the through movement)."*

NCHRP Report 672, Roundabouts: An Informational Guide, second edition also addresses this concern and states:

> *"Analysts should use caution in using deceleration as a limiting factor to establish entry speed for design. To promote safe design, deflection of the R_1 path radius should be the primary method for*

controlling entry speed. Therefore, while Equation 6-3 may provide an improved estimate of actual speed achieved at entry, for design purposes it is recommended that predicted speeds from Equation 6-1 be used."

(Note: In this White Paper, NCHRP Report 672 Equation 6-3 and Equation 6-1 are reported as Equation 4 and Equation 1 respectively)

Similar to entry speed, NCHRP Report 572 developed an equation that utilizes vehicle acceleration ability for predicting exit speed based on the standard uniform acceleration equation to better correlate predicted exit speed with observed exit speed for investigative purposes. As with the deceleration rate for entry speed, the report developed a vehicle exit acceleration value of 6.9 ft/s2 from observed information.

Equation 5 – Alternative Exit Speed Calculation, V_3

$$\boldsymbol{V_3 = \frac{1}{1.47}\sqrt{(1.47V_2)^2 + 2a_{2,3}d_{2,3}}}$$

V_3 = Exit Speed, mph

V_2 = circulating speed based on path radius, mph

$a_{2,3}$ = average acceleration between midpoint of V_2 path and the point of interest along V_3 path = 6.9 ft/s^2

$d_{2,3}$ = distance along vehicle path between midpoint of V_2 path and the point of interest along the V_3 path, ft.

The authors of NCHRP 572 did not provide a caveat for not using the alternate V_3 calculation method for design as was provided for the alternate V_1 calculation method. There is no explanation provided in the report to indicate why one calculation may be considered more valid than the other. One must remember the reason for the derivation of these equations. The intent was to provide a prediction of exit speed that better correlated to observed exit speed at roundabout locations. The use of these equations lies in the assumption that since the predicted exit speed using the speed, radius relationship is greater than the observed speed, there must be something affecting the speed, radius relationship at exits. Acceleration rates were determined to make a better correlation. However, it works fine for R_2,V_2 and R_4,V_4 predicted and observed values. There may be other driver behavior factors that also affect observed R_1,V_1 and R_3,V_3 relationships. The authors are concerned this is the case with entrance speed and the same may be true for exit speed. The derived equations use a single deceleration or acceleration rate determined from observed data. Applying these acceleration rates to large radius or tangential exits and small radius, tight curvilinear exits equally may not produce effective design results in both cases. Using the same rates for both exit types assumes acceleration in a straight line or in a large radius is the same as acceleration in a tighter curvilinear path. This may not be the case. Therefore, lowering the acceleration rate for smaller radius paths seems reasonable. The research done in 2004 used 3.5 ft/s^2 as an acceleration rate for their investigation into exit geometry. This seems a more reasonable acceleration rate for smaller radial paths. NCHRP 572 uses 6.9 ft/s^2 as an acceleration rate. This seems reasonable for larger radius or tangential exits and seems to represent where, by observation, American drivers currently feel comfortable when exiting a roundabout. However, will this rate increase as drivers become more familiar with roundabouts? This is a concern of the authors of NCHRP Report 572 for V_1 values.

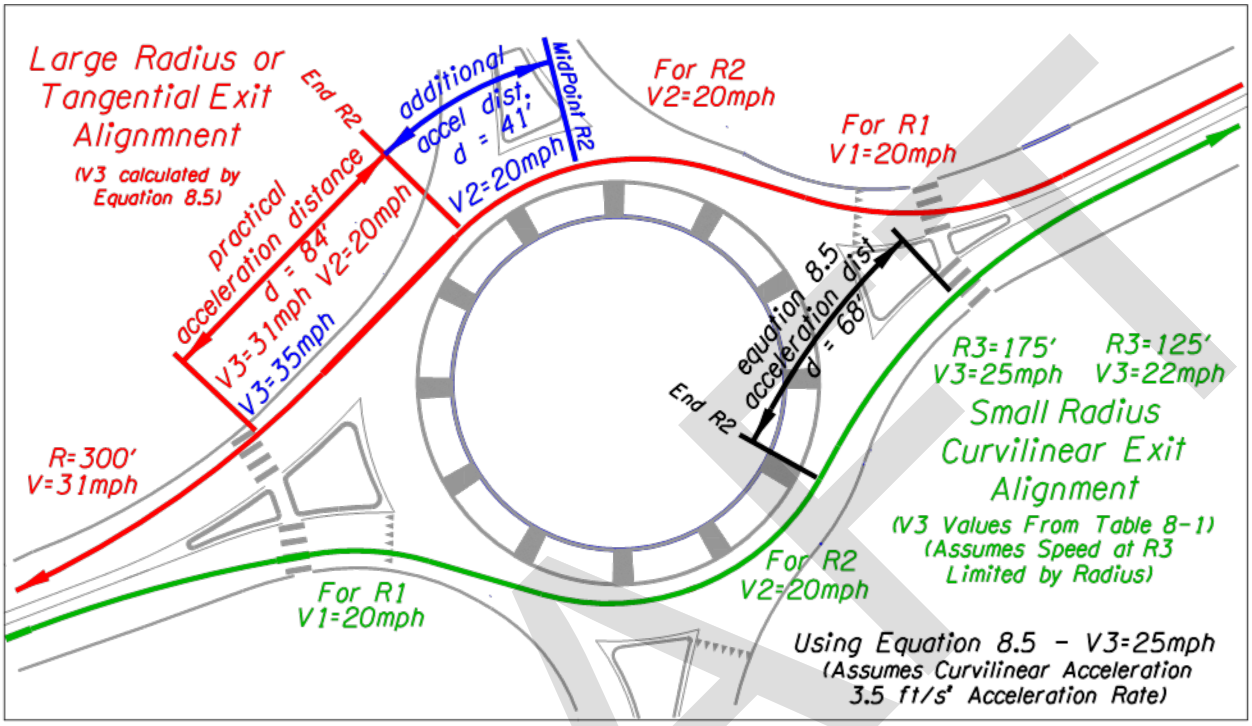
510.2 Evaluation of Large Radius or Tangential Exits and Small Radius Exits

In addition to determining an acceptable acceleration rate, the other two critical variables in these equations are the V_2 speed and the distance, d, over which the deceleration or acceleration can take place. Therefore, if a large radius or tangential exit is designed for a roundabout, the R_2 value must provide the appropriate design V_2 and the acceleration distance must be effective in limiting a vehicle's potential downstream speed to design values.

Figure 500-64 is a hypothetical roundabout layout based on real roundabout dimensions that portrays potential differences in speed between a smaller curvilinear exit and a more tangential or large radius exit. The vehicle path alignment shown from lower left to upper right (green) assumes radii for R_1 and R_2 that provide a 20 mph V_1 and V_2. The curvilinear R_3 exit radius is shown as both 175 ft. and 125 ft. for illustrative purposes and correlates to a V_3 speed of 25 mph and 22 mph respectively. These V_3 values are based on the speed, radius equations discussed previously in this report and is shown in Table 500-5, Figure 500-61. For comparison, the speed, acceleration equation was used to calculate a predicted V_3 exit speed along the radial R_3 path. Since the exit radius is small, using the 3.5 ft/s^2 acceleration rate discussed previously and coupled with the relatively short acceleration distance shown, a predicted V_3 of 25 mph was determined. This is equal to the value predicted for V_3 using the speed, radius relationship for a 175 ft. exit radius. This is in line with the conclusions of the 2004 research report. However, keep in mind, this geometry has a smaller curvilinear alignment with a short acceleration distance that helps limit a vehicle's ability to accelerate. For comparison, increasing the acceleration rate for the calculation to the NCHRP Report 572 value of 6.9 ft/s^2 yields a predicted speed of 29 mph at the crosswalk. This is beginning to reach the unacceptable level for speed at the crosswalk when considering pedestrian safety.

Large radius or tangential exit geometry set for increased capacity or exit geometry opened up due to skewed approach alignments or other site specific parameters that might dictate positioning of roundabout elements may have equal or greater impact to potential vehicle speeds at the crosswalk.

Figure 500-64: Exit Geometry – Comparison Tangential and Small Radius



The vehicle path shown on the opposite side of the roundabout from upper right to lower left (red) in Figure 500-64 also assumes radii for R_1 and R_2 that provide a 20 mph V_1 and V_2. However, the V_3 value of 31 mph is based on the potential for vehicle acceleration from the end of R_2 to the crosswalk. This distance is shown as a "practical acceleration distance", d, and for this layout is equal to 84 ft. This distance assumes a driver does not accelerate until reaching the end of the circulating path radius R_2. This is the approach the researchers in 2004 preferred. However, the equation parameters listed in NCHRP 672, Roundabouts: An Informational Guide, second edition define the acceleration distance as the distance from the midpoint of the V_2 path and a point of interest along the V_3 path. The point of interest is the downstream crosswalk in this analysis. Adding the additional acceleration distance back along the path to the midpoint of R_2 and assuming a vehicle is capable of accelerating at 6.9 ft/s2 along this reversing radial to tangential path, yields a total distance of 124 ft. that a vehicle can accelerate prior to the downstream crosswalk increasing the calculated V_3 speed to 35 mph. These calculated speeds are 6 mph and 10 mph faster than the predicted V_3 speed of 25 mph at the tighter curvilinear exit on the opposite path of the roundabout. Either of these speeds would be considered excessive for design at the downstream crosswalk. This exemplifies the need to limit the acceleration distance, d, to provide acceptable exit speed if a tangential or large radius design is used.

510.3 Conclusion

The two research projects discussed both used uniform acceleration in their calculations. However, they each used different rates of acceleration. Baranowski and Waddell used 3.5 ft/s^2 for acceleration. NCHRP Report 572 used 6.9 ft/s^2, which is almost double the rate used by Baranowski and Waddell. Both these rates appear to be rates that were field observed by the authors of the reports. The difference may be attributed to the focus of the individual research. Baranowski and Waddell were studying roundabout locations where they considered exit radii to be excessively tight to restrict speeds. Therefore, the observed rates of acceleration were compatible with the geometry. In the case of NCHRP Report 572, the authors were trying to correlate observed exit speed with predicted speed and they noted there was a greater discrepancy when the exit radius was large – predicted speed greater than actual observed speed. In these cases, it appears the acceleration rate was determined to match the observed speed and the 6.9 ft/s^2 value they determined in 2007 may in fact be a comfortable rate for American drivers at larger radius exits. This is further borne out when looking at potential 0 – 60 mph maximum performance characteristics of the current vehicle fleet. Table 500-6 is a listing of maximum performance and straight line acceleration of various late model production vehicles ranging from 4 cylinder compact cars to high performance 10 cylinder "muscle cars". The data was collected from the on-line automotive sight AutoRooster at http://www.autorooster.com. The site reports 0 60 times for a variety of current vehicles. The corresponding accelerations were calculated and added to the table as 60 mph acceleration values in ft/s^2. The acceleration values ranged from 9.09 ft/s^2 for a 2008 Honda Civic, 4-cylinder vehicle to 24.50 ft/s^2 for a 2010 Dodge Viper, 10 cylinder vehicle. The mathematical average (non-weighted for numbers of vehicle type) for all the vehicles in the table is 12.89 ft/s^2. This indicates that the 6.9 ft/s^2 value determined from observed speeds in NCHRP Report 572 may be an acceptable overall value as a "comfortable" acceleration rate to most drivers, since the average in Table 2 of 12.89 ft/s^2 was determined from maximum, straight line performance.

Currently, there is no definitive answer to what is the best method to predict entrance and exit speed when designing a roundabout. Research has shown that in some cases where exit radii are smaller and/or acceleration distances are short limiting a vehicle's ability to accelerate prior to the exit crosswalk, opening up exit geometry may not have a great effect on exit speed. However, relaxed exit geometry that increases acceleration distances and acceleration rates can potentially have significant effects on the exit crosswalk impacting pedestrian movements. This is particularly true for multi-lane roundabouts in off-peak times when a vehicle's fastest path may cross adjacent lanes. In any roundabout layout, it is the designer's responsibility to provide vehicle alignments that consistently control vehicle speeds from entrance to exit in an effective manner for all modes of transportation utilizing the roundabout. For this reason, after the above discussion, it seems reasonable to use roundabout entrance and exit alignments that limit a driver's ability to accelerate prior to the exit crosswalk and it appears that a good method to do that is the standard radius, speed relationship.

Table 500-6: Maximum Straight Line Acceleration Performance by Vehicle

Maximum Performance - Straight Line Speed, Acceleration				
Data From AutoRooster (autorooster.com/0-60-times)				
Vehicle Data	**0-60 (sec)**	**1/4 mile (sec)**	**60 mph dist (ft)**	**60 mph acel (ft/sec^2)**
2008 Honda Civic, 4cyl	9.7	17.1	427.8	9.09
2010-12 Nissan Versa, 4 cyl	9.4	18.3	414.5	9.38
2013 Ford Escape, 4 cyl	9.3	17.4	410.1	9.48
2011-14 Chevy Cruze, 4 cyl	9.0	16.5	396.9	9.80
2009-12 Toyota Corolla. 4 cyl	8.9	16.7	392.5	9.91
2010-13 Chevy Tahoe, 8 cyl	8.5	16.9	374.9	10.38
2013 Ford Fusion, 4 cyl	8.5	16.9	374.9	10.38
2014 Ford Focus, 4 cyl	8.5	16.7	374.9	10.38
2012 Toyota Camry, 4 cyl	8.3	15.6	366.0	10.63
2011-12 Dodge Caravan, 6 cyl	8.1	16.7	357.2	10.89
2014 Chevy Impala, 6 cyl	8.1	16.3	357.2	10.89
2012-14 Ford Explorer, 4 cyl	7.8	15.9	344.0	11.31
2013 Honda Accord, 4cyl	7.7	15.8	339.6	11.45
2013 Nissan Altima, 4 cyl	7.1	15.5	313.1	12.42
2012 Mercedes S Class, 6 cyl(D)	7.0	15.3	308.7	12.60
2013 Toyota Avalon, 6 cyl	6.8	15.3	299.9	12.97
2012 Mercedes C Class, 4 cyl	6.8	15.3	299.9	12.97
2011-13 Ford F-150, 6cyl	6.5	15.3	286.7	13.57
2012-13 BMW 5 Series, 4 cyl	6.1	14.5	269.0	14.46
2012-13 Chevy Camero, 6 cyl	6.0	14.4	264.6	14.70
2009-12 Nissan Maxima, 6 cyl	5.8	14.4	255.8	15.21
2012-12 BMW 3 Series, 4 cyl	5.6	14.4	247.0	15.75
2011-13 Ford Mustang, 6 cyl	5.3	14.0	233.7	16.64
2014 Chevy Corvette, 8 cyl	3.9	12.1	172.0	22.62
2008-10 Dodge Viper, 10 cyl	3.6	11.9	158.8	24.50
				Avg, 12.89 ft/s^2

Section 511 References

511.1 AASHTO References

- A Policy on Geometric Design of Highways and Streets – 2018 (AASHTO Green Book)
- Guide for Development of New Bicycle Facilities – 2012

511.2 Other References

- Oregon Standard Drawings
- The 1999 Oregon Highway Plan
- ODOT Traffic Manual
- ODOT Traffic Line Manual
- Oregon Bicycle and Pedestrian Plan
- Oregon Bicycle and Pedestrian Design Guide
- Manual on Uniform Traffic Control Devices and Oregon Supplements
- NCHRP Report 672, Roundabouts: An Informational Guide, Second Edition, 2010
- NCHRP Report 572, Roundabouts in the United States, 2007
- Research Report: Alternate Design Methods for Pedestrian Safety at Roundabout Entries and Exits: Crash Studies and Design Practices in Australia, France, Great Britain and the

Part 600 Interchanges and Grade Separations

Section 601 Introduction

Interchanges and grade separations are an integral part of freeways, and also a feature of certain other facilities in select locations and contexts. Much has been learned about how interchanges operate and the role they play in safety and efficiency of our roadway network. Some features of earlier generations of freeways and other facilities have proven to be problematic or have become obsolete as the demands on them have grown. Several ODOT facilities started with a mix of interchanges and at-grade intersections, over time changing to fully access controlled highways. Some still have a mix of interchanges and at-grade intersections. In some cases, very early versions of grade separated facilities (Harbor Drive and Interstate Avenue in Portland) have been changed into at-grade arterial roadways, with vestiges of the original still in service. Valuable insights have been gained from these transitional facilities. Most of those insights have been incorporated into ODOT standards and practices over time. Detailed explanations of current standards and practices are provided in each Section.

Interchange contexts can vary widely, from simple rural locations to complex urban systems and large freeway to freeway connections. A wide variety of interchange forms have been used over the last several decades. There are some design features, however, that are common to all interchanges no matter the context.

Part 600 of the HDM provides specific guidance on design and planning for interchanges and grade separations on ODOT facilities. Design criteria and standard practices have been developed (and continue to be refined) as operational, safety, and constructability experience has increased. Key design and planning considerations are discussed in detail. Recognizing that in many (if not most) situations, it isn't practical (or in some cases possible) to meet full standards, Part 600 includes discussion of the tradeoffs involved when working on existing facilities. Also included are numerous design aids and example applications of design criteria and practices in typical situations.

601.1 Font Key

Within this manual text is presented in specific fonts that are used to show the documentation and/or approval that is required if the design does not meet the requirements shown.

Table 600-1: Font Key

Font Key Term	Font	Deviations	Approver
Standard	**Bold text**	Design Exceptions require STRE	STRE or FHWA

Guideline	***Bold Italics text***	Design Decisions Document	Region with Tech Expert input
Option	*Italics Text*	Document decisions	EOR
General Text	Not bold or italics	N/A	N/A

601.2 Definitions

Definitions of some basic terms and ODOT specific terminology is appropriate. The following terms are commonly used in the context of Interchange Planning and Design.

At-Grade Intersection - An intersection of two roadways at the same level, typically featuring stop control, roundabout control, or traffic signal control.

Grade Separation - a roadway that is carried at a different level than a through roadway. They may be part of an interchange, or a stand alone feature.

Interchange - A system of interconnecting roadways in conjunction with one or more grade separations that provides for movement of traffic between two or more roadways or highways at different levels.

Freeway - An arterial roadway with full control of access. It's intended to provide high levels of safety and efficiency in moving high volumes of traffic at high speeds. Access to a Freeway is only by way of entrance and exit ramp roadways.

Ramp - In the context of interchanges, a ramp is a connecting roadway between different level roadways. They feature full access control and perform the key function of transitioning to/from higher speeds to lower speeds or a full stop.

FHWA - Federal Highway Administration

Access Modification Request - A formal document submitted by ODOT to FHWA regarding modified access to the Interstate System. FHWA approval is required for implementing those changes.

Interchange Area Management Plan (IAMP) - An ODOT process that is intended to provide engineering and access management guidance for new and existing interchanges. It is developed in conjunction with local officials and public input. Planned improvements, expected operational characteristics and high level environmental evaluations are part of the final document, which when approved by the Oregon Transportation Commission, becomes an amendment to the Oregon Highway Plan. Future improvements, projects, and management decisions are informed and guided by the IAMP.

Mainline - In the freeway and interchange context, the mainline is the primary or through roadway (such as an Interstate) being served by the interchange

Crossroad - The primary roadway intersecting the through roadway by way of grade separation and ramp roadways. The crossroad may be a State Highway or local jursdiction roadway. In the interchange area, the crossroad must take into account the local context and the necessary interchange functions.

Auxiliary Lane - An Auxiliary Lane is defined as the portion (normally a full lane) adjoining the through lanes for speed change, turning, storage for turning, weaving maneuvers, truck climbing, or other purposes that supplement through traffic movements. They are typically used for relatively short section of a roadway, such as between two closely spaced interchanges.

Speed Change Lane - The portion of a ramp roadway used for speed matching, gap identification and merging maneuvers (entrances) or deceleration to appropriate speeds or a stop (exits). ODOT uses parallel type entrances and tapered type exits. Standard ramp configurations in the HDM provide the necessary/appropriate speed change lengths.

Section 602 General Information

There are three types of roadway intersections: intersections at-grade, grade separations without exit or entrance ramps, and interchanges, where all access to the facility is by way of exit and entrance ramps. Each of these has specific characteristics and applications. Each is appropriate to use in the proper context. In some situations intersections at-grade and interchanges can be used together, with appropriate spacing and other criteria being applied, but this needs to be carefully evaluated regarding safety and operations. Design and planning practitioners need to keep in mind that using an inappropriate solution for a specific context can lead to serious safety and operational issues. This section discusses both general considerations and specific design features for interchange and grade separation facilities in a variety of contexts.

Interchanges require major investments and typically have significant impact on the natural and built environments. The decision to use an interchange as a transportation solution requires adequate study, including traffic analysis, geometric design, and environmental/land use impacts. In order to work properly, an interchange needs to fit into the context of the roadway system, the surrounding area, and be supported by an adequate network of local facilities. When these features, for whatever reason, are not feasible, a new interchange is not advisable.

Basic interchange forms (diamond, partial cloverleaf, etc.) have inherent strengths, weaknesses and tradeoffs when they are applied. Section 603 has discussion and examples of various basic forms and issues to consider when working in both planning and design. Variations are too numerous to list; experience has taught us that it is advisable to stick with the basic forms in most cases. Striving to provide clear, simple, and familiar patterns for drivers is the best practice. When it’s deemed appropriate, basic forms can be modified to fit the immediate context.

Existing interchanges often have operational and safety issues to consider as well. Much of our freeway system was designed and initially built in the late 1950s and early 1960s. Although they were deemed appropriate at the time, decisions were made without the benefit of operational experience we now enjoy. Common problem areas on these facilities include: close spacing to adjacent interchanges, inadequate speed change areas, queue storage issues, crossroads that have deficient capacity, tight geometry that restricts sight lines or operations, and inadequate weaving areas on the mainline.

Close interchange spacing is often a root cause of other problems, such as speed change and weaving issues. Solutions for these types of problems are commonly expensive and difficult to implement. Existing facilities normally can't avoid these problems, unless there is a willingness to remove an interchange (although the grade separation structure may remain) or some connections. Adding frontage roads and grade separations without ramps often helps to maintain or improve the local road network around the interchange, but these come with a cost as well. **When new interchanges are considered, designers and planners need to adhere to the spacing and design guidelines provided in Part 600.**

Particularly during planning efforts, it is important to not default to minimum design values. Defaulting to minimums may entirely preclude future options for managing problems, or make them more costly and impactful. When working in fully developed areas, compromises are normally unavoidable, at least for some elements. Designers should always look for opportunities, however, to provide as many incremental improvements as possible within the context of the work. Where greater uncertainty exists, planning for future needs should always allow for as much flexibility as is reasonable. Alternatives need to be evaluated to an appropriate level of detail to understand the implications of these basic decisions.

ODOT has several example facilities that have made provision for future needs. Some were originally built to accommodate future construction which has since taken place, and others have made provision for work yet to be done. Examples include:

- The four laning of OR 22 between Joseph Street interchange and Stayton interchange (several grade separation structures dating back to 1960).
- I-205 in Portland made provision for a future system of busways and slip ramps in some areas, and some of that space was ultimately used for Light Rail Transit.
- OR 140 in Klamath Falls has an interchange at Washburn Way; the structure overhead was constructed to provide for a four lane section on the highway, even though the highway is currently two lanes.
- I-5 in Salem is configured with sufficient median width to allow for possible future needs.
- The recently constructed two-lane Phase 1 of the Newberg-Dundee Bypass has also made provision for future needs.

Designers and planners must remember that any interchange, no matter how simple or basic, functions as a unit. The various components all have their functions and features to make the facility work. While the interchange always needs to make appropriate accommodation for the context in which it is present, it still needs to be able to function as a discrete piece of the overall system.

602.1 Warrants for Interchanges and Grade Separations

Interchanges are integral features of freeways and are adaptable for solving safety, operational, and traffic congestion problems on other types of facilities provided that adequate access management features are present. They can vary from single ramps connecting between local facilities and arterials to large and complex arrangements connecting two or more highways or freeways. Grade separations without ramps are also integral features on freeways. They also can provide significant system benefits to other facilities. Since a wide variety of factors come into play at each location, specific warrants for justifying an interchange cannot be conclusively stated. There are several conditions that need to be considered when making a decision whether to use an interchange as a transportation solution. These include:

1. Design Designation – Fully Access Controlled Facilities, e.g.
2. Reduction of Bottlenecks or Congestion
3. Reduction of Crash Frequency and Severity
4. Site Topography
5. Traffic Volume
6. Road User Benefits – Cost of Delays and Congestion, e.g.

Chapter 10 of the AASHTO *"Policy on Geometric Design of Highways and Streets – 2018"*, page 10-3 to 10-5 has a detailed discussion on things to consider for each interchange warrant. Warrants pertaining to grade separations are also located in that section

602.2 Interchange Spacing

Interchanges are expensive to build and to upgrade. Therefore, it is critical that they operate as efficiently as possible. Interchange spacing and access control should be an integral part of interchange planning and design. With the high number of vehicles and demand in an urban area, the interchange spacing for urban freeways is less than the spacing for rural interchanges. Minimum spacing for an added interchange is 3 miles in urban areas and for rural areas it is 6 miles. The spacing is measured from crossroad to crossroad. See OAR 734, Division 51 for additional guidance on other Interstate and Non-Interstate interchange spacing criteria.

Existing interchange spacing that does not meet current standards will not require a design exception. Consideration of design exceptions for interchange spacing should always include coordination with the Region Access Management Engineer (RAME). This section does not change the requirements of mainline spacing standards and deviations outlined in OAR 734, Division 51.

Table 600-2 shows the spacing standards for interchanges for freeway and non-freeway locations. The spacing shown is based upon crossroad to crossroad centerline distance. **Provide crossroad to crossroad spacing for new interchanges according to the values listed.**

Table 600-2: Freeway and Non-Freeway Interchange Spacing

Access Management Classification	Area	Interchange Spacing
Freeways Interstate and Non-Interstate	Urban Rural	3 miles 6 miles
Non-Freeways Expressways, Statewide, Regional, and District Highways	Urban Rural	1.9 miles 3 miles

NOTES:

Spacing distance is measured from crossroad to crossroad.

A design exception is required if interchange spacing standards are not met for new interchanges.

When long range plans call for new interchanges or converting grade separations into interchanges, new interchange criteria apply. A design exception is required where spacing standards are not met. The DE needs to be prepared by internal or external staff making the proposal.

Existing interchanges that do not meet current spacing standards do not require a design exception. *Interchange ramp spacing guidelines (explained in OAR Chapter 734, Division 51) apply and need to be considered during project development. An operational and safety analysis needs to be completed.* **This analysis is prepared by ODOT or external staff doing the project work.**

FHWA Interstate Access Modification approval is required for added or modified access to Interstate highways. The policy requires specific items to be addressed in a formal submittal document, known as an Interstate Access Modification Request (IMR for short). This document is prepared by ODOT or by others delegated to do so. Details on the policy are available online at: Interstate Access Policy - Interstate

System - Design - Federal Highway Administration (dot.gov). Other ODOT jurisdiction highways (including freeways) are not subject to the FHWA policy; approvals in those cases are internal to ODOT.

602.3 Access Control at Interchanges

Access spacing along the crossroad in an interchange area is equally important as the interchange spacing. Spacing and operation of accesses and intersections adjacent to the ramp terminal are key part of how well service interchanges can serve their function. Recurring problems are often present in facilities operating at or near capacity. Poorly performing intersections, inadequate progression between them, and the effects of turning moves at accesses create conditions which potentially back traffic onto the freeway.

Access management is one of the most valuable tools ODOT has in preserving the existing transportation system and addressing safety issues. It allows balancing between land access and preserving the movement of traffic in a safe and efficient manner.

Access spacing standards have been developed that are dependent on the type of area adjacent to the freeway interchange. Urban areas have two types of area, fully developed and urban. A fully developed interchange management area occurs when 85 percent or more of the parcels along the developable frontage are developed at urban densities and many have driveways connecting to the crossroad. Fully developed areas are also characterized by slower speeds. Urban interchange management areas are areas within an urban growth boundary that are not fully developed. OAR 734, Division 51 and the OHP provide information and spacing requirements for interchanges and interchange management areas at urban and rural locations.

At new interchanges with new crossroads, provide access control in the interchange area consistent with the following:

1. At all rural and suburban/urban fringe area interchanges, access shall be controlled a minimum distance of 1320 feet from the centerline of the ramp. The access control shall be applied equally to both sides of the crossroad. No reservations of access are allowed within these access controlled areas. No private access is allowed across from the interchange ramp terminal.
2. All other urban interchange areas should also be access controlled for 1320 feet from the centerline of the ramp. In many existing urban interchange environments however, this distance will be very difficult to achieve due to the built-up environment surrounding the interchange. In these situations, provide access control for a minimum distance of 750 feet. This controlled section applies equally to both sides of the crossroad and shall not include any reservations of access. No private access is allowed across from the interchange ramp terminal.

When a new interchange is added to an existing crossroad, full standard spacing is often not feasible. *In those situations, every effort needs to be made to move in the direction of meeting the full spacing criteria.* Often it is necessary to do added traffic analysis to support decision making. Investing in this level of improvement makes it very important to understand how the system will operate, both at opening and over time with the non-standard features.

When appropriate, exceptions from the above criteria need to be developed through a deviation process associated with interchange access management area planning. This is not a design exception, but rather a part of the project's Access Management Plan. It is developed by the project team in conjunction with the Region Access Management Engineer as part of the project's decision making records. OAR Chapter 734-051 provides information and rules involving access management for road connections to state highways. Potential justifications for not obtaining the minimum access control may include but are not limited to:

1. The cost of obtaining the access rights far exceeds the benefits.
2. Existing development patterns make it difficult and costly to provide alternative access routes such as frontage roads, combined access, or completing local roadway networks.
3. Topographical constraints make it impractical to achieve the desired spacings.

Exceptions from the access control standards for new interchanges with new crossroads will generally not be approved. In these situations, the standards should be achievable at a reasonable cost and impact. Only extreme cost or environmental impacts may justify an exception. Substantial inability to meet access criteria may in itself be sufficient reason to dismiss a new interchange alternative.

Again, in those situations and contexts where meeting full spacing standards is not possible, every effort needs to be made to move in the direction of the standard. Exceptions and deviations are nearly always necessary in fully developed and urban areas. Many rural locations have significant terrain constraints that preclude full standards. Recognizing these facts, it's still important to document the reasons for not meeting the criteria, both in planning and project development.

Also remember that additional guidance on access management at interchanges can be found in the Oregon Highway Plan and OAR Chapter 734-051.

602.4 Interchange Area Management Plans (IAMPs)

An Interchange Area Management Plan (IAMP) is an ODOT long term (20+ years) transportation facility plan that focuses on solutions that manage transportation and land use decisions over a period of time at an interchange. An IAMP is a valuable tool in protecting the long term function and operations of an interchange.

The ODOT Interchange Area Management Plan Guidelines provide additional information on IAMPs and are maintained by the Planning Unit of ODOT's Policy, Data, and Analysis Division. They are Facility Plans and as such require approval from the ODOT Chief Engineer or designated representative. Completed IAMPs are adopted by the Oregon Transportation Commission and become amendments to the Oregon Highway Plan.

IAMPs involve many local and state stakeholders. The purpose of an IAMP includes the following objectives:

1. Protect the state and local investment in major facilities;
2. Establish the desired function of interchanges;
3. Protect the function of interchanges by maximizing the capacity of the interchanges for safe movement from the mainline highway facility;
4. Balance the need for efficient interstate and state travel with local use;
5. Preserve and improve safety of existing interchanges;
6. Provide safe and efficient operation between connecting roadways;
7. Adequately protect interchanges from unintended and unexpected development while accommodating planned community development;
8. Manage the existing interchange capacity and new capacity provided through improved interchange improvements;
9. Establish how future land use and transportation decisions will be coordinated in interchange areas between ODOT and the local governments;
10. Minimize impacts to farm and forest lands and other resource lands around rural interchanges in accordance with adopted Statewide Planning Goals;

602.5 Traffic Studies

Appropriate levels of traffic analysis are necessary for decision making and design on interchanges. This is the case regardless of the type of work (new construction or upgrading/modifying existing facilities). Traffic studies should be requested as early in the development of the design as possible, and the appropriate level of analysis detail determined at that time. Typical requests for analysis include peak hour volumes, turning movements, capacity (Volume/Capacity ratios), storage lengths and levels of service. Analysis for weaving sections, storage lengths, and spacing should also be done as needed. **Analysis shall be considered on the basis of a 20-year design life after construction of the project.** There are also situations where sensitivity analysis is needed. An example of this is estimating when traffic volumes or V/C ratios are expected to reach certain levels. This information helps to inform planning and future facility needs, which in turn can also inform current project efforts. Providing flexibility for future needs is always desirable.

602.6 Design Reviews and Approvals

Prior to the location and design stage, ODOT and FHWA approval must be obtained for the reconstruction, reconfiguration, adding an interchange, or adding new access points to an existing interchange on the Interstate system. Depending on the level of interchange detail, FHWA approval is obtained at the Division Office for new or revised access on the Interstate System, except for Freeway to Freeway and partial interchanges, which require consultation with FHWA Headquarters staff in Washington D.C. The approval procedures are submitted to and processed through the Roadway Engineering Unit in Technical Services. Justification for new or modified access is based on a number of factors, including roadway system analysis, traffic studies, interchange spacing, cost/benefit ratio, etc. The HDM and following documents provide the basis of interchange planning and design process:

- AASHTO “A Policy on Geometric Design of Highways and Streets - 2018”
- AASHTO “A Policy on Design Standards-Interstate System - 2016”
- FHWA Policy Statement on Additional Interchanges to the Interstate System – May 22, 2017 Revision
- The “Oregon Highway Plan - 1999” (“OHP”), plus amendments.
- Oregon Administrative Rules (OAR) Chapter 734, Division 51.

New or modified interchanges on non-Interstate facilities do not require FHWA approval. *These proposals do require coordination between Region Technical Center design staff and Traffic-Roadway Section Interchange Engineers. The same fundamental principles apply as in evaluation of Interstate access.*

Standard Interchange Layout Sheets

The proposed interchange design (new or modified) may be prepared on the Standard Interchange Layout Sheet to serve as the documentation of basic design features for the interchange. Draft copies are submitted to the Traffic-Roadway Section Interchange Engineers, Transportation Planning Analysis Unit (or Region Traffic), and the Bridge Engineering Section for review. The Standard Interchange Layout Sheet, when developed, are normally developed by the Design Acceptance stage of project development, at least in draft form. Guidelines for preparation of Standard Sheets are available at the following link:

(http://www.oregon.gov/ODOT/HWY/ENGSERVICES/Pages/interchange_design.aspx)

Alternative formats can be prepared for interchange approval, coordinate with Traffic-Roadway Section Interchange Engineers for guidance.

Section 603 Guiding Principles for Interchange Planning and Design

603.1 Route Continuity

The concept of Route Continuity refers to providing a clear directional path along the entire length of a designated route on the principal highway mainline. *Through drivers, especially those not familiar with a route, should be provided with a continuous through path on which it is not necessary to change lanes to continue on that route.* Applying this principle simplifies the driving task because it reduces lane changes and allows for simpler signing. It makes navigating unfamiliar routes easier and reduces the number of tasks drivers need to deal with at any given time. Operationally, fewer lane changes often helps to reduce congestion on the main route.

Route continuity applies to entire systems of roadways, but interchange (or series of interchanges) design features are used to provide for it. A practical aspect of route continuity is that interchange configurations and designs should favor the through route instead of heavy volume connections. Heavier movements can be accommodated with more generous geometry, more direct connections and auxiliary lanes. The net result may be that for an interchange to provide good route continuity more grade separating structures are needed. The effects of poor route continuity are more pronounced when a route goes through an urban area or on a bypass, but they still apply in other contexts.

Some locations have overlapping routes on a single roadway. In some situations this feature is relatively simple (a US route that overlaps with an Interstate in a rural area, e.g.). In urban areas the issues are usually more complicated. Signing is more complex and weaving sections are needed in many cases. It is important to establish relative priority of the Routes (Interstate, US, State Route, e.g.). The priority Route should be given primary consideration in design (such as I-84/US 395 between Exits 188 and 209). **When the relative priorities are essentially equal, the heavier volume route may be given design priority.** In some cases this might not be the case, such as two Interstates where one is a through Route and the other is a spur or looping Route (such as I-5 and I-205 or I-405). *The primary Interstate Route should have priority in that case.* Not all existing facilities are configured in line with this guidance - it may be infeasible in some situations.

Appropriate levels of traffic analysis, evaluation of constructability, and identifying other major constraints are needed to determine if operational/safety/incident response issues are problematic enough to warrant correction.

AASHTO's "*A Policy on Geometric Design of Highways and Streets -2018*", Section 10.9.5.5, pages 10-83 to 10-85 has a more detailed discussion of Route Continuity and Overlapping Routes, and includes illustrative example figures.

603.2 Basic Number of Lanes

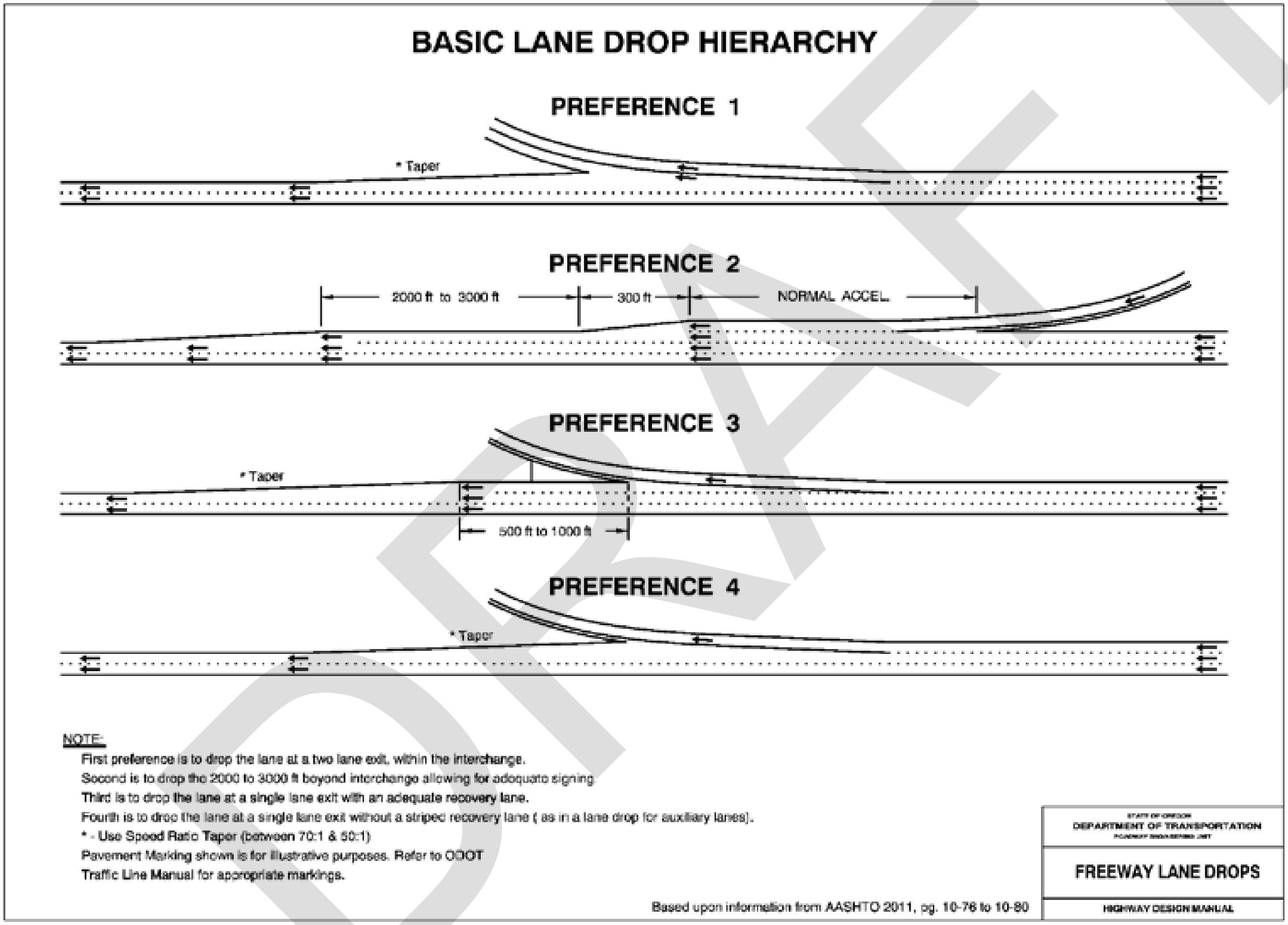
A basic lane is simply a through travel lane that continues for a specified distance along a highway route. For example, an **Interstate route has a minimum of four basic lanes (two in each direction) over its entire length.** The basic number of lanes is maintained over a significant length of the route based on the capacity needs of that section. A typical situation where the number of basic lanes varies is a through route that traverses a major urban area. Basic lanes are added and terminated at locations where volumes and system considerations make it appropriate. Localized variations in traffic volume, such as weaving areas between interchanges, do not change the basic number of lanes. These variations are handled by introducing auxiliary lanes, or in some cases Collector-Distributor roadways. (See 603.6 for discussion).

It is very important in systems planning to identify the appropriate number of basic lanes and their logical termini. AASHTO's "*A Policy on Geometric Design of Highways and Streets -2018*", pages *10-86* and *10-87*, discusses the concept of Basic Number of Lanes and includes a schematic (*Figure 10-51*) that illustrates the idea clearly. This concept is closely associated with the principles of Route Continuity and Lane Balance.

The freeway systems in Oregon were mostly planned and built between the late 1950s and early 1970s. Some of these concepts were not well defined in that era. Many of the facilities were built with minimal (or no) room allowed for future improvements. Decisions to invest in major improvements or to add capacity are not just engineering choices. The impact to the natural and man-made environment, budgets, future planning objectives, and the communities nearby generally require compromises from "ideal" solutions. While it may not be feasible to provide all the exact guidance around Route Continuity, Lane Balance, and the Basic Number of Lanes, designers need to seek every opportunity to provide for future flexibility with the updated infrastructure.

When basic through lanes are suddenly added or dropped on a facility in an unexpected manner, it often leads to confusion for users – especially those who are unfamiliar with the area. Adding a basic lane is usually not as problematic – it typically happens at major entrance ramps. Lane drops should be clearly visible to approaching users, preferably on flat horizontal alignment and grade. They should occur at places that make sense to drivers, and are as free as possible from other features that place demands on drivers' attention. Reductions in the basic number of lanes should only be done when overall traffic demand on the route drops significantly. Examples of this include the outer edge of a major metro area, a major system interchange, or a series of service exits that remove enough demand so that the basic lane is no longer necessary. Figure 600-1 shows, in order of preference, typical configurations for dropping a basic lane.

Figure 600-1: Freeway Lane Reductions



603.3 Lane Balance

To realize efficient traffic operation through an interchange, there should be a balance in the number of traffic lanes on the highway and ramps. Design traffic volumes and capacity analysis determine the number of lanes to be used on the highway and on the ramps, but the number of lanes for some sections should be increased to ease operation from one roadway to another. Lane balance should be checked after the minimum number is determined for each roadway on the basis of the following principles:

- The number of lanes beyond the merging of two traffic streams should not be less than the sum of all traffic lanes on the merging roadways minus one, but may be equal to the sum of all traffic lanes on the merging roadways.
- For exits, the number of approach lanes on the highway should be equal to the number of lanes on the highway beyond the exit plus the number of lanes on the exit, minus one.
- For entrance ramps bringing two lanes of traffic onto a highway, the road beyond the ramp entrance should be at least one lane wider than the road approaching the entrance. These types of entrances are often where an added basic lane begins, but not always. **The parallel design for two lane entrance ramps shall be used (see Figure 600-16 for details) in any case. Any exception from this standard shall be approved by the State Traffic-Roadway Engineer.** ODOT operational experience with tapered (aka "instant on") entrance connections has not been positive, particularly with two lane ramps. Exceptions are strongly discouraged.
- See AASHTO's "*A Policy on Geometric Design of Highways and Streets - 2018*", pages: 10-87 to 10-90 for additional information regarding Lane Balance. Several figures are provided that illustrate the concept.

603.4 Weaving Sections

Weaving sections occur when entrance ramps are closely followed by exit ramps, and an auxiliary lane is utilized. Such areas present special design problems due to the concentrated lane changing maneuvers of merging and diverging traffic. The development of the design involves the following factors: desired mobility standard; length; number of lanes; traffic volumes; weaving and non-weaving vehicles; and average speed. Auxiliary lane lengths generally will be below access management spacing standards and may require a deviation. Design guidance may be obtained from "Design Controls and Criteria, Chapter 2 of AASHTO's "*A Policy on Geometric Design of Highways and Streets – 2018*" and from *"Freeway Weaving"* TRB #209, Highway Capacity Manual, Chapter 24.

Consult with the Transportation Planning Analysis Unit and Region Traffic staff for data and direction on the design of each weaving section and the location of consecutive entrance and exit ramps.

As a preliminary guide, the minimum distance between a freeway entrance and exit ramp at separate interchanges is one mile for urban freeways and two miles for rural freeway (see OAR Chapter 734-051 guidelines). Provide a minimum distance between successive freeway entrance and exit ramp terminals of 1000 feet. Provide a minimum distance for a single exit followed by a secondary exit or split of 800 feet. Exceptions from the standard spacing must be obtained from the State Traffic-Roadway Engineer. All exception requests in these situations will be reviewed by the Region/Tech Services Traffic and Roadway staff, or others designated to do the work to ensure the freeway and ramps will function acceptably.

Where the distance between an entrance terminal and an exit terminal is 2500 feet or less, the interim space generally becomes a weaving section and must be analyzed for required length and design by the Transportation Planning Analysis Unit, Regional Traffic staff, or others designated to do the appropriate analysis*. Where the distance is 1500 feet or less, provide an auxiliary lane to help to smooth traffic flow should be considered.*

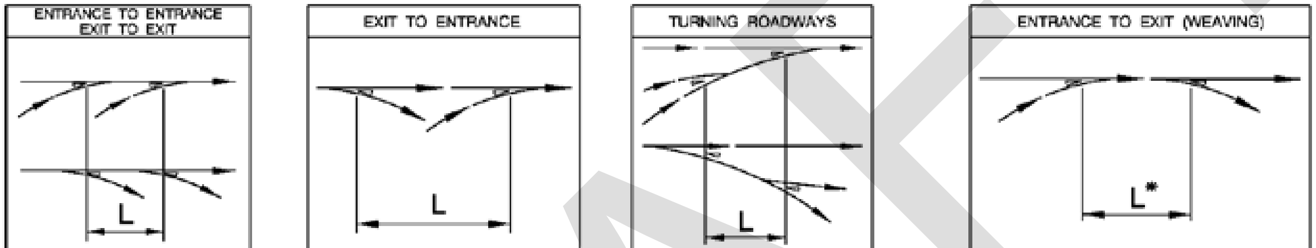
Collector-Distributor roads can also be used to reduce traffic friction from multiple entrance and exit connections on the same side of the freeway, thereby permitting more uniform speeds and smoother operations on the through traffic lanes. More guidance on C_D roads is provided in 603.6.

Figure 600-2 shows the terminal points for measuring the length of a weaving section.

Figure 600-2: Minimum Ramp Terminal Spacing

RECOMMENDED MINIMUM RAMP TERMINAL SPACING (ft.)

(BASED UPON OPERATIONAL EXPERIENCE AND NEED FOR FLEXIBILITY)



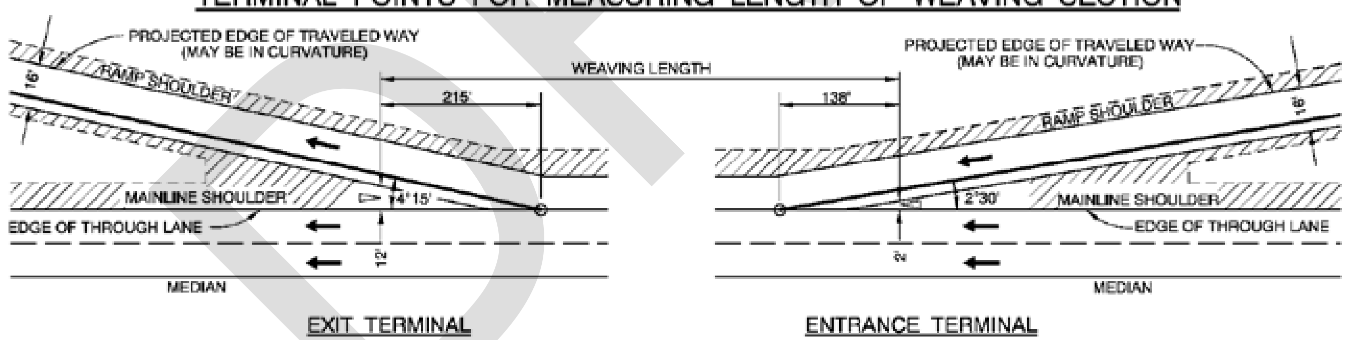
	ENTRANCE TO ENTRANCE / EXIT TO EXIT			EXIT TO ENTRANCE			TURNING ROADWAYS			ENTRANCE TO EXIT (WEAVING)				
										SYSTEM TO SERVICE INTERCHANGE		SERVICE TO SERVICE INTERCHANGE		
GUIDELINES	FULL FREEWAY	C-D ROAD OR FWY. DIST.	GUIDELINES	FULL FREEWAY	C-D ROAD OR FWY. DIST.	GUIDELINES	SYSTEM INTCHG.	SERVICE INTCHG.	GUIDELINES	FULL FREEWAY	C-D RD. OR FWY. DIST.	FULL FREEWAY	C-D RD. OR FWY. DIST.	GUIDELINES
DESIRABLE	1500	1200	DESIRABLE	750	600	DESIRABLE	1200	1000	DESIRABLE	3000	2000	2000	1500	DESIRABLE
ADEQUATE	1200	1000	ADEQUATE	600	500	ADEQUATE	1000	800	ADEQUATE	2500	1800	1800	1200	ADEQUATE
MINIMUM	1000	800	MINIMUM	500	400	MINIMUM	800	600	MINIMUM	2000	1600	1600	1000	MINIMUM

*RECOMMENDED: SHOULD BE CHECKED IN ACCORDANCE WITH PROCEDURE OUTLINED IN THE HIGHWAY CAPACITY MANUAL, 2001. (LARGER OF THE VALUES TO BE USED)

SOURCE: FOR DESIRABLE AND ADEQUATE RAMP TERMINAL SPACING, TRANSPORTATION RESEARCH RECORD 1100 DESIGN AND OPERATIONAL EFFECTS OF GEOMETRICS, PAGE 42. TRANSPORTATION RESEARCH BOARD, 1986.

FOR MINIMUM RAMP TERMINAL SPACING, SEE AASHTO, 2011. FIGURE 10-68, PAGE 10-106.

TERMINAL POINTS FOR MEASURING LENGTH OF WEAVING SECTION



DEPARTMENT OF TRANSPORTATION

RAMP TERMINAL SPACING

HIGHWAY DESIGN MANUAL

603.5 Auxiliary Lanes

Auxiliary lanes are introduced adjacent to through lanes for limited distances for specific operational or capacity reasons. They are used to provide lane balance, facilitate weaving maneuvers, and help smooth out flow in through lanes. A typical application is to provide an added lane on the mainline between closely spaced interchanges.

Auxiliary lanes have the same width as through lanes. Shoulders adjacent to auxiliary lanes should be the same width as the remainder of the corridor (typically 10 feet or more), with a minimum width of eight feet (plus 2 feet if longitudinal barrier is present). **Auxiliary lane drops at exits shall be configured according to the details in Figure 600-13 and Figure 600-14.**

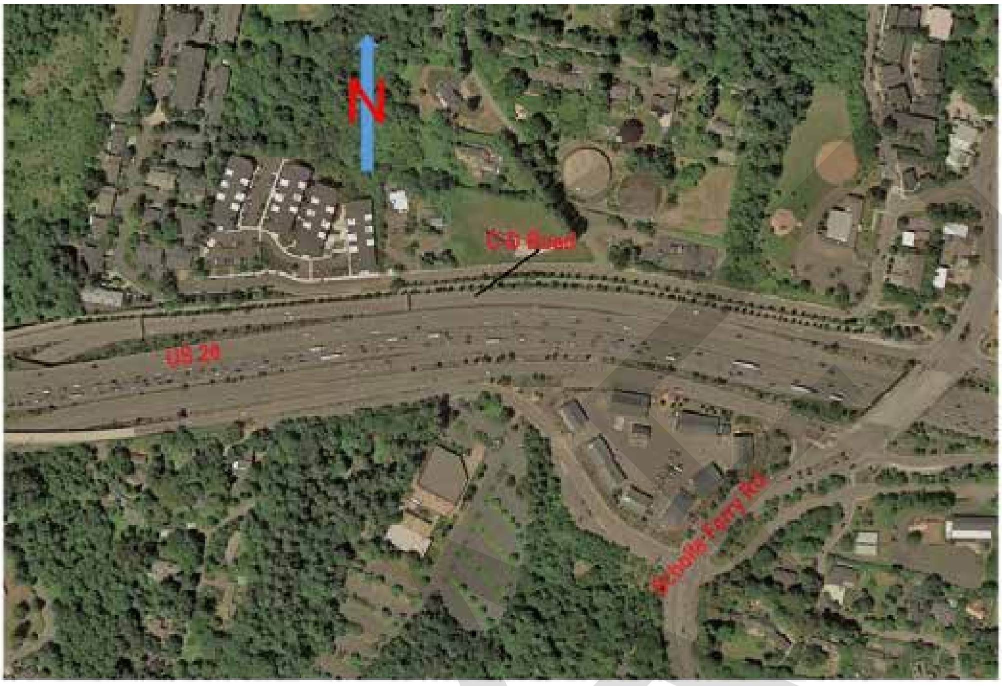
603.6 Collector-Distributor (C-D) Roads

C-D roads are introduced to freeway systems to eliminate weaving directly on mainline through lanes. They are physically separated from the through roadway and connect to it by way of slip ramps. They may be provided within a single interchange, between two adjacent interchanges, or even continuously between several interchanges of a freeway segment. Ramp connections occur on the C-D road, which then conveys traffic to the mainline lanes.

C-D roads are one-way facilities similar to frontage roads except that access to abutting property is not permitted. **The design speed of the C-D can be less than the through roadway, although it's preferred to keep that differential to no more than 10 mph**. They may have single lane or more commonly, multi-lane configurations. Typical cross sections for C-D roads should, as a minimum, match the ODOT standard ramp dimensions as shown in Figure 600-32. The outer separation between edges of travelled way should be a minimum of 20 feet (preferably 30 feet) with an appropriate barrier separating the two roadways. Slip ramp connections to or from the through lanes are configured the same as any other exit or entrance ramp.

Figure 600-3 shows a C-D road system on a freeway in Portland. A two lane exit from the freeway forms the backbone, which also serves as a directional connection to an urban arterial highway. Local access ramps enter and leave from the C-D road rather than the freeway mainline.

Figure 600-3: Collector Distributor System (US 26 Sylvan Interchange - Portland)



In all cases, provide vertical clearance on interchange structures in accordance with Part 300 guidelines. Along with the selection of interchange form, the grade separation structure should consider vertical clearance requirements and mobility concerns.

As interchange structure options are explored (both with existing and new bridges), vertical clearance requirements for the interchange and the corridor, along with alternate “up and over” options, should be considered. Some interchange forms do not provide for direct “up and over” movement where larger oversized freight vehicles can exit the freeway and then return to the freeway at the same interchange (usually due to the oversized load being impacted by the existing interchange structure vertical clearance). They also need to provide for adequate sight lines. Particularly at depressed interchanges, structure elements can impair sight lines for traffic stopped at ramps. The appropriate sight lines to consider for design are usually based on Stopping Sight Distance, (SSD) or Intersection Sight Distance (ISD). The roadway context (urban or rural, higher or lower speed), type of intersection traffic control and geometry at the ramp intersections all need to be considered when considering which sight distance case to apply. Skewed ramp intersections and abrupt vertical curves can make it difficult to achieve sight distance goals. Shoulder widening or flaring the corners of structures may be needed to achieve SSD, so early coordination with structural designers is important. Use the “C” Table on Figure 600-23 as a guide for minimum requirements.

Although it is often appropriate to provide Intersection Sight Distance (ISD) at the intersections, this is sometimes difficult to achieve on existing facilities. When the ramp intersection is stop controlled, using ISD is the most appropriate treatment. Designers should refer to "*A Policy on Geometric Design of Highways and Streets – 2018*"- Sections 3.2 and 9.5 for guidance on selecting the most appropriate sight distance case to use. Designers should also consider using ISD at signal or roundabout controlled intersections. SSD for the design speed of the crossroad is the minimum to be provided in all cases – again in accordance with Figure 600-23.

Structure layout needs to consider future needs for both the through road and the crossroad. This normally means two things. First, the clear opening underneath the structure needs to accommodate the "ultimate" typical section envisioned for the facility (future lane additions, e.g.). Secondly, grades on the structure should also allow for future widening without restricting vertical clearance. It is also important to check sight lines on long flyover and viaduct structures. The combination of horizontal and vertical curvature and superelevation transitions can sometimes result in sight line limitations. Bridge rails can also limit sight lines. Geometric designers need to coordinate with structure designers to arrive at appropriate solutions, since it's normally impractical to widen these structures to allow for added sight distance.

Refer to AASHTO's "*A Policy on Geometric Design of Highways and Streets – 2018*" - Chapter 10 for detailed discussion on grade separation design.

Section 604 Interchange Types and Forms

Regardless of the type of facility, it is very important that the basic form of the interchanges fits the basic function it is expected to perform. Inappropriate applications can lead to early obsolescence and safety issues.

There are two basic types of interchanges – "System" and "Service". System interchanges connect two or more freeways. The focus is on providing free flow and higher speed connections to facilitate mobility. System interchange examples in Oregon include: I-5/I-205 in Tualatin, I-84/I-82 near Hermiston, and I-5/I-105/OR 126 in Eugene-Springfield. Service interchanges connect freeways (or other expressways) to local facilities. Mobility is also an important function of service interchanges, but it needs to be balanced with the need to get access to the surrounding area and the rest of the local roadway network. The majority of ODOT interchanges are service types.

The selection of interchange form should take into account vertical clearance requirements and mobility concerns. Some interchange forms do not provide for a direct "up and over" movement where larger oversized freight vehicles can exit the freeway and then return to the freeway at the same interchange (usually due to the oversized load being impacted by the existing vertical clearance at the interchange structure). As interchange options are explored, vertical clearance requirements for the interchange and the corridor, along with alternate "up and over" options, should be considered.

A preliminary layout of guide signing is a very useful tool when comparing interchange alternatives. The sign plan may help to identify potential confusion points for drivers navigating the facility, and helps to show where design features might cause operational problems. A sign concept should be developed for each alternative considered during early stages of design.

Figure 600-4 illustrates basic system interchange forms. System interchanges are often complex and need to be customized to local conditions. Because of this, they may not fit exactly to the basic forms shown. ODOT has relatively few system interchanges on its facilities, and the majority of them are in the Portland Metro area.

Figure 600-5 illustrates basic service interchange forms. They tend to be much simpler in configuration. With very few exceptions, service interchanges provide for all moves to and from the main facility. Figure 600-6 shows compact service forms. ODOT has not used the compact forms extensively, but they are considered proven concepts (when applied in the proper context).

In a few cases, system movements are provided within the confines of a service interchange, such as the I-5/Chemawa Rd/Salem Parkway and Canby/Charbonneau/Wilsonville-Hubbard Highway interchanges. A standard diamond interchange is "superimposed" over a directional Y (See Figure 600-7). For these types, additional care must be taken with respect to spacing between consecutive ramps, lane balance, guide signing, the length of speed change lanes, and providing for driver expectations. Each of these areas are discussed in more detail later in this chapter.

A few Non-freeway interchange forms are shown in Figure 600-8. These types of solutions are not appropriate for Interstates or other freeways.

Figure 600-9 shows interchange forms for specialized situations. ODOT has used the Trumpet form in a few locations. It is suitable for connecting two highways as a low level system interchange, and as a service type. The Three-Level diamond is appropriate for connecting two limited access facilities, using a third level to handle turning movements through at-grade intersections, completely separate from thru moves. It too can serve as a low level system type connection. It may be adaptable in non-freeway situations where adequate access control is provided on both facilities. ODOT has not used this form, but it is used in several midwestern states and in Texas.

Partial interchanges (1/2 diamond or "Y") have sometimes been used in less developed areas to connect local roads or bypassed routes that have no access to other highways. These are limited applications, and usually consist of a pair of interchanges. Examples include: I-84 Exits 313/317 (Encina/Pleasant Valley) in Region 5, and I-5 Exits 76A & 76B (Wolf Creek) in Region 3. Partial interchanges tend to violate driver expectations, and thus can lead to operational and safety problems, especially for unfamiliar users. Drivers using service interchanges expect to be able to exit and enter the highway at the same location. FHWA policy strongly discourages the use of partial interchanges on the Interstate system.

Less than "full movement" interchanges may be considered on a case-by-case basis for applications requiring special access for managed lanes (e.g. Transit, HOV or HOT lanes) or major Park and Ride Lots. The same logic applies to non-Interstate facilities. Contact the ODOT Interchange Engineer for guidance.

Each situation and context have unique characteristics, so it is not possible to say which interchange form is most appropriate for all situations. In general, it is best to avoid using configurations that require heavy left turn demands to go through standard signalized intersections. The exceptions to this are the Single Point and Diverging Diamond forms, where the left turns are handled in a way that works better with through traffic. Also, it is good practice to use the simplest interchange form that will meet expected demands. Driver expectancy is key – drivers should be presented with clear choices and the fewest number of decisions necessary to navigate the interchange (or series of interchanges). Details for Single Point intersection layout are found in Figure 600-23 and Figure 600-24.

Full cloverleaf interchanges have operational issues that make their use problematic, even when Collector-Distributor (C-D) roads are used. The key problem is that loop ramps on the same side of the through roadway have significant safety and operational problems. Loop ramps generally have tight curvature (25 – 30 mph). The speed differentials between entering and exiting traffic combined with relatively short weaving/speed change lanes are a serious safety concern. C-D roads (discussed in detail in 603.6) can provide some limited benefits by removing the weaving and speed change maneuvers from the mainline. Traffic congestion on the C-D facility can also reach levels where backups onto freeway mainlines occur – thus rendering the C-D facility obsolete. These issues make it highly preferable to use other interchange forms**; ODOT will not approve the use of full or ¾ cloverleafs in any context.**

Partial Cloverleafs with loops in opposite quadrants are considered acceptable, although exit loop configurations have additional issues. Loop ramps of necessity are designed with sharper curves and require longer speed change lanes. Exit loops on the far side of a crossroad can have sight lines obscured by fills, or in the case of depressed interchanges, the mainline profile. Areas prone to regular freezing conditions may see more issues with vehicles sliding off loop ramps. **Transitions to exit loops require longer spirals and the loop itself needs to have a minimum radius of 191' (30° curve).** The area beyond the exit loop gore needs to be kept as free of obstructions as possible and should be contour graded.

There are cases where loop ramps on the same side of the crossroad work adequately. They are not configured as free-flowing ramps, but rather as "T" intersections in a Folded Diamond configuration. Figure 600-10 depicts I-84 Exit 261 (OR 82 Wallowa Lake Hwy.) in La Grande; a good example of the concept.

Figure 600-4: Examples of System Interchange Forms

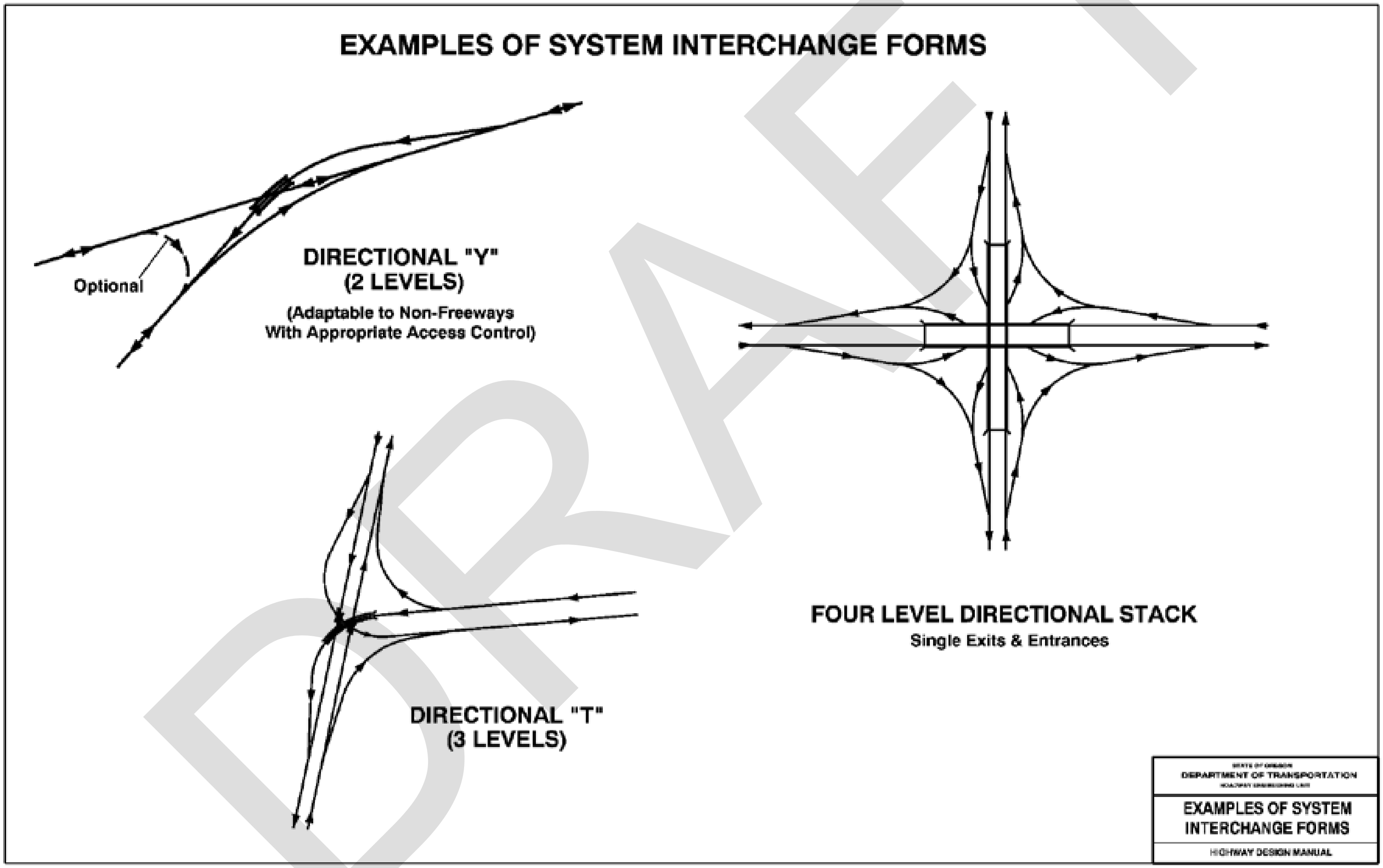


Figure 600-5: Common Service Interchange Forms

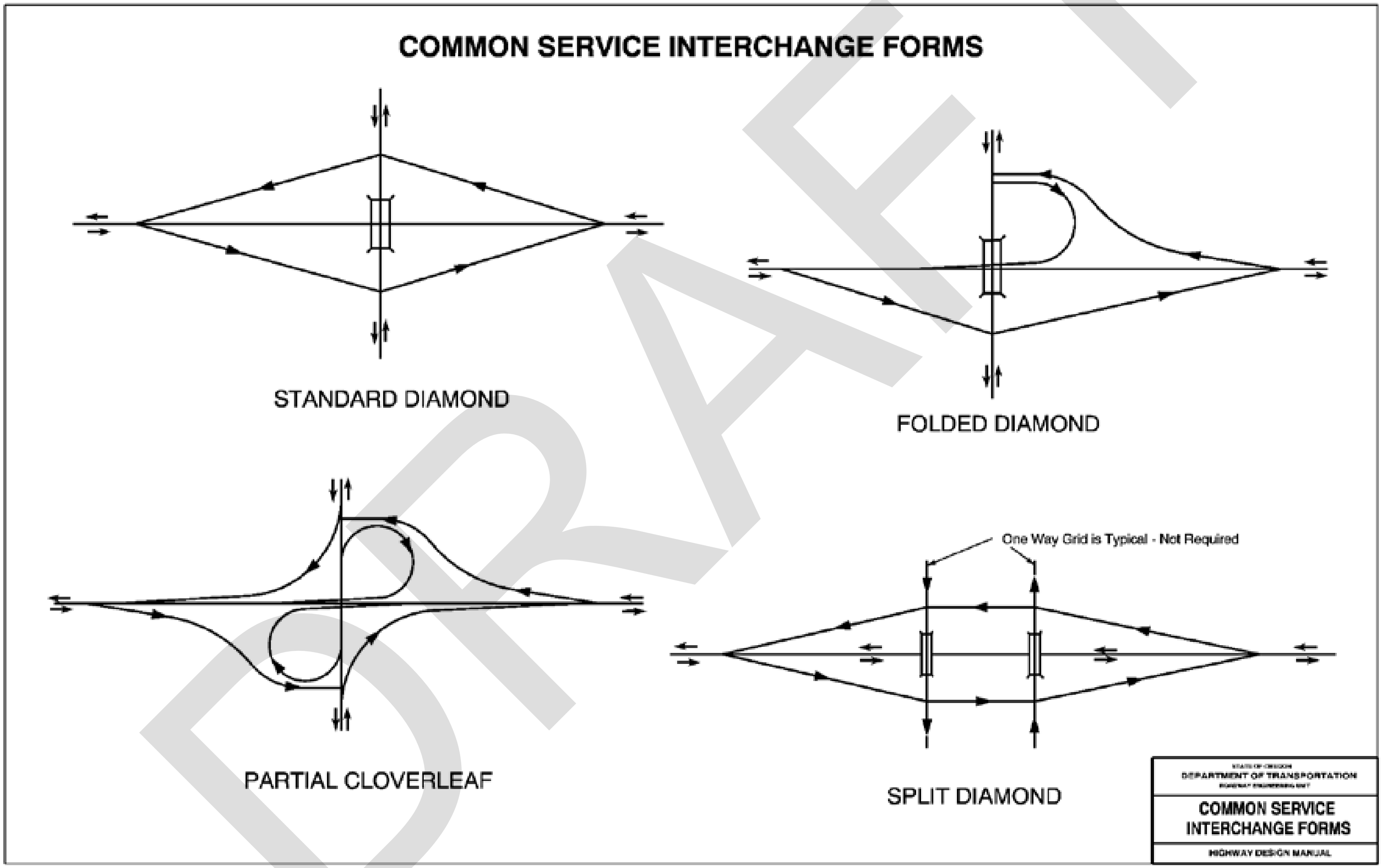
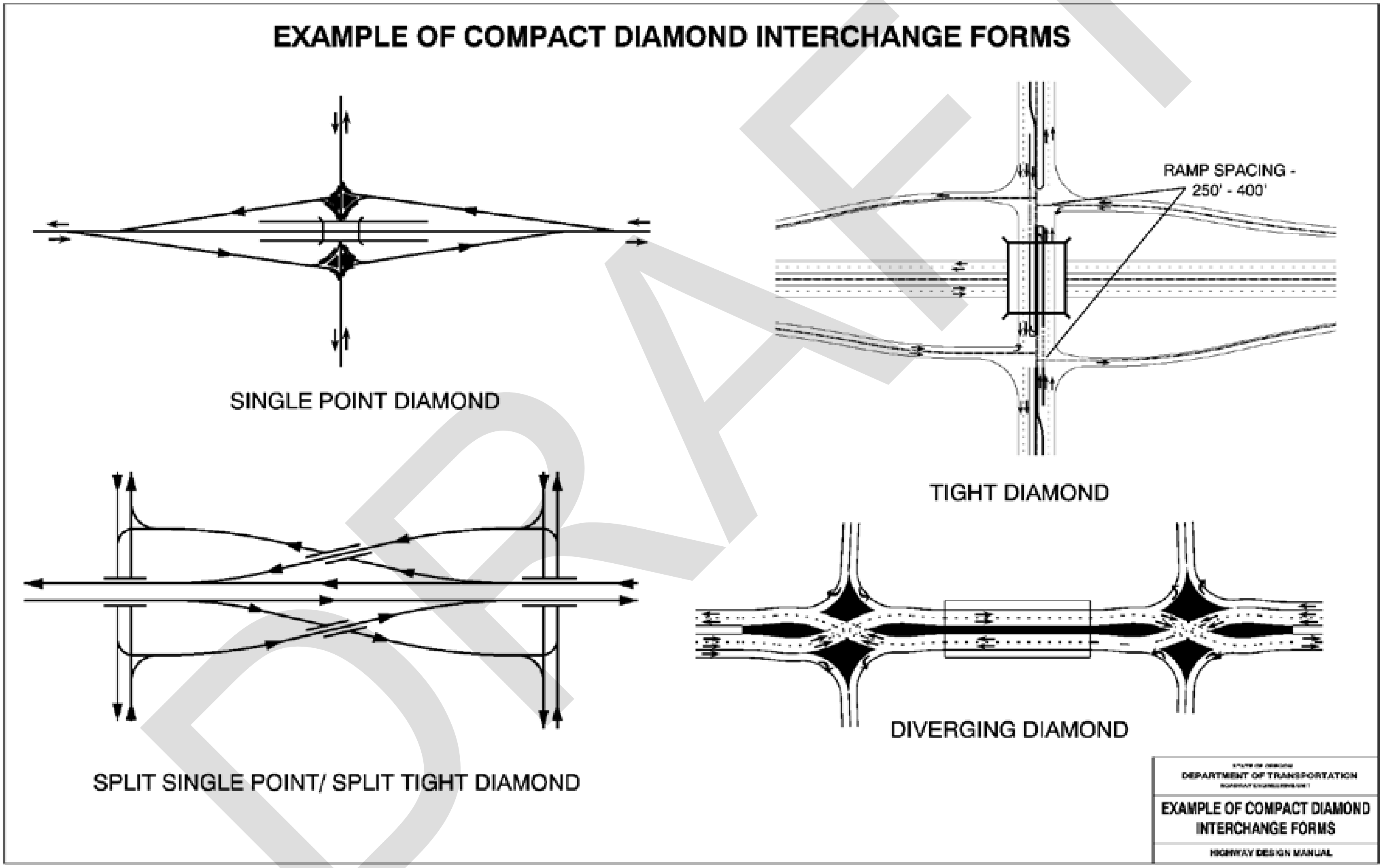
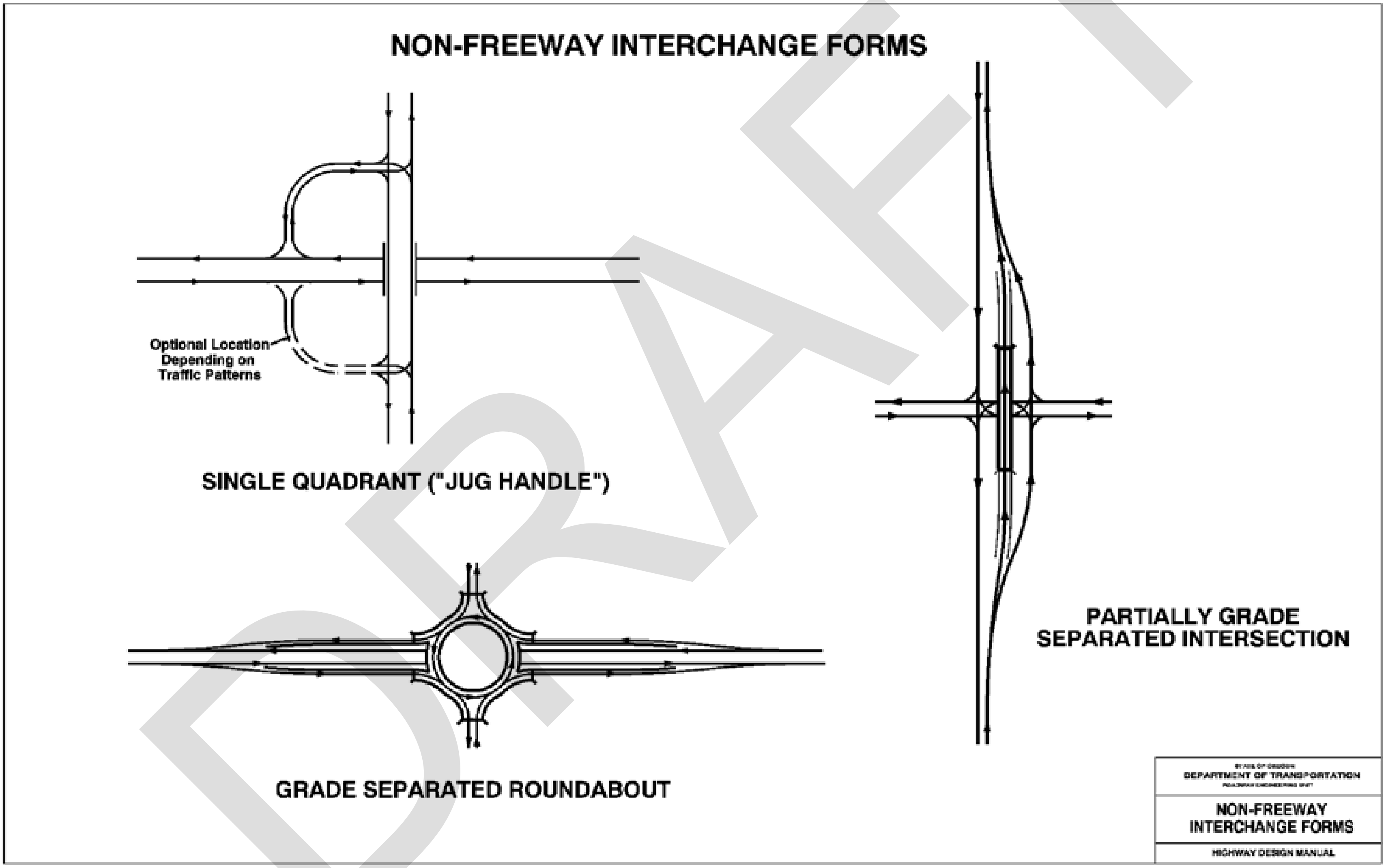


Figure 600-6: Examples of Compact Diamond Interchange Forms

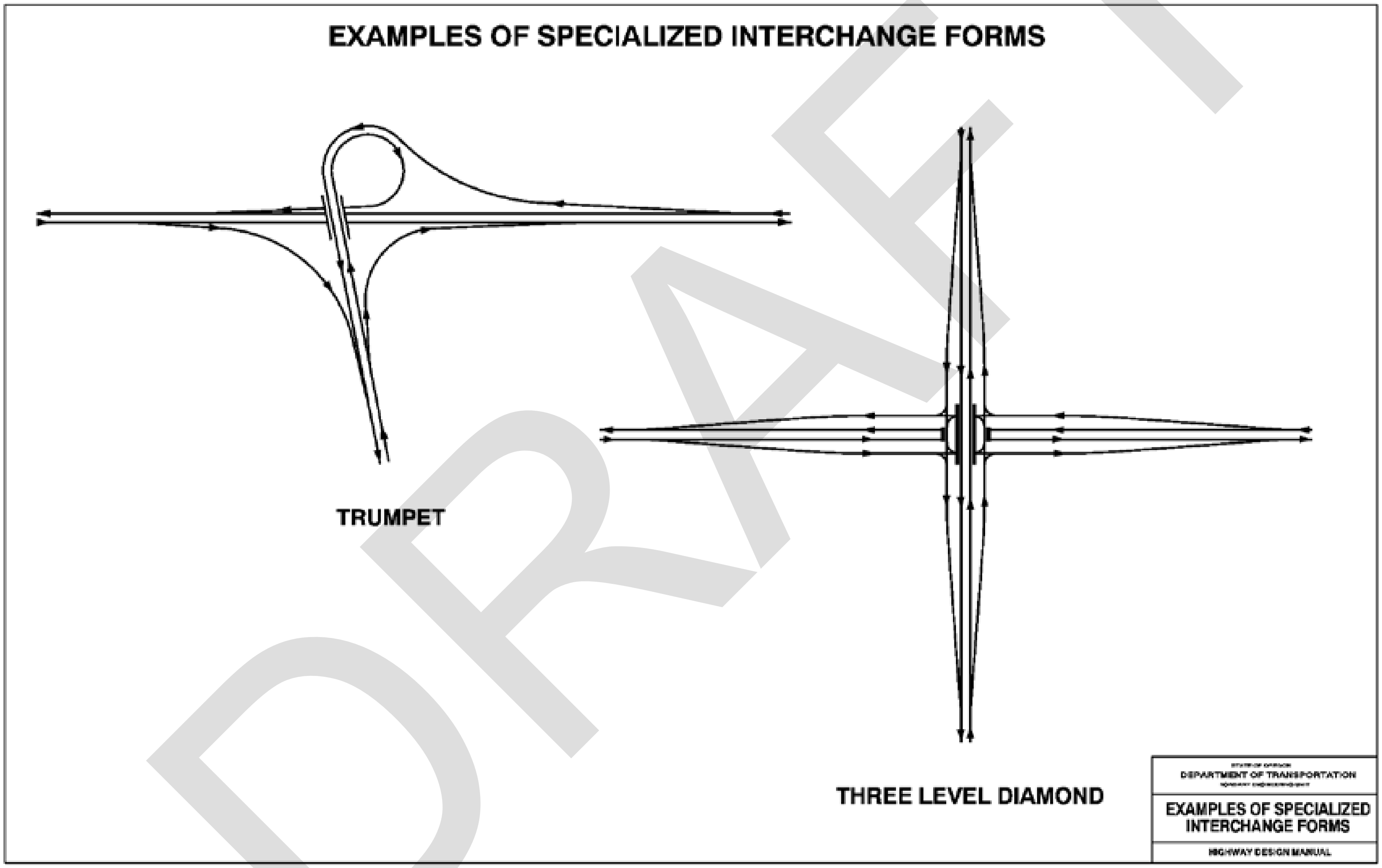


1 Figure 600-7: Superimposed Interchange in Keizer, OR (I-5 Exit 260)

Figure 600-8: Non-Freeway Interchange Forms



1 Figure 600-9: Examples of Specialized Interchange Forms



1 Figure 600-10: I-84 Exit 261 in La Grande

Several features and issues are common to all types of interchanges. These items are important to consider in all contexts. New or Existing facilities, Freeway or Non-Freeway, Urban, Rural or Transitional Areas - these features must be evaluated for all projects.

Common elements include:

1. Clear Sight Lines (vertical & horizontal)
2. Interchange Form – appropriate for traffic types and patterns
3. Appropriate Horizontal/Vertical Geometry
4. Adequate Speed Change Lanes
5. Driver Expectancy/Positive Guidance – adequate perception/reaction distances for typical maneuvers – all exits/entrances to the right of through traffic
6. Design Vehicle Offtracking
7. Adequate Storage for Vehicle Queues
8. Bike, Pedestrian and Transit Needs (accessibility features under the ADA for site arrival and destinations points)
9. Adequate Accommodation for Signing
10. Long Range Planning Vision for the Interchange – including the crossroad facility
11. Adaptibility/Flexibility for Changing Needs Over Time

"Ideal" designs are typically not possible, especially in retrofit situations and in fully developed areas. In retrofit situations evaluating deficiencies and making tradeoffs is necessary. Designers must still consider the key features and how to make safety and operational improvements whenever possible. Tools such as the Highway Safety Manual and FHWA's Interchange Safety Analysis Tool – Enhanced (ISAT-E) are available to help in evaluations. ODOT Interchange Engineer and the State Traffic Safety Engineer are available to help in using tools and providing guidance on tradeoff situations.

Section 605 Interchange Geometric Design

605.1 Crossroad Design

Parts 200, 300, 800, and 900, discuss typical section and other design elements for roadways. Crossroad design, including nearby intersections, is an integral part of the overall interchange, regardless of whose jurisdiction the road falls under. The local context for the crossroad must also be considered during design and planning efforts. Deficient crossroads often create safety and operational issues, such as vehicle queues extending back to freeway thru lanes on exit ramps. In developed areas, crossroad characteristics are largely set, and the changes need to maintain the interchange functions will require tradeoffs in the design. New interchange layouts generally have more flexibility, but need to provide good profiles, intersection design, and appropriate access management. Retrofit designs, especially in developed areas, need to carefully consider identified design and operational issues and make appropriate accommodation. In all contexts, essential information for crossroad design includes: traffic volumes and queue lengths, crash history and analysis, clearly defined project goals, and clear understanding (agreed to by appropriate parties) of the crossroad context.

605.2 Interchange Ramp Design

An interchange ramp is a connecting roadway that provides for movement between grade separated roadways as part of an interchange. Well planned and designed ramps are important to the proper functioning of interchanges, which in turn are a key feature of well planned and designed access controlled highways. Because interchange ramps are the transition roadway between high speed, free flowing traffic and the local road system, they need to accommodate the various things drivers are dealing with at that point. That functional transition needs to guide design decisions in all contexts. Designs that require drivers to deal with too much information or maneuvering in a short time span will often have operational and safety problems. Another significant problem is queuing on interchange exit ramps, sometimes extending to the mainline. Queue length is a function of interchange ramp intersection operations, in turn a function of crossroad operations. The point to remember is that interchanges work as a system, and each part of that system that struggles to function will create issues for the rest of the system.

Interchange ramps consist of three discrete elements and functions:

1. The Speed Change Area (including the gores).
2. The Main Transition Area (sometimes called the “Main Curve”, although it may be on tangent alignment).
3. The Terminal Area – which is in some ways an extension of the intersection with the crossroad.

Each discrete piece of the ramp has design features intended to accommodate typical things drivers are dealing with in that area. Interchange exit ramps that experience significant queuing will limit the speed change area’s ability to function well. Peak hour mainline speeds may be significantly less than off-peak speeds, so the speed change function is somewhat mitigated. The speed change on entrances is likewise altered during peak hours. Finding gaps and safely making the entry maneuver becomes more difficult; the length of the parallel portion of the interchange ramp needs not only to meet minimums, but be as long as possible.

The Main Transition portion of the interchange ramp needs to provide for a smooth, "stepped down" driving path. *When the HDM makes reference to Design Speed on interchange ramps, it is referring to the Main Transition Area. The main transition area should have a design speed of between 50 and (preferably) 70 to 85 % of the mainline.*

Terminal Areas should continue the "stepped down" approach for design speed (between 50 and 85% of the main transition curve). It's very common for the terminal curve area to also have queue storage. The interchange ramp horizontal and vertical alignments need to provide appropriate stopping sight distance for this condition. Terminal curves have their own set of standard spiral lengths and superelevation rates; these are shown in Figure 600-25.

In cases where interchange ramps connect two freeways in a System Interchange, the Terminal Area is replaced with a second Speed Change Area - an exit at the leading end and entrance at the trailing end. Two lane entrances should be designed according to the information in Figure 600-13.

Oregon uses parallel type entrance ramps only. **Tapered entrances are not permitted**. **ODOT uses a tapered configuration for both single and multi-lane exits**. In certain multi-lane exit situations it is appropriate to provide an auxiliary parallel deceleration area next to the outermost through lane. An example of this is the two lane SB exit at the I-5/OR 22 (Mission St.) interchange in Salem (Exit 253).

Figure 600-11: Discrete Areas of Typical Ramps

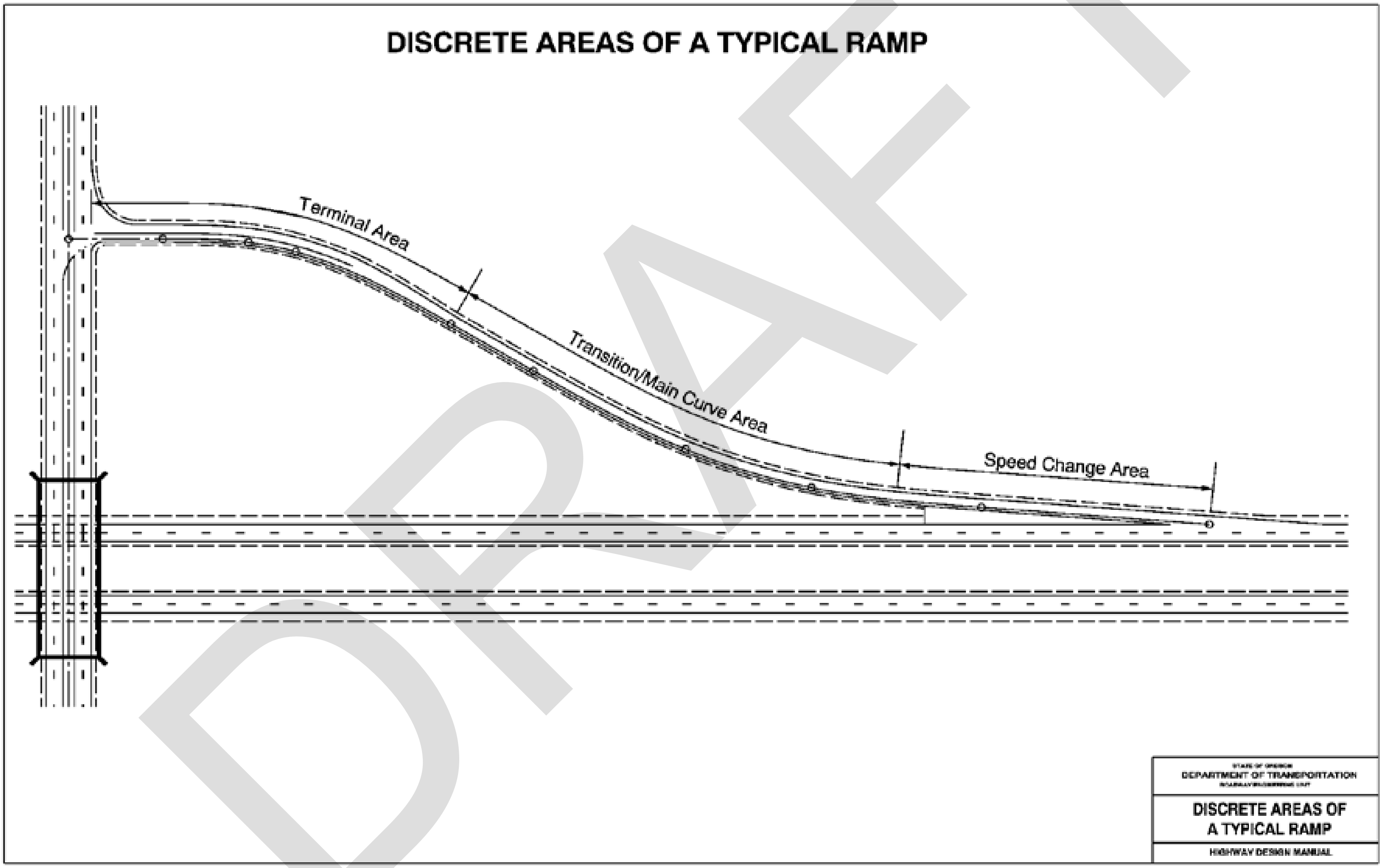


Figure 600-12 illustrates examples of different types of interchange ramps. Some types are only appropriate for non-freeway applications. Assuming adequate access control is in place, the other types can be adapted for non-freeway use as well.

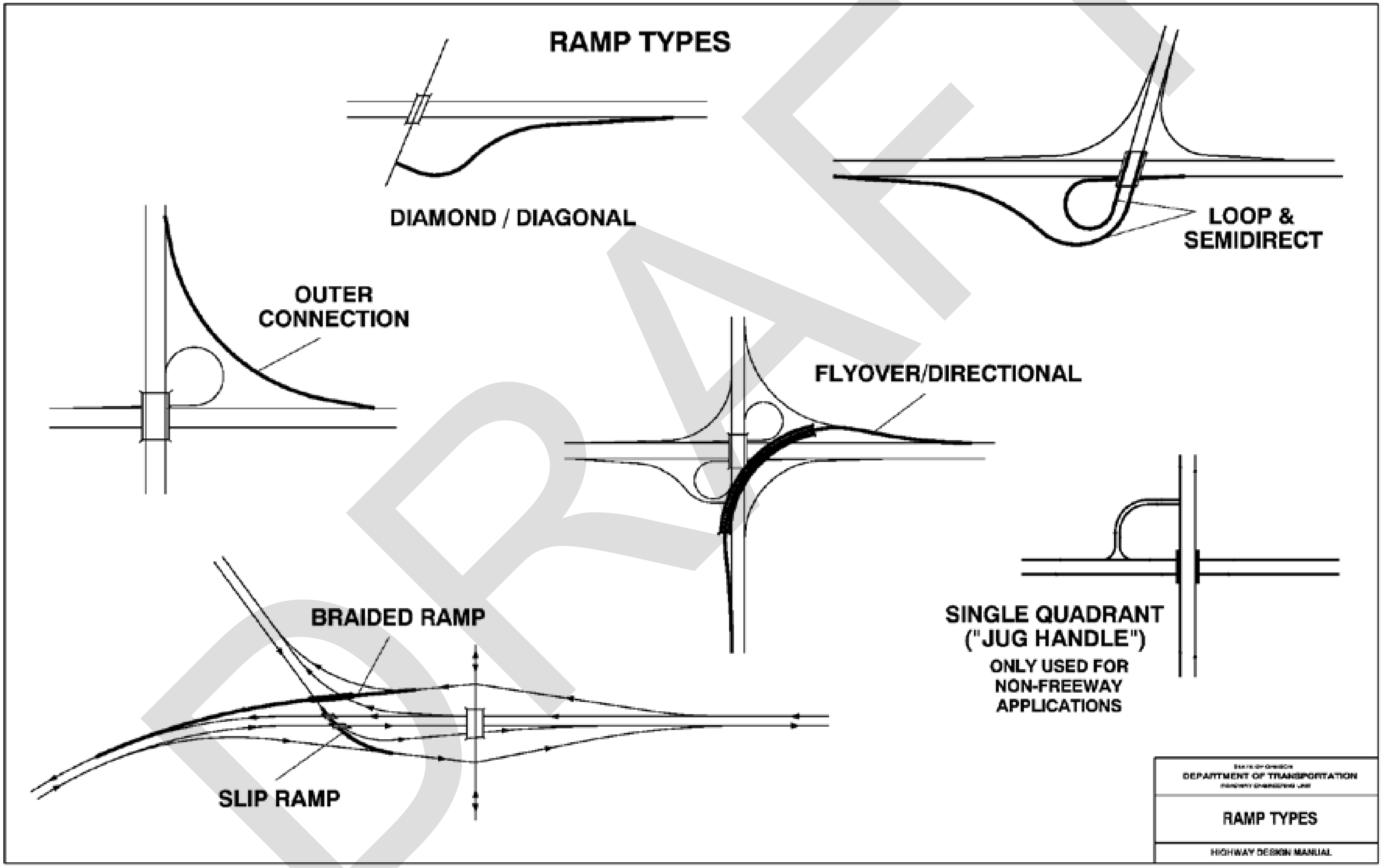
Interchange ramp designs need to provide flexibility for the future. This doesn't mean over-designing, just making sure that there is flexibility to deal with changing needs. **Providing additional deceleration length and at least 100' of tangent on the horizontal alignment between the main curve and the terminal curve will often help in this regard**. Designing to bare minimums often leads to operational and safety issues. Another consideration is an interchange where future lanes may be added to the right. Interchange ramp gores in these situations should be developed to fit the future condition so that the interchange ramp itself would not have to be rebuilt. The interim condition will provide added speed change length.

Typical problem areas on interchange ramps include: inadequate speed change length, insufficient storage for vehicles stopped on the ramp, inadequate or unsuitable intersections at the cross-road, obstructed sight lines, and deficient geometry. Each of these elements needs to be checked to make sure they will be adequate and appropriate for expected operations.

Geometry on existing interchange ramps often can't be significantly altered, but the basic functions of each portion need to be accommodated to the extent possible. Assuming that there are no significant geometric issues, as a minimum the speed change area shall be long enough for traffic to stop before reaching the end of vehicle queues in the terminal area. This means providing for deceleration to a complete stop from mainline operating speed. Vehicle queues on ramps are typically (but not always) at their greatest length during the mainline peak hour traffic, when thru speeds may be less than off-peak hours. During off-peak, queues may be much shorter, but deceleration needs are usually increased. Each location needs to be evaluated to determine the most appropriate condition to use for design. Designers need to evaluate other interchange features (such as sight lines) to make sure they aren't compromised by using minimal solutions on ramps.

Interchange ramp terminal intersection design and controls have a significant impact on the safety and efficiency of the entire interchange. If interchange ramp intersections are not able to manage the traffic demands at an appropriate level, it can quickly lead to queues building up on interchange exit ramps and the cross street. This can occur because of deficient geometric design or intersection controls that are inappropriate for the context. Geometric issues are normally easy to identify but sometimes difficult to correct, especially in more fully developed areas. Evaluation of the intersection controls should be done in a timely enough manner to be incorporated into project scoping efforts.

Figure 600-12: Ramp Types



605.3 Interchange Ramp Design Speed

Interchange ramp design speed normally varies from 50% (minimum) to 85% (desirable) of the freeway speed, with the exception of interchange loop ramps, which are usually designed to 25 or 30 mph. Design speed applies to the interchange ramp proper and not to the terminals and speed change areas, which are relative to the speed of the highway involved. The design speed influences the horizontal and vertical curvature of the ramp, and the length of speed change lanes. Table 600-3 below can be used to determine the appropriate ramp design speed. Ramp capacity is also influenced by the design speed. (See Table 600-4).

Table 600-3: Ramp Design Speed

Ramp Design Speed (mph)	Highway Design Speed (mph)				
	50	55	60	65	70
Desirable	45	45	50	55	60
Minimum	25	30	30	*35	*35

NOTE:

1. Loop Ramp Design Speed shall not be less than 25 **mph (36°, 159.15' Radius). When a loop ramp exits the mainline on a downgrade, the minimum degree of curve should be 30° (190.99' Radius) and the spiral at the entry end should be at least 300 feet long.** *Loop radii are seldom greater than a 30 mph design (24°, 238.73' Radius). The footprint for larger radii curves often becomes impractical (or infeasible) in areas that have even modest levels of development.*
2. See Figure 600-35 and Figure 600-36 for Loop Alignment details.

Table 600-4: Single Lane Ramp Capacity

Approximate Ideal Service Flow Rates for Single Lane Ramps (Passenger Cars Per Hour)				
LOS	**Ramp Design Speed (mph)**			
	21 - 30	**31 - 40**	**41 – 50**	**Over50**
A	*	*	*	600
B	*	*	900	900
C	*	1100	1250	1300
D	1200	1350	1550	1600
E	1450	1600	1650	1700
F	Variable	Variable	Variable	Variable

* Level of service not obtainable due to restricted design speed.

NOTE: For two lane ramps, multiply the values in the table by:

1.8 for 21 - 30 mph

1.9 for 31 - 40 mph

2.0 for 41 mph or over

605.4 Speed Change Lanes

ODOT uses tapered type exit and parallel type entrance configurations. Tapered exits fit the direct path most drivers use during the exit maneuver, and give them a clear indication of the point where the exit departs from the through roadway. Parallel interchange entrance ramps provide an added lane of sufficient length to aid in gap acceptance and merging. The actual merging maneuver is similar to changing lanes to the left. The gore area is the configured the same for all entrances. The length of the parallel portion varies to account for speed changing and the effects of longitudinal grades. Figure 600-13 and Figure 600-14 show the ODOT standard for interchange ramp acceleration and deceleration lanes, and dimensions for gore areas. Information on making adjustments for grades is also shown on those two figures. Figure 600-15 shows the details for consecutive entrances at the same interchange (typical in partial cloverleaf interchanges). Figure 600-16 shows details for two lane parallel entrances.

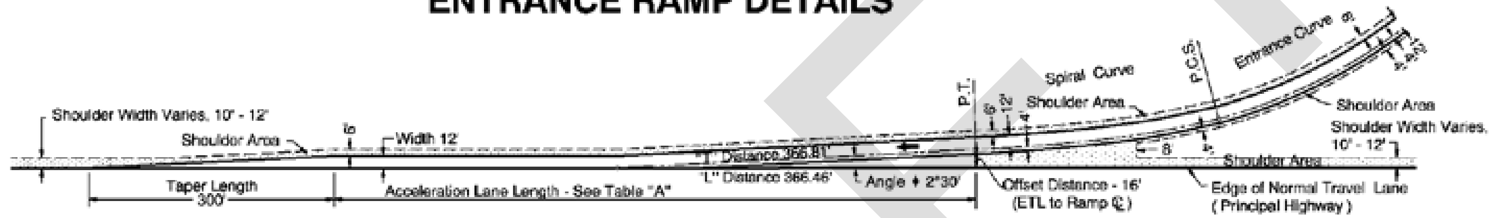
The deceleration and acceleration characteristics of trucks are quite different from the normal passenger vehicle. When there is significant truck traffic (over 20 trucks with 4 or more axles per hour), the minimum deceleration design lengths for trucks should be consistent with Figure 600-13. Due to the longer acceleration requirements, it is normally not practical for acceleration lanes to be designed for large trucks. Instead, all types of vehicles should be considered in the design of interchange ramps. When significant truck traffic is present, as much parallel acceleration length as is reasonable should be added to the minimum values listed in Figure 600-13.

Standard gore area details are shown on Figure 600-13 and Figure 600-14, including minimum acceleration and deceleration lengths. Since gore areas (especially exit gores) are important decision points for drivers, their layout and dimensions can directly affect safety. Gores should present drivers with a clear and easily understood view of how to transition from the mainline to the ramp (or vice-versa). Non-standard elements are not necessarily unsafe; many existing ramps have non-standard features and are not experiencing significant safety issues. Each situation needs to be evaluated for its potential effects on safety and operations and documented in a Design Exception.

Tradeoffs requiring non-standard features in gore design are unavoidable in some situations, even on new ramps. Examples of this include: exits on elevated structures, bridge columns in the gore, or tightly constrained urban facilities. In these types of situations, the key elements for helping drivers make safe transitions are the deceleration (or acceleration) distance, adequate room in the gore for impact attenuators (or traffic separators), and pavement cross slopes in the gore area. Non-standard features cannot compromise these elements. Refer to AASHTO "*A Policy on Geometric Design of Highways and Streets*" – Chapter 10 for more information on gore design.

Figure 600-13: Entrance Ramp Details

ENTRANCE RAMP DETAILS



ACCELERATION LANE

TABLE "A"
MINIMUM ACCELERATION LANE LENGTHS

Design Speed of Entrance Curve (mph)	25	30	35	40	45	50+
Minimum Curve Radius (ft.)	160	230	320	430	555	695
Design Speed of Highway (mph)	TOTAL LENGTH OF ACCELERATION LANE (WITHOUT TAPER) Length (ft.)					
40	540	540	540	540	540	540
45	540	540	540	540	540	540
50	550	540	540	540	540	540
55	780	670	550	540	540	540
60	1020	910	800	550	540	540
65	1220	1120	1000	770	*600	*540
70	1420	1350	1230	1000	820	*580

* Desirable length is **750'**, this allows additional decision time for picking gaps.

ENTRANCE CURVES & SPIRALS

Ramp Design Speed (mph)	Degree of Curve	Radius (ft)	e (%)	Spiral Length (ft.)	Spiral Parts 'a' Value	Spiral Parts "S" Value
70	1° 00'	5729.58	3.5	200	0.5	1.0
	2° 00'	2864.79	6.5	200	1.0	2.0
	3° 00'	1909.86	8	240	1.25	3.6
65	4° 00'	1432.39	9	240	1.667	4.8
60	5° 00'	1145.92	9.5	250	2.0	6.25
55	6° 00'	954.93	10	240	2.5	7.2
50	7° 00'	818.51	10.5	240	2.917	8.4
	8° 00'	716.20	10.5	250	3.2	10.0
45	10° 00'	572.96	11	250	4.0	12.5
40	12° 00'	477.46	11.5	240	5.0	14.4
	14° 00'	409.26	11.5	200	7.0	14.0
35	16° 00'	358.10	12	200	8.0	16.0
	18° 00'	318.31	12	200	9.0	18.0
30	20° 00'	286.48	12	200	10.0	20.0
	24° 00'	238.73	12	200	12.0	24.0
25	30° 00'	190.99	12	200	15.0	30.0
	36° 00'	159.15	12	200	18.0	36.0

TABLE "B"
RATIO OF LENGTH OF ACCELERATION LANES ON MAINLINE GRADES TO LENGTH ON LEVEL

Design Speed of Highway (mph)	Design Speed of Turning Roadway (mph) 25	30	35	40	45	50	ALL Speeds
	3% to 5% Upgrade						3% to 5% Down
40	1.30	1.30	1.20	1.00	1.00	1.00	0.70*
45	1.30	1.35	1.30	1.00	1.00	1.00	0.65*
50	1.35	1.40	1.40	1.40	1.35	1.00	0.65*
55	1.40	1.45	1.45	1.45	1.45	1.00	0.65*
60	1.45	1.50	1.50	1.50	1.55	1.60	0.60*
65	1.50	1.55	1.55	1.60	1.65	1.70	0.60*
70	1.55	1.60	1.65	1.70	1.75	1.80	0.60*
	5% and over Upgrade						5% and over Down
40	1.50	1.50	1.50	1.00	1.00	1.00	0.60*
45	1.55	1.60	1.65	1.00	1.00	1.00	0.60*
50	1.60	1.70	1.80	1.90	1.45	1.00	0.55*
55	1.70	1.80	1.90	2.05	2.15	1.00	0.55*
60	1.80	1.90	2.05	2.20	2.35	2.50	0.50*
65	1.95	2.05	2.20	2.40	2.60	2.75	0.50*
70	2.10	2.20	2.40	2.60	2.80	3.00	0.50*

* If the ratio from Table "B" yields a length less than 540', use 540' as the minimum acceleration lane length. The desirable length is 750', this allows additional decision time for picking gaps.

EXAMPLE:

Find: Adjusted Acceleration Lane Length
Given: Principal Highway design speed 70 mph
Turning Highway design speed 30 mph
Meeting on a 5% upgrade

Solution: From Table "A" acceleration lane length = 1350'
From Table "B" ratio on upgrade = 2.20
Adjusted acceleration lane length = 1350' x 2.20 = 2970'

Note: If adjusted acceleration lane length appears impractical, a merge analysis should be performed. Lengthening of acceleration lane length may be necessary due to high truck volumes.

DEPARTMENT OF TRANSPORTATION

ENTRANCE RAMP DETAILS

HIGHWAY DESIGN MANUAL

Figure 600-14: Exit Ramp Details

EXIT RAMP DETAILS

EXAMPLE 1:

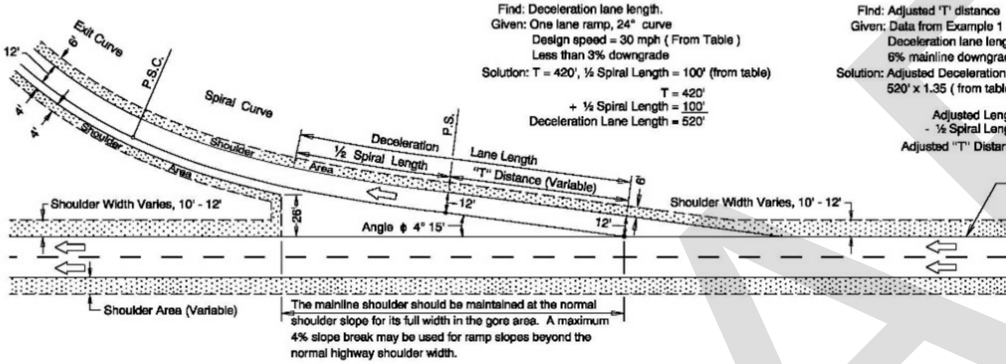
Find: Deceleration lane length.
Given: One lane ramp, 24° curve
Design speed = 30 mph (From Table)
Less than 3% downgrade
Solution: T = 420', ½ Spiral Length = 100' (from table)

T = 420'
+ ½ Spiral Length = 100'
Deceleration Lane Length = 520'

EXAMPLE 2:

Find: Adjusted 'T' distance
Given: Data from Example 1
Deceleration lane length (calculated in Example 1) = 520'
6% mainline downgrade.
Solution: Adjusted Deceleration Lane length =
520' x 1.35 (from table) = 702' (round to 705')

Adjusted Length = 705'
- ½ Spiral Length = 100'
Adjusted "T" Distance = 605'



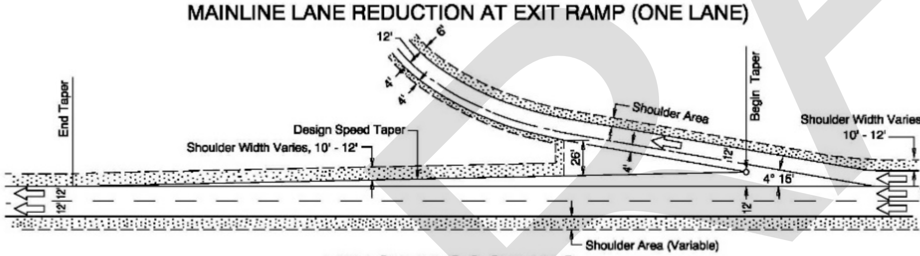
MINIMUM DECELERATION LANE LENGTHS (1 LANE)

Design Speed of Highway (mph)	Design Speed of Turning Curve (mph)					
	25	30	35	40	45	50
	DECELERATION LENGTHS (ft.)					
40	235	185	155	-	-	-
45	295	250	220	-	-	-
50	355	315	285	225	175	-
55	410	380	350	285	235	-
60	460	430	405	350	300	240
65	500	470	440	390	340	280
70	550	520	490	440	390	340

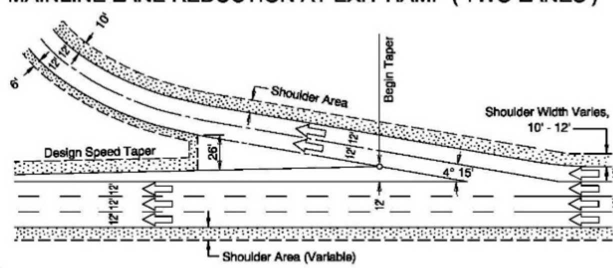
Ratio of Length of Deceleration Lanes on Mainline Grade to Length on Level		
Grade	Down	Up
3% to 5%	1 .20	0.9
5% and over	1 .35	0.8

NOTE: Adjust "T" Distance to the length required to give adjusted deceleration lane length.

MAINLINE LANE REDUCTION AT EXIT RAMP (ONE LANE)



MAINLINE LANE REDUCTION AT EXIT RAMP (TWO LANES)



EXIT CURVES & SPIRALS

Ramp Design Speed (mph)	Degree of Curve	Radius (ft)	e (%)	1 LANE (Highway Design Speed 70 mph) Spiral Length (ft.)	Spiral Parts "a" Value	Spiral Parts "S" Value	"T"* Distance (ft.)	"T" TRUCK Distance (ft.)	2 LANE (Highway Design Speed 70 mph) Spiral Length (ft.)	Spiral Parts "a" Value	Spiral Parts "S" Value	"T"* Distance (ft.)	"T" TRUCK Distance (ft.)
70	1° 00'	5729.58	3.5	200	0.5	1.0	240	340	300	0.333	1.5	300	400
	2° 00'	2864.79	6.5	200	1.0	2.0	240	340	300	0.667	3.0	300	400
	3° 00'	1909.86	8	240	1.25	3.6	220	320	360	0.833	5.4	300	370
65	4° 00'	1432.39	9	240	1.667	4.8	220	320	360	1.111	7.2	300	370
60	5° 00'	1145.92	9.5	250	2.0	6.25	215	315	375	1.333	9.375	300	365
55	6° 00'	954.93	10	240	2.5	7.2	220	320	360	1.667	10.8	300	370
50	7° 00'	818.51	10.5	240	2.917	8.4	220	400	360	1.944	12.6	300	450
	8° 00'	716.20	10.5	250	3.2	10.0	215	395	375	2.133	15.0	300	445
45	10° 00'	572.96	11	250	4.0	12.5	265	470	375	2.667	18.75	315	520
40	12° 00'	477.46	11.5	240	5.0	14.4	320	545	360	3.333	21.6	370	595
	14° 00'	409.26	11.5	200	7.0	14.0	340	565	300	4.667	21.0	400	625
35	16° 00'	358.10	12	200	8.0	16.0	390	650	300	5.333	24.0	450	710
	18° 00'	318.31	12	200	9.0	18.0	390	650	300	6.0	27.0	450	710
30	20° 00'	286.48	12	200	10.0	20.0	420	700	250	8.0	25.0	505	785
	24° 00'	238.73	12	200	12.0	24.0	420	700	240	10.0	28.8	510	790
25	30° 00'	190.99	12	200	15.0	30.0	450	745	240	12.5	36.0	540	835
	36° 00'	159.15	12	200	18.0	36.0	450	745	240	15.0	43.2	540	835

* "T" distance is based upon spiral length shown. Variations in spiral lengths will cause change in "T" distance. If spiral length is shortened, then lengthen "T" distance for minimum deceleration length. "T" should be increased if high truck volumes are present on the ramp. "T" truck distance to be used with high truck volumes.

Contact the Roadway Engineering Unit for assistance on any portion of this drawing.

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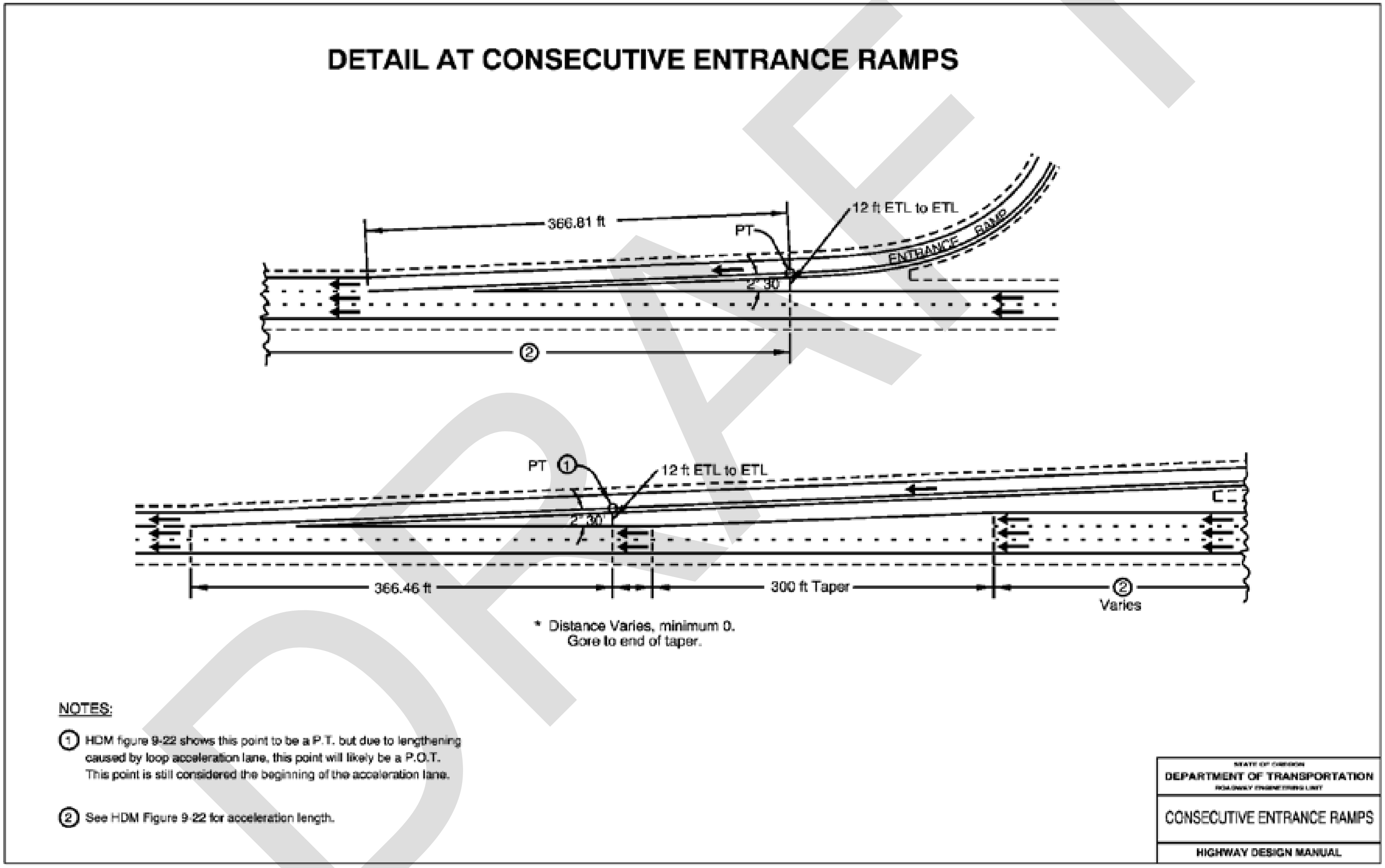
EXIT RAMP DETAILS

HIGHWAY DESIGN MANUAL

1 Figure 600-15: Consecutive Entrance Ramps



2

Figure 600-16: Two-Lane Parallel Entrance Ramp

TWO-LANE PARALLEL ENTRANCE RAMP DETAIL

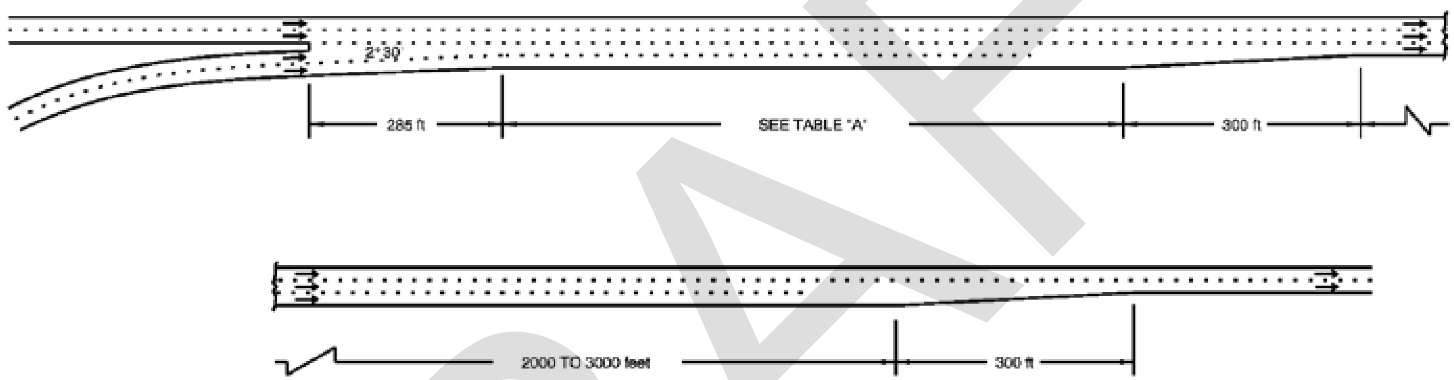


TABLE "A"

Design Speed of Turning Curve	25	30	35	40	45	50 +
Minimum Curve Radius in feet	160	230	320	430	555	695
Design Speed of Highway mph	TOTAL LENGTH OF ACCELERATION LANE (WITHOUT TAPER) Length in feet					
45	540	540	540	540	540	540
50	550	540	540	540	540	540
55	780	670	550	540	540	540
60	1020	910	800	* 550	540	540
65	1220	1120	1000	770	* 600	* 540
70	1420	1350	1230	1000	820	* 580

* Where possible minimum length for design should be **750 ft**, this allows additional decision time for picking gaps.

NOTE: This is the standard two lane ramp configuration.

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TWO-LANE PARALLEL ENTRANCE RAMP

HIGHWAY DESIGN MANUAL

605.5 Horizontal Alignment

The main curve (the curve immediately following the exit taper or preceding the entrance taper) should conform to the desirable ramp design speed, with maximum degrees of curvature shown in **Error! Reference source not found.**. Variations of this will require adjustments to the exit taper or acceleration lane length. Ramp alignments use standard spiral lengths that are different from those used for open road design. See Figure 600-13, Figure 600-14, and Figure 600-16 for ramp spiral data. Ramp Terminal Curve spirals also have unique values, shown in Figure 600-25.

Table 600-5: Maximum Degree of Curvature and Sight Distance on Interchange Ramps

Design Element	**Design Speed of Ramp (mph)**							
	25	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Maximum Design Degree of Curvature	36°	26°	19°	14°	10°30’	8°15’	6°30’	5°
Stopping Sight Distance (feet)	159	200	250	305	360	425	495	570

The layout of the interchange is influenced by the skew and horizontal alignment of the crossroad. The skew of the crossroad to the highway should be as close to 90 degrees as possible. The use of horizontal curves on either highway through the interchange should be avoided. However, there are numerous existing interchanges on ODOT highways that include horizontal curves. It is often not practical or necessary to remove these features, unless significant safety issues have been documented that relate directly to the curved alignment. Even in those cases, there are often alternatives for solving problems that don’t require major roadway realignments.

When one way, one-lane ramps exceed 1500 feet in length, consider adding a second lane to relieve congestion caused by slow moving or stalled vehicles. Steep grades and/or a high percentage of trucks may require an added lane on shorter ramps.

Typical horizontal entrance and exit details for the connection to the main highway can be found in Figure 600-13 and Figure 600-14. Ramp terminals are desirably perpendicular to the crossroad as shown on Figure 600-24. Various acceptable configurations for terminal area horizontal geometry are shown on Figure 600-24. **Ramp terminal alignments that have spirals at one end only (the entering end on exit ramps and the trailing end on entrance ramps) do not require design exceptions**. The first two Options are the most desirable, with Option 2 being common practice. Using Option 3 or Option 4 on is generally discouraged when developing new ramp alignments – contact the ODOT Interchange Engineer for guidance.

Designers need to keep in mind that roadside barriers and bridge ends can create sight distance restrictions for the ramp intersections. The appropriate sight distance (Stopping or Intersection) application needs to be determined, each location needs to be evaluated to clearly identify and prioritize problems and the potential solutions. The following figures (Figure 600-17 thru Figure 600-19) include numerous design aids and tools for fitting alignments. The Roadway Engineering Unit can provide guidance on the application of these tool.

1 Figure 600-17: Ramp Alignment Fitting

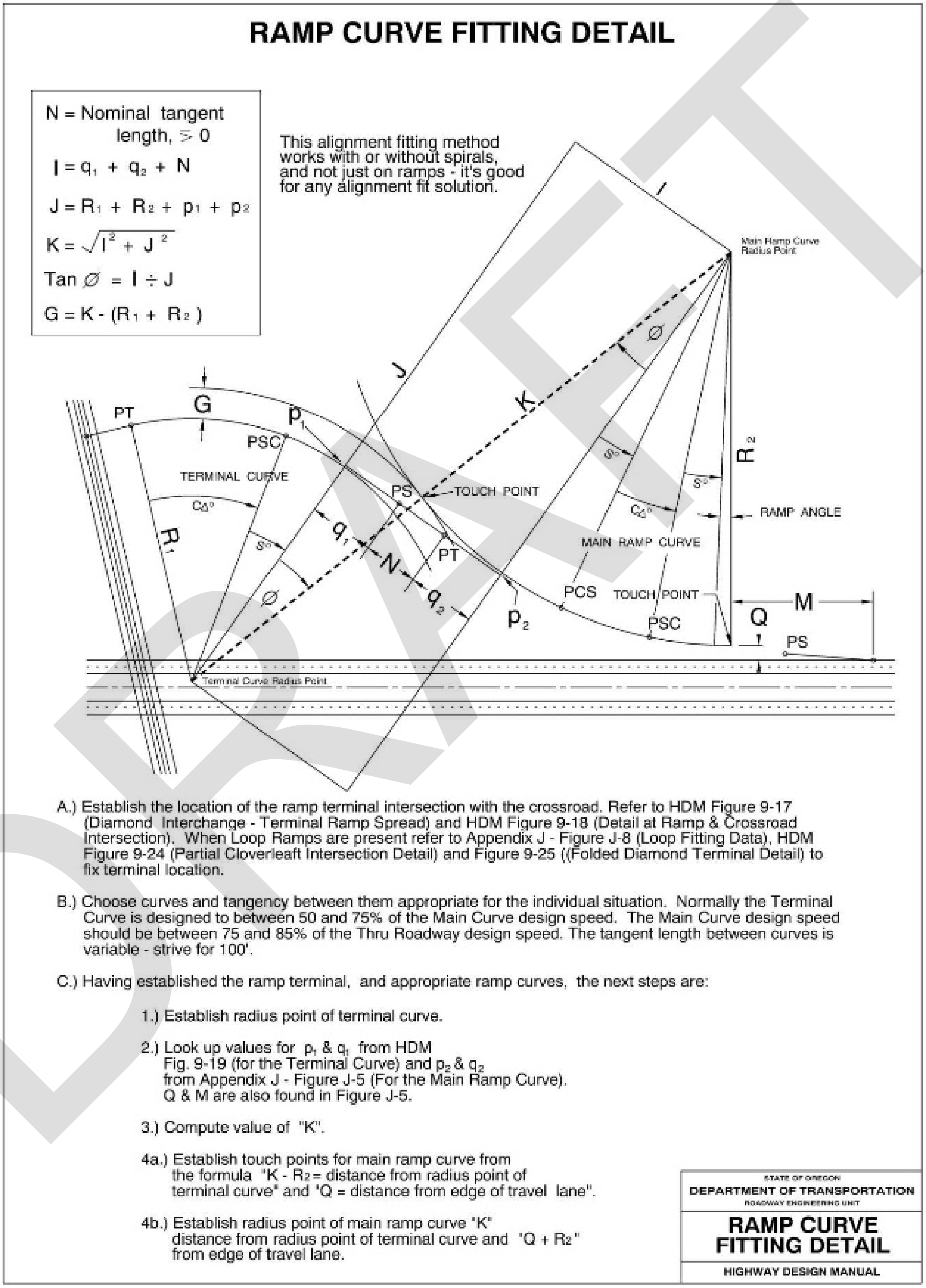

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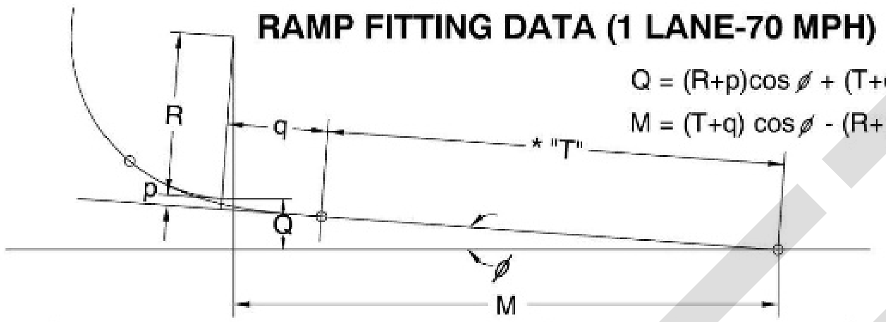
Figure 600-18: Alignment Fitting Data 70 MPH

RAMP FITTING DATA (1 LANE-70 MPH)

Q = (R+p)cos ∅ + (T+q)sin ∅ - R

M = (T+q) cos ∅ - (R+p)sin ∅



RAMP FITTING DATA @ HIGHWAY DESIGN SPEED 70 MPH									EXIT ∅ = 4° 15'			ENTRANCE ∅ = 2°30', T= 366.81		
mph	D	R	L	e %	a	S°	p	q	* T	Q	M	Q	M	Accel
70	1	5729.58	200	3.5	0.50	1.00	0.2909	99.9990	240	9.7316	-85.5679	15.1992	216.4307	*580
70	2	2864.79	200	6.5	1.00	2.00	0.5818	99.9959	240	17.8991	126.7127	18.2163	341.3753	*580
70	3	1909.86	240	8.0	1.25	3.60	1.2565	119.9842	220	21.1970	197.4194	20.6711	402.9686	*580
70	3°15'	1762.95	240	8.5	1.35	3.90	1.3611	119.9815	220	21.7051	208.2964	20.9154	409.3695	*580
65	3.5	1637.02	240	9.0	1.46	4.20	1.4658	119.9785	220	22.1556	217.6178	21.1397	414.8547	*580
65	3.75	1527.89	240	9.0	1.56	4.50	1.5705	119.9753	220	22.5598	225.6946	21.3480	419.6074	*580
65	4	1432.39	240	9.0	1.67	4.80	1.6751	119.9719	220	22.9265	232.7603	21.5433	423.7648	*580
60	4.25	1348.14	250	9.5	1.70	5.31	1.9311	124.9642	215	23.4129	238.9779	22.0970	432.4164	*580
60	4.5	1273.24	250	9.5	1.80	5.63	2.0446	124.9599	215	23.7317	244.5156	22.2815	435.6741	*580
60	4.75	1206.23	250	9.5	1.90	5.94	2.1581	124.9553	215	24.0288	249.4689	22.4585	438.5876	*580
60	5	1145.92	250	9.5	2.00	6.25	2.2716	124.9504	215	24.3075	253.9252	22.6290	441.2065	*580
55	5.5	1041.74	250	10.0	2.20	6.88	2.4985	124.9400	215	24.8195	261.6182	22.9545	445.7323	*580
55	6	954.93	240	10.0	2.50	7.20	2.5119	119.9369	220	25.0713	268.0476	22.8322	444.5199	*580
55	6.5	881.47	240	10.0	2.71	7.80	2.7209	119.9259	220	25.4809	273.4649	23.1104	447.7040	*580
50	7	818.51	240	10.5	2.92	8.40	2.9299	119.9141	220	25.8616	278.1036	23.3787	450.4294	*580
50	7.5	763.94	250	10.5	3.00	9.38	3.4056	124.8885	215	26.4841	282.0868	24.1228	457.7586	*580
50	8	716.20	250	10.5	3.20	10.00	3.6321	124.8732	215	26.8402	285.5931	24.3939	459.8161	*580
45	8.5	674.07	250	11.0	3.40	10.63	3.8586	124.8569	265	30.8861	338.5447	24.6596	461.6275	820
45	9	636.62	250	11.0	3.60	11.25	4.0850	124.8395	265	31.2136	341.2859	24.9206	463.2338	820
45	9.5	603.11	250	11.0	3.80	11.88	4.3113	124.8212	265	31.5300	343.7340	25.1777	464.6672	820
45	10	572.96	250	11.0	4.00	12.50	4.5374	124.8019	265	31.8370	345.9328	25.4315	465.9534	820
45	10.5	545.67	250	11.0	4.20	13.13	4.7635	124.7817	265	32.1360	347.9177	25.6825	467.1134	820
40	11	520.87	250	11.5	4.40	13.75	4.9894	124.7604	315	36.1333	399.5805	25.9308	468.1642	1000
40	12	477.46	240	11.5	5.00	14.40	5.0152	119.7478	320	36.2775	402.7827	25.7793	465.0486	1000
40	13	440.74	200	11.5	6.50	13.00	3.7746	99.8266	340	35.1473	405.6771	23.7060	446.8046	1000
40	14	409.26	200	11.5	7.00	14.00	4.0636	99.8013	340	35.5202	407.9615	24.0236	448.1378	1000
35	15	381.97	200	12.0	7.50	15.00	4.3527	99.7720	390	39.5866	459.7953	24.3370	449.2860	1230
35	16	358.10	200	12.0	8.00	16.00	4.6413	99.7406	390	39.9377	461.5118	24.6466	450.2834	1230
35	17	337.03	200	12.0	8.50	17.00	4.9296	99.7073	390	40.2807	463.0183	24.9533	451.1564	1230
35	18	318.31	200	12.0	9.00	18.00	5.2176	99.6719	390	40.6168	464.3493	25.2573	451.9252	1230
35	19	301.56	200	12.0	9.50	19.00	5.5052	99.6346	390	40.9469	465.5323	25.5590	452.6061	1230
30	20	286.48	200	12.0	10.00	20.00	5.7925	99.5952	420	43.4952	496.5066	25.8586	453.2120	1350
30	22	260.44	200	12.0	11.00	22.00	6.3659	99.5106	420	44.1324	498.3098	26.4526	454.2384	1350
30	24	238.73	200	12.0	12.00	24.00	6.9377	99.4180	420	44.7555	499.7834	27.0405	455.0676	1350
30	26	220.37	200	12.0	13.00	26.00	7.5077	99.3175	420	45.3669	501.0019	27.6230	455.7434	1350
25	28	204.63	200	12.0	14.00	28.00	8.0758	99.2092	450	48.1919	531.9358	28.2007	456.2970	1420
25	30	190.99	200	12.0	15.00	30.00	8.6417	99.0931	450	48.7852	532.7891	28.7741	456.7514	1420
25	34	168.52	200	12.0	17.00	34.00	9.7667	98.8376	450	49.9500	534.1161	29.9083	457.4272	1420
25	36	159.15	200	12.0	18.00	36.00	10.3256	98.6984	450	50.5227	534.6296	30.4694	457.6721	1420

* These Accel Lane lengths are bare minimums. Operational analysis should be done to either validate these lengths or recommend additional distance for gap acceptance and merging needs. Alignments are normally not affected by this. See HDM Figure 9-11.

NOTE: Where exit ramp "T" distances are variable for grades in excess of 3% see HDM Figure 9-12 to calculate "T" distance.

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RAMP FITTING DATA
(1 LANE - 70 MPH)

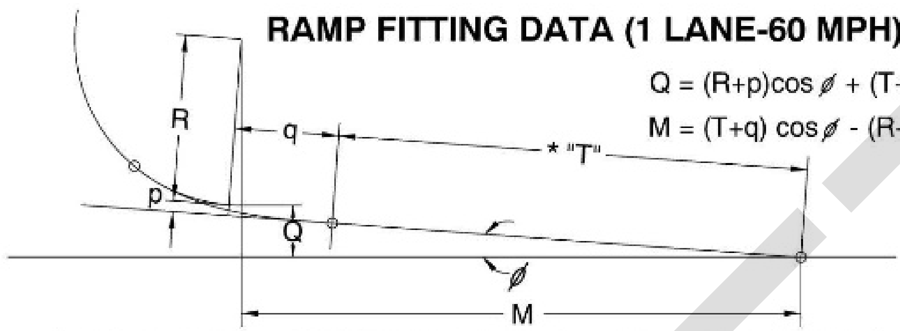
HIGHWAY DESIGN MANUAL

Figure 600-19: Alignment Fitting Data 60 MPH

RAMP FITTING DATA (1 LANE-60 MPH)

$$Q = (R+p)\cos\phi + (T+q)\sin\phi - R$$

$$M = (T+q)\cos\phi - (R+p)\sin\phi$$



RAMP FITTING DATA @ HIGHWAY DESIGN SPEED 60 MPH									EXIT ϕ = 4° 15'			ENTRANCE ϕ = 2°30', T= 368.81		
Ramp Curve (mph)	D	R	L	e %	a	S°	p	q	*T	Q	M	Q	M	Min. Accel
70	1	5729.58	200	3.5	0.50	1.00	0.2909	99.9990	140	2.3208	-185.2929	15.1992	216.4307	*540
70	2	2864.79	200	6.5	1.00	2.00	0.5818	99.9969	140	10.4882	26.9877	18.2163	341.3753	*540
70	3	1909.86	240	8.0	1.25	3.60	1.2565	119.9842	120	13.7861	97.6944	20.6711	402.9686	*540
70	3°15'	1762.95	240	8.5	1.35	3.90	1.3611	119.9815	120	14.2943	108.5713	20.9154	409.3695	*540
65	3.5	1637.02	240	9.0	1.46	4.20	1.4658	119.9785	120	14.7447	117.8927	21.1397	414.8547	*540
65	3.75	1527.89	240	9.0	1.56	4.50	1.5705	119.9753	120	15.1489	125.9696	21.3480	419.6074	*540
65	4	1432.39	240	9.0	1.67	4.80	1.6751	119.9719	120	15.5156	133.0353	21.5433	423.7648	*540
60	4.25	1348.14	250	9.5	1.70	5.31	1.9311	124.9642	115	16.0020	139.2529	22.0970	432.4164	*540
60	4.5	1273.24	250	9.5	1.80	5.63	2.0446	124.9599	115	16.3209	144.7906	22.2815	435.6741	*540
60	4.75	1206.23	250	9.5	1.90	5.94	2.1581	124.9553	115	16.6180	149.7438	22.4585	438.5876	*540
60	5	1145.92	250	9.5	2.00	6.25	2.2716	124.9504	115	16.8967	154.2002	22.6290	441.2085	*540
55	5.5	1041.74	250	10.0	2.20	6.88	2.4965	124.9400	115	17.4087	161.8932	22.9545	445.7323	*540
55	6	954.93	240	10.0	2.50	7.20	2.5119	119.9369	120	17.6604	168.3225	22.8322	444.5199	*540
55	6.5	881.47	240	10.0	2.71	7.80	2.7209	119.9259	120	18.0701	173.7398	23.1104	447.7040	*540
50	7	818.51	240	10.5	2.92	8.40	2.9299	119.9141	120	18.4508	178.3786	23.3787	450.4294	*540
50	7.5	763.94	250	10.5	3.00	9.38	3.4056	124.8885	115	19.0733	182.3618	24.1228	457.7586	*540
50	8	716.20	250	10.5	3.20	10.00	3.6321	124.8732	115	19.4294	185.8681	24.3939	459.8161	*540
45	8.5	674.07	250	11.0	3.40	10.63	3.8586	124.8569	150	22.3637	223.8609	24.6596	461.6275	*540
45	9	636.62	250	11.0	3.60	11.25	4.0850	124.8395	150	22.6911	226.6021	24.9206	463.2338	*540
45	9.5	603.11	250	11.0	3.80	11.88	4.3113	124.8212	150	23.0075	229.0502	25.1777	464.6672	*540
45	10	572.96	250	11.0	4.00	12.50	4.5374	124.8019	150	23.3146	231.2490	25.4315	465.9534	*540
45	10.5	545.67	250	11.0	4.20	13.13	4.7635	124.7817	150	23.6135	233.2340	25.6825	467.1134	*540
40	11	520.87	250	11.5	4.40	13.75	4.9894	124.7604	225	29.4636	309.8279	25.9308	468.1642	*550
40	12	477.46	240	11.5	5.00	14.40	5.0152	119.7478	230	29.6078	313.0302	25.7793	465.0486	*550
40	13	440.74	200	11.5	6.50	13.00	3.7746	99.8286	250	28.4776	315.9246	23.7060	446.8046	*550
40	14	409.26	200	11.5	7.00	14.00	4.0638	99.8013	250	28.8505	318.2090	24.0236	448.1378	*550
35	15	381.97	200	12.0	7.50	15.00	4.3527	99.7720	305	33.2874	375.0290	24.3370	449.2860	*800
35	16	358.10	200	12.0	8.00	16.00	4.6413	99.7406	305	33.6385	376.7456	24.6466	450.2834	*800
35	17	337.03	200	12.0	8.50	17.00	4.9296	99.7073	305	33.9815	378.2520	24.9533	451.1564	*800
35	18	318.31	200	12.0	9.00	18.00	5.2176	99.6719	305	34.3176	379.5830	25.2573	451.9252	*800
35	19	301.56	200	12.0	9.50	19.00	5.5052	99.6346	305	34.6477	380.7660	25.5590	452.6061	*800
30	20	286.48	200	12.0	10.00	20.00	5.7925	99.5952	330	36.8255	406.7541	25.8586	453.2120	*910
30	22	260.44	200	12.0	11.00	22.00	6.3659	99.5106	330	37.4627	408.5572	26.4526	454.2384	*910
30	24	238.73	200	12.0	12.00	24.00	6.9377	99.4180	330	38.0857	410.0309	27.0405	455.0676	*910
30	26	220.37	200	12.0	13.00	26.00	7.5077	99.3175	330	38.6972	411.2494	27.6230	455.7434	*910
25	28	204.63	200	12.0	14.00	28.00	8.0758	99.2092	360	41.5222	442.1833	28.2007	456.2970	*1020
25	30	190.99	200	12.0	15.00	30.00	8.6417	99.0931	360	42.1155	443.0366	28.7741	456.7514	*1020
25	34	168.52	200	12.0	17.00	34.00	9.7667	98.8376	360	43.2803	444.3636	29.9083	457.4272	*1020
25	36	159.15	200	12.0	18.00	36.00	10.3256	98.6984	360	43.8530	444.8771	30.4694	457.6721	*1020

* These Accel Lane lengths are bare minimums. Operational analysis should be done to either validate these lengths or recommend additional distance for gap acceptance and merging needs. Alignments are normally not affected by this. See HDM Figure 9-11.

NOTE: Where exit ramp "T" distances are variable for grades in excess of 3% see HDM Figure 9-12 to calculate "T" distance.

NON-STANDARD -
USING 60 MPH DESIGN SPEED AS A BASIS FOR SPEED CHANGE AREAS REQUIRES AGREEMENT BETWEEN REGION AND TECH SERVICES ROADWAY MANAGERS.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

RAMP FITTING DATA (1 LANE - 60 MPH)

HIGHWAY DESIGN MANUAL

Special treatments are used in cases where ramps connect to the mainline on curves. Figure 600-20 and Figure 600-21 provide guidance on developing curved ramp horizontal alignments. The intent of these configurations is to approximate the conditions where ramps merge or diverge on tangent alignments. Additional information is also located at the end of Part 600. The figures at the end of Part 600 provide guidance for specific cases and recommended configurations are shown. In many of these cases it is necessary to use spiral segments to deal with compound horizontal curves. Details on spiral segments are presented in Part 200 of this manual.

Superelevation at curved ramps is generally controlled by the mainline cross slope throughout the gore area. When curved ramps reach the "physical nose" (see Figure 600-14) the ramp and mainline become separate roadways. Ramp cross slopes become mostly independent. Designers must keep in mind the need for smooth cross slope transitions through this area. Development of these transitions will often not fit neatly calculated mathematical or runoff chart solutions. Using multiple line profiles (based on traveled way edges) that approximate precise solutions will normally provide adequate results.

Figure 600-22 is intended as a guide for typical cross slope transitions at ramps. Detailed guidance for developing super transitions at curved ramp connections is provided in **AASHTO 2018 – Section 9.6.4**. Although the discussion is about turning roadways at intersections, the basic ideas are also applicable for interchange ramps (keeping in mind the higher speed transitions). Often it's necessary to use cross slope breaks in gore areas to provide suitable transitions. **Table 9-18 in AASHTO** lists suggested maximum cross slope breaks in various situations; **ODOT's standard for freeways and expressways is to limit cross slope breaks to four percent.** Minimal horizontal alignment, especially on ramps, often has a negative impact on vertical alignment as well. Designers need to pay careful attention to the combined effects of horizontal and vertical geometry. In fully developed areas it is often infeasible to change the crossroad profile, but ramps may have more flexibility. A general discussion on horizontal alignments for roadways can be found in Section 200.

Figure 600-20: Entrance Ramps on Curves

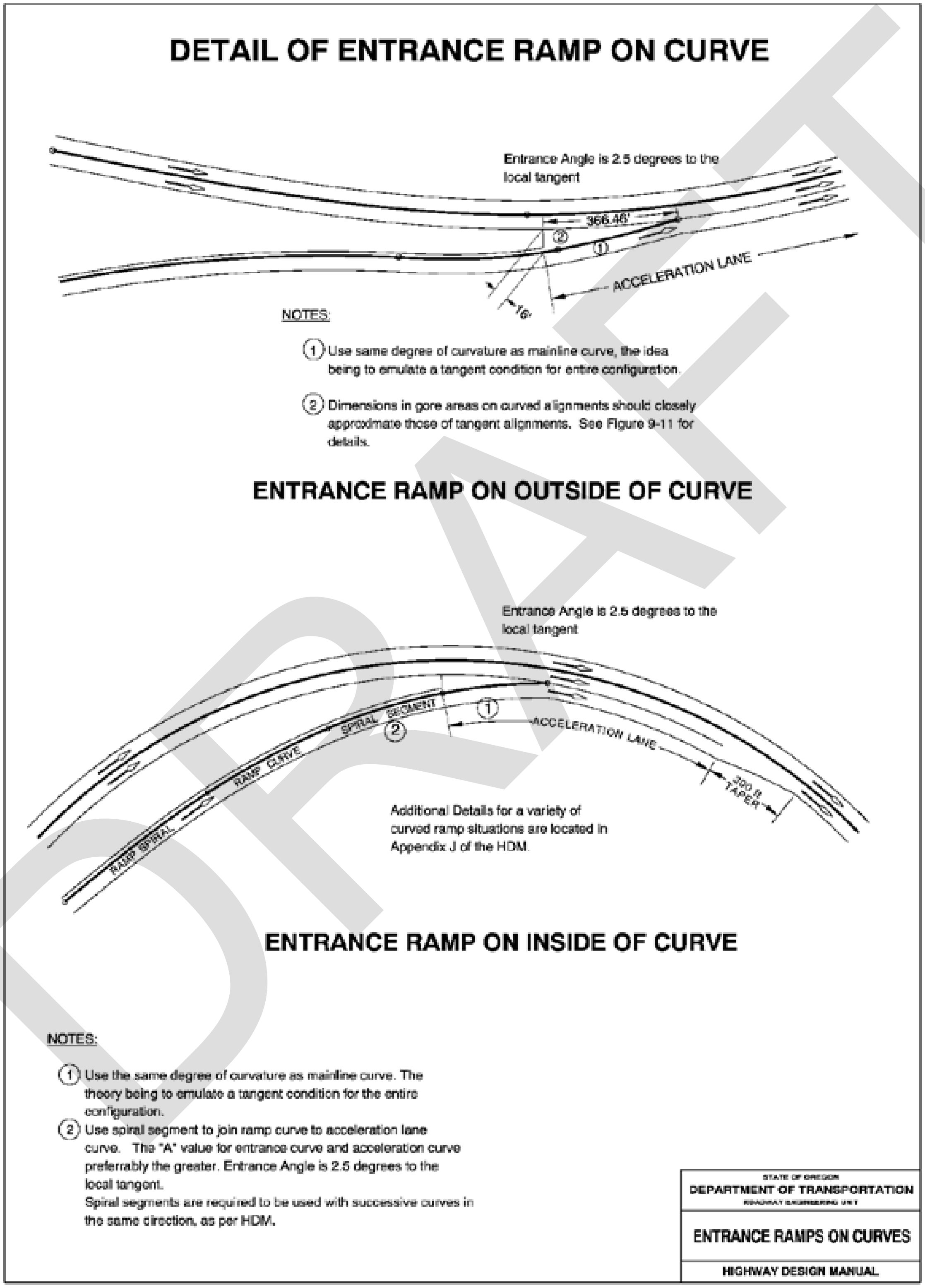


Figure 600-21: Exit Ramps on Curves

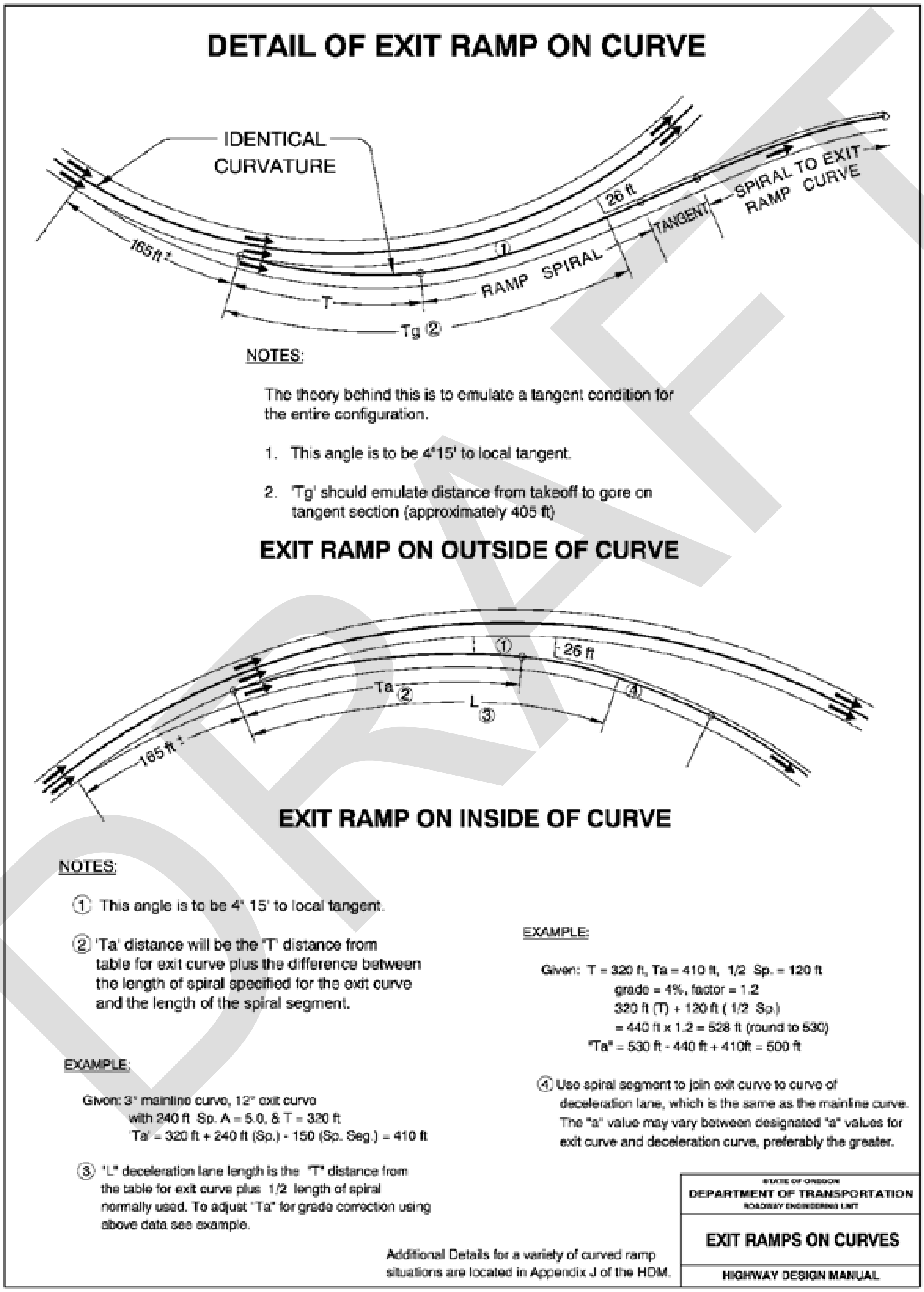
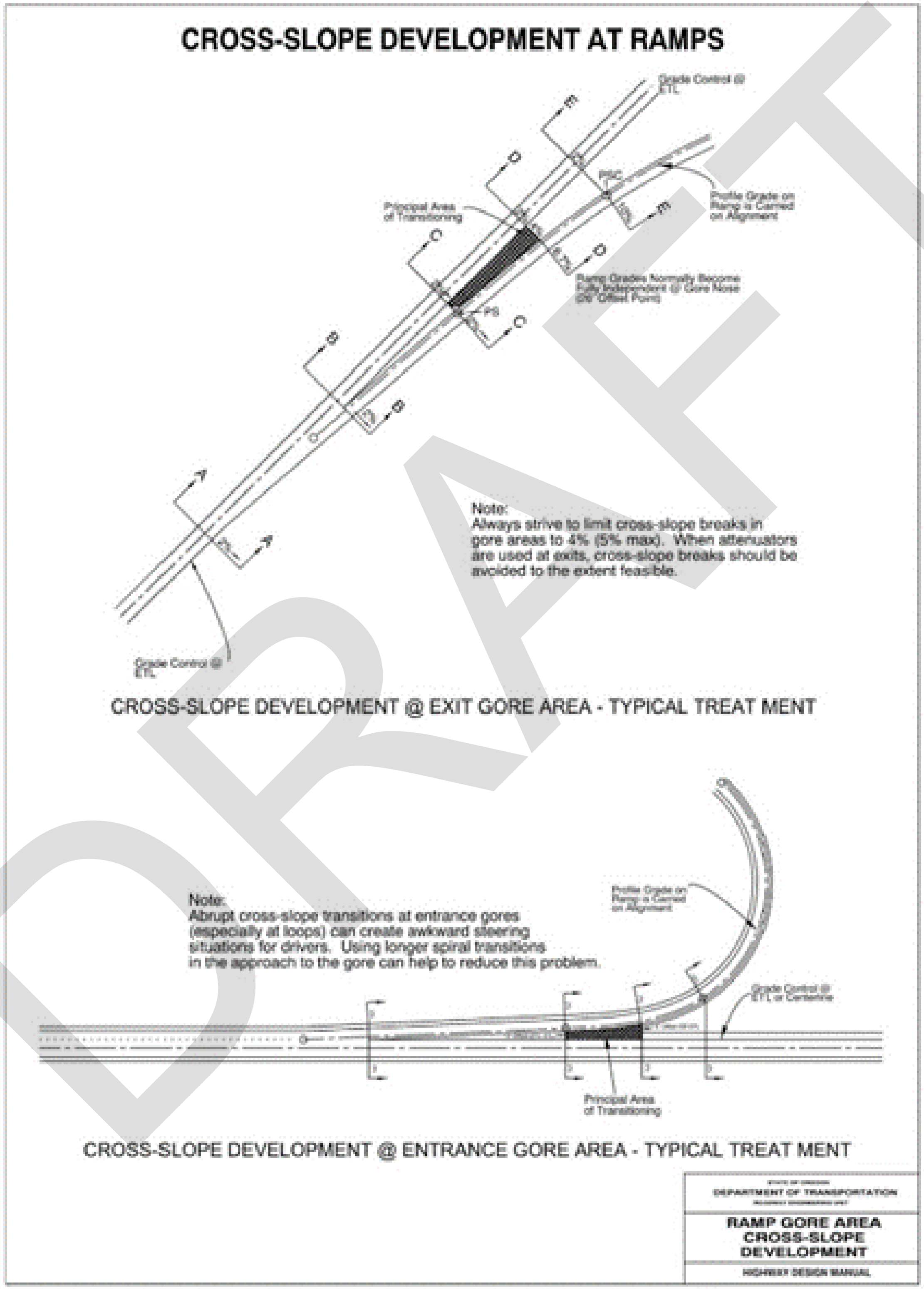


Figure 600-22: Cross Slope Development at Gore Areas



605.6 Vertical Alignment

Ramp grades should be as flat as possible. (See Table 600-6) Steep grades at the terminal area may have significant operational effects, especially for large vehicles. **Where ramp traffic has a significant percentage of heavy trucks or buses, 3 or 4% approach gradients are strongly preferred.** *The grades at the landing area (where the ramp meets the crossroad) should match the cross-slope on the crossing road, preferably close to 2%.* Vertical alignments and clearances for the crossroad and ramps should be designed in accordance with Part 200 guidelines. Ramp profile grades are normally carried at the horizontal alignment.

Table 600-6: Maximum Grades for Ramps

Design Speed (mph)	Ascending Grades %		Descending Grades %	
	Desirable	Maximum	Desirable	Maximum
25-30	5	7	7	8
35-40	4	6	6	7
45-50	3	5	5	6

Except in special cases, descending grades on exit ramps should be the same as the ascending grades. Depressed interchanges are the most common situation where this would apply. Exits on downgrades require added deceleration length, and steeper grades increase this requirement. Steeper grades also make it more difficult to provide an appropriate vertical curve in the gore area, thus the recommendation for keeping the descending exit grades similar to the ascending. In certain special cases grades can vary from the standard as appropriate. Examples of special cases would be an outer connection on a partial cloverleaf or system interchange, or entrance ramps in mountainous terrain. These ramps do not have to account for stopped vehicles in a queue (although they still need to provide SSD and appropriate vertical curves), so there is greater flexibility in the profile design. **Ramp grades steeper than the standard need to be documented in a design exception**. Contact the ODOT Interchange Engineer for guidance in unusual situations.

Ramp profiles in gore area need to be developed to match the mainline profile adequately, in order to minimize cross slope variations in that area. It is preferable to develop grades in gore areas based on the mainline profile up to the point where gore paving ends (refer to Figure 600-13 and Figure 600-14 for details). The ramp profile can become independent at that point. In constrained situations it may be necessary to vary from this practice. *Significant cross slope breaks can create problems for vehicles traversing the gore area, especially at exits, so the profile always needs to match mainline to the extent possible in each situation.*

Ramp grades have significant operational impacts, but it's equally important to provide adequate sight distance along the entire length of the ramp. When the crossroad is over the main facility, the ascending exits and descending entrances generally have fewer problems, provided they have sufficient length and good horizontal alignment. Sight line limitations are often found on depressed interchanges (crossroad under), both on ramps at the gore area and at the intersection with the crossroad. Sight distances at exit and entrance gore areas require careful evaluation, as these are higher speed conflict areas. The vertical alignment at the terminal end of a ramp may also have adverse impacts on sight lines. A profile that includes a relatively steep grade at the terminal end affects not only sight lines, but startup and stopping operations, which in turn affects the sight distance needed for safe operation.

Partial cloverleaf ramp arrangements may create sight line restrictions as well, in the area where the outer ramp wraps around the loop. The combined effects of horizontal and vertical alignment and the ramp cross section need to be carefully evaluated in all cases. **Horizontal and vertical sight lines both need to checked for obstructions.**

In situations where it is impractical to make significant changes to the profile, sight lines should take priority over specific gradient controls. **Design exceptions are necessary when either or both of these criteria aren't met. As a minimum, exit ramp profiles shall provide appropriate stopping sight distance to expected vehicle queues.** *Exit profiles, especially at depressed interchanges, need to provide appropriate sight distance in the gore area.*

605.7 Ramp Terminal Curves

Ramp terminal curves are the portion of a ramp where it meets the crossroad. In some respects, these are a part of the intersection with the crossroad. Sometimes there is no horizontal curve present, but the same principles and thought process need to be followed as with curved terminal areas.

Terminal curves (where a ramp terminates at a crossroad) are generally sharper than the main curve, varying with the conditions. Ramp Terminal areas are typically designed to between 50% (minimum) and 85% of the main ramp curve speed.

Ramp Terminal Intersections The separation or "spread" between ramp terminal intersections on the crossroad should be adequate to allow for standard median channelization if left turns are required. Figure 600-23 **gives minimum spread distances for a basic diamond interchange at various design speeds.** Particular attention should be paid to adequate vertical and horizontal sight distance at the ramp terminals. Design elements such as barrier, protective screening, superelevation rates, and landscaping can have an impact on the sight distance of ramp terminals. Exit ramp and entrance ramp terminals on the crossroad should be offset to encourage drivers to use the entrance ramp and to discourage wrong way moves. Figure 600-24 and Figure 600-25 provide details on exit and entrance ramp terminal intersection design. AASHTO *"A Policy on Geometric Design of Highways and Streets-2018"*- Chapter 10, pages 10-82 to 10-87, discusses issues and possible mitigations to help discourage wrong-way entry. Wrong-way potential can be minimized by using conventional, easily recognized intersection and interchange layout, clear pavement markings, and proper signing.

Due to the crossroad grade often being adverse to a normal superelevation for terminal curves and the fact that traffic is slowing to stop at the crossroad, ramp terminal curves seldom are fully superelevated and may not be superelevated at all. Therefore, the need for spirals, particularly standard length ramp spirals, is diminished and sometimes eliminated on terminal curves. While spirals may not be required for superelevation transition, their use is always beneficial for leading traffic smoothly into the terminal curve. **The ramp terminal curve superelevation rate is typically one-half the full superelevation rate for that curve.** Refer to Figure 600-25 for spiral length and superelevation details on Terminal Curves. Contact the ODOT Interchange Engineer for guidance as needed.

Ramp terminals on many existing facilities do not meet the "X-X Minimum" distance shown in Figure 600-23. Achieving this target distance is often not feasible, particularly in fully developed areas. Designers need to work with traffic analysis staff to determine the range of options for dealing with anticipated left turn demand on the crossroad. It may be necessary to widen a structure to provide additional turn lanes for storage (along with widening of ramps to receive the added lane). In some cases it may be necessary to reconfigure the interchange to a more compact form, such as a Tight Diamond or Single Point. Oftentimes at existing interchanges, these values are difficult or infeasible to achieve. Sight lines and intersection features still need to be considered. **Design exceptions are necessary when SSD can't be provided at ramp intersections.**

On the other hand, where interchanges are in remote locations with very little traffic demand, the need for accommodating turn lanes is practically non-existent. In those cases, the chief control is sight lines (as shown in Figure 600-23, Table C). The type of traffic control at the intersection guides in the selection of the most appropriate case to use – Stopping Sight Distance for the crossroad design speed being the minimum. Designers should consider whether it is appropriate to provide Intersection Sight Distance, although in many situations this may prove impractical. Each individual situation must be evaluated to determine the appropriate sight distance condition that will control for design.

In cases where the crossroad is on a horizontal curve, added caution is necessary. Superelevated crossroads introduce awkward breaks in the cross-slope that have serious operational and safety implications, especially when there are significant numbers of trucks present. Horizontal curves can also make it more difficult to provide appropriate sight lines. Crossroad alignments should therefore be as close to tangent alignment as possible.

Refer to Part 500 of this manual and AASHTO "*A Policy on Geometric Design of Highways and Streets*" Chapter 9 for detailed discussion on intersection design and Intersection Sight Distance.

Figure 600-23: Interchange Ramp Spread

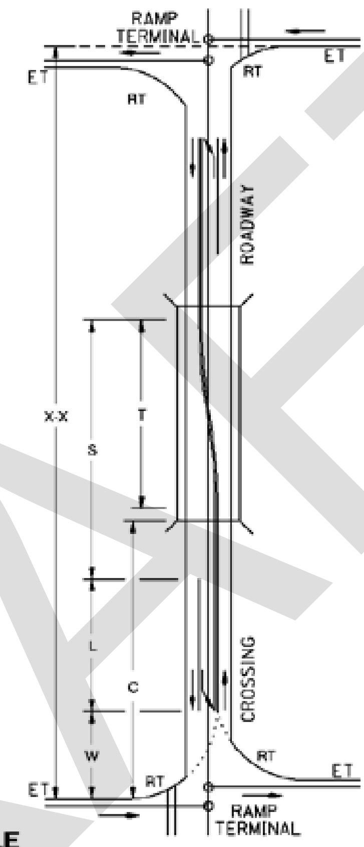
DIAMOND INTERCHANGE - TERMINAL RAMP SPREAD

CHANNELIZATION DIMENSIONS

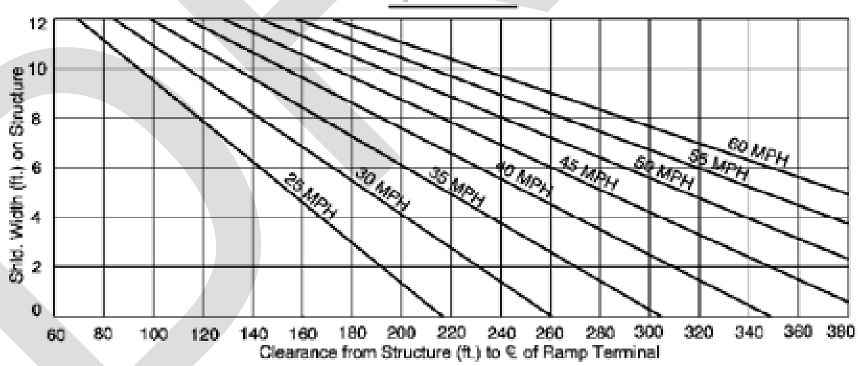
MPH	R (ft.)	T (ft.)	S (ft.)	L min. (ft.)	X-X MIN	
					3-Lane	5-Lane
25	195	100	150	100	600	510
30	195	100	150	100	600	510
35	250	110	160	100	610	520
40	305	120	180	100	640	550
45	370	135	235	100	735	645
50	435	145	295	150	945	855
55	510	160	355	150	1050	960
60	595	170	420	150	1170	1080
65	680	180	485	150	1290	1200
70	680	180	555	150	1430	1340

GLOSSARY OF TERMS

MPH = Design speed of crossing roadway.
R = Radius of reversing curve.
T = Length of reversing curve.
*S = Stopping sight distance for a speed 10 mph less than the Design Speed.
L = Length of storage determined by storage analysis - Minimums shown.
W = 100' for 3-lane @ 90° in tangent section. 55' for 5-lane @ 90° in tangent section. W determined by where turning vehicle's off-track crosses edge of left-turn lane (See figure right). This is where stop bar should be placed.
X-X = Minimum distance between the left edges of travel of the ramp terminals (see diagram left). X-X = 2(W+L+S)-T ; where S ≥ T. Else X-X = 2(W+L)+T.
C = Combined horizontal and vertical sight distance clearance from the structure. Typically 200 feet or more.
RT = Ramp terminal radii should accommodate a WB-67 Interstate Design Vehicle (IDV). Two Centered radii should be used to satisfy this requirement.
ET = Edge of Travel



'C' TABLE



'C' TABLE NOTES

1) 'C' Table values are based on the appropriate vertical curve and Stopping Sight Distance values for the design speed in a tangent section. These represent minimum clearance needs. Intersection Sight Distance (ISD) is the desirable condition, but is often difficult to achieve in existing conditions (unless the structure can be modified). See AASHTO *"A Policy on Geometric Design of Highways and Streets-2011"*- Chapter 9 for detailed discussion on ISD.

2) Clearance calculations do not include sidewalks; as there may or may not be barrier separation from the roadway. Barriers must be used when the cross-road design speed is 45 mph or greater.

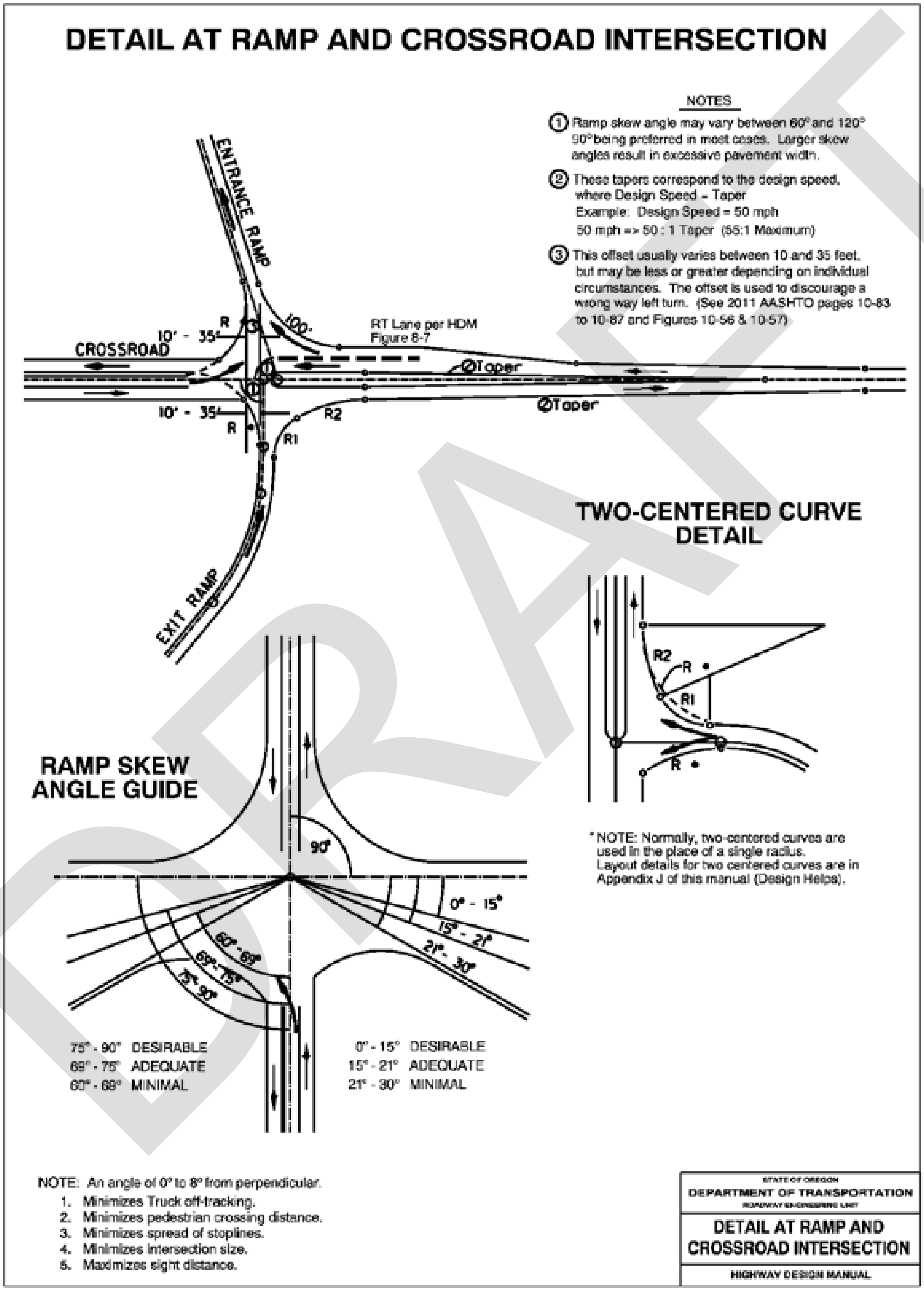
3) Many low volume and rural interchanges do not have a left turn lane on the crossroad. In this case the sight distance requirements and allowance for truck (WB-67) off-tracking are the controlling features. The spread between ramps should always consider possible future turn lane needs.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

INTERCHANGE RAMP SPREAD

HIGHWAY DESIGN MANUAL

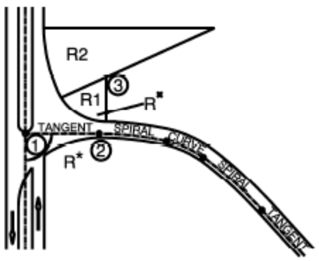
Figure 600-24: Detail at Ramp/Crossroad Intersection



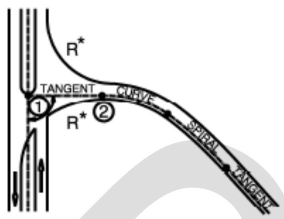
1 Figure 600-25: Terminal Curve Design Options

ACCEPTABLE TERMINAL CURVE DESIGNS

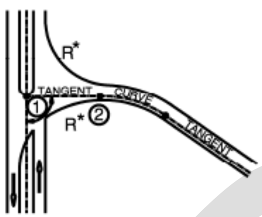
in descending order of preferrence



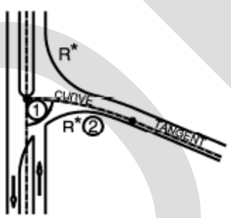
OPTION 1



OPTION 2



OPTION 3

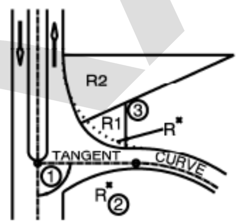


OPTION 4

TERMINAL CURVE SPIRAL DATA (ONE LANE)

Curve	Sp. length	e %	a	S°	p	q	x	y
1°	100	1.75	1	0.5	0.0727	49.9999	99.9992	0.2909
2°	100	3.25	2	1	0.1454	49.9995	99.9970	0.5818
3°	120	4	2.5	1.8	0.3141	59.9980	119.9882	1.2565
4°	120	4.5	3.3333	2.4	0.4189	59.9965	119.9789	1.6753
5°	125	4.75	4	3.1250	0.5681	62.4938	124.9628	2.2721
6°	120	5	5	3.6	0.6282	59.9921	119.9526	2.5126
7°	120	5.25	5.8333	4.2	0.7329	59.9893	119.9355	2.9310
8°	125	5.25	6.4	5	0.9088	62.4841	124.9048	3.6341
10°	125	5.5	8	6.25	1.1358	62.4752	124.8513	4.5413
12°	120	5.75	10	7.2	1.2559	59.9684	119.8106	5.0209
14°	100	5.75	14	7	1.0176	49.9751	99.8508	4.0681
16°	100	6	16	8	1.1627	49.9675	99.8052	4.6477
18°	100	6	18	9	1.3078	49.9589	99.7535	5.2268
20°	100	6	20	10	1.4529	49.9493	99.6958	5.8051
24°	100	6	24	12	1.7426	49.9270	99.5622	6.9595
30°	100	6	30	15	2.1763	49.8860	99.3168	8.6840
36°	100	6	36	18	2.6088	49.8360	99.0175	10.3984

Spiral lengths are based on using ½ of standard superelevation.
Use on terminal curves only.



*** TWO-CENTERED CURVE DETAIL**

Two-centered curves should be used in place of a single radius. See Appendix J for additional details.

TERMINAL CURVE NOTES

1. This angle may vary between 60° and 120°; where 90° is desirable in most cases.
2. To minimize intersection opening ramp curve should end near tangency of the variable crossing radius.
3. A two-centered curve design should be used to optimize intersection area and accommodate truck off-tracking.

STATE OF OREGON
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ROADWAY ENGINEERING UNIT

RAMP TERMINAL CURVE DESIGN

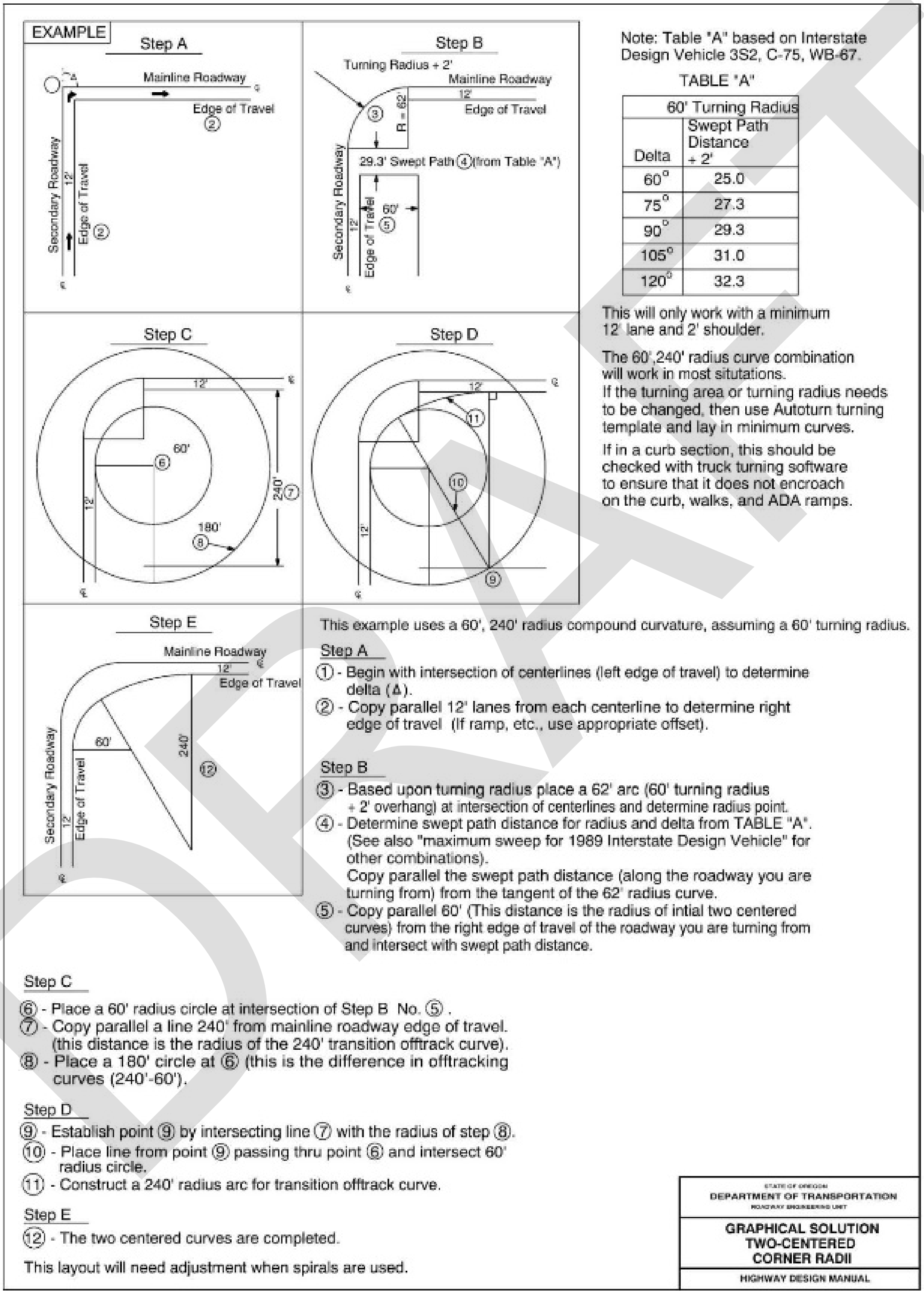
HIGHWAY DESIGN MANUAL

2

Freeway ramp terminals, and intersections pre-approved interstate trucks as shown on Route Map 7 (Route Map 7 can be found at: http://www.odot.state.or.us/forms/motcarr/od/8104.pdf **) at major truck use locations, shall accommodate the current Interstate Design Vehicle (WB-67)**. *Other intersections that have known large truck usage should also be designed to accommodate the current Interstate Design Vehicle.* Computer and CADD generated wheel paths of the design vehicle should be used to determine adequate clearances. This is particularly important when determining stop lines for left turn bays and when designing double left turns and two lane loop ramps.

Interstate Design Vehicle swept path requirements can also be found on Figure 600-28. Typically, two centered curves are used at ramp terminals due to the benefits of matching the turning characteristics of large vehicles. Two centered curves assist in reducing the crossing distance at ramp terminals while accommodating the turning requirements of the design vehicle. Figure 600-26 and Figure 600-27 have detailed helps on developing two-centered curves.

Figure 600-26: Two Centered Corner Graphical Solution



Note: Table "A" based on Interstate Design Vehicle 3S2, C-75, WB-67.

TABLE "A"

60' Turning Radius	
Delta	Swept Path Distance + 2'
60°	25.0
75°	27.3
90°	29.3
105°	31.0
120°	32.3

This will only work with a minimum 12' lane and 2' shoulder.

The 60',240' radius curve combination will work in most situtations. If the turning area or turning radius needs to be changed, then use Autoturn turning template and lay in minimum curves.

If in a curb section, this should be checked with truck turning software to ensure that it does not encroach on the curb, walks, and ADA ramps.

This example uses a 60', 240' radius compound curvature, assuming a 60' turning radius.

Step A

1 - Begin with intersection of centerlines (left edge of travel) to determine delta (Δ).

2 - Copy parallel 12' lanes from each centerline to determine right edge of travel (If ramp, etc., use appropriate offset).

Step B

3 - Based upon turning radius place a 62' arc (60' turning radius + 2' overhang) at intersection of centerlines and determine radius point.

4 - Determine swept path distance for radius and delta from TABLE "A". (See also "maximum sweep for 1989 Interstate Design Vehicle" for other combinations). Copy parallel the swept path distance (along the roadway you are turning from) from the tangent of the 62' radius curve.

5 - Copy parallel 60' (This distance is the radius of intial two centered curves) from the right edge of travel of the roadway you are turning from and intersect with swept path distance.

Step C

6 - Place a 60' radius circle at intersection of Step B No. 5 .

7 - Copy parallel a line 240' from mainline roadway edge of travel. (this distance is the radius of the 240' transition offtrack curve).

8 - Place a 180' circle at 6 (this is the difference in offtracking curves (240'-60').

Step D

9 - Establish point 9 by intersecting line 7 with the radius of step 8.

10 - Place line from point 9 passing thru point 6 and intersect 60' radius circle.

11 - Construct a 240' radius arc for transition offtrack curve.

Step E

12 - The two centered curves are completed.

This layout will need adjustment when spirals are used.

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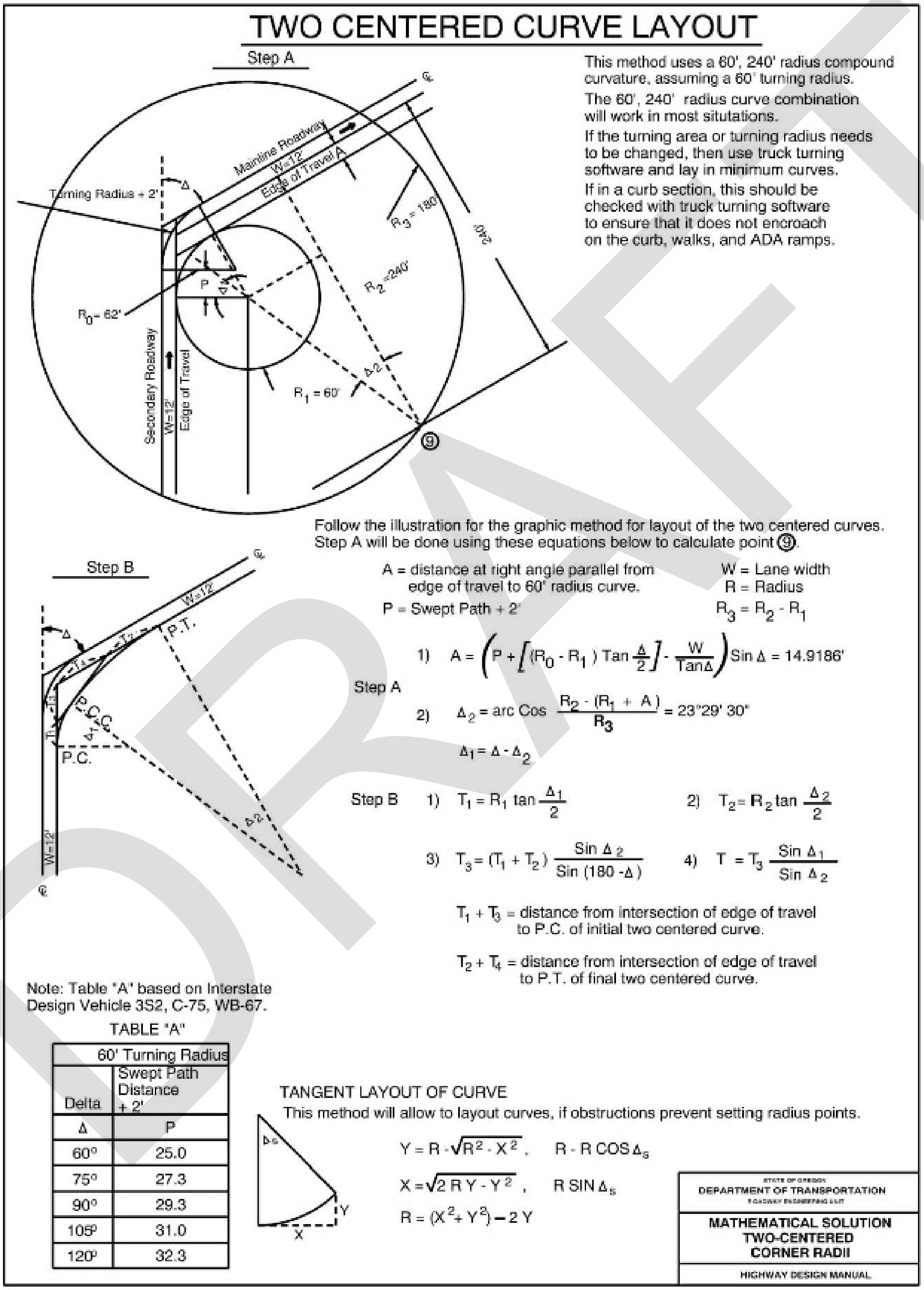
GRAPHICAL SOLUTION
TWO-CENTERED
CORNER RADII

HIGHWAY DESIGN MANUAL

Figure 600-27: Two Centered Corner Mathematical Layout



Ramp intersection design simultaneously needs to provide for design vehicle movements, pedestrian crossings, good lines of sight, and appropriate traffic control devices. As mentioned above, care needs to be taken to minimize wrong-way movement potential. Minimizing the skew angle will normally help in dealing with these issues. Ramp intersection design also needs to make appropriate accommodation for bicycles, pedestrians, and transit use (when applicable). HDM Parts 800 and 900 have detailed discussion on bike and pedestrian design. Refer to Part 700 for discussion of Public Transportation design. Each individual situation needs to be evaluated to determine the most appropriate solutions to apply. Coordination between all disciplines involved, preferably early in design, is important for getting good results. All of these considerations need to be balanced with the need to keep the intersection to a manageable size, and to accommodate the expected demand at an acceptable level.

Figure 600-28: Maximum I.D.V. Swept Path

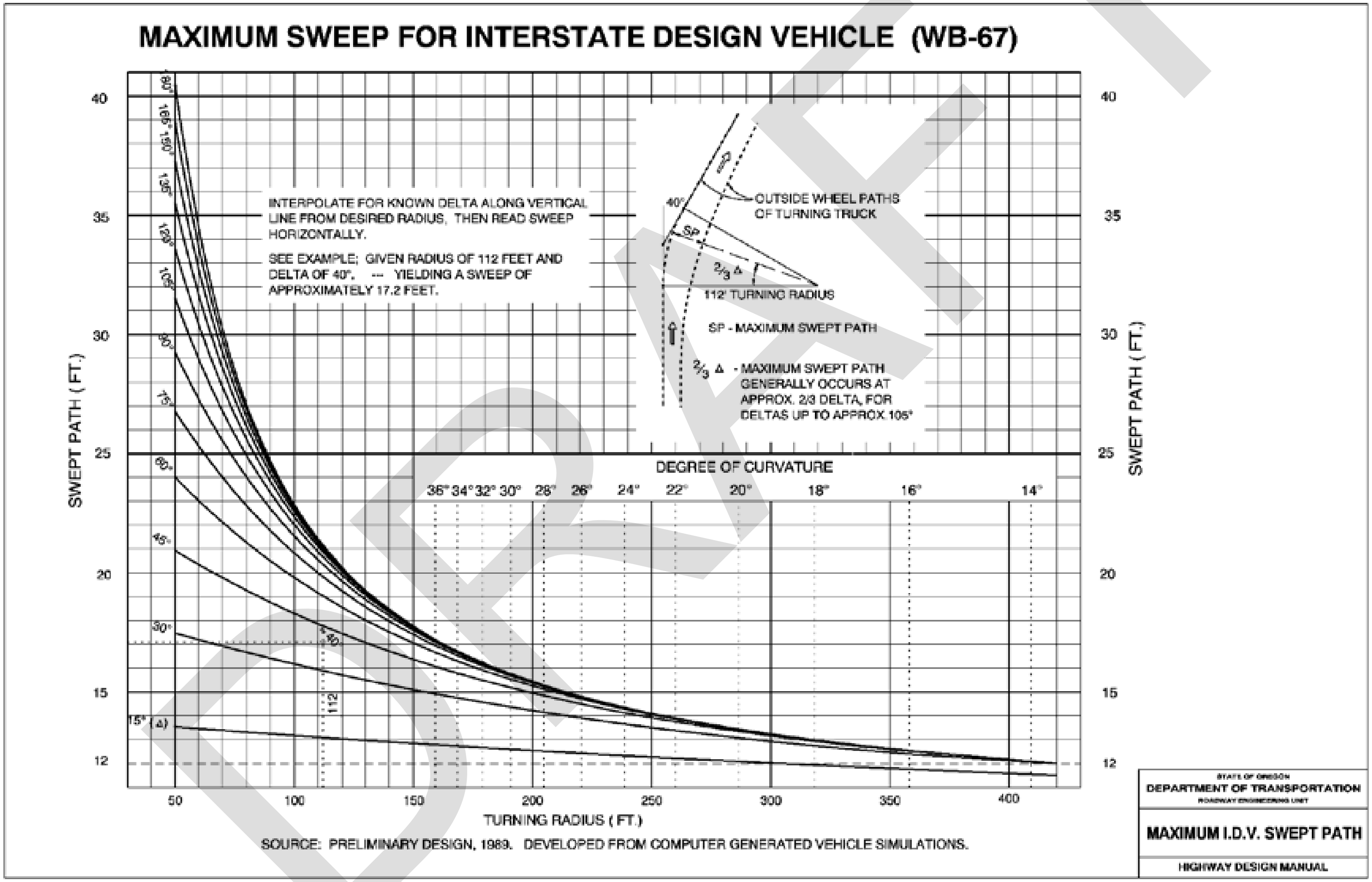
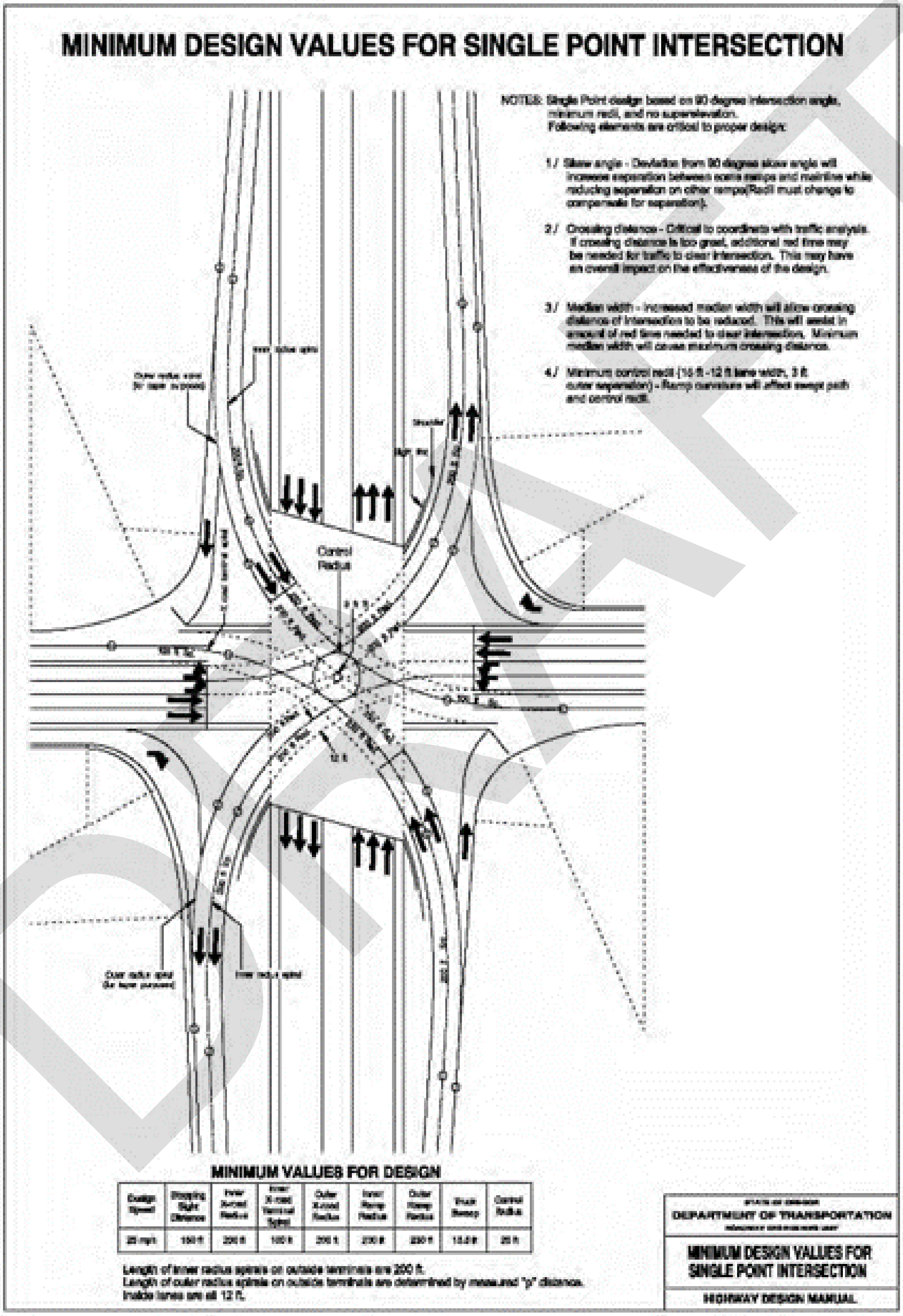
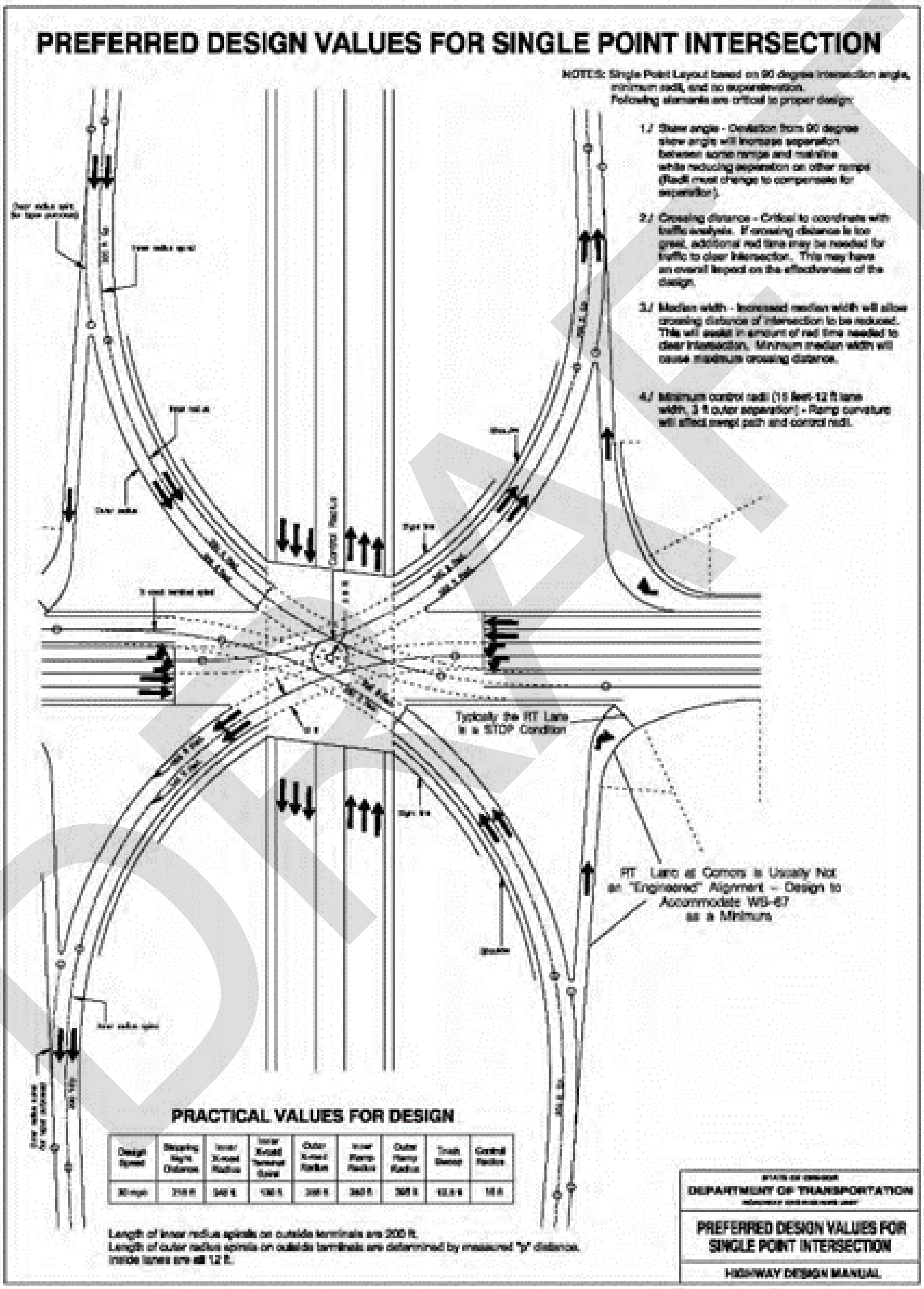


Figure 600-29 and Figure 600-30 provide details on intersection layout at Single Point interchanges. The details apply for both overcrossing and undercrossing situations. Contact the ODOT Interchange Engineer for guidaince.

Figure 600-29: Minimal Single Point Intersection Details



1 Figure 600-30: Preferred Single Point Intersection Details



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605.8 Ramp Meters

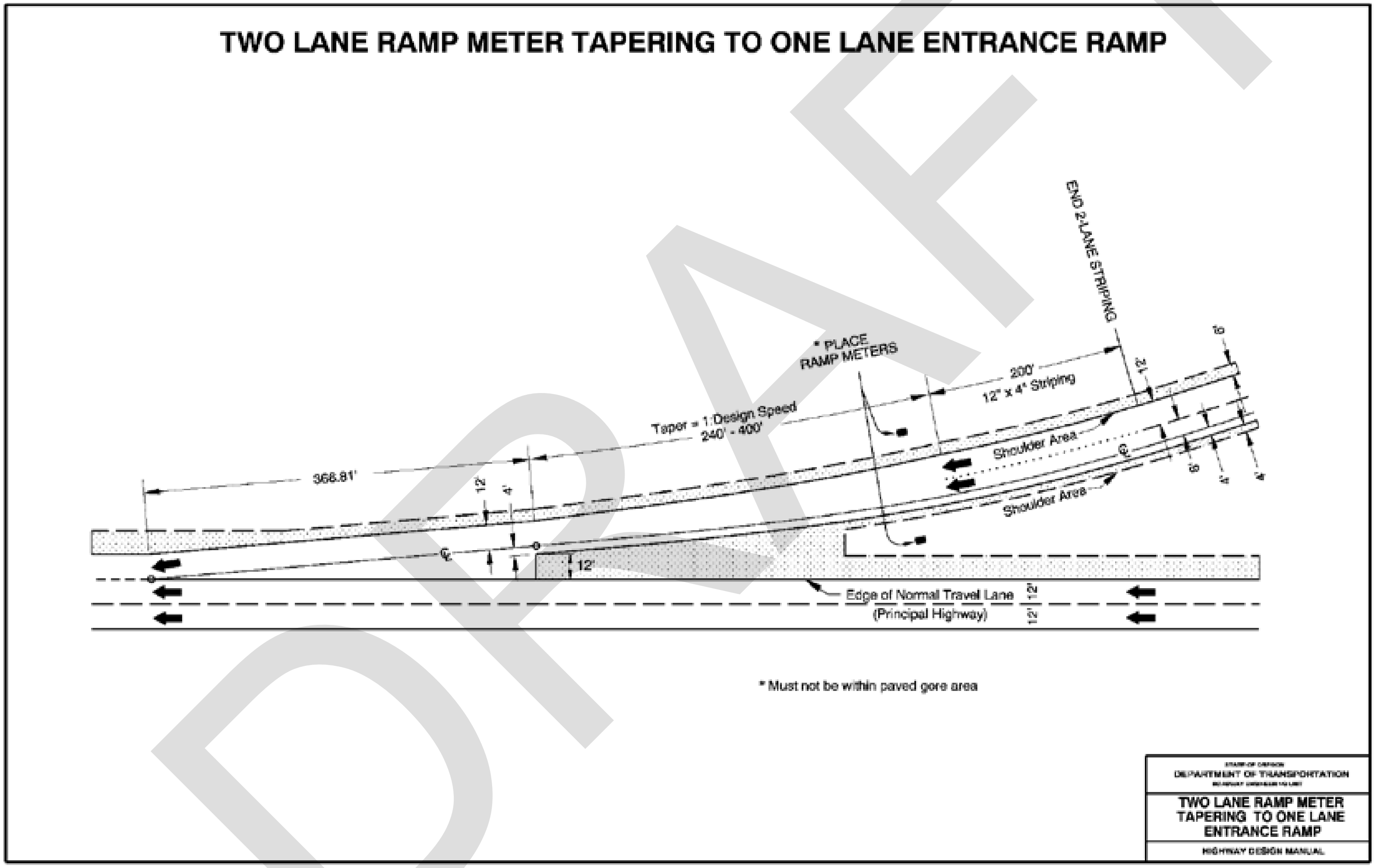
In highly congested areas, typically urban, the use of ramp meters may be beneficial to freeway traffic operations. Ramp meters reduce merge area turbulence and regulate total freeway flow through downstream bottlenecks. **The Traffic-Roadway Section should be contacted when ramp meters are being considered in the project development process**. In addition, there are geometric and safety issues with the design of the ramps and placement of the ramp meter signals that should be considered in the design.

Ramp meters can be installed on single lane or two lane entrance ramps. Ramp meters should not be installed on ramps connecting freeways to freeways, as those types of ramps are designed to operate as free flow ramps. Where ramp meters are installed on a single lane entrance ramp, the ramp design shall be consistent with the appropriate design for 4R/New Construction for Freeway or Non-Freeway Ramps found in Figure 600-13 and Figure 600-14. **Metered ramp acceleration lanes shall, as a minimum, meet the values in Table “A” of Figure 600-13.** This may require lengthening existing acceleration lanes that don’t meet current criteria.

In a 3R project, installation of a two lane ramp meter on a single lane ramp should be built to 4R/New Construction standards (the ramp should be widened to full two lane ramp standards). In constrained areas, an evaluation should be made to determine if the existing one lane ramp should be widened to two full standard lanes or if the existing one lane ramp width can be retrofitted for installation of two ramp meters. **Single lane ramps retrofitted for two lane ramp meters require a design exception.** The ramp meter signals should be located just prior to the paved edge of the ramp gore area. Figure 600-31 details the proper location and typical section for a two lane tapered to one lane parallel entrance ramp meter.

It is important to locate the ramp meter signals outside of the freeway clear zone. It is equally important that queued vehicles not be stopped within that same clear zone. Following the guidance in Figure 600-31 should yield a design that meets that requirement. Flat entrance curves may have some design issues, since the more gradual convergence of the roadways has a longer paved gore area. Each location where a ramp meter is considered needs to be checked to verify the clear zone issue. For further information contact the Traffic-Roadway Section Interchange Engineers.

1 Figure 600-31: Two-Lane Ramp Meter with Tapering to One-lane Entrance Ramp



2

605.9 Freeway Ramp Typical Sections

The number of lanes at the actual exit or entry point determines the how a ramp is categorized. Single lane ramps that taper to multiple lanes after exiting are still considered one lane – standard shoulders for one-lane ramps are appropriate. Some entrance ramps include added lanes and then taper to a single lane prior to actual freeway entry – again these are considered single lane ramps. Figure 600-32 shows standard dimensions for freeway ramps.

Standard single-lane freeway ramps are 26 feet wide. The 26’ width provides for continued operation if a stalled heavy vehicle or maintenance activity requires using some of the width, although a large truck offtracking in relatively sharp ramp curves can make this more difficult. When roadside barriers are introduced, the right shoulder is widened by 2 feet. The left shoulder is normally not widened when barriers are used.

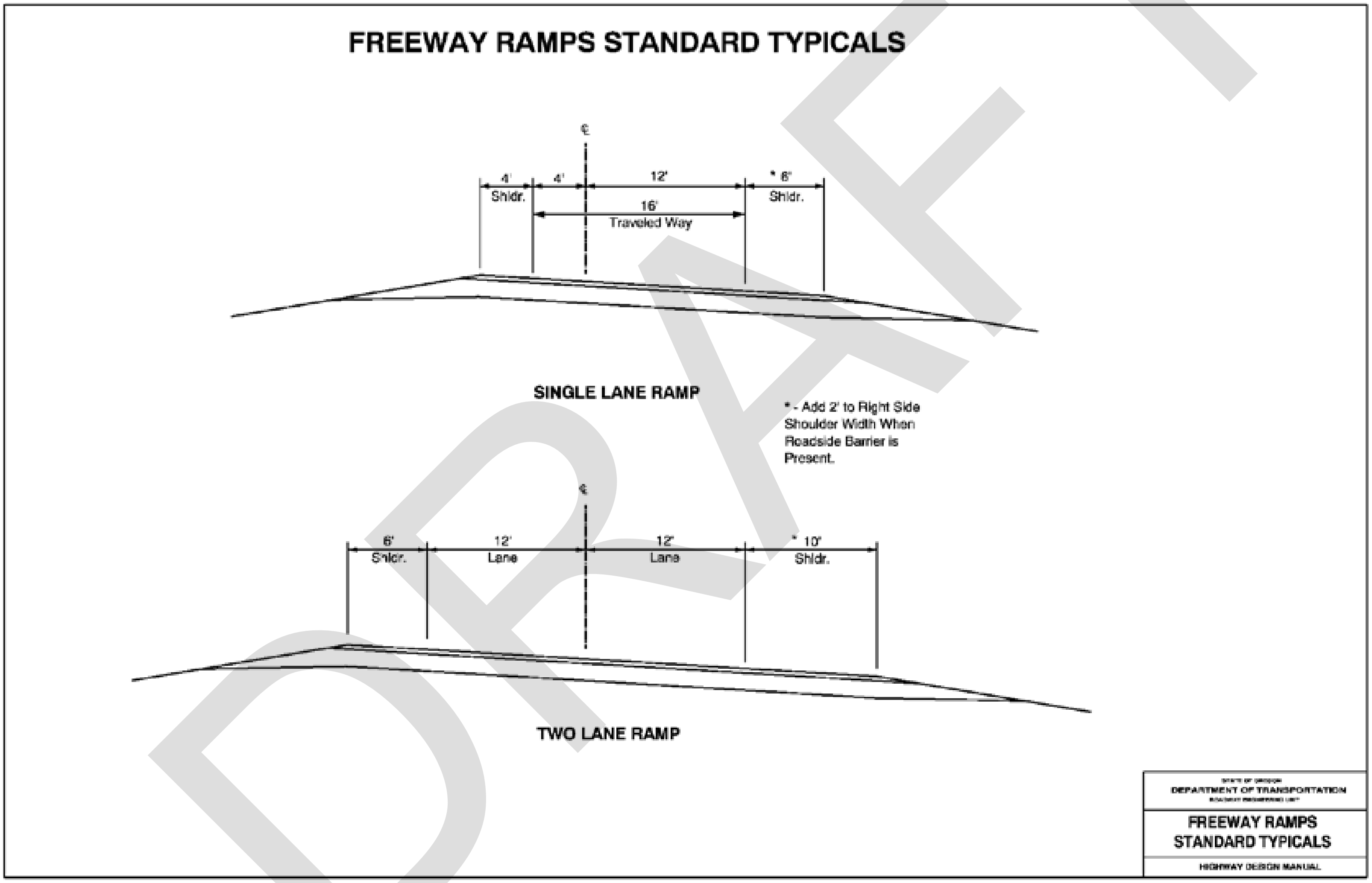
If an additional lane is being added to the ramp, it will normally only require adding eight feet of width – enough to get two 12 foot wide travel lanes. If multiple lanes are needed, they should all be a minimum of 12 feet wide. More width may be needed to accommodate truck offtracking on relatively sharp curvature. Use a taper rate of at least 10:1 when adding the width. The width can be added either to the left or right of the horizontal alignment as appropriate. Always evaluate truck offtracking as part of the ramp design process. **A ramp that adds lanes downstream of the exit is still considered a single lane exit. Likewise, entrance ramps that have multiple lane upstream from the gore area are considered single lane ramps. Single lane criteria apply in these cases**.

Two lane interchange ramps are normally only used at system interchanges, although there are a few two lane loop connections on ODOT facilities that use two lane criteria. **Two-lane ramps consist of two 12 foot wide lanes, ten foot right and 6 foot left shoulders for a total of 40 feet width.** *Two lane loops should use the same cross section.* Two lane entrances and exits between service interchanges normally use single lane ramp shoulders. When standard shoulders are provided and barriers are present on two-lane ramps, no additional shoulder width is normally necessary (apart from the 2-foot “e” distance to right side barriers). When tighter horizontal geometry requires extra width for truck offtracking (as on loop ramps), or horizontal sight lines are restricted, more width may be necessary. The horizontal alignment for two-lane ramps is carried on the center of the traveled way (on the skip stripe between the two lanes). If more lanes are added past the gore, the location of the horizontal alignment remains the in the same place.

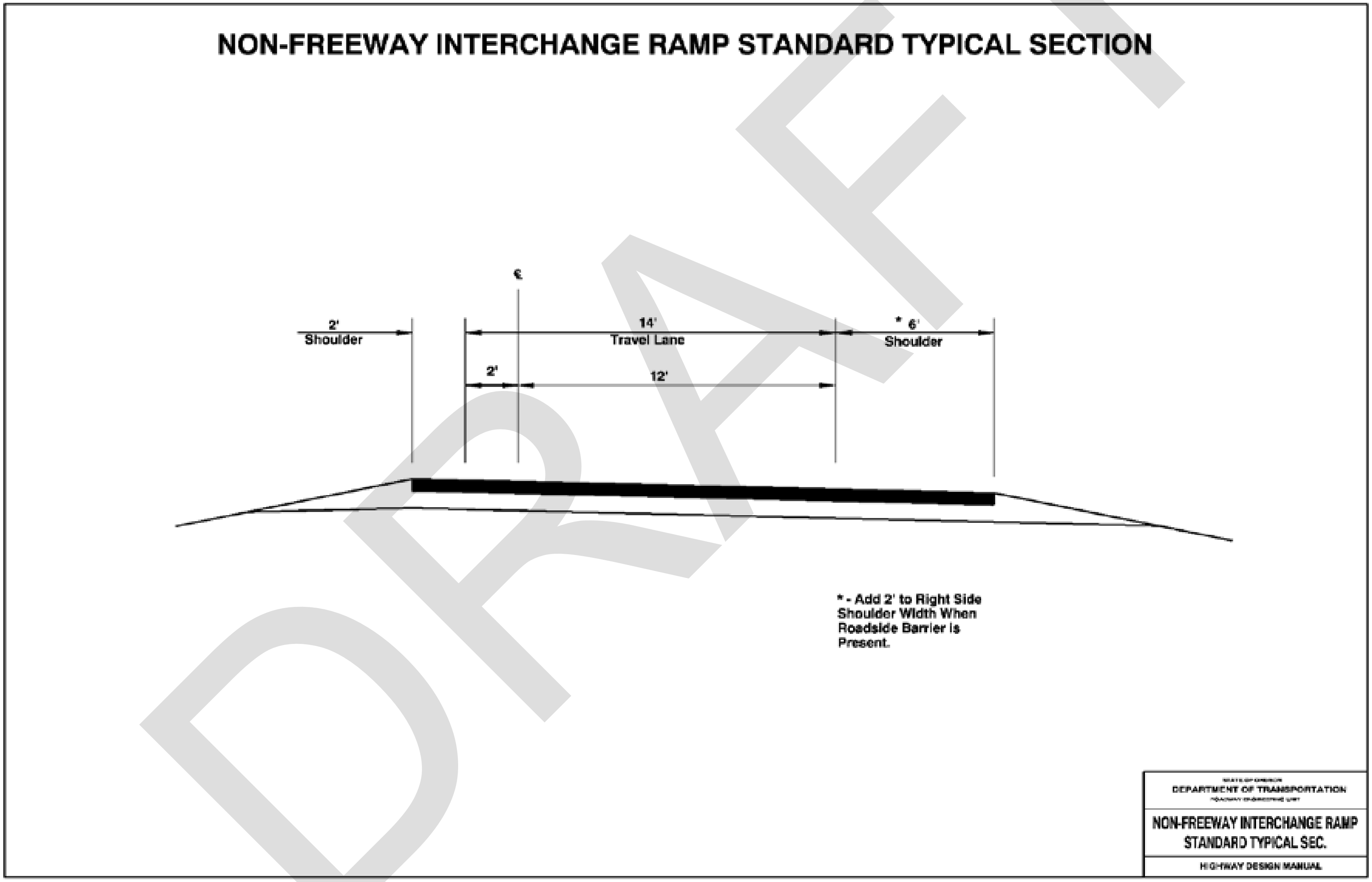
Non-freeway ramps can take different forms, and may have slightly reduced typical cross section dimensions. Refer to Figure 600-33 for those dimensions. The horizontal alignment in that case is carried 2 feet from the left edge of traveled way. As with freeway style ramps, add 2 feet (also referred to as “e” distance) to the right shoulder width when roadside barriers are present, but not to the left shoulder.

Many non-freeway ramps are basically the same configuration as the freeway style with slightly reduced cross sectional dimensions. Jug-handle style ramps often have two-way operations and require a physical separator between directions of travel. Concrete median barrier is often not appropriate for this situation. A raised traffic separator (as shown in Standard Drawing RD706) is often preferable. Each direction of travel on jug handle ramps needs to be the same width as shown in Figure 600-33 (22’ total).

Figure 600-32: Freeway Ramps Standard Typical Sections



1 Figure 600-33: Non-Freeway Interchange Ramp Typical Section



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605.10 Loop Ramps

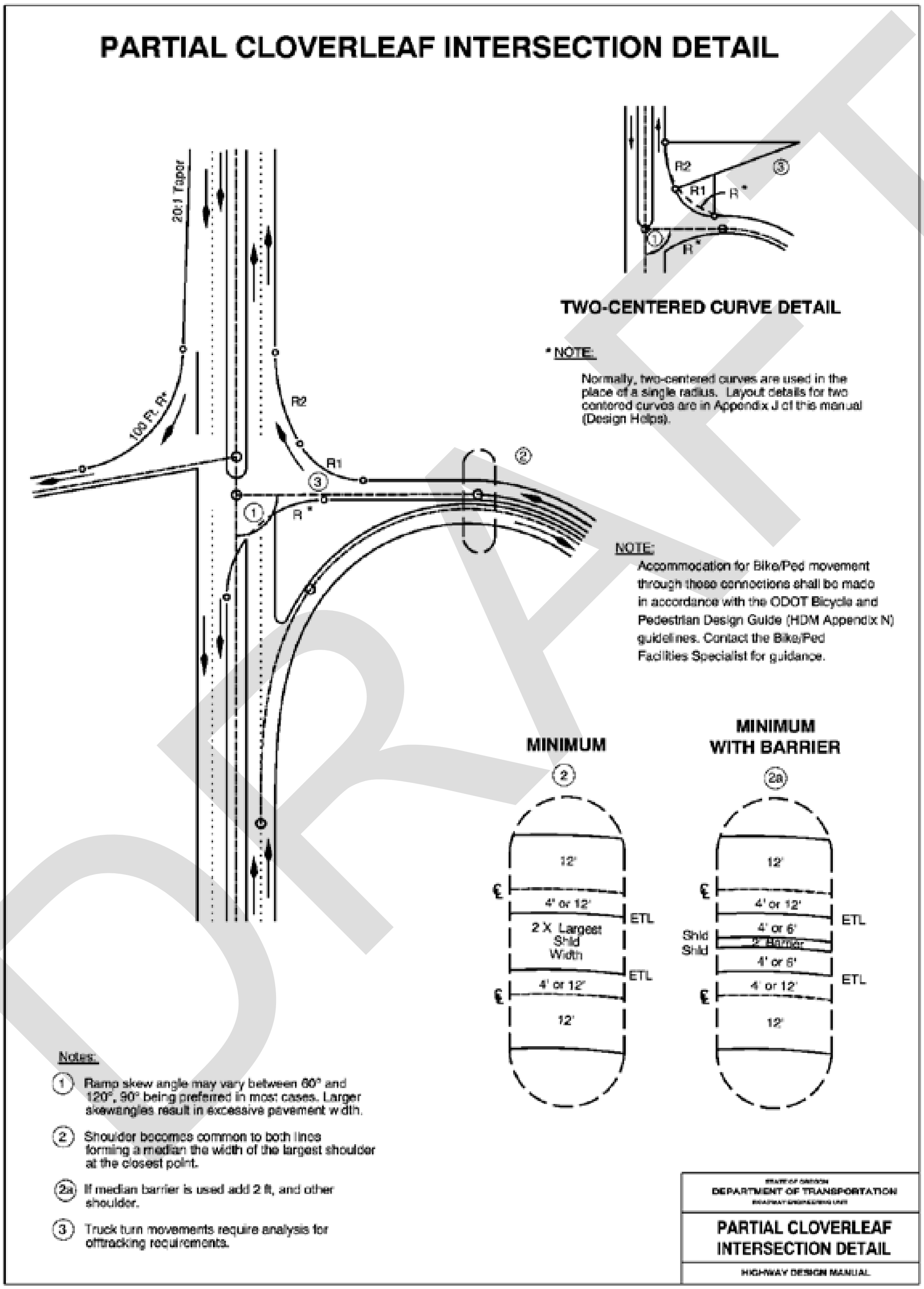
Loop ramps should be as large as practical and with a minimum of a 36 degree curve. When designing an exit loop ramp where the crossroad is below the freeway, the maximum degree of curve should be 30 degree, and using spirals longer than the standard is recommended. Details for fitting loop ramp horizontal alignments are located in Figure 600-36 and Figure 600-37. Loop ramp connections usually come parallel to the crossroad using a spiral rather than an angled connection, but can also terminate at a regular intersection. Figure 600-34 and Figure 600-35 show details for loop intersections at crossroads.**Error! Bookmark not defined.**

Adjacent loop ramps on the same side of the freeway are not usually permitted unless the weaving section is carried on a Collector-Distributor (C-D) road. Free flowing Loop ramps on the same side of the crossroad are discouraged due to the short weaving section normally available between them.

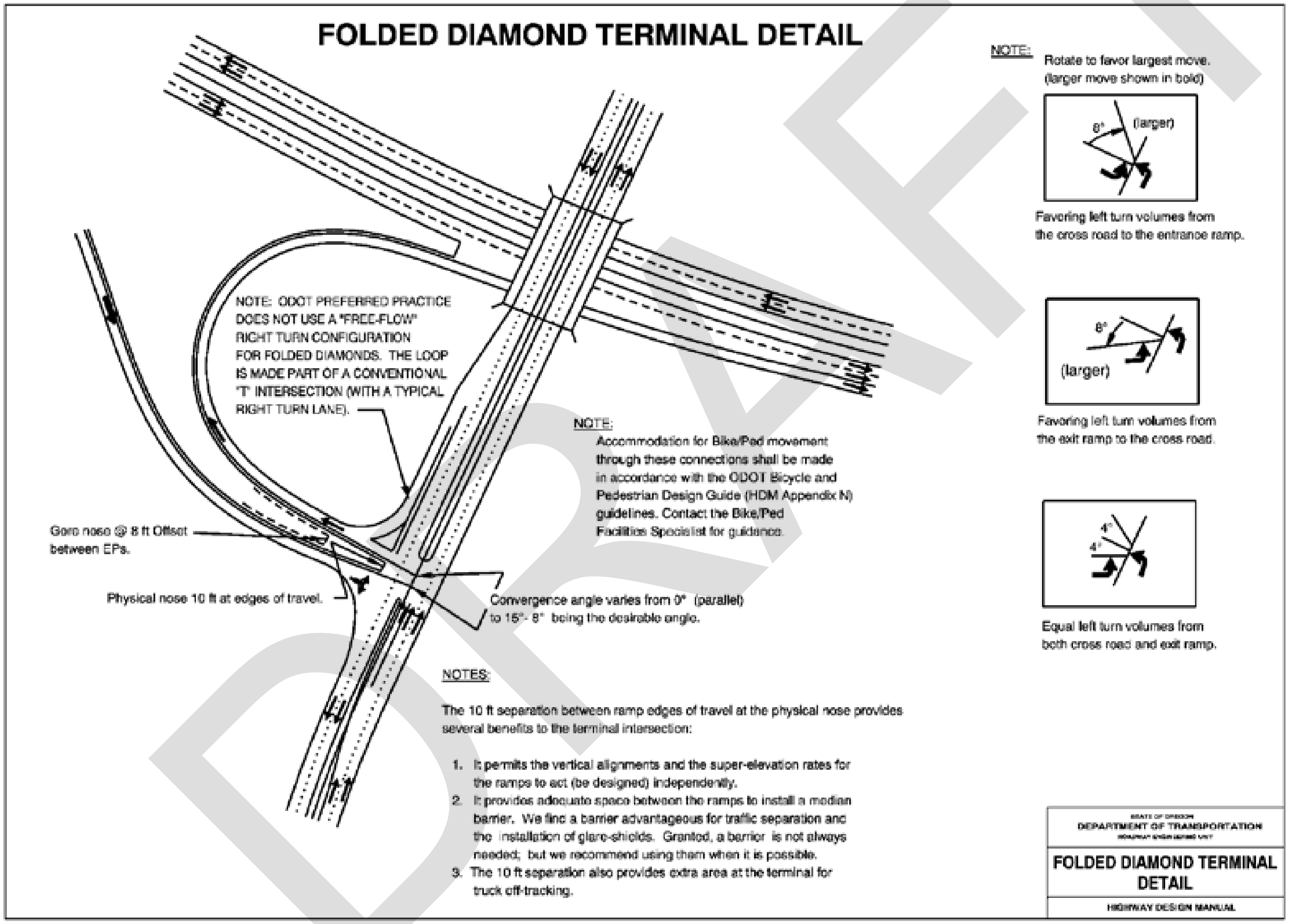
Loop ramp intersections with the crossroad must make appropriate provision for bicycle and pedestrian traffic. For rural interchanges the configuration shown in Figure 600-34 is typically the appropriate design. In urban or urbanizing areas, the treatment in Figure 600-35 is normally the most appropriate configuration. Each location must be evaluated for the most appropriate treatment to use, based on current and projected traffic conditions, the physical constraints on the roadway design, and other factors such as potential land use changes in the interchange area. HDM Part 800 and 900 provide guidance for various design situations. Contact the ODOT Bicycle and Pedestrian Design Engineer for additional guidance.

Loop exit ramps have issues that make their use undesirable in some situations. Deceleration areas need to be substantially longer due to tight radii on the ramps, especially on downgrades. When the loop is located beyond a grade separation structure and fills, it is not as visible to approaching users. Increasing the length of the structure to provide greater visibility can create longer spans (or more short spans with barriers) and can be costly. Significant superelevation is needed on the sharper curves, and this can create problems in areas with snow and icing issues. Trucks also have more issues negotiating the sharper curves. When loops exit on a downgrade, such as in a depressed interchange, many of the above issues can combine to create operational problems. When considering new interchanges, designs that include loop exits should be used with caution. Existing loop exits need to be evaluated to make sure they sufficiently provide for the above concerns. It may be infeasible to deal with every issue, but opportunities for making incremental improvements should always be sought.

Figure 600-34: Partial Cloverleaf Intersection Detail



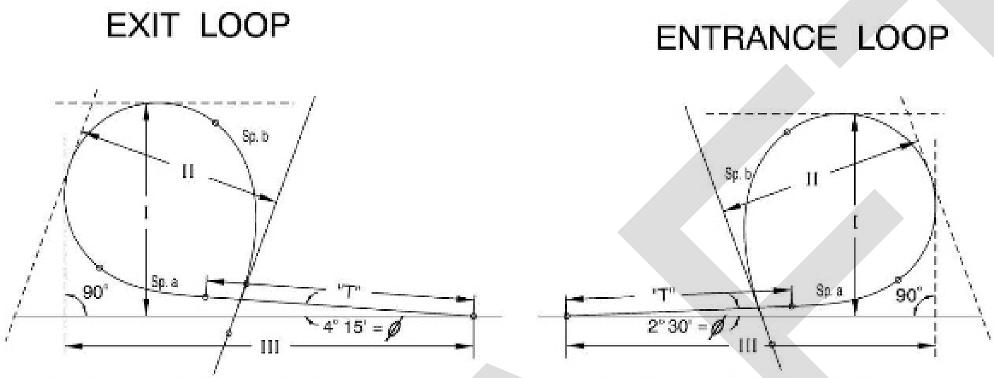
1 Figure 600-35: Folded Diamond Terminal Detail



2

Figure 600-36: Loop Fitting Data (Single Lane)

LOOP FITTING DATA (1 LANE)



I = (R+p)cos Ø + (T+q)sin Ø + R

II = 2R + p_b

III = (T+q)cos Ø - (R+p)sin Ø + R

Highway Design Speed=70 mph															
								EXIT				ENTRANCE			
SPEED MPH	CURVE RADIUS	Sp. a LENGTH	p_a	q_a	Sp. b LENGTH	p_b	q_b	* "T"	I	II	III	"T"	I	II	III
30	238.73	200	6.9377	99.4180	400	27.2356	195.4112	420	522.2203	504.7005	738.5158	366.81	504.5053	504.7005	693.8000
25	220.37	200	7.5077	99.3175	400	29.3778	194.6327	450	488.3270	470.1146	751.2878	366.81	468.3598	470.1146	676.1118
25	204.63	200	8.0758	99.2092	400	31.4902	193.7978	450	457.4475	440.7458	736.5636	366.81	437.4563	440.7458	660.9248
25	190.99	200	8.6417	99.0931	400	33.5708	192.9079	450	430.7571	415.5427	723.7750	366.81	410.7459	415.5427	647.7373
25	179.05	200	9.2054	98.9692	400	35.6177	191.9644	450	407.4696	393.7163	712.5577	366.81	387.4418	393.7163	636.1730
25	168.52	200	9.7667	98.8376	400	37.6291	190.9687	450	386.9840	374.6631	702.6331	366.81	366.9423	374.6631	625.9442
25	159.15	200	10.3256	98.6984	400	39.6030	189.9224	450	368.8326	357.9129	693.7846	366.81	348.7793	357.9129	616.8270

** Minimum deceleration lengths for exit ramps with heavy truck volumes								
					EXIT			
SPEED MPH	CURVE RADIUS	Sp. a LENGTH	p_a	q_a	* "T"	I	II	III
30	238.73 (24°)	200	6.9377	99.4180	790	542.9707	504.7005	1017.7459
25	220.37 (26°)	200	7.5077	99.3175	835	510.1890	470.1146	1045.4766
25	204.63 (28°)	200	8.0758	99.2092	835	479.3095	440.7458	1030.7524
25	190.99 (30°)	200	8.6417	99.0931	835	452.6191	415.5427	1017.9638
25	179.05 (32°)	200	9.2054	98.9692	835	429.3316	393.7163	1006.7465
25	168.52 (34°)	200	9.7667	98.8376	835	408.8460	374.6631	996.8219
25	159.15 (36°)	200	10.3256	99.6984	835	390.6946	357.9129	987.9734

NOTES:

* Exit Loop "T" Distances variable for grades in excess of 3%.

** Consideration for use should be given whenever truck volumes reach or exceed 6 trucks per hour.

A 36° exit loop is considered very minimal for design; using 30° or flatter is highly desirable.

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LOOP FITTING DATA (1 LANE)

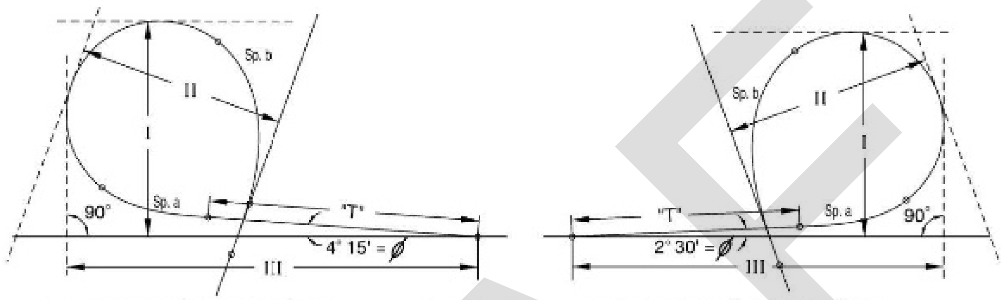
HIGHWAY DESIGN MANUAL

Figure 600-37: Loop Fitting Data (Two Lane)

LOOP FITTING DATA (2 LANE)

EXIT LOOP

ENTRANCE LOOP



I = (R+p)cos ø + (T+q)sin ø + R

II = 2R + p_b

III = (T+q)cos ø - (R+p)sin ø + R

Highway Design Speed=70 mph																
								EXIT				ENTRANCE			
SPEED MPH	CURVE RADIUS	Sp. a LENGTH	p_a	q_a	Sp. b LENGTH	p_b	q_b	* "T"	I	II	III	"T"	I	II	III
30	238.73	240	9.9629	118.9964	400	27.2356	195.4112	510	533.3578	504.7005	847.5688	550.2141	516.3816	504.7005	896.4580
25	220.37	240	10.7762	118.8236	400	29.3778	194.6327	540	499.7018	470.1146	860.2506	550.2141	480.4760	470.1146	878.6869
25	204.63	240	11.5856	118.6375	400	31.4902	193.7978	540	469.0573	440.7458	845.4309	550.2141	449.8103	440.7458	863.4117
25	190.99	240	12.3907	118.4381	400	33.5708	192.9079	540	442.5992	415.5427	832.5415	550.2141	423.3352	415.5427	850.1306
25	179.06	240	13.1911	118.2255	400	35.6177	191.9644	540	419.5412	393.7163	821.2182	550.2141	400.2637	393.7163	838.4673
25	168.52	240	13.9867	118.0000	400	37.6291	190.9687	540	399.2822	374.6631	811.1825	550.2141	379.9941	374.6631	828.1344
25	159.15	240	14.7771	117.7616	400	39.6030	189.9224	540	381.3544	357.9129	802.2180	550.2141	362.0581	357.9129	818.9081

** Minimum deceleration lengths for exit ramps with heavy truck volumes								
					EXIT			
SPEED MPH	CURVE RADIUS	Sp. a LENGTH	p_a	q_a	* "T"	I	II	III
30	238.73 (24°)	240	9.9629	118.9964	790	554.1082	504.7005	1126.7988
25	220.37 (26°)	240	10.7762	118.8236	835	521.5638	470.1146	1154.4394
25	204.63 (28°)	240	11.5856	118.6375	835	490.9193	440.7458	1139.6197
25	190.99 (30°)	240	12.3907	118.4381	835	464.4612	415.5427	1126.7303
25	179.06 (32°)	240	13.1911	118.2255	835	441.4032	393.7163	1115.4070
25	168.52 (34°)	240	13.9867	118.0000	835	421.1442	374.6631	1105.3714
25	159.15 (36°)	240	14.7771	117.7616	835	403.2164	357.9129	1096.4068

NOTES:

* Exit Loop "T" Distances variable for grades in excess of 3%.

** Consideration for use should be given whenever truck volumes reach or exceed 6 trucks per hour.

A 36° (R-159.15') exit loop is considered very minimal for design; using 30° (R-190.99') or flatter is highly desirable.

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ROADWAY ENGINEERING UNIT

LOOP FITTING DATA (2 LANE)

HIGHWAY DESIGN MANUAL

605.11 Frontage Roads and Outer Separations

The area between the traveled ways of a through traffic roadway and a frontage road or street is called the outer separation. **Outer separations shall be a minimum of 33 feet (desirably 40 feet)** between edge of travel lanes for one way frontage roads with traffic proceeding in the same direction as the adjacent freeway or expressway traffic. **A minimum of 40 feet (desirably 50 feet)** is the required outer separations for frontage roads having two way traffic. **These same minimums also apply between ramps and frontage roads**. **Screening of headlight glare should be used on frontage roads with two way traffic or traffic opposing the main roadway or ramp traffic.** These outer separation requirements should not be confused with the ramp terminal and roadway spacing standards (OAR Section 734-051 criteria).

A thorough study should be made to determine appropriate widths of outer separations on ground level freeways. The outer separation should be as wide as can be economically attained to provide a safe buffer zone (see AASHTO's *"A Policy on Geometric Design of Highways and Streets – 2018"*, page 8-5).

At intersections on major streets and on expressways, outer separations shall be minimum of 40 feet (desirably 65 feet) to provide room for turning movements.

Intersections of roads or streets with a crossroad having a structure shall be located 200 feet or more from the end of the structure to improve sight distance for vehicles on the intersecting facilities, unless the intersections are signalized. This applies to grade separations without ramps (non-interchanges). Spacing to crossroad intersections (including frontage roads) in the vicinity of interchanges is subject to OAR Chapter 734-051 criteria.

Section 606 Non-Freeway Interchange Design

606.1 General

The types of interchange designs on highways other than freeways are quite varied. They can range from freeway designs to intersection right in/out jug handles. Many of the design standards for freeway interchange design are also applicable to non-freeway interchange design. Unless otherwise noted below, the freeway design standards generally apply to non-freeway designs as well. However, other design elements and issues related to non-freeway design are also discussed below.

606.2 Interchange Spacing

Table 600-2 shows the access spacing standards for non-freeway locations. The spacing shown is measured crossroad to crossroad centerline distance. Other access management spacing standards such as the distance between the ramp terminal and the first approach or first full intersection, and the distance between start and end of tapers of adjacent interchanges need to comply with the OAR Chapter 734-051 spacing standards or **obtain a spacing deviation, approved by the Region Access Management Engineer (RAME).**

606.3 Design Speed

As with freeway style interchanges, the design speed of the ramps should be between 50% and 85% of the design speed of the mainline. **However, the ramp design speed should never be below 25 mph.**

606.4 Typical Section

The design of the crossroad should be the same as for freeways. The ramp cross sections may be different, however. Non-freeway ramp sections *can use the Stypical section shown in Figure 600-33 when using "jug handle' style designs.* **If the interchange is a more typical open road type design, using the regular freeway ramp typical section is preferred.**

606.5 Access Control

In addition to controlling access at the ramp terminals at the crossroad, access control along the mainline needs to be acquired upstream and downstream of the deceleration and acceleration lanes. **Access needs to be controlled one mile (urban)/two miles (rural) in advance of a deceleration lane and one mile (urban)/two miles (rural) downstream of an acceleration lane.** Achieving the access spacing may be very difficult on already developed existing roadways and often requires a spacing deviation. OAR Chapter 734-051 contains information on access management requirements.

606.6 Deceleration Lanes

All exit ramps for non-freeway interchanges require a deceleration lane. The deceleration lane can be a freeway style exit taper with gore area or an intersection right turn deceleration lane.

Either option is adequate for loop ramp or jug handle style ramps. Interchanges that look like a standard diamond should use freeway style deceleration design.

606.7 Acceleration Lanes

The decision to use acceleration lanes will vary depending upon the speed of the highway, ramp volume, highway volume, number of lanes, level of service, and the highway roadside culture downstream from the ramp.

Acceleration lanes should generally only be used when merging with a multilane highway. Only where safety is not compromised, could acceleration lanes be considered on two lane two-way roadways. Safety can be compromised when intersections or road approaches are located in the area of the acceleration lane (even on multi-lane facilities), or if the length of the lane is inappropriate for the specific situation. Acceleration lanes that are longer than necessary may encourage their use as a passing section, while those that are too short will probably not be used effectively. Where acceleration lanes are used, they should conform to the lengths shown on Figure 600-13. Non-freeway acceleration lanes may or may not use the entrance angle design associated with freeway interchanges. Consistency among ramps and throughout sections should be maintained as much as possible. If the exit ramps utilize an exit angle, the following acceleration lane should use the entrance angle. However, each interchange and ramp needs to be evaluated separately to determine the appropriate design. Typically, if the facility uses a "freeway style" interchange, exit and entrance angles should be used. "Jughandle style" interchanges should use parallel deceleration and acceleration ramps. Refer to Figure 600-8 for examples of non-freeway interchange designs.

Acceleration lanes for at-grade intersections that are not associated with non-freeway interchange design shall follow the requirements outlined in Part 500 of this manual.

606.8 Transitional and Combination Type Facilities

Facilities that are transitioning from at-grade to grade separated connections require special attention. Mixing of at-grade and interchange type controls can create safety and operational problems. An example of this situation is when an at-grade intersection is located near the end of an interchange acceleration lane, setting up conflicting speed/lane change maneuvers.

It is also very undesirable to have an at-grade intersection in between two interchanges, even those with jughandle style ramps. It is preferable to proceed with grade separating and adding ramps in a more "linear" fashion, adding the grade separations from one intersection to the next in progression. Traffic demand, existing development, and other factors can make this approach impractical. Consideration must always be given to the likely operational and safety effects of transitioning a corridor in a non-linear fashion. **Tables 6 and 7 in OAR Chapter 734-051 give**

minimum spacing criteria to guide on planning and design for non-freeway facilities. A basic purpose of these criteria is to provide for safe operating conditions.

As a practical matter, meeting these criteria may require developing frontage road systems for local access. It may suffice to complete missing elements of the local road network (where terrain and existing development allow for it). Grade separations without ramps spaced at regular intervals provide for connectivity across the main facility.

Long-term planning for transitioning facilities should consider the need for and impact of future improvements. An example of this is the future conversion of a jughandle type interchange to a standard freeway style set of ramps. In cases where it is expected that a grade separation might be converted to an interchange, adequate spacing between other features is necessary.

Coordination between planning and project development is very important in this context. Good communication can help to minimize difficult, expensive, and sometimes not too effective afterthought fixes. Planners and engineering staff must strive to get a common understanding of problems, needs, and constraints from each others viewpoint.

Figure 600-38: Non-Freeway Interchange Example

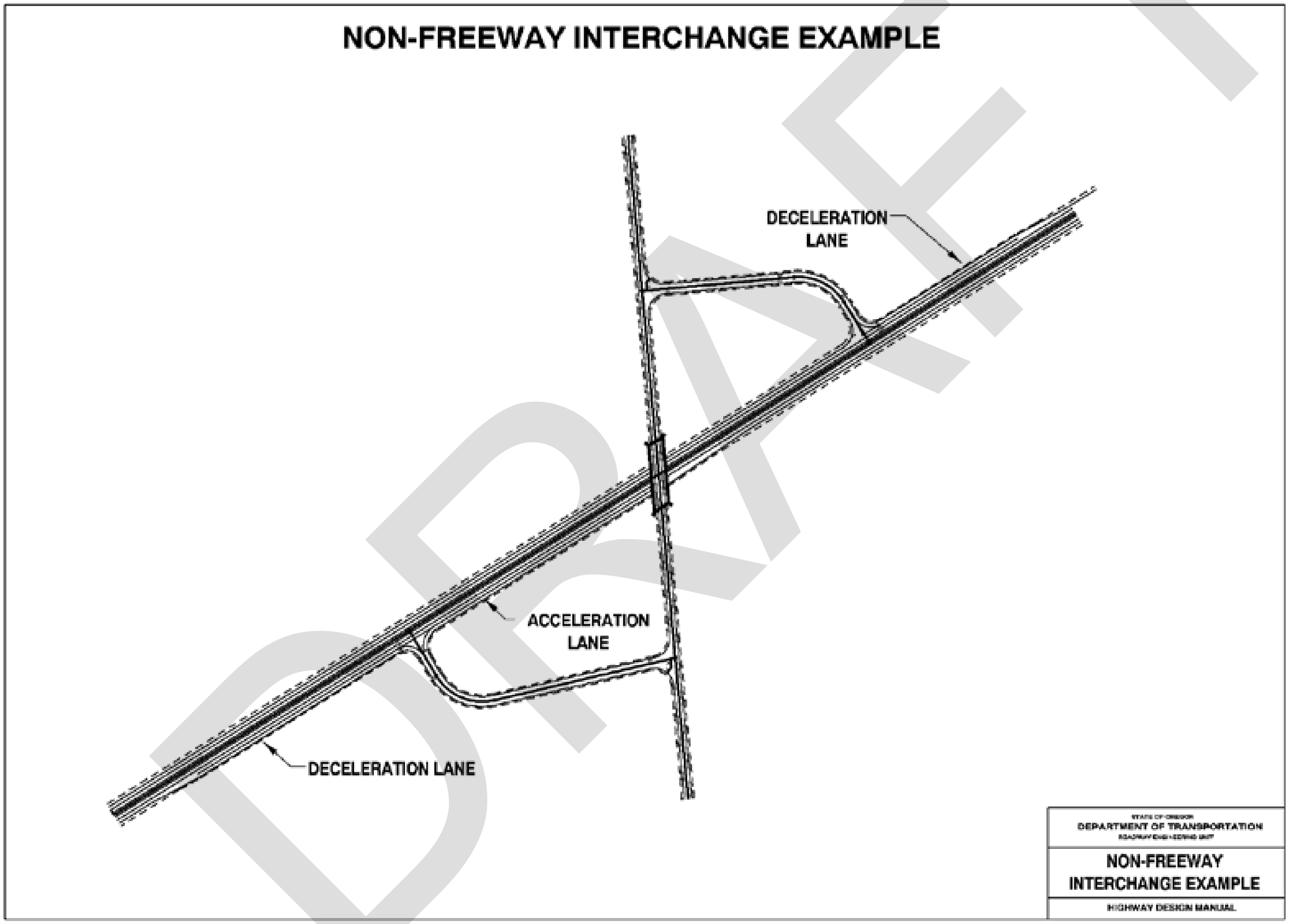
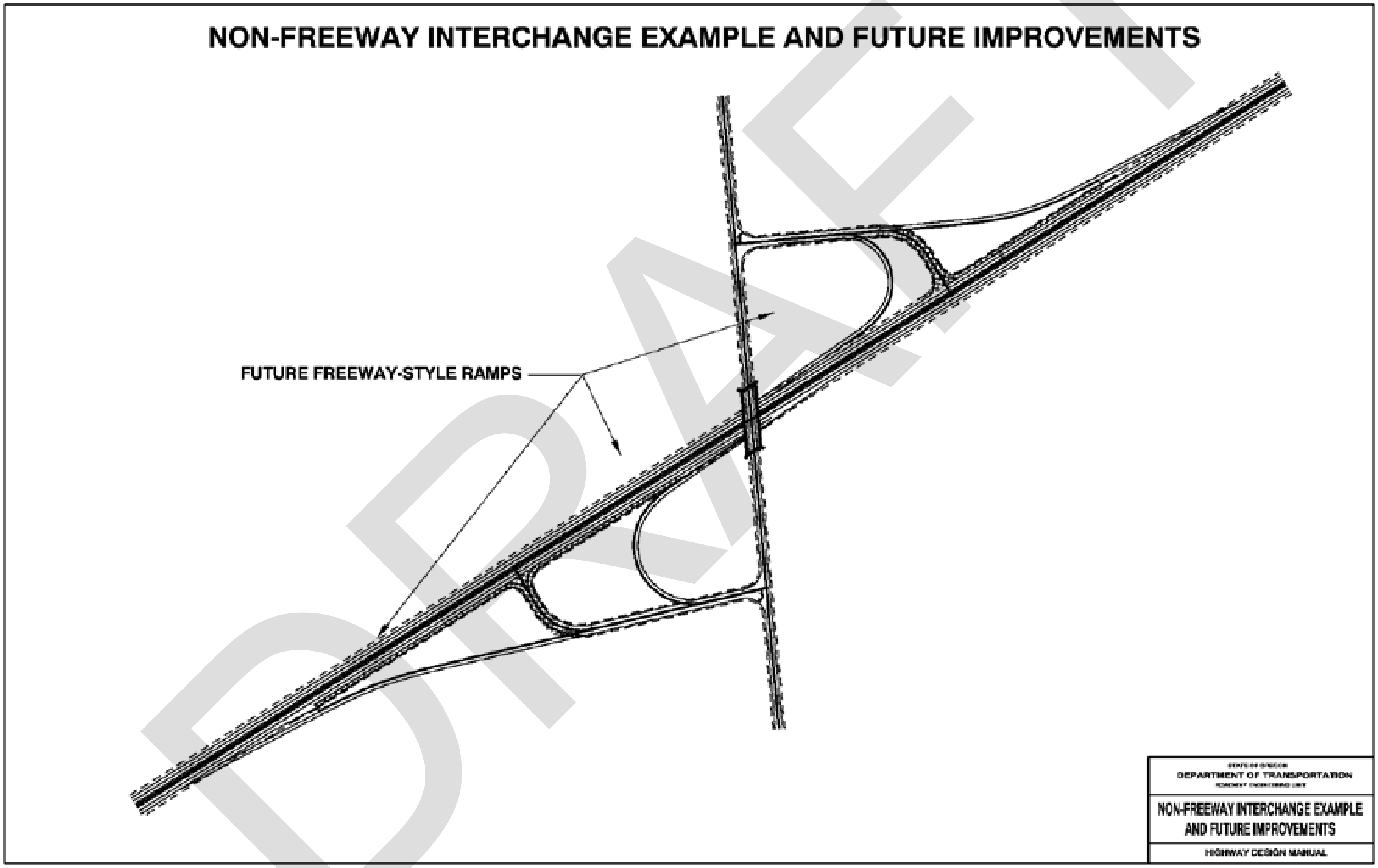


Figure 600-39: Non-Freeway Interchange Example and Future Improvements



Section 607 Accommodating Bicycles and Pedestrians

Bicycle and pedestrian movements must be accommodated through interchanges, even in rural locations. Even in urban or suburban areas where sidewalks are in place, the existing accommodations may not be suitable for current needs. It is equally important to develop the design for bikes and peds as well as vehicles. Some interchange configurations (such as the Single Point or Diverging Diamond) require multi-stage crossings and refuge islands. Occasionally it is necessary to provide separated facilities through complex interchanges. Overhead illumination may also be needed. Each discipline involved in the design (geometry, traffic, structure) needs to coordinate to ensure the needs of various users are met.

The primary conflict points for these modes are at the ramp intersections. Refer to Part 500 (Intersections), 800 and 900 (bike-ped-ADA) of this manual for detailed guidance on how to treat these areas.

For all interchange projects, designers should coordinate with the ODOT Bike/Ped Facility Specialist Region Alternative Mode specialists, and the ODOT Interchange Engineer. The combined effects of interchange operations and the context in which the interchange is located can be complex and needs a careful review.

Section 608 References and Design Aids

AASHTO "A Policy on Geometric Design of Highways and Streets - 2018"

AASHTO "A Policy on Design Standards-Interstate System - 2016"

FHWA Policy Statement on Additional Interchanges to the Interstate System – May 22, 2017 Revision

The "Oregon Highway Plan - 1999" ("OHP"), plus amendments.

Oregon Administrative Rules (OAR) Chapter 734, Division 51.

AASHTO *"A Policy on Geometric Design of Highways and Streets-2018"*- Chapter 10, pages 10-82 to 10-87

Chapter 10 of the AASHTO *"Policy on Geometric Design of Highways and Streets – 2018"*, page 10-3 to 10-5 has a detailed discussion on things to consider for each interchange warrant.

Tables 6 and 7 in OAR Chapter 734-051 give minimum spacing criteria to guide on planning and design for non-freeway facilities.

Figure 600-40: Design Aid 600-1 - Exit on Inside of Curve – Case A

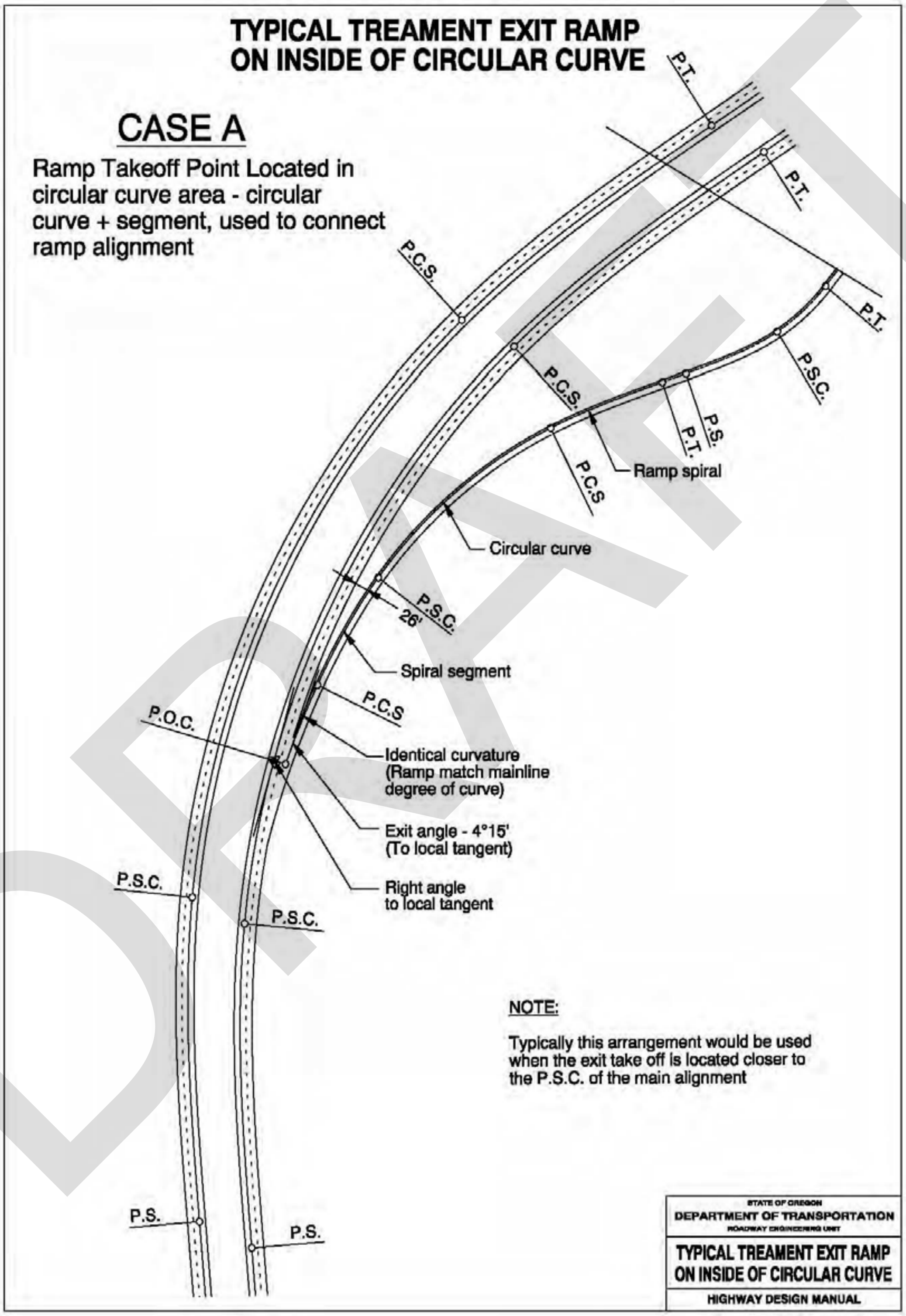


Figure 600-41: Design Aid 600-2 – Exit on Inside of Curve Case B

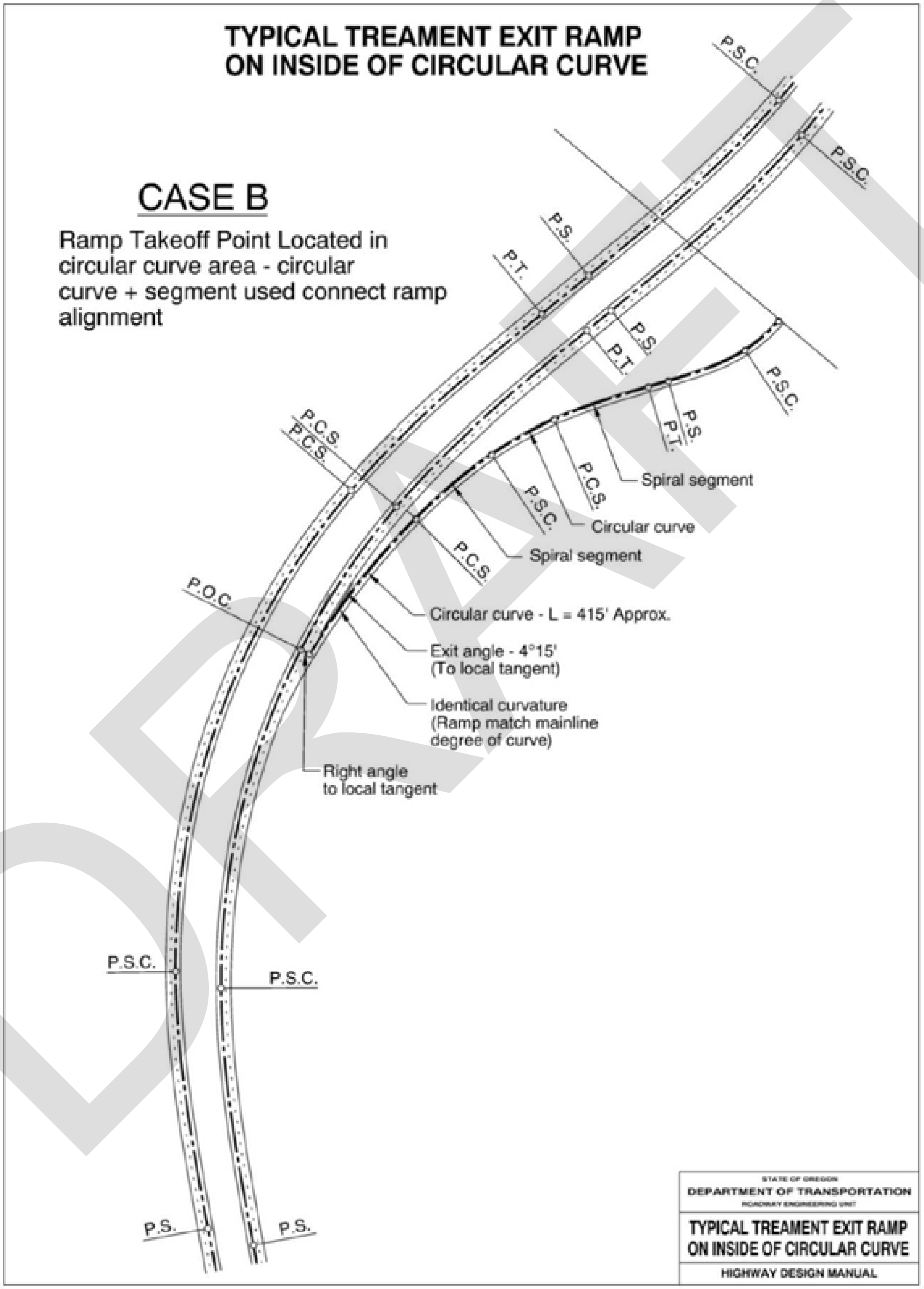
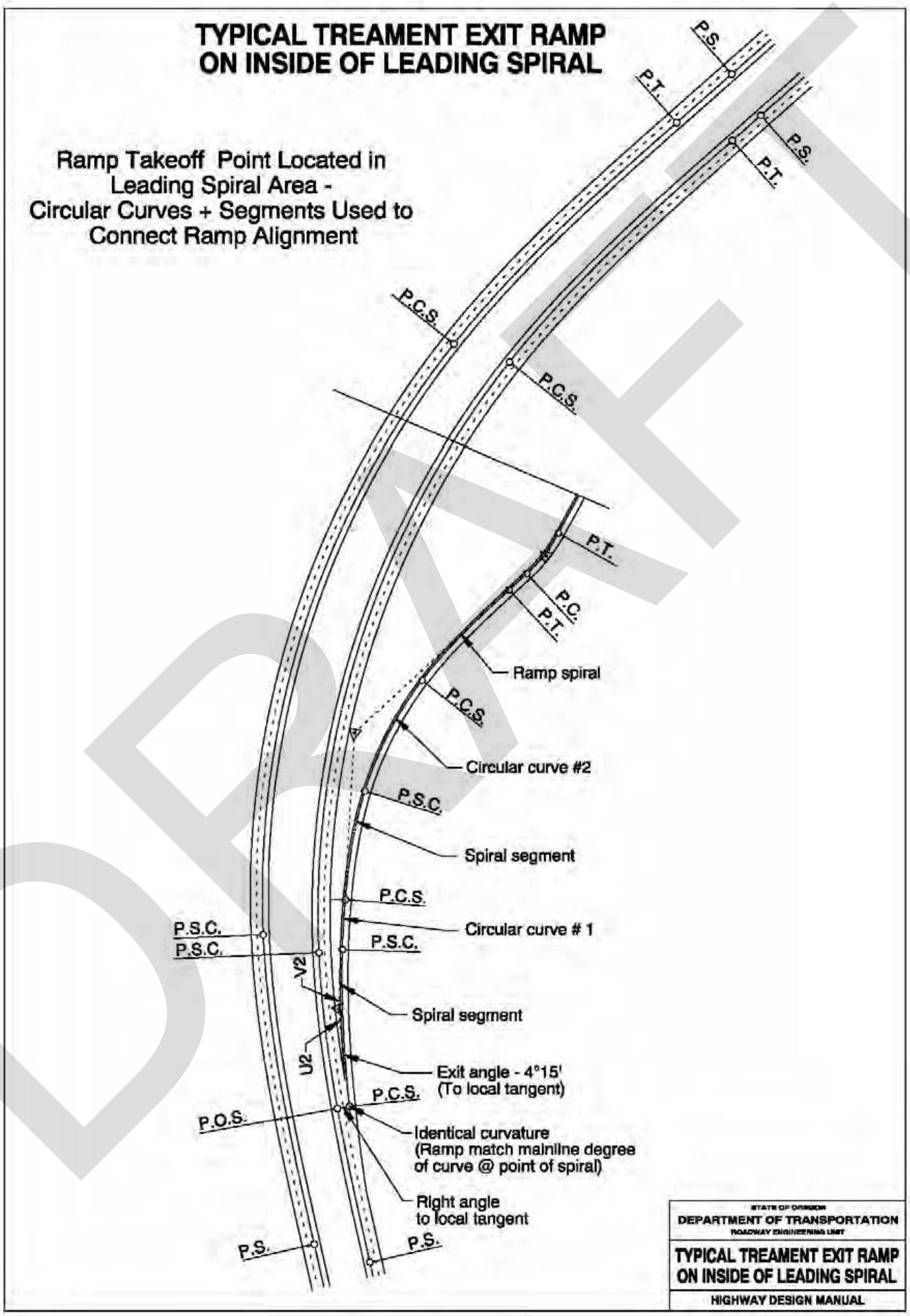
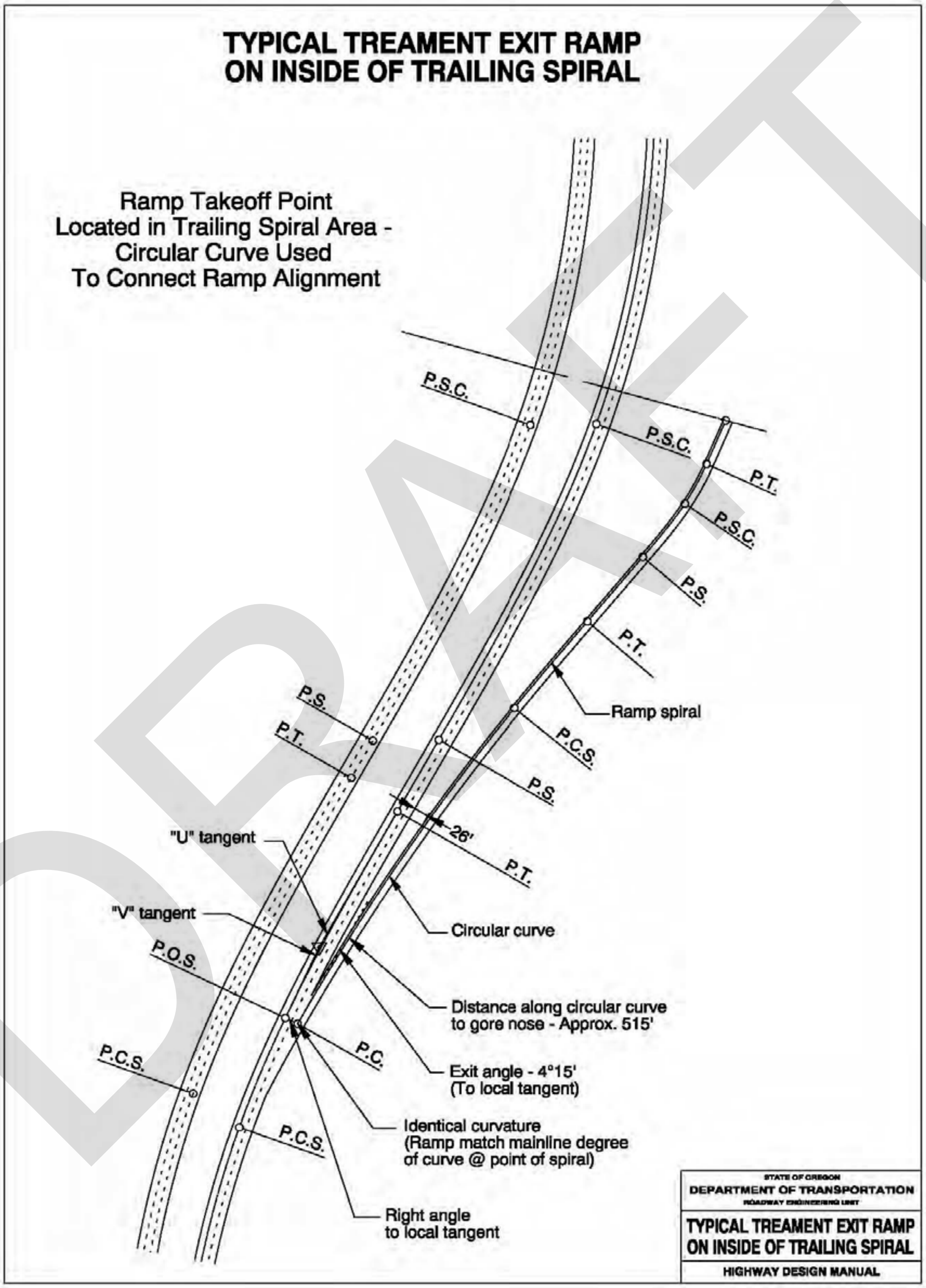


Figure 600-42: Design Aid 600-3 - Exit From Inside of Curve in Leading Spiral Area

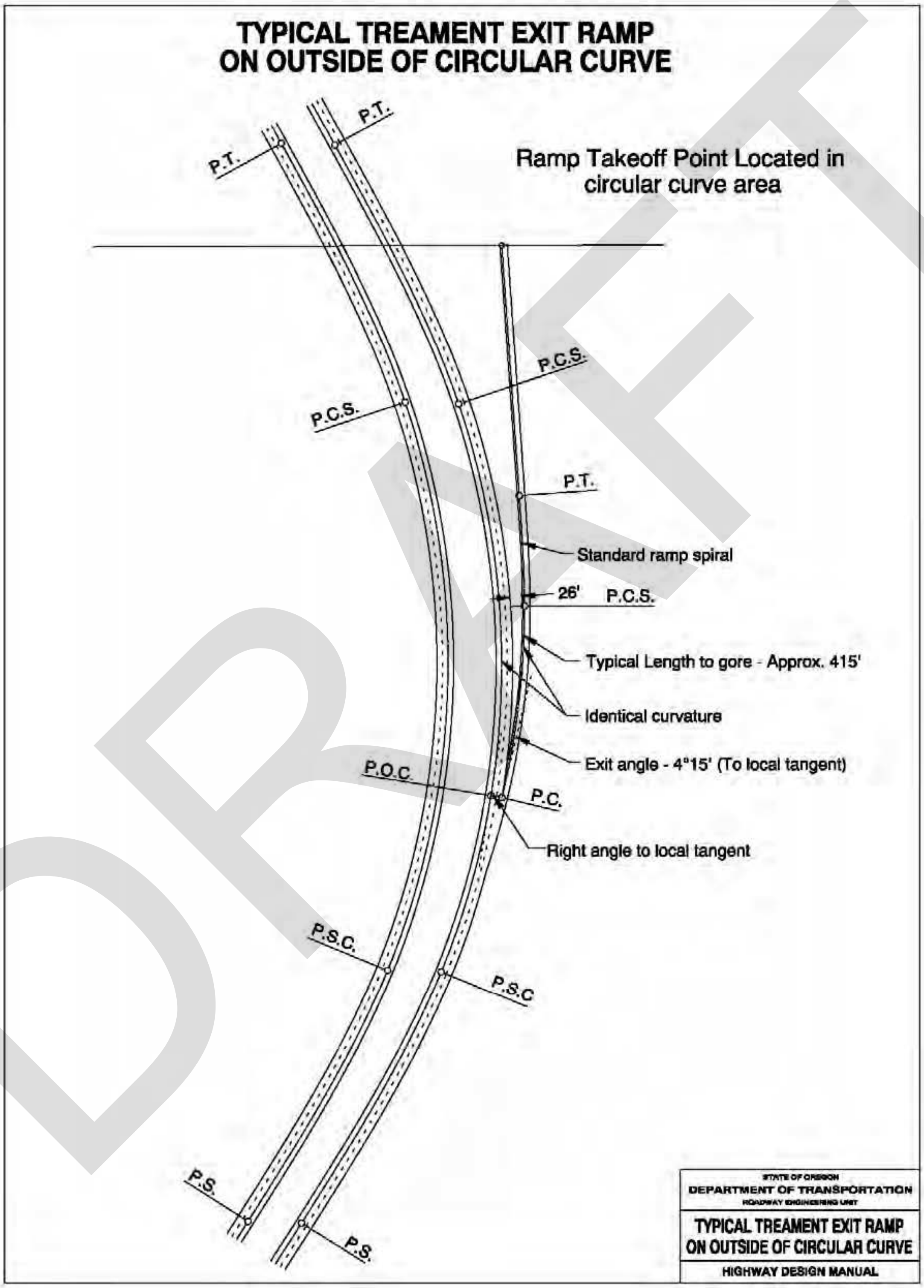


1 Figure 600-43: Design Aid 600-4 -Exit From Inside of Curve in Trailing Spiral Area

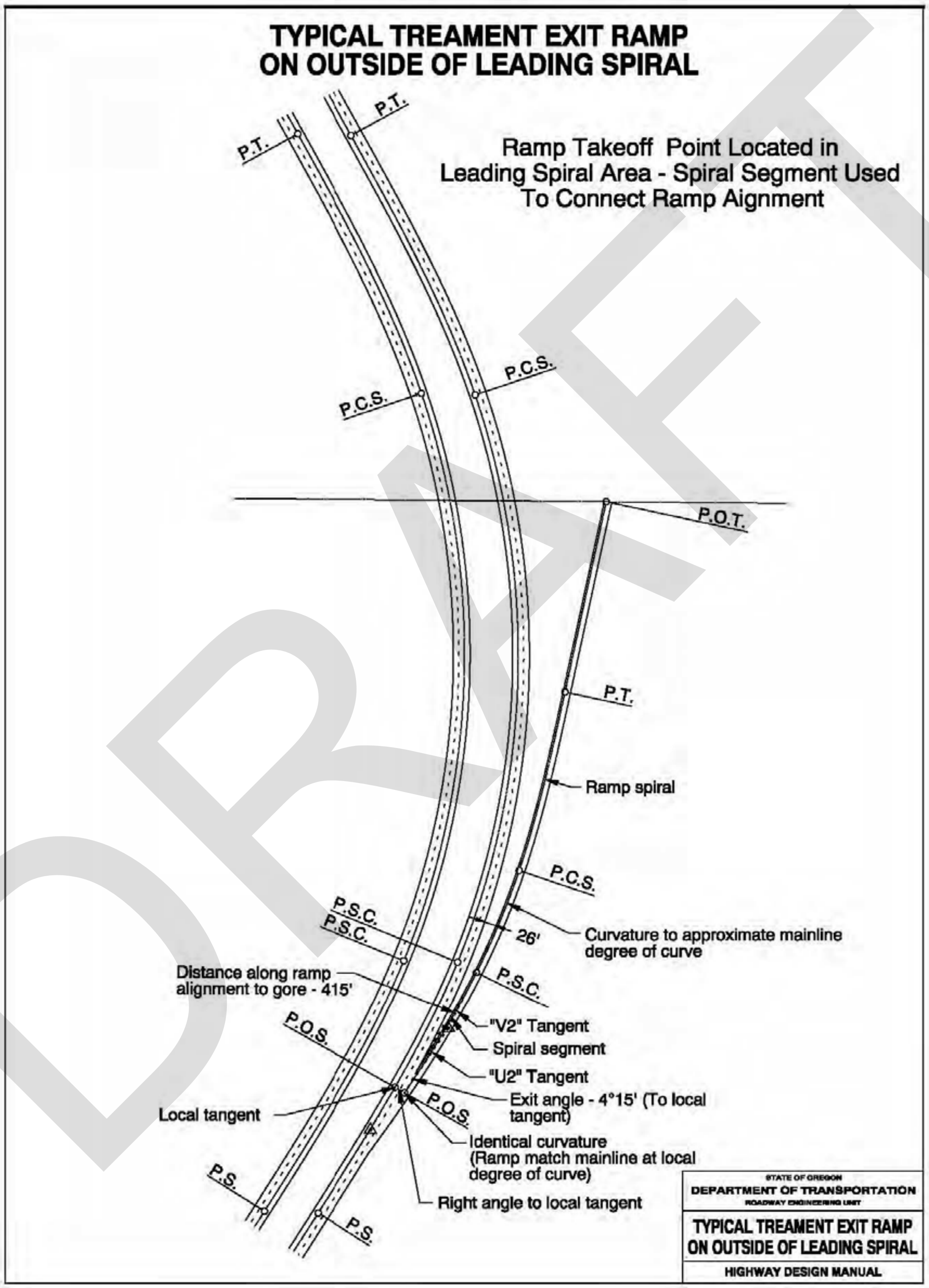


2

Figure 600-44: Design Aid 600-5 -Exit From Outside of Circular Curve

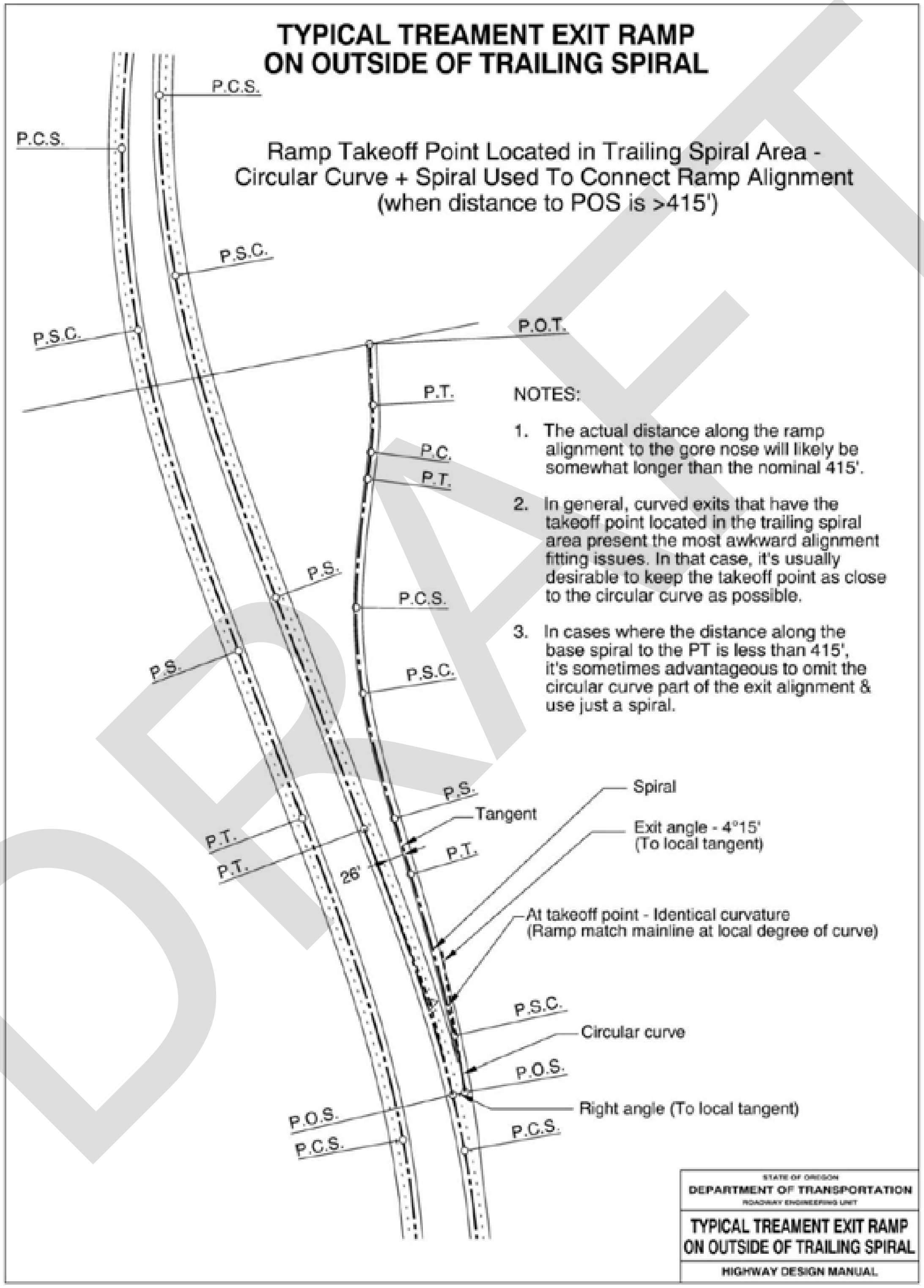


1 Figure 600-45: Design Aid 600-6 Exit on Outside of Curve in Leading Spiral Area



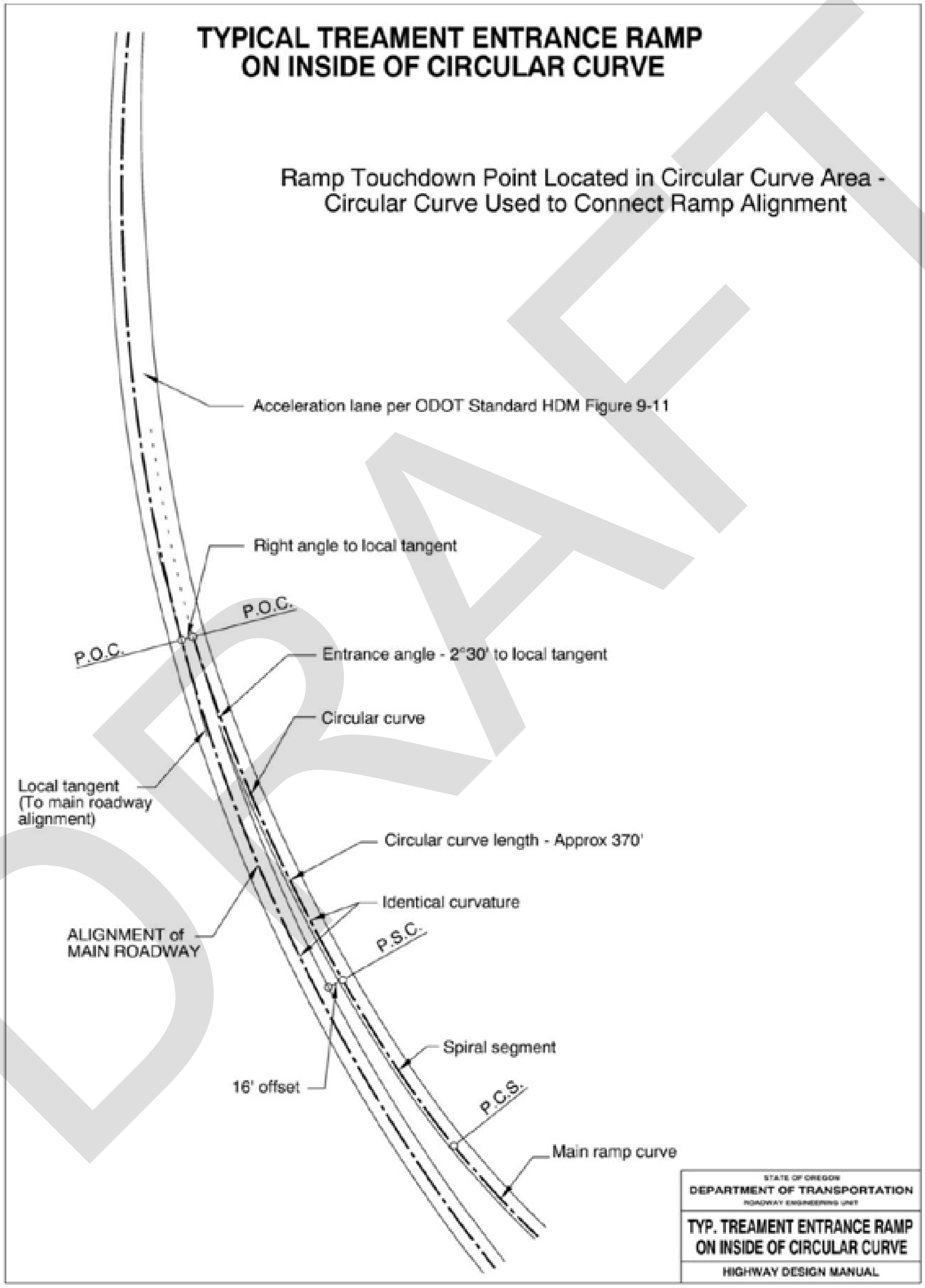
2

1 Figure 600-46: Design Aid 600-7 -Exit From Outside of Curve in Trailing Spiral Area



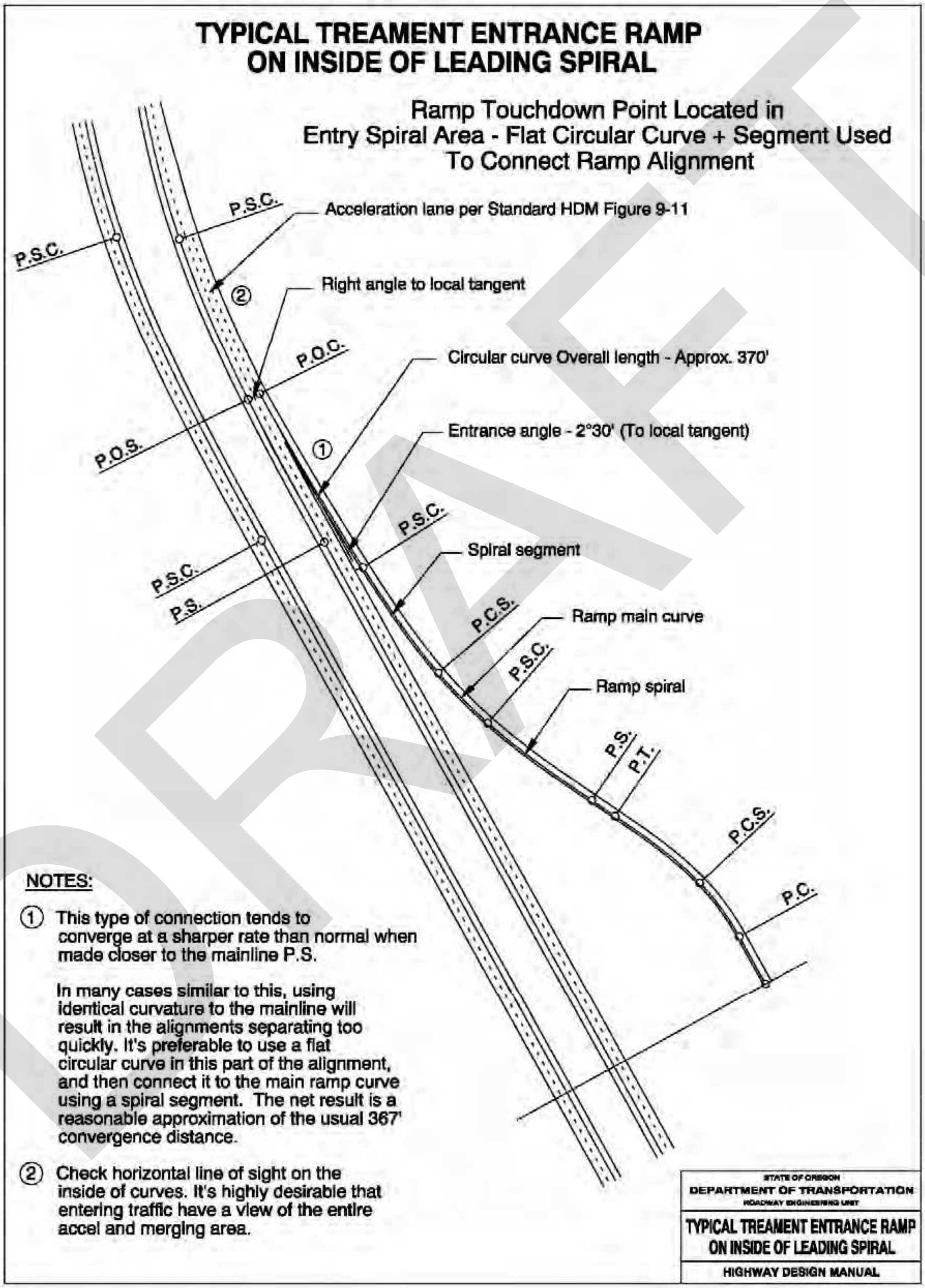
2

1 Figure 600-47: Design Aid 600-8 – Entrance on the Inside of a Circular Curve Area



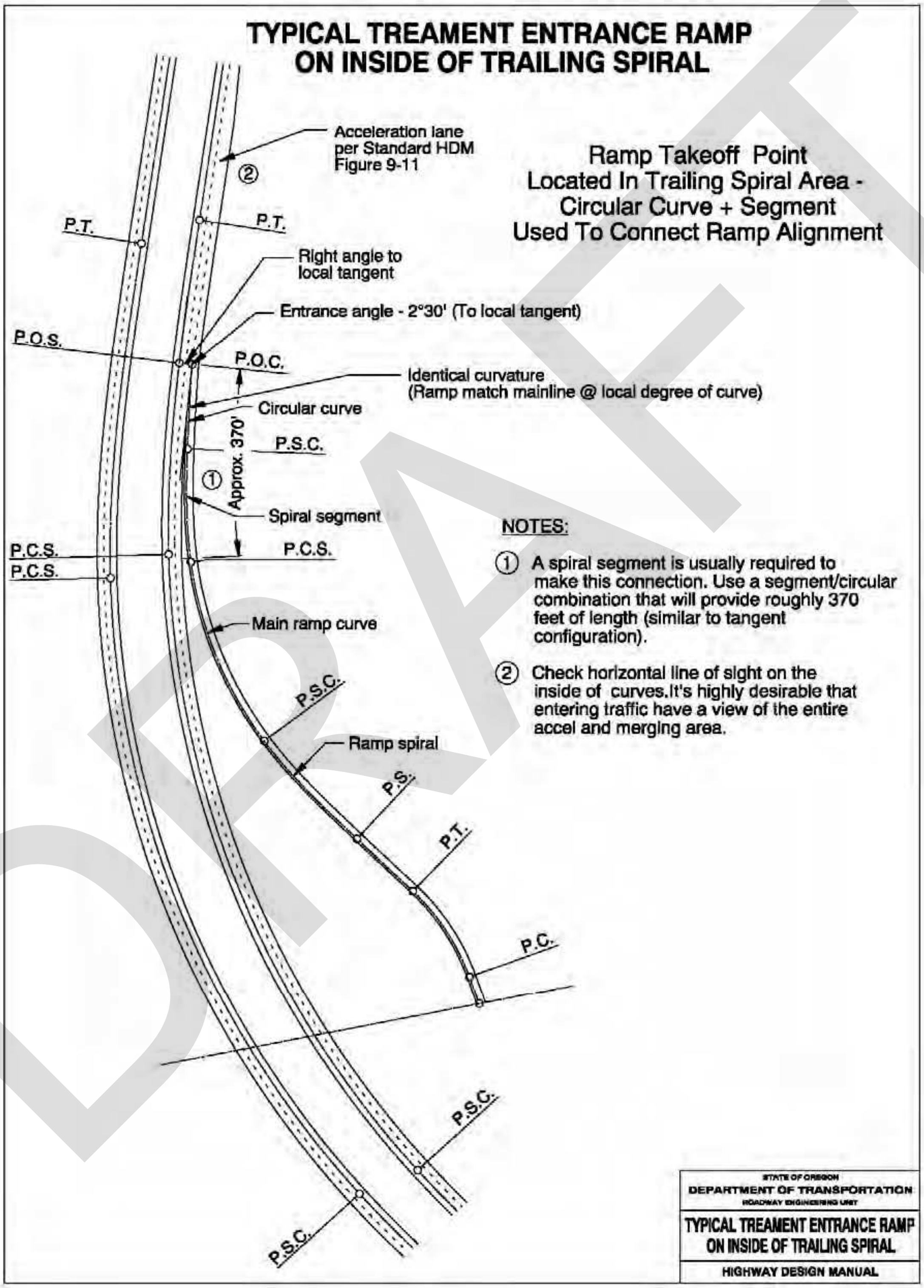
2

1 Figure 600-48: Design Aid 600-9 –Entrance on the Inside of the Leading Spiral Area



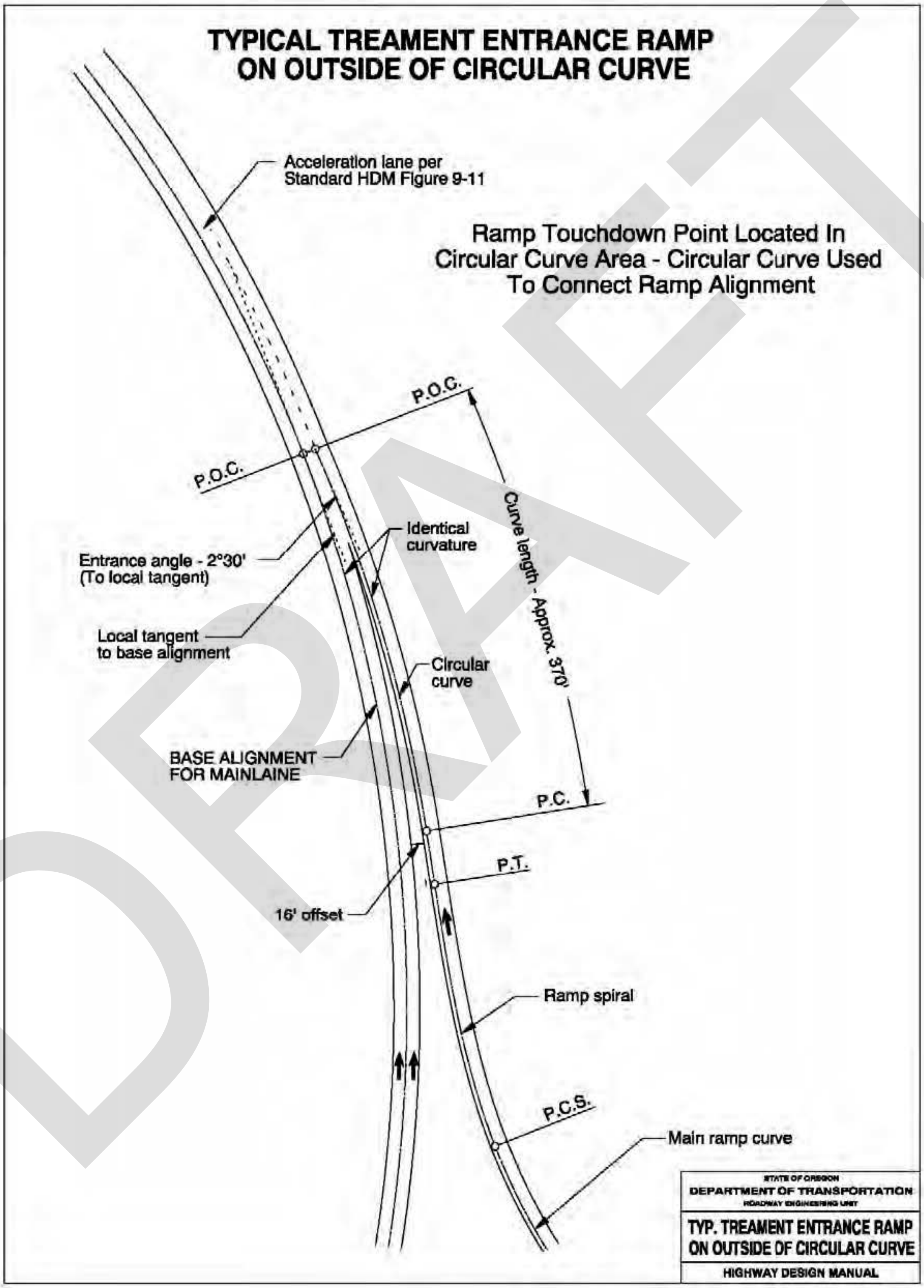
2

1 Figure 600-49: Design Aid 600-10 – Entrance on Inside in the Trailing Curve Area



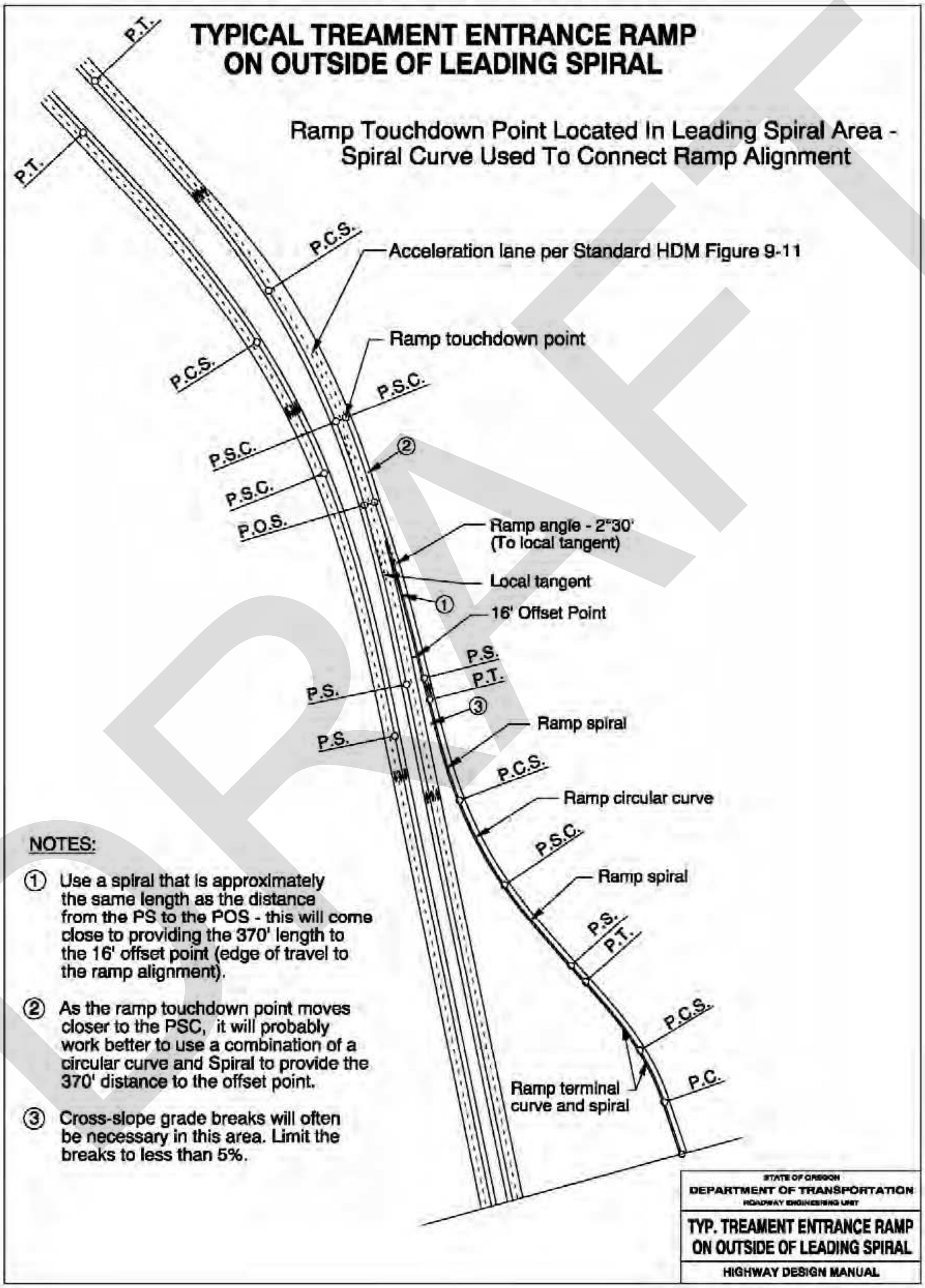
2

1 Figure 600-50: Design Aid 600-11 –Entrance on the Outside in Circular Curve Area

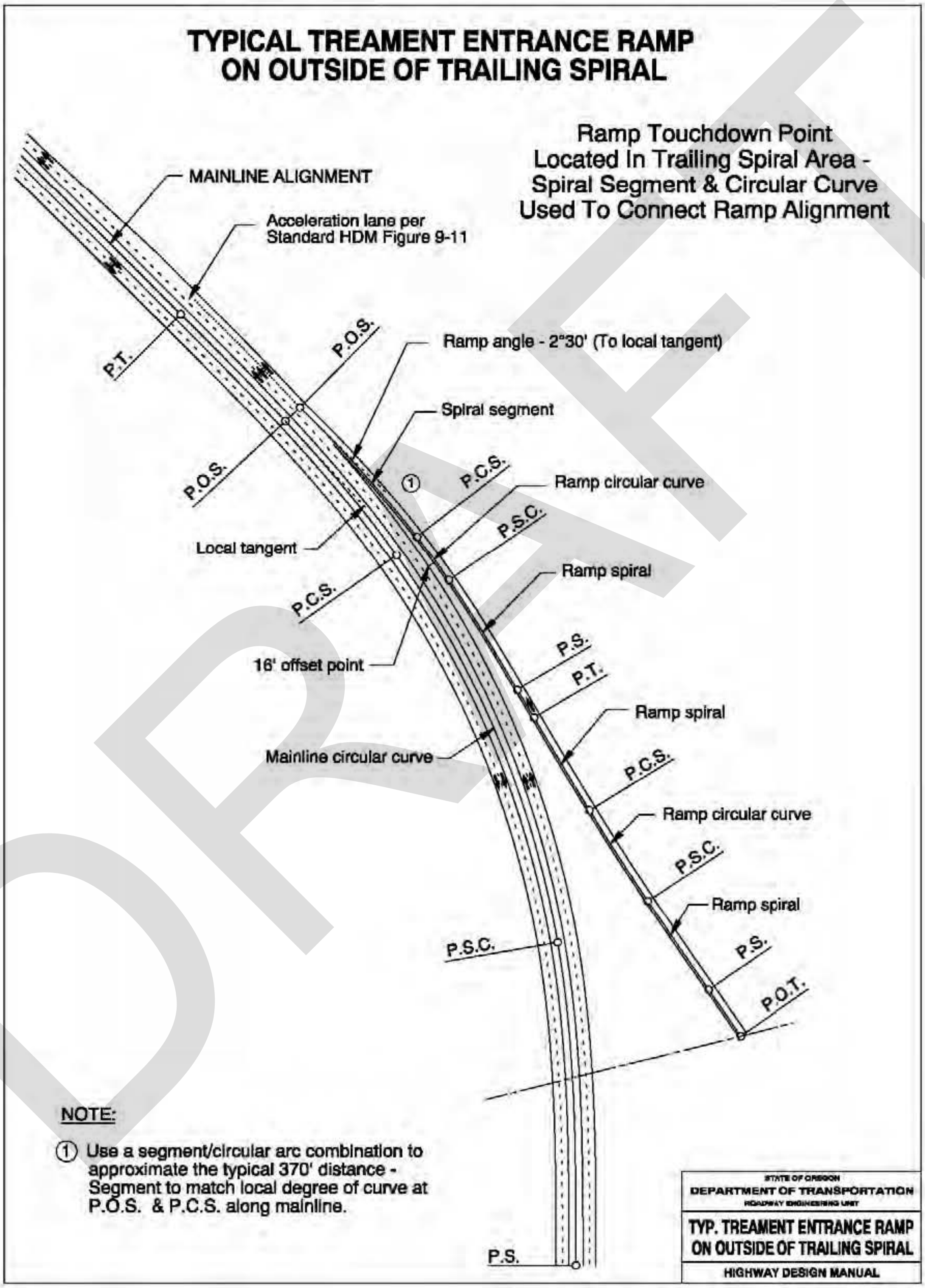


2

Figure 600-51: Design Aid 600-12 Entrance on Outside in Leading Spiral Area



1 Figure 600-52: Design Aid 600-13 Entrance on Outside in Trailing Spiral Area



2

Part 700 Public Transportation and Guidelines

Section 701 General

The Oregon Department of Transportation is committed to providing a multi-modal transportation system. As a part of this system, public transportation needs should be examined during all phases of a project. When ODOT sponsored projects are proposed for state highways where transit facilities exist or are proposed, project teams should work with the local transit agency and other local agencies during the planning and preliminary design process to ensure early consideration of transit needs, to ensure an integrated transportation system, and to ensure that design conflicts are resolved early. Likewise, when local transit agency projects are proposed on state highways, the local transit agency design team needs to work with ODOT design personnel to ensure design conflicts are mitigated in an equitable manner to minimize impact to the state highway. Future needs of the state highway system also need to be considered in addition to current design conflict mitigations.

Consultation with the local transit agency is critical to ensure appropriate placement and design of transit facilities. Each public transportation provider has unique needs which should be identified and addressed by the project development team working with the Regional Transit Coordinator. The project leader should involve the Region Traffic Engineer and landscape architectural staff when necessary.

This section of the Highway Design Manual provides guidance to designers for integrating good public transportation design practices into projects. This is especially important in urban settings. The best practices outlined in this section are intended to provide consistent guidance for all designers working on ODOT projects, as well as local agency projects and developer projects. The designs provide a basis for designers to develop interaction with local stakeholders during project development.

The design criteria are consistent with American Association of State Highway and Transportation Officials (AASHTO) standards. As with all engineering designs, they must be applied using sound engineering judgment. The objective is to ensure efficient, cost-effective facilities that meet the needs of the traveling public, transit agencies, and the community.

Section 702 Design Considerations

Public transportation designs must consider a variety of issues:

1. **Yield to Bus Law** - ORS 811.167 gives a bus the right of way after stopping to receive or discharge passengers, if it is displaying a standardized sign that flashes “YIELD.” This law influences the decision of the local jurisdiction and ODOT to construct either bus pull-outs or curbside stops.

2. **Bus Priority System** - ORS 184.616, 184.619 and 810.260, 815.445, and OAR 734-020-0300 through 0330 relate to the use of signal preemption devices and traffic control signal operating devices. These systems can provide arriving buses the capability to alter the timing (but not the sequence) of green intervals. The preemption standards consider the safety and efficiency of emergency, bus, and general traffic operations, and the requirements for traffic signal maintenance. Any signal design in a project area with existing or future transit facilities needs to consider the impacts of these laws. Discussions with the local transit agency will result in identifying the need for bus priority signalization. The installation of a bus priority system must be approved by the State Traffic-Roadway Engineer. Consideration must be given to the impact on intersection operation if bus priority systems are proposed. Future amenities such as bus arrival displays that may require additional design elements such as conduit or pedestal locations should be considered in transit designs.

3. **Americans with Disabilities** - Public transportation provides service to persons with disabilities. Designs need to address the requirements of people who have mobility, vision, or hearing impairments. Designs must comply with the requirements of the Americans with Disabilities Act (ADA) of 1990. ADA Standards for Accessible Design can be found at HTTP://www.ada.gov/2010ADAstandards_index.htm. Public Right-of-Way Access Guidelines (PROWAG) can be found at http://www.access-board.gov/prowac/nprm.htm. The Public Rights-of-Way Access Advisory Committee (PROWAAC) has also published guidance for public rights-or-way. This document is, Special Report: Accessible Public Rights-of-Way, Planning and Designing for Alterations. It can be found at

   http://www.access-board.gov/prowac/alterations/guide.pdf

4. **Safety and Personal Security** - Design considerations include safety elements such as pedestrian access, passenger visibility, and traffic impacts, and personal security elements such as lighting, nearby development, and open areas. Passenger safety and personal security play significant roles in attracting transit ridership.

5. **Local Differences** - Each local jurisdiction or public transit agency has different requirements. All new public transportation facility designs should be coordinated with the local stakeholders to ensure they are compatible with the local transportation system and coordinated public transit-human services transportation plans.

6. **Modal Connectivity** - Public transportation designs need to consider connections to other modes. For example, park-and-ride designs should be reviewed for transit accommodations; bus stop locations should consider connections to light rail and intercity facilities; and pedestrians and bicyclists should have safe, accessible routes to bus stops.

7. **Urban vs. Rural Design** - Public transportation facility designs for rural areas will have needs that vary greatly from the urban system needs. Roadway width, design speeds,

and bus stops without curbs and/or sidewalks are just a few examples of the issues that may differ between urban and rural settings.

8. **How Do Transit Needs Change Over Time** - Communities change over time and the transit needs of these communities change as well. Transit stops may need to be relocated. Different modes of transit may be installed in the area. Routes may increase or decrease in ridership. New routes may need to be added. Designers need to communicate with the Regional Transit Coordinator, local transit agency and/or review of local transit planning documents to determine future impacts to both the highway system and the transit system.

Section 703 Transit Stops

703.1 Bus Stops

The spacing, location, and design of bus stops significantly influence transit system performance and ridership. Bus stops should utilize sites which maximize transit efficiency, encourage safe pedestrian crossings, offer proximity to activity centers, satisfy the general spacing requirements, minimize the disruption to other street traffic, including bicycles and provide convenient connections to other modes. Appropriate transit facilities should be incorporated into the design of transportation projects. The following location guidelines and design standards are intended to provide guidance to designers and planners.

703.2 Bus Stop Locations Selection

In general, bus stop spacing affects overall travel time, and therefore, demand for transit. However, bus stops should be spaced to minimize pedestrian walking distances near major passenger generators. Bus stop locations are generally determined by the local transit agency and are based on goals to meet the needs of the passengers and maximize passenger convenience. Table 700-1 lists some typical bus stop spacings that would be expected based on highway segment designations. These spacing distances are not intended to be suggested spacings. They are ranges of spacing distances that have been determined from analysis of information provided by transit agencies throughout Oregon. Generally, the more urban and pedestrian oriented a highway segment designation is, the greater density of transit stops needed.

Table 700-1: Typical Ranges for Bus Stop Spacing Based on Highway Segment Designation

Area	Spacing Range (feet)

CBDs and STAs [1]	330 – 1000
Urban/Developed Areas, CCs, and UBAs [2]	650 – 1300
Urbanizable/Suburban Areas	740 – 2300
Unincorporated Communities/Rural Lands	As Needed

[1] Central Business Districts (CBDs) and Special Transportation Areas (STAs)

[1] Commercial Centers (CCs) and Urban Business Areas (UBAs)

Communication between ODOT and the local transit agency is important. The location of the bus stop must address both traffic operation issues and passenger accessibility issues. If possible, the bus stop should be located in an area where typical improvements, such as a bench or shelter, can be placed in the public right of way. Bus stop location should consider potential ridership, traffic and rider safety, and bus operation elements that require site-specific evaluation. Significant emphasis should be placed on factors affecting personal security; well-lit open spaces visible from the street create a safer environment for waiting passengers. Elements to consider in bus stop placement include the following:

1. Use:
    a) Proximity to major trip generators;
    b) Presence of or need for addition of sidewalks, crosswalks, and curb ramps;
    c) Connection to nearby pedestrian circulation system;
    d) Access for people with disabilities- Minimum 8'x5' landing area
    e) Accessible sidewalk connections;
    f) Convenient passenger transfers to other routes; and
    g) Convenient connections to other transportation modes.
2. Traffic and Rider Safety:
    a) Conflict between buses and other motor vehicle traffic;
    b) Passenger protection from passing traffic;
    c) All weather surface to step to/from the bus;
    d) Open and lighted spaces for personal security and passenger visibility; and
    e) Street illumination
3. Bus Operations:
    a) Adequate curb space for the number of buses expected at the stop at one time;

b) On-street automobile parking and truck delivery zones;
c) Traffic control devices near the bus stop, such as signals or stop signs;
d) Volumes and turning movements of other traffic, including bicycles;
e) Adequate sidewalk width to accommodate expected ridership;
f) Pedestrian activity through intersections;
g) Proximity and traffic volumes of nearby driveways;
h) Street and sidewalk grades;
i) Ease of re-entering traffic stream; and
j) Proximity to rail crossings.

Bus stops are generally located at intersections where they may be placed near-side or far-side. They may also be placed mid-block. In general, a near-side stop is preferred for non-signalized intersection on two lane streets when the bus stops in the lane and vehicles will not pass around a stopped bus. In the case of a street with wide shoulders or multiple lanes where vehicular traffic may pass uncontrolled around the bus, a far-side stop is preferred for sight distance issues. In the case of a street with wide shoulders or multiple lanes where vehicular traffic is controlled by a signal, the bus stop may be located either near-side or far-side. Far-side bus stops at signalized intersections should have a pull-out area to minimize vehicle queuing back into the intersection. Stops should be placed to minimize the difficulties associated with lane changes and weaving maneuvers on the approach to a left turn. Where it is not acceptable to stop the bus in traffic and a bus pullout is warranted, (see following discussion, "Guidelines for Special Treatments"), a far-side or mid-block stop is generally preferred. As with other elements of the roadway, consistency of stop placement lessens the potential for operator and passenger confusion. In order to minimize conflicts and maintain sight distance, bus stops should not be located close to driveways. Table 700-2 presents a comparison of the advantages and disadvantages of each bus stop type.

Table 700-2: Advantages and Disadvantages of Far-side, Near-side and Mid-block Bus Stops

FAR-SIDE STOP	
Advantages	**Disadvantages**
• Minimizes conflict between buses and right turning vehicles traveling in the same direction • Minimizes sight distance problems on approaches to the intersection • Encourages pedestrians to cross behind the bus • Minimizes area needed for curbside bus zone • If placed just beyond a signalized intersection in a bus pullout, buses may more easily reenter the traffic stream • If a pullout is provided, vehicle capacity through intersection is unaffected	• If bus stops in travel lane, could result in traffic queued into intersection behind the bus (pullout will allow traffic to pass around the stopped bus and should be installed with signalized intersections) • If bus stops in travel lane, could result in a high rate of rear-end accidents as motorists fail to anticipate stopped traffic • May cause passengers to access buses further from crosswalk • May interfere with right turn movement from cross street
NEAR-SIDE STOP	
Advantages	**Disadvantages**
• Minimizes interference when traffic is heavy on the far side of an intersection • Allows passengers to access buses close to crosswalk • Driver may use the width of the intersection to pull away from the curb • Allows passengers to board and alight when the bus is stopped for a red light • Provides the driver with the opportunity to look for oncoming traffic, including other buses with potential passengers when more than one route stop is located at the intersection	• Stopped bus may interfere with a dedicated right turn lane • May cause sight distance problem for cross-street traffic and pedestrians • If located at a signalized intersection, and if the shoulder width at the stop is such that buses will exit the traffic stream, a traffic queue at a signal may make it difficult for buses to re-enter the traffic stream • At single lane, signalized intersections with no pullout, prohibits through traffic movement with green light, similar to far-side stop without a bus pullout • May cause pedestrians to cross in front of the bus at intersections
MID-BLOCK STOP	
Advantages	**Disadvantages**
• Minimizes sight distance problems for vehicles and pedestrians • May result in passenger waiting areas experiencing less pedestrian congestion • May be closer to passenger origins or destinations on long blocks • May result in less interference with traffic flow	• Requires additional distance for no-parking restrictions • Increases walking distance for patrons crossing at intersection, or requires special features to assist pedestrians with mid-block crossing

Source: Adapted from the Guidelines for Planning, Designing, and Operating Bus-related Street Improvements. Texas Transportation Institute.

703.3 Bus Stop Layout and Delineation

The bus stop must be clearly delineated to ensure that other traffic will not use the stop area and to give bus operators direction on where to stop the bus. Delineation may include appropriate signing and pavement markings at and near to the bus stop location. For curbside stops, the bus stop zones (no parking designation) should be a minimum of 100 feet for near-side stops and 80 feet for far-side stops. Curbside mid-block stop zones should be a minimum of 150 feet. Bus stop zones are lengthened 20 feet for articulated buses. Bus stop zones may be shortened significantly with curb extensions as discussed in the next subsection. Designs should be coordinated with the local jurisdiction and transit agency. Generally, buses and bicycles are able to share available road space. However, stopped buses hinder a bicyclist's progression and slower moving bicycles can hinder buses. On routes heavily traveled by both bicyclists and buses, separation of the two modes can reduce conflict and is the preferred method. Final design of separating bus and bicyclist can take many forms and should be considered on a case by case basis. One method is an adjacent bike lane to delineate the areas. Another method is a completely separated bike path or cycle track behind the bus stop. There may also be other appropriate ways to accomplish bicycle and bus separation specific to a site. Potential right of way needs may be associated with bus stop and bicycle design and should be considered early in the development process.

More than one bus may occupy a stop at a given time. The number of bus-loading positions required at a given location depends on:

1. The rate of bus arrivals, and
2. Passenger service time at the stop.

Curb space for one bus will typically be adequate for up to 30 buses per hour. If passenger service time is more than 30 seconds per bus and bus arrivals exceed 30 buses per hour, then more than one loading/unloading position will likely be required. Bus stop area should be lengthened by 50 feet for each additional single unit bus and 70 feet for each additional articulated bus.

703.4 Bus Stop Guidelines for Special Treatments

♦ Bus Pullout

Bus stops may be designed with a pullout, which allows the transit vehicle to pick up and discharge passengers in an area outside the traveled way. Bus pullouts are provided primarily on high-volume and/or high-speed arterials. Since most ODOT facilities have a roadway classification of arterial, bus pullouts should be considered at all stops on state highways.

Lower vehicle speeds, greater public acceptance of delay, development intensity and limited right of way may make pullouts inappropriate in some urban situations. Bus pullouts are frequently constructed at bus stops with a high number of passenger boardings such as large shopping centers, factories, and office buildings. Bus pullouts reduce potential conflicts between bicyclists and passengers exiting the bus. They also provide a means for bicyclists to pass a stopped bus and continue along the roadway. Providing a bus pullout for bus stop locations is the preferred design option on state highways. However, when a bicycle lane is present, the bus driver must be careful when crossing the bike lane to enter and exit the pullout.

Well placed, carefully designed bus pullouts offer safe passenger loading and unloading with minimal delays to both transit and other roadway traffic. While serving as a bus stop, they may also be used simultaneously as a schedule layover area. Table 700-3 lists the advantages and disadvantages that should be considered in the decision to provide a bus pullout:

Table 700-3: Advantages and Disadvantages of Bus Pullouts

Advantages	Disadvantages
• Allows traffic, including bicycles to proceed around bus, reducing delay for other roadway traffic • Assists in maximizing the vehicle capacity of the roadway • Defines bus stop • Passenger loading and unloading may be conducted in a more relaxed manner • Less potential for rear-end accidents	• More difficult to reenter traffic, increasing bus delay and slower average travel time for bus • Bus may need to cross bike lane • Uses additional space, may require additional right of way • May increase rates of sideswipe accidents • Cost • Impacts transit operation times

The Yield to Bus Law, ORS 811.167, gives a bus the right of way when pulling away from a bus stop when it is displaying a standardized sign that flashes "YIELD." This law should improve the operational problem of buses re-entering the traffic stream.

A bus pullout is most appropriate when one or more of the following situations exist:

1. Average vehicle speed exceeds 40 mph;
2. Traffic in the curb lane exceeds 250 vehicles during the peak hour;
3. History of a high rate of accidents, particularly rear-end accidents;
4. More than 5 bus stops per hour;

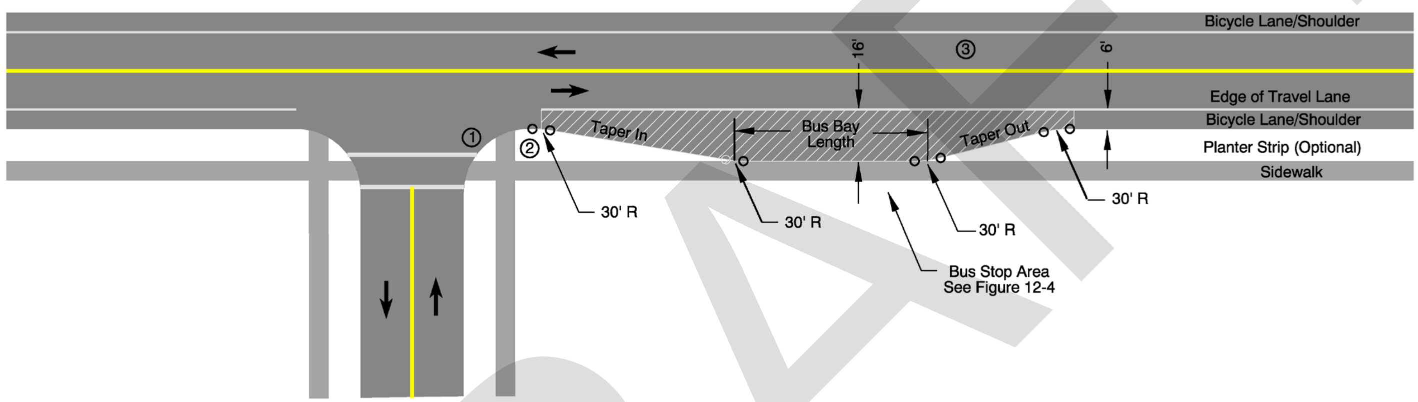
5. Passenger boardings exceed 30 boardings per hour; or
6. Transit agency desires an area for dwelling time.
7. A bike lane is present or in a high bike use area

Multilane, one-way streets may have sufficient gaps in the traffic stream to allow all other traffic, including bicycles to pass around a stopped bus. Bus pullouts are generally not appropriate on these roadways.

When a bus pullout is justified, it should be placed to allow buses to easily reenter the traffic flow. The design of a bus pullout should allow through vehicle and bicycle traffic to flow freely without the obstruction of stopped buses. They should generally be placed on the far-side of a signalized intersection so that the signal can create gaps in traffic. Due to the highly concentrated wheel loadings on the pavement, bus pullouts should generally be constructed of plain doweled concrete pavement. Typical dimensions for a bus pullout are shown in Figure 700-2. The bay length should be increased by 50 feet for each additional single unit bus expected to concurrently use the pullout. Figure 700-2 and related bus pullout drawings shown are intended to provide design guidance for transit stops to comply with minimum ODOT requirements. Local transit agencies may have their own design criteria that differ from the ODOT minimum. The designer should contact the local transit agency to determine specific transit stop design criteria to comply with the local agency. Collaboration between ODOT and the local transit agency using the state highway is critical to successfully designing transit stops.

Figure 700-1: Minimum Bus Pullout Details

BUS PULLOUT DETAILS



① Intersection should be designed for the appropriate design vehicle. When appropriate, use two-centered curve to minimize intersection area.

② A short tangent section (+/- 30') may be added between the curb return and the entrance taper at intersections with right-turning buses.

③ May be reduced to 14' if bicycle lane/shoulder is less than 6'.

DATA TABLE

Design Speed (mph)	Taper In	Taper Out	Bus Bay Length*	
			40-ft Bus	60-ft Bus
< 45	6:1	4:1	60'	80'
≥ 45	8:1	6:1	60'	80'

* Based on one bus.
For each additional single unit (40') bus, add 50'
For each additional articulated (60') bus, add 70'.

NOTE: Bus stops with pullouts should be located on the far-side of the intersection or at mid-block locations. In areas of special need, they may be placed on the near-side of a signalized intersection in conjuction with a queue jump signal phase.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

BUS PULLOUT DETAILS

HIGHWAY DESIGN MANUAL

(Consult Local Transit Agency for Project Specific Details Required)

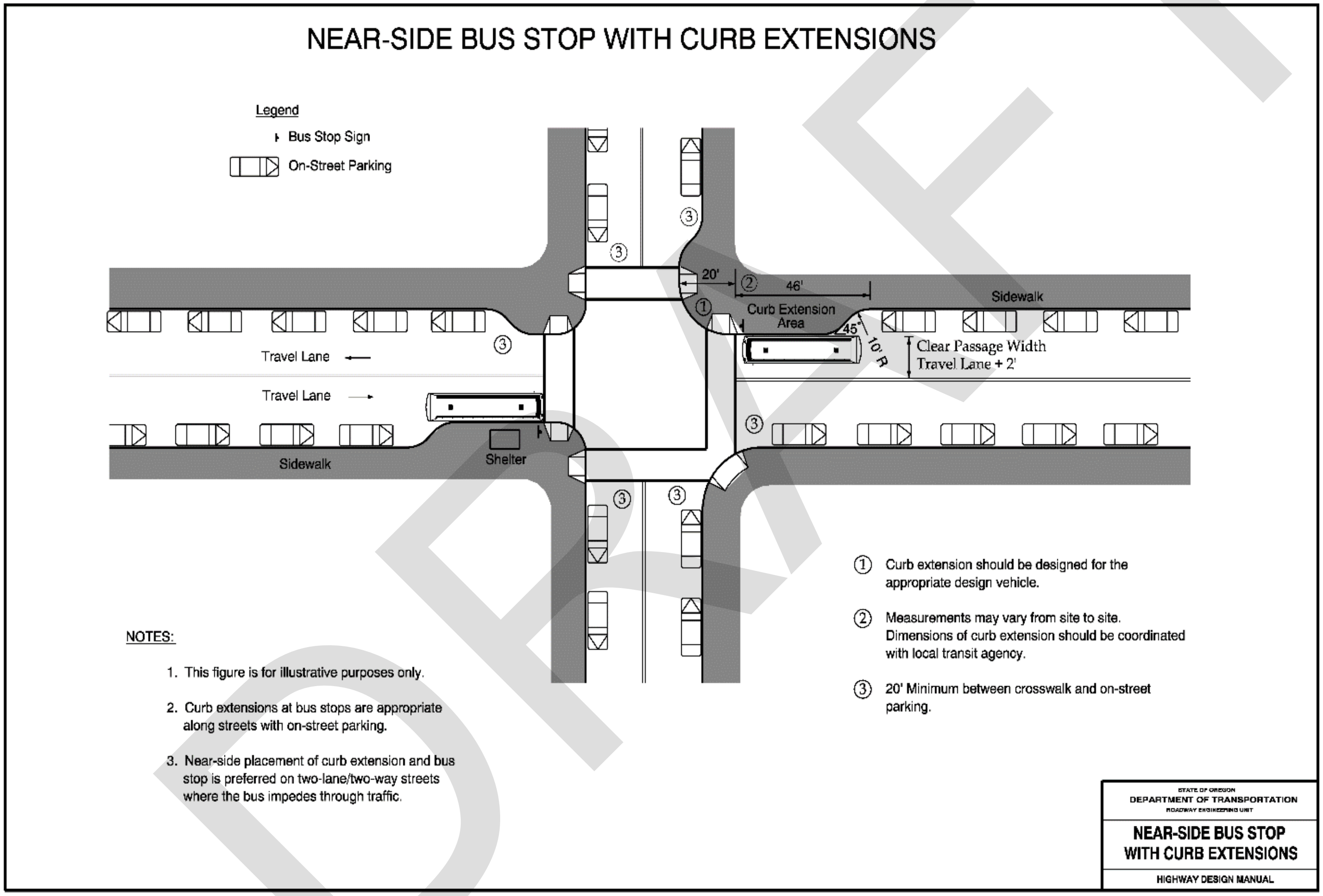
♦ Curb Extensions

A curb extension may be constructed along streets with on-street parking in areas with high pedestrian use such as downtown shopping districts and central business districts. Curb extensions may be designed in conjunction with bus stops to facilitate bus operations and passenger access. The combination of curb extension and pullout can make design a challenge, particularly the drainage design. The placement of a bus stop on a curb extension should follow the same guidelines as those previously stated (a near-side stop is preferred on two lane streets where vehicles will not pass around a stopped bus. In the case of a street with wide shoulders or multiple lanes where vehicular traffic may pass uncontrolled around the bus, a far-side stop is preferred for sight distance issues). A bus stop on the near-side of a single lane entrance into an uncontrolled intersection should completely obstruct the traffic behind it. Where it is not acceptable to have stopped buses obstruct a lane of traffic, and a bus pullout is justified according to the previously discussed conditions, a bus stop may be placed far-side in the parking strip just beyond the curb extension. It may be appropriate to place a bus stop on a far-side curb extension at an uncontrolled intersection if the warrants for a bus pullout are not met and its placement will not create undue traffic hazards.

Near side curb extensions are usually about the width of the parking lane and of sufficient length to allow passengers to use the front and back doors of a bus. Typical dimensions of curb extensions with near side bus stops are shown in Figure 700-3. Besides reducing the pedestrian crossing distances, curb extensions with near side bus stops can reduce the impact to parking (compared to typical bus zones), mitigate traffic conflicts between autos and buses merging back into the traffic stream, make crossing pedestrians more visible to drivers, and create additional space for passenger amenities such as a shelter and/or a bench.

In areas where curb extensions are desired, but it is not acceptable to have the bus stop in the travel lane, a far side pullout area can be created in the parking strip as shown in Figure 700-4. This location and design, which is generally preferred for low-speed, high volume, four lane roadways, eliminates the safety hazard of vehicles passing the bus prior to entering the intersection.

Figure 700-2: Near-Side Bus Stop with Curb



♦ Roundabouts

A roundabout is a form of intersection design and control which accommodates traffic flow in one direction around a central island, operates with yield control at the entry points, and gives priority to vehicles within the roundabout. The placement of bus stops near roundabouts should be consistent with the needs of the users and the desired operations of the roundabout. As with locating bus stops at other types of intersections, pedestrian crossings of the roundabout legs should be minimized. A bus stop is best situated:

On an exit lane, in a pullout just past the crosswalk; or

On an approach leg 65 feet upstream from the crosswalk, in a pullout; or

On an entrance leg, just upstream from the crosswalk where the traffic volume is low and the stopping time is short. This location should not be used on two-lane entrances (a vehicle should not be allowed to pass a stopped bus in the interest of pedestrian crossing safety).

Information on roundabout design can be found in Part 500.

703.5 Light Rail, Bus Rapid Transit and Streetcar Stops

Most of the design principles for bus stops listed previously would also apply to Light Rail Transit (LRT), Bus Rapid Transit (BRT) and Streetcar stop locations. However, there are a few design items that are unique to these modes that may not be found at bus stops. When designing stop locations for LRT, BRT or Streetcars, the following should be considered:

1. Transit stops may need to be on either side of a transit vehicle. These vehicles generally have access on both sides for convenience.
2. Transit stops may be located in a median necessitating safe pedestrian access to the center of the roadway.
3. Rail stops or BRT pathways are more permanent than bus stops, as the route is more difficult to alter.

Section 704 Transit Accessibility and Amenities

704.1 Sidewalk

At transit stops, sidewalks should be provided at a minimum to the nearest intersection or to the nearest section of existing sidewalk. It may also be necessary to wrap a sidewalk around a corner to join an existing sidewalk on a side street. If a transit route does not have complete sidewalks, it is still important to provide a suitable area for waiting pedestrians. Projects should be considered that provide sidewalks on transit routes, for continuous access to all stops.

704.2 Providing Accessibility

Transit ridership is usually made up of a higher than usual proportion of disabled users as many people with disabilities cannot drive. It is therefore critical that all transit stops be fully accessible. The two primary groups for whom this is an issue are the mobility impaired and the vision impaired. Both require a continuous, level passage free of obstructions. This passage should be a minimum of 5 feet wide, with at least 6.7 feet (2 meters) of vertical clearance. A minimum allowable passage of 4 feet wide may be acceptable in constrained areas.

At the transit stops, ADA requires a minimum 8 foot (measured perpendicular to the curb, street or highway edge) by 5 foot (measured parallel to the curb, street or highway edge) landing pad at all vehicle entrances and exits. If a transit vehicle has more than one entrance or exit, each access point requires an 8 foot by 5 foot landing area. To avoid the choppy affect this creates at permanent transit stop locations, it may be preferable to construct a continuous 8 foot wide sidewalk the length of the transit stop, or at least to the front and rear vehicle doors (see Figure 700-5). ADA also requires an accessible route from the bus landing pad to the shelter area.

At stops in uncurbed areas, the shoulder should be 8 feet wide to provide a landing pad. Uncurbed areas can also have an impact on wheel chair lifts. Transit agencies often have approved bus stop specifications and plans for bus stops in urban and rural areas. The designer should contact the transit agency early in the design process to ensure appropriate bus stop design, location and infrastructure

704.3 Amenities for Waiting Passengers

Transit ridership is enhanced by the provision of safe, pleasant and comfortable places for waiting passengers. Protection from the elements, seating, and personal security are key to a pleasant waiting experience. The following amenities are recommended to be placed where feasible and cost effective. The list is not a complete compilation of amenities available. It is merely a starting point for possible inclusion. The local transit agencies typically have guidelines for amenities and should be contacted to determine which amenities should be included in the project.

♦ Bus Shelter

Type, size, and placement of shelter depends on land use characteristics, transit frequency, and transit capacity. A standard-size bus shelter requires a 6 foot x 10 foot pad. The shelter should be placed at least 2 feet from the curb when facing away from the street and at least 4 feet when facing towards the street. The adjacent sidewalk must still have a 5 foot clear-passage. Orientation of the shelter should take into account prevailing winter winds. Sidewalks separated from the roadway with a planter strip offer a unique opportunity to provide a bus shelter out of the path of passing pedestrians.

♦ Signing

Appropriate directional signing (way finding) can help people find major transit stops such as intercity bus stops, transit centers, and park-and-ride lots.

♦ Seating

Benches can make waiting more pleasant for transit passengers. Mobility impaired riders, in particular, may be unable to stand while waiting for the bus; seating may increase their ability to used fixed route service.

♦ Shade

The strategic placement of shelters, benches, and bus stops should also account for trees (existing, new) to provide shade for passengers. Deciduous shade trees which cast afternoon shade on the bus stop are generally most effective.

♦ Trash Receptacles and Other Amenities

These improvements can make waiting more pleasant, increasing the likelihood that people will use transit as a mode choice.

♦ Bicycle Parking

Bike racks or storage lockers should be considered at bus stops in urban fringe areas and park-and-ride facilities.

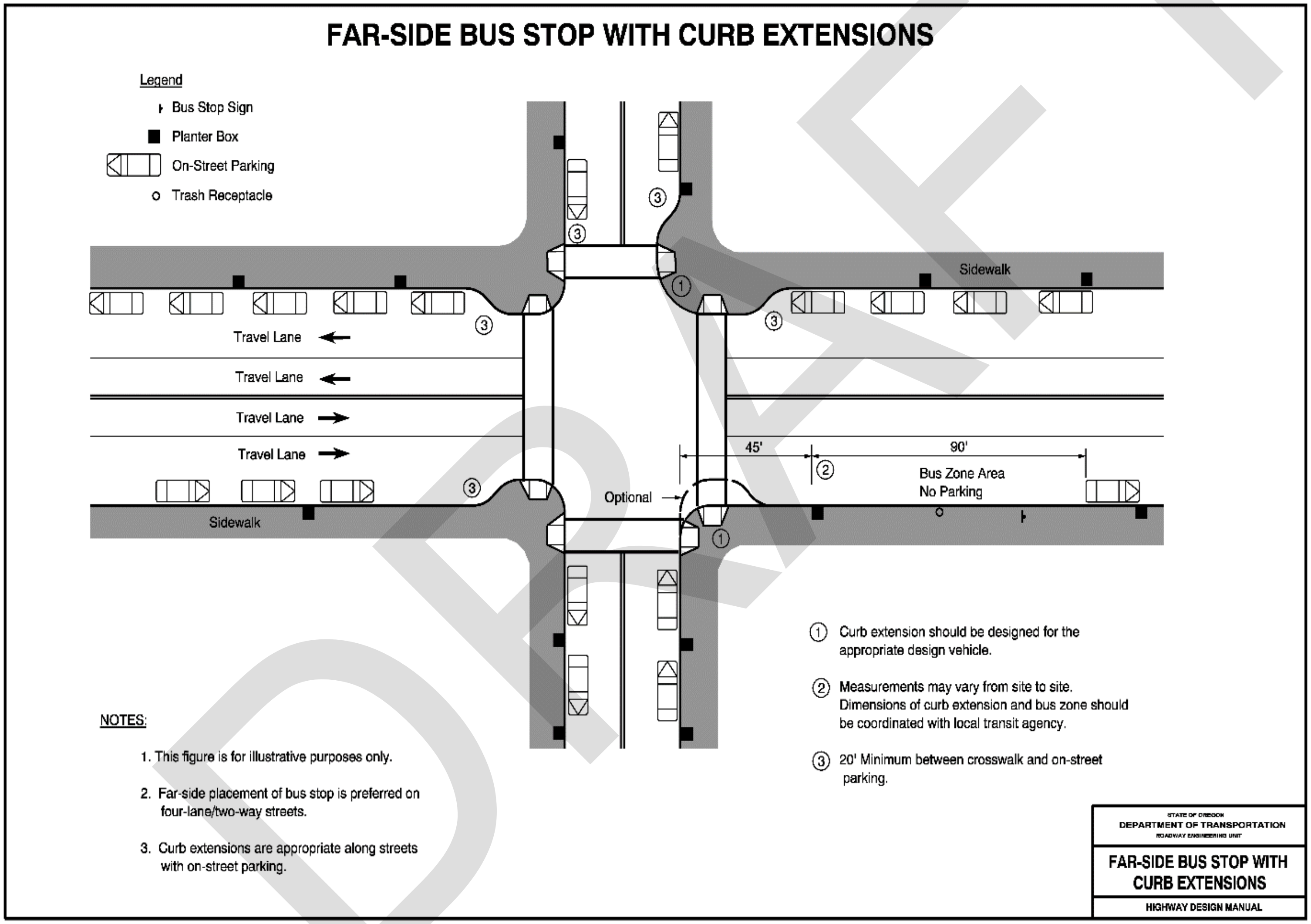
♦ Transit Arrival Information

Electronic transit arrival information in real time is a convenient addition to a transit stop. Coordinate with the transit agency to see if it will be included with the project. At a minimum, facilities to provide hard copy of pertinent transit schedules should be included with transit stops.

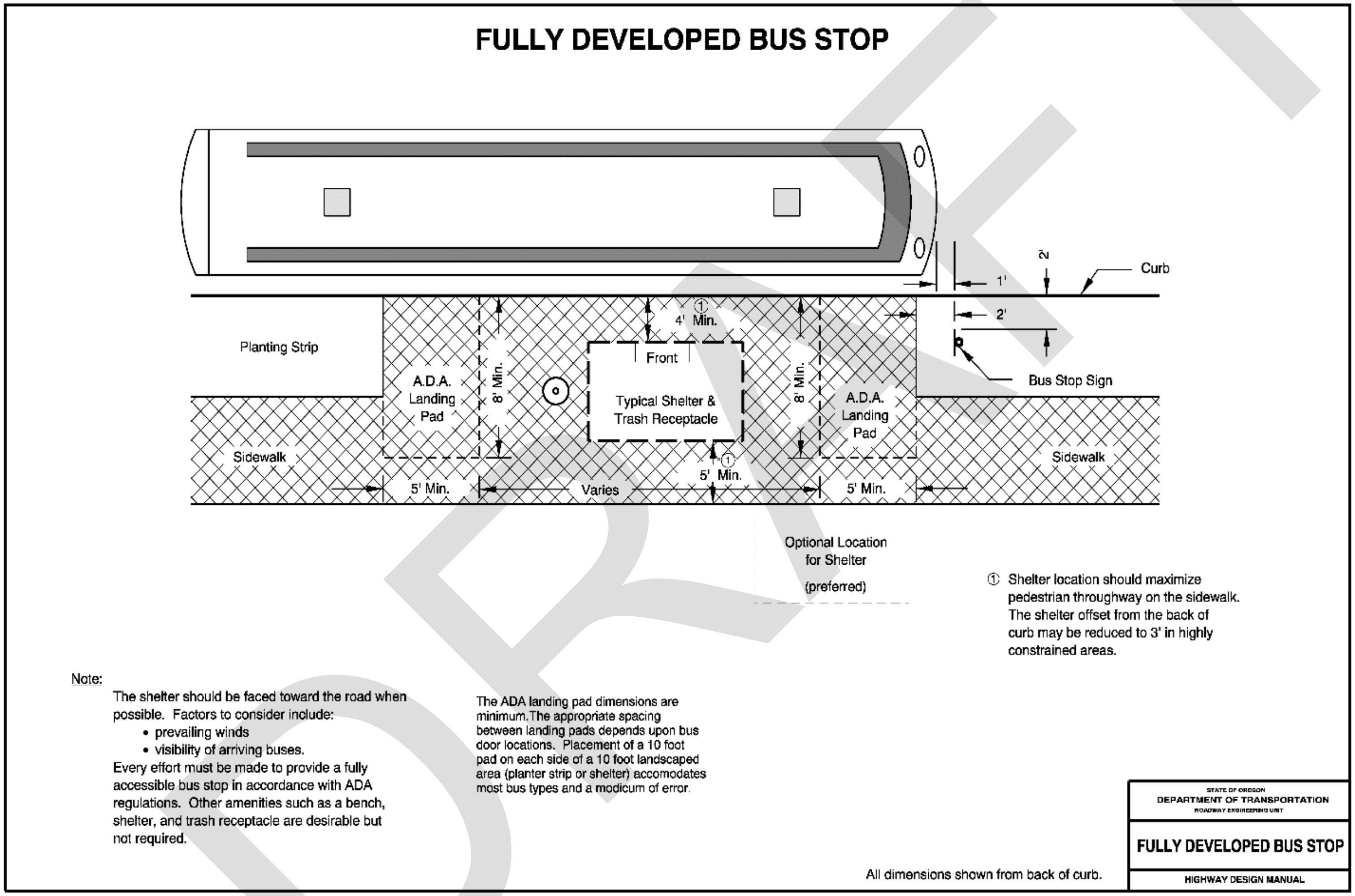
♦ Future Amenities

Not always can all amenities be provided at the outset when a transit stop is being constructed. Work done for future amenity items anticipated at a transit stop should be coordinated with the local transit agency. It may be beneficial to install conduit for electrical or communication networks (real time signage, lighting and other infrastructure) as part of the current project, eliminating the need to remove portions of roadway and sidewalk in the future.

1 Figure 700-3: Far-Side Bus Stop with Curb



1 Figure 700-4: Fully Developed Bus Stop



704.4 Security and Safety

Safety is a concern for both the transit user and the operator. Examples of design features that can enhance or degrade personal security include:

1. **Location:** Placement of transit stops should account for access and connectivity to sidewalks, pedestrian crossings, and near activity centers.
2. **Visibility**: Waiting areas should be easily seen by nearby residences, businesses and passers-by. Transparent shelters and materials further contribute to visibility and security.
3. **Illumination:** Waiting areas should be well-lit; consider pedestrian scale lighting, avoiding creating virtual shadows and free of obstructions.
4. **Soundwalls:** Design features that can dramatically degrade both access and security are soundwalls or other similar structures which can isolate waiting passengers from the neighborhood. In general, there is no reason to locate transit stops adjacent to soundwalls or fences, as these preclude direct access from neighborhoods. Should this situation arise, the structure's design should consider breaks that allow for pedestrian access.
5. **Landscaping:** Street furnishings, trees, and bushes should be designed to provide an open area near the bus stop. Bushes and shrubbery should be smaller near a bus stop. Funding for landscaping and other amenities may need to come from different sources and should be discussed during project development.

Section 705 Roadway and Intersection Design for Transit

The size and operating characteristics of all motorized vehicles regularly using the facility, including transit vehicles are to be considered in the design of roadways and intersections. In addition to motorized vehicles, bicycles and pedestrian needs, movements and interactions must also be included in appropriate intersection design. To begin design, the designer should contact the local roadway jurisdiction and transit agency to determine the appropriate design vehicle for the intersection. Even when transit vehicles are not determined to be the design vehicle, they must be considered in the overall interaction within the intersection. Roadway features such as intersection radii, curb type and height, lane width, and pavement thickness are to be designed to accommodate transit vehicles where necessary. Properly designed intersection features will maximize all vehicle type operations, reduce transit travel times, reduce vehicle conflicts, minimize pedestrian crossing distances, and improve the overall driving/riding experience of the roadway users. When designing transit alignments and layouts on state highway facilities, transit agencies need to work with ODOT to minimize impacts to future highway projects and future highway needs.

Buses have unique operational characteristics including relatively low power-to-weight ratios, high axle loads, short wheel bases, and long overhangs that may necessitate special treatments.

Bus Rapid Transit (BRT) routes have many of the same design criteria as for regular bus routes. However, the BRT route is usually in a dedicated pathway and may be located in the center of the roadway. The BRT vehicles are often articulated vehicles. Turning movements and turning radii at intersections can be challenging to fit with other lane configurations in an intersection.

Light Rail Transit (LRT) and streetcars both run on rails. This creates challenges for designers at intersections where these vehicles need to make turns. They may have very limited turning radii and require additional space. Track grades are important design criteria for LRT systems and streetcar systems. Often, where track sections cross each other, the crossing grade needs to be very close to zero percent to allow transition to the other track effectively.

705.1 Roadway and Intersection Design for Buses

While a roadway may be designed to accommodate large trucks, some design elements may be controlled by the unique needs of public transit. Some of these elements are:

1. Shoulder width: On roadways without curbs and sidewalks, the shoulder width at the bus stop should be 8 feet as required by ADA guidelines.
2. Right of way: The wheelchair landing pad at a bus stop must extend at least 8 feet beyond the curbline. Additional right of way may also be needed for a bus shelter (see Section 707.4).
3. Clearance: Overhead obstructions should be a minimum of 12 feet above the street surface, obstructions should not be located within 2 feet of the edge of the street to avoid being struck by a bus mirror.

Intersections should be designed for use by either a standard bus or an articulated bus. The turning and off-tracking characteristics of the two bus types are slightly different and must be accounted for in the intersection design. (The swept path of an articulated bus is about 1.5 feet wider than that for a standard bus for a right angle turn.) The overhang of buses is considerable and will affect the design corner radii, bus stop location, and placement of bus stop amenities. Street lighting, signals, signs, and other intersection furnishings should be placed clear of the turning paths of buses.

Curb radii design should minimize pedestrian crossing distance, while accommodating the off-tracking characteristics of the bus. Consideration needs to be given not only to buses on the mainline route, but also for buses entering and exiting the mainline roadway from a crossroad. In designing the curb radii for a bus entering a multi-lane road from a signalized crossroad, the design may allow for the bus to initially turn into the inside lane next to the median before returning to the outside lane or entering a bus pullout/stop area. This design will allow for a tighter curb radius or curb extension to be included (if appropriate) which will reduce pedestrian crossing distance while maintaining bus operation. It may be desirable at unsignalized intersections to design the curb radius so that the bus may enter a multilane roadway without encroaching upon the inside lane. At no time should the design encourage the vehicle to turn across opposing lanes. Appropriate curb radii in combination with usable shoulder width and number of cross street lanes are shown in Figure 700-6.

♦ Bus Pads

Very concentrated wheel loading coupled with the dynamic nature of braking place high demands on the pavement at bus stops. Some curbside stop areas may require strengthened pavement sections. On high to moderate speed roadways, these bus pads are generally placed outside of the travel lane. Roadway pavements need to be of sufficient strength to accommodate repetitive bus axle loads of up to 25,000 lbs. Due to the highly concentrated nature of the vehicle paths, consideration should be given to constructing bus pads with plain doweled concrete pavement (see Oregon Standard Drawing RD600 for PCC Pavement Details). Pavement designs should be coordinated with ODOT Pavement Services and ODOT Maintenance. The pavement section will depend on anticipated use and site-specific soil conditions. Also, the operating transit agency should be contacted to determine how to include any agency specific needs or requirements concerning bus pads. Some transit agencies have their own standards for construction of bus pullouts and bus pads.

705.2 Roadway and Intersection Design for Bus Rapid Transit

Many of the design concerns for regular bus routes and facilities mentioned in the previous subsections apply to Bus Rapid Transit routes as well. Installation of Bus Rapid Transit (BRT) systems will generally trigger 4R design requirements where they interact with the state highway system. BRT systems are expected to be quick and efficient. Therefore, they have some specific requirements that regular bus routes do not.

1. BRT systems often run in a dedicated pathway separate from the general lanes of traffic. As such, they are expected to run independent of other traffic. At intersections, however, the BRT system must interact with general traffic.
2. BRT vehicles may get pre-emption at signalized intersections.

3. BRT stops may need to be located in the median creating a need for safe pedestrian areas for waiting and boarding activities.
4. The designer may need to provide additional pedestrian crossing locations to accommodate the BRT stop locations.
5. If the BRT route is in the median and then makes a right turn at an intersection to another roadway, provision must be made for the movement across adjacent traffic lanes. This may require a split-phase signal or other means of accommodation.
6. BRT vehicles are often articulated type vehicles that may have specific turning radii that could impact intersection design and interaction with general traffic.
7. BRT routes on dedicated pathways are more permanent than regular bus routes running with general traffic. Therefore, the BRT facility is less likely to change over time.

705.3 Roadway and Intersection Design for Light Rail Transit and Streetcars

Many of the primary design considerations for roadways and intersections relating to bus routes and BRT routes also apply to Light Rail Transit (LRT) and streetcar routes. However, since these vehicles run on rails, they have some unique characteristics that differentiate them from regular bus routes or BRT routes. Coordination with the local transit agency is necessary to establish allowable design criteria specific to LRT and streetcar routes that minimize impacts to the state highway. Adding LRT or Steetcar facilities to the state highway is constructing a new feature that did not exist previously in the roadway. Installation of LRT or Streetcar facilities on the state highway system is a major, permanent impact to highway operations and is considered reconstruction of the highway. Therefore, installation of these facilities will trigger 4R design criteria. The following list assumes the LRT or streetcar route runs on surface streets with general traffic and not on a separate alignment. Where LRT or streetcar routes run along separated alignments, many of these challenges do not pose as great a concern.

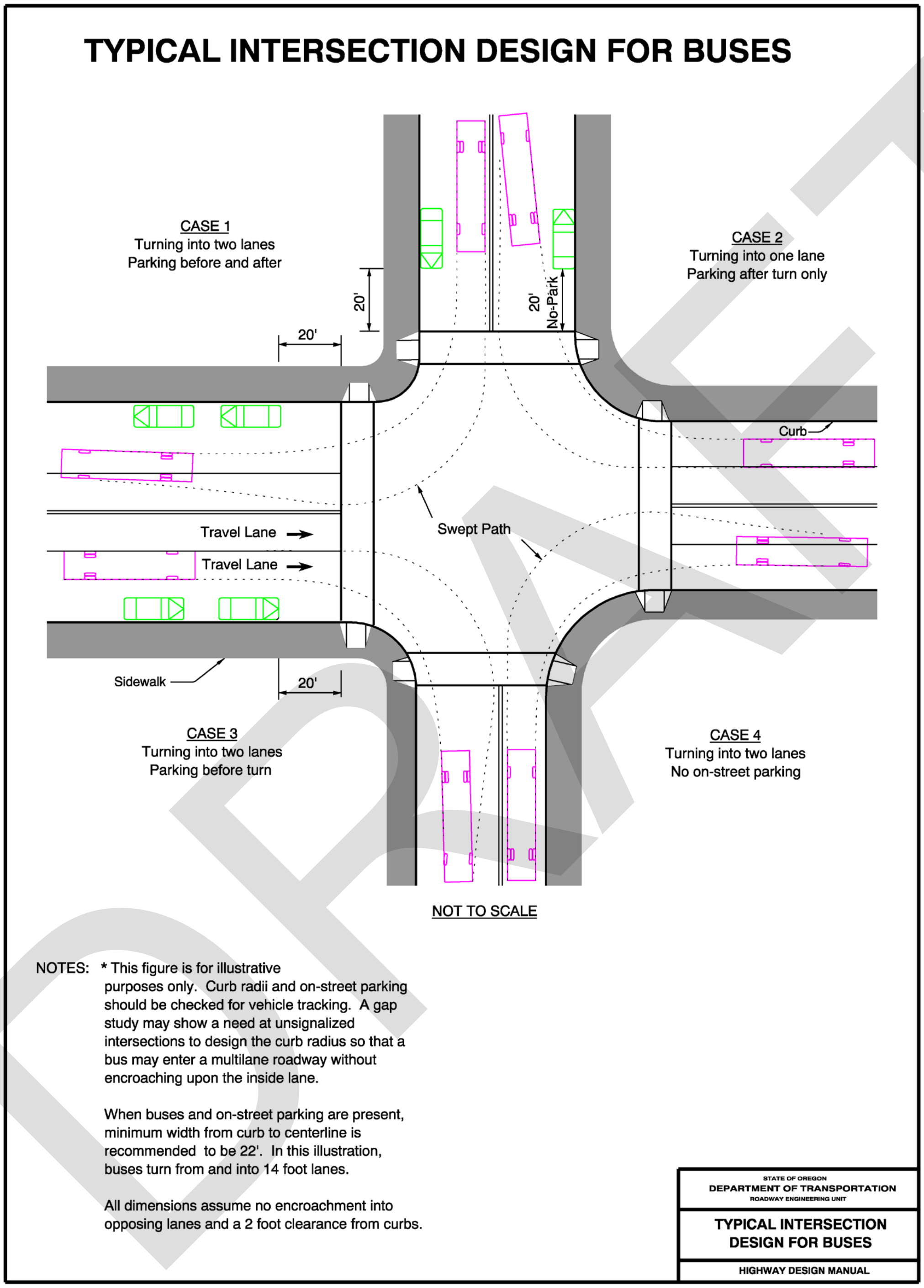
1. Vertical grades along the track line are critical to LRT and streetcar routes. These vehicles require flatter grades than regular bus routes or BRT routes.
2. Track cross-slope grades are less forgiving than with other modes. Cross-slope may need to be held at or near zero percent. On heavily superelevated roadways, roadways with excessive cross-slope or excessive crown sections, it can be challenging to establish adequate transition between roadway cross-slopes and track cross-slopes. As a result, construction challenges can occur and long term traffic operation can be affected.
3. Tracks crossing roadway grades perpendicular to the roadway can also create construction challenges and long term operation issues for general traffic due to the introduction of short, steep vertical roadway grades to match required track cross-slope.

4. Potential drainage issues due to the change in cross-slope, vertical alignment or superelevation needed to fit track to roadway.
5. Lane balance may be affected on multi-lane roadways. Drivers may tend to avoid driving in the lane with the tracks.
6. Utility relocations and sloped paving patches to match rail installation can cause rough, uneven surfaces with undesirable cross-slopes for motor vehicles, pedestrians and bicyclists. The final paving surface should be a completely overlaid surface matching acceptable cross-slope grades.
7. LRT and Streetcar rails are often installed in a concrete pathway. The wide swath of gray concrete in the black asphalt roadway can appear as a separate lane confusing drivers when the LRT or Streetcar facility deviates from a travel lane. Travel lane delineation and markings need to be understood by drivers to avoid their following the rail facility when it turns from the main line. This is of particular importance at mid-block, off-street stops or at transit terminal facilities.
8. Horizontal curvature may be more limited than other modes due to the LRT or Streetcar vehicle's turning radius and side friction on rails. Wider turning arcs may require use of more than one lane.
9. LRT and streetcar routes are fixed by the rail network and are more permanent than some other modes. LRT and streetcar facilities are less likely to change over time.
10. Steel rails placed in the travel lane may create potential hazards for bicycle traffic. Wet rails may become slippery and bicycle tires can get caught in the rail opening causing a rider to fall.

LRT vehicles and streetcars are usually designed for entrance and egress from either side allowing flexibility along the route. However, this can create special challenges for roadway or intersection design.

1. Stops may need to be located in medians or in the center of roadways.
2. On multi-lane roadways or one-way roadways, the stops may vary from side to side creating the need for the tracks to change from one lane to another resulting in conflicts between transit vehicles and general traffic.
3. Transitioning tracks from one lane to another and holding track grades constant can impact roadway grades and general traffic operations.
4. Transitioning tracks from one lane to another can impact bicycle riders forcing them to cross the track section more frequently increasing the potential for mishap.

1 Figure 700-5: Typical Intersection Design for Bus



Section 706 Park-and-Ride Facilities

Park-and-ride facilities provide parking for people who wish to transfer from their personal vehicle to public transportation or carpools/vanpools. These facilities are one of many Transportation Demand Management (TDM) tools designed to increase highway efficiency, reduce energy demands, increase highway safety by reducing highway congestion, and provide commute options for the trip to work. Park-and-rides are frequently located near freeway interchanges, at train or transitway stations, or on express bus routes.

Oregon Highway Plan, Policy 4E states that it is the Policy of the State of Oregon to encourage the efficient use of the existing transportation system and to seek cost-effective expansion of the highway system's passenger capacity through development and use of park-and-ride facilities at appropriate urban and rural locations adjacent to or within the highway right of way.

Many park-and-ride facilities are located within urban areas and served by public transportation. Some smaller facilities may have only local transit service. Facilities placed in more rural areas may primarily serve carpools and vanpools. Park-and-ride facilities may be either shared use, such as at a church or shopping center, or exclusive use. Shared use facilities are generally designated and maintained through agreements reached between the local public transit agency or rideshare program operator and nearby businesses or churches. The possibility of meeting the needs of the community with a shared-use lot should be investigated before building an exclusive use park-and-ride lot.

The following guidelines are primarily intended for planning and design of the exclusive park-and-ride facility. If the facility is expected to be served by public transit, the project leader should involve the responsible local agency in the entire project starting with the initial needs assessment and continuing through the planning and design phases of project development. In all cases, the local public transit agency and rideshare program operator should be involved. For areas served by public transit, projects without the support of the local public transit agency should be avoided.

Plans for new park-and-ride facilities should incorporate the design philosophies of this and other generally accepted sources such as AASHTO's Guide for the Design of Park and Ride Facilities. An inappropriately located or designed park-and-ride facility may be counter-productive in terms of visibility, image, and promotion of non-SOV (single occupant vehicle) travel.

706.1 Needs Assessment

The need for a park-and-ride facility may be identified in a region's transportation system plan (TSP), a transportation corridor plan, transit agency development plan or capital improvement plan. The expected demand for parking spaces at a proposed park-and-ride will be related to the quality of public transportation service, the number of commuters traveling the corridor, accessibility of the facility, the cost and availability of parking at the travelers' destination, and a variety of economic factors and public attitudes. Local experience with park-and-ride facilities is often the most accurate gauge to sizing future facilities.

706.2 Site Selection

Present and future needs are the main considerations in determining the location of a park-and-ride facility. If served by public transit, local transit agency input is critical to ensure that transit service and ridership are optimized with the project. As the necessary size of a park-and-ride facility is difficult to predict, the facility should be sited to allow for a conservative first phase with space available for later expansion. A number of site selection criteria should be considered in the site selection process, most notably:

- Input from local transit and rideshare program operators
- Local transit agency master plan
- Local or regional transportation plan
- Accessibility for transit and motorists
- Local public input
- Traffic impacts
- Commuter distance
- Local government zoning
- Environmental impacts
- Cost effectiveness
- Access by other modes of travel
- Visibility for passing motorist recognition
- Visibility for security
- Maintenance
- Existing right of way
- Shared use
- Future expansion flexibility.

Due to the substantial cost increase associated with buying or leasing property, government-owned right of way should receive prime consideration, assuming the other selection criteria are favorable. Sites with poor access for either transit vehicles or passing motorists should be avoided. It is likely that more users will be attracted by maximizing accessibility for inbound morning traffic than by improving the flow for exiting evening traffic. The selected site should not jeopardize the present and future integrity of the state highway or local transportation facility.

The alternative of a shared lot with off-peak demand, such as a church, movie theater, or shopping center should be explored. Shared lots can save the expense of building a new parking lot and increase the utilization of existing spaces. The site selection should consider the criteria listed above. If a shared use arrangement is agreeable with the lot owners, good pedestrian connections to the boarding areas should be provided.

ODOT frequently sells excess property, known as surplus property, upon completion of a project. All surplus property parcels should be evaluated for future use as a park-and-ride facility or carpool facility before disposal.

706.3 Site Design

Most facilities outside the Portland metropolitan area will require fewer than 300 spaces, and facilities in rural areas will generally not exceed the need for more than 100 spaces. Lots should be appropriately sized, and may be as small as only five spaces.

Some example layouts of park-and-ride facilities are shown in Figure 700-7. Design features must be in compliance with applicable design standards, specifications, operating standards, and any other local requirements that may apply. Design features such as the entrances and exits, internal circulation, shelter location, illumination, landscape preservation and development, and passenger amenities are generally site specific. Below are presented some design principles used to maximize the efficiency and usefulness of the facility.

Transit stop considerations will include those discussed.

♦ Access

A variety of transportation modes are used to arrive at and depart from park-and-ride facilities: private automobile, carpool/vanpool, bus or other transit vehicle, walking, bicycle, and motorcycle. These modes should be safely accommodated.

Often the most efficient access to a park-and-ride facility will be from an intersecting collector or local street. If the intersection is already signalized, excellent access may be available. If the park-and-ride warrants a signal at a later date, the accesses should be located with signal spacing and operations in mind. The Traffic Management Section should be contacted if signalization is anticipated. Due to cost considerations, sites that do not require signalization may be preferred.

Access to a park-and-ride should not increase congestion on the facility it serves. For this reason, it is not desirable to provide direct freeway access for private automobiles. However, direct access for transit vehicles may be desirable on freeway entrance ramps, provided that this access does not present safety and operational problems. Appropriate measures should be taken to avoid significant adverse impacts to adjacent neighborhoods and nearby streets. Ease of access, especially for the morning commuters, will encourage use of the facility. The appropriate ODOT access and spacing standards contained in the 1999 Oregon Highway Plan should be followed.

When a facility has more than 300 parking spaces, multiple entrances and exits may be required. With facility sizes greater than 500 parking spaces, exits may warrant a traffic signal. Facilities having more than 1000 spaces may require access to two adjacent streets to avoid congestion.

The transit route from the freeway or arterial to a park-and-ride facility, internal circulation route, and return route should be designed to minimize transit travel time. Automobile traffic should not be in conflict with transit vehicles. It may be desirable to provide an exclusive entrance and exit for transit vehicles.

♦ Internal Circulation

Major circulation routes within a park-and-ride facility should be located along the outside edges of the parking area to minimize vehicle-pedestrian conflicts. The priority sequence for the design of the individual user modes should favor the high occupancy vehicles, namely the transit vehicles and carpool/vanpools. It is critical that facility layout and circulation patterns are coordinated with the local transit agency. Bus circulation routes should be designed to provide for easy movement, with efficient terminal operations and convenient passenger transfers. Personal vehicle traffic should be separated from bus traffic. Curb radii and driveway widths should be designed to accommodate the turning characteristic of the largest expected vehicle. The internal circulation should accommodate the needs of pedestrians and bicycles. Providing secure parking or storage facilities for bicycles in the park and ride layout can promote the combination of bicycle commuting with transit as a viable option for getting to and from work.

The passenger waiting areas should be easily accessed by transit riders. Aisles should be aligned to facilitate convenient pedestrian movement toward the bus loading zone. Large facilities may require a central location for the passenger waiting area with parking for the various user modes surrounding the waiting area. In shared-use type facilities, the passenger waiting area should be placed away from the other activity centers to minimize the impacts of pedestrian, automobile, and bus traffic. Bicycle parking facilities should not conflict with passenger waiting areas.

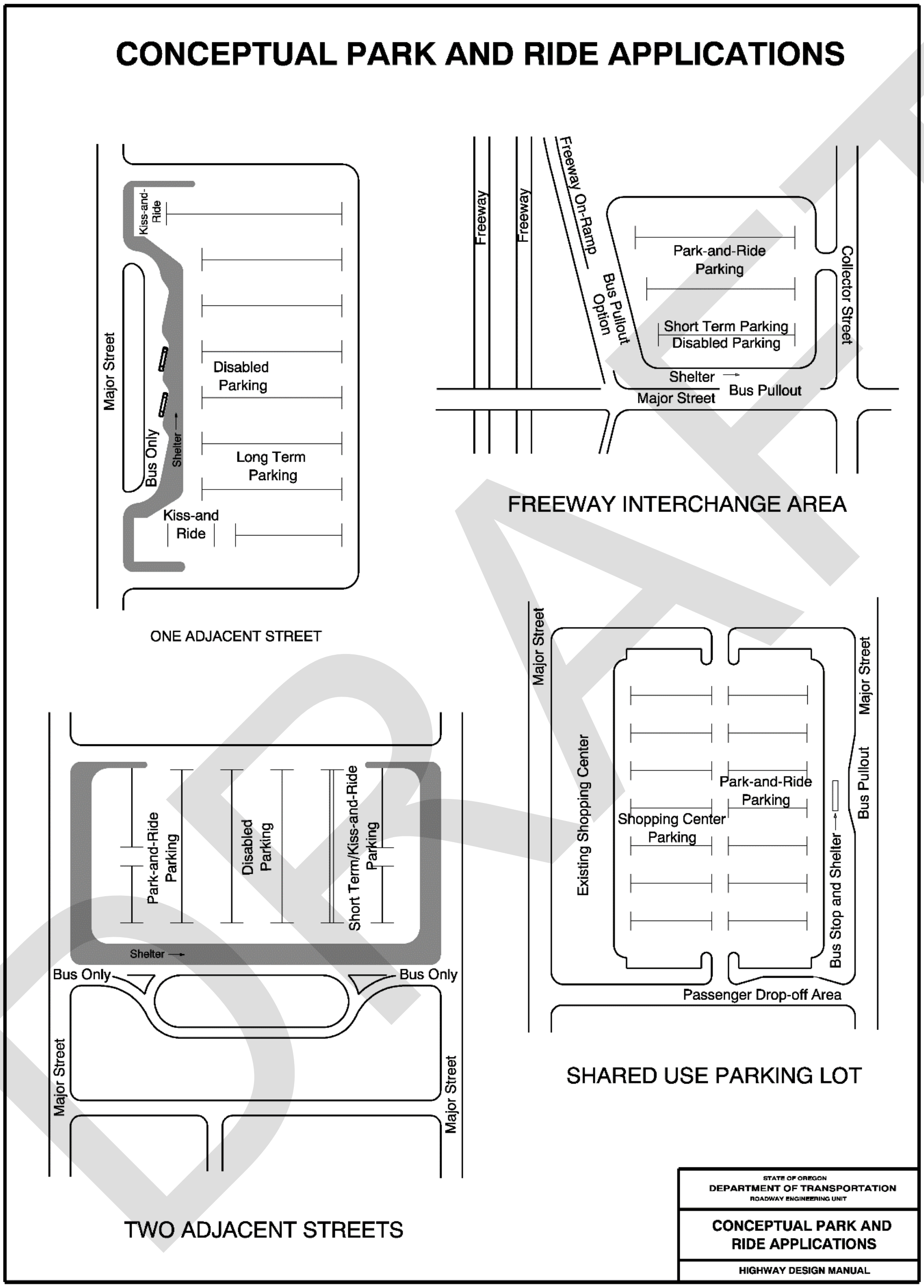
♦ Pavement, Drainage, and Landscaping

Pavement design shall conform to state design specification for each of the functional areas of a facility. The surfacing type shall have the concurrence of the ODOT Pavement Services Unit. Asphalt concrete or portland cement concrete are the ideal surfacing options for all facilities officially designated for park-and-ride. If a facility is to be unpaved, ADA Standards are applicable to unpaved facilities.

Adequate slope should be provided for surface drainage to prevent ponding of water. The recommended grade is 2 percent. Curb, gutter, and surface drains should be installed where needed.

A well-landscaped facility can enhance the appearance of a facility, improve public and neighborhood acceptance, add to the feeling of security and provide runoff water quality mitigation. Landscaping should be compatible with the surrounding area, and should not interfere with sight distance, vehicle operations, or access for potential users. Selective preservation of existing vegetation is often a cost-effective means to reduce environmental impacts and provide a pleasant environment for facility users. Landscaping should be designed so that security patrols can see into the facility from adjacent streets without entering. Landscape design should keep maintenance requirements to a minimum. Trees should generally be the dominant plant material as they provide shade and visual interest, reduce glare, and are less costly to maintain than shrubs and ground cover. Funding for landscaping and other park and ride amenities will vary and should be discussed early on in project development and the establishment of local agency agreements.

1 Figure 700-6: Conceptual Park and Ride Applications



♦ Amenities

Passenger amenities will vary depending upon the type of facility (e.g., exclusive or shared use), the anticipated patronage levels, local policies, adjacent land use and available funding. Amenities that are often found at park-and-rides include shelters, benches, trash receptacles, bus route information, and vending machines, and sometimes heated waiting areas, telephones, restrooms, and small convenience stores.

♦ Lighting and Security

Adequate lighting is important from a safety standpoint and as a deterrent to criminal activity in both the parking area and the shelters. Illumination should be considered for all park-and-ride facilities. Special emphasis should be given to bus loading and unloading areas, passenger amenities and pedestrian/bike pathways within park and ride facilities3. Future expansion plans and nearby development may influence the placement of the luminaire poles.

♦ Signs and Pavement Markings

Control of traffic movements can be greatly improved by proper pavement markings and signing. Reflectorized markings for center lines, lane lines, and lane arrows are necessary to guide or separate patron traffic and transit vehicles. Park-and-ride identification signs shall be installed. Guide signs may be placed to direct vehicles to parking areas, passenger drop-off and pick-up points, and waiting areas. Signs may also be necessary to designate bus-only lanes, no parking areas, and handicapped parking areas.

♦ Bicycle Parking

Almost all facilities will see some bicycle usage. At a minimum, bicycle racks should be provided. The provision of bicycle storage lockers will depend upon usage. Providing convenient and secure bicycle parking or storage is important to encourage the utilization of bicycles in combination with transit as a viable commute option. When a transit rider is comfortable knowing their bicycle is safe from theft during the time they are at work and they do not have to go through the hassle of loading the bike on the transit vehicle, they may be more willing to leave the car at home and ride the few miles to the park and ride. The bicycle parking area should be relatively close to the transit loading area, separated from motor vehicles by a curb or other barrier, and have a direct route from the adjacent streets. The bicycle parking area should not conflict with passenger waiting and loading areas. For additional information on bicycle facilities, see Part 900.

♦ Accessible Parking

The number of accessible parking spaces required for government buildings and publicly maintained or operated parking facilities, subject to ORS 447.233, shall conform to the requirements in ORS 447.233 including the following:

Total Parking Spaces In Lot	Required Minimum Number of Accessible Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2% of Total
1001 and over	20 plus 1 for each 100 over 1000

Exceptions to this requirement are:

1. Outpatient units and facilities: 10% of the total number of parking spaces provided serving each such outpatient unit or facility shall be accessible parking.
2. Units and facilities that specialize in treatment or services for person with mobility impairments: 20% of the total number of parking spaces provided serving each such unit or facility shall be accessible parking.

The dimensions and layout of accessible parking spaces shall be as per Oregon Standard Drawing TM500. No ramp or obstacle may extend into the parking space or the aisle. Curb cuts and ramps may not be situated in such a way that they could be blocked by a legally-parked vehicle. Parking spaces and aisles shall be level with surface slopes not to exceed 2% in all directions.

♦ Environmental Considerations

The design of a park-and-ride facility should consider and address any environmental issues associated with the site. Possible environmental concerns may include stormwater runoff and water quality, wetlands, protected species, noise, visual, traffic impacts and land uses such as public parks and recreation areas. Landscaping and design treatments can help minimize these impacts.

Part 800 Pedestrian Design

Section 801 Introduction

The purpose of this section is to provide design standards for pedestrian facilities on state highways. Other sections in this manual address the design of the roadway realm and bicycle realm including geometric considerations for intersections, interchanges, urban design, and public transportation amenities. Information on pedestrian design considerations are incorporated in other sections as it relates to those amenities. Reference Part 900 for discussion on design principles in areas where pedestrians and bicyclists interactions occur.

A thorough guide for bicycle and pedestrian design is contained in Appendix L, the Oregon Bicycle and Pedestrian Design Guide. Where there is a discrepancy between content in this Part 800 and the Oregon Bicycle Pedestrian Design Guide, this Part 800 takes precedence. The Oregon Bicycle and Pedestrian Design Guide is for use by local agencies to develop their standard of practice for the bicycle and pedestrian realms. Appendix L contains design guidance that may only apply to city and county roads.

To reflect ODOT's commitment to provide facilities for pedestrians with varying abilities, the ODOT design standards for pedestrian facilities in this section may exceed the Americans with Disability Act minimum requirements. The Americans with Disability Act is a federal civil rights law that mandates both the private and public sectors to make their facilities accessible to people with disabilities.

The design standards in this section reflect ODOT’s commitment to the US Department of Transportation policy statement, issued on March 11, 2010, recommending that states accommodate bicyclists and pedestrians while accommodating motorized vehicles. The design standards in this section are also reflective of ODOT’s statewide initiatives and programs including social equity, climate change, reducing emission goals, reducing the carbon footprint and making every mile count.

801.1 Font Key

Text within this part is presented in specific fonts that show the required documentation and/or approval if the design does not meet the requirements shown.

Table 800-1: Font Key

Font Key Term	Font	Deviations	Approver
Standard	**Bold text**	Design Exceptions require STRE	STRE or FHWA
Guideline	***Bold Italics text***	Design Decisions Document	Region with Tech Expert input

Option	*Italics Text*	Document decisions	EOR
General Text	Not bold or italics	N/A	N/A

Standard - A statement of required, mandatory, or specifically prohibitive practice regarding a roadway geometric feature or appurtenance. All Standard statements appear in bold type in design parameters. The verb "provide" is typically used. The adjective "required" is typically used in figures to illustrate Standard statements. The verbs "should" and "may" are not used in Standard statements. The adjectives "recommended" and "optional" are only used in Standard statements to describe recommended or optional design features as they relate to required design features. Standard statements are sometimes modified by Options. A design exception is required to modify a Standard. The State Traffic-Roadway Engineer (STRE) gives formal approval, and FHWA approves as required.

Guideline - A statement of recommended practice in typical situations. All Guideline statements appear in bold italicized type in design parameters. The verb "should" is typically used. The adjective "recommended" is typically used in figures to illustrate Guideline statements. The verbs "provide" and "may" are not used in Guideline statements. The adjectives "required" and "optional" are only used in Guideline statements to describe required or optional design features as they relate to recommended design features. Guideline statements are sometimes modified by Options. While a formal design exception is not required, documentation of the decisions made by the Engineer of Record in the Design Decision documentation or other engineering reports is required. Region approval, with input from Technical Experts, is formally recorded via the Urban Design Concurrence Document in the Design Decision portion.

Option - A statement of practice that is a permissive condition and carries no requirement or recommendation. Option statements sometimes contain allowable ranges within a Standard or Guideline statement. All Option statements appear in italic type in design parameters sections. The verb "may" is typically used. The adjective "optional" is typically used in figures to illustrate Option statements. The verbs "shall" and "should" are not used in Option statements. The adjectives "required" and "recommended" are only used in Option statements to describe required or recommended design features as they relate to optional design features. While a formal design exception is not required, documentation of the decisions made by the Engineer of Record in the Design Decision documentation or other engineering reports is best practice.

General Text - Any informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. The remaining text in the manual is general text and may include supporting information, background discussion, commentary, explanations, information about design process or procedures, description of methods, or potential considerations and all other general discussion. General text statements do not include any special text formatting. General text may be used to inform and support design exception requests, particularly where narrative explanations show best practices or methods of design that support the requested design exception.

801.2 Definitions

The following are definitions of words and phrases used in the HDM. Other definitions may be in the individual parts to which they apply. These definitions do not necessarily apply outside the context of the HDM. These definitions are used to identify the ODOT applicable standards and sections for the design and construction on right of way. Construction of these facilities can be funded with various specialized funding programs with terms that are not synonymous with these definitions. Eligibility for funding is determined by the program definitions, rules and manager.

Unless otherwise defined in this document, the terms used in the HDM are defined according to American Association of State Highway Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets (2018 7th edition) which ODOT has adopted and incorporated into the HDM. Oregon Administrative Rules (OAR) and Oregon Revised Statutes (ORS) have specific definitions for legal regulations that are specific to Oregon Law and may not be in alignment with the HDM definitions. Collegiate dictionaries are used to determine the meaning of terms that are not defined in the HDM, AASHTO, and referenced MUTCD standards.

Americans with Disabilities Act (ADA) - Americans with Disabilities Act is a Civil Rights law passed by Congress in the 1990s making it illegal to discriminate against people with disabilities in employment, services provided by state and local governments, public and private transportation, public accommodations and telecommunications.

Audible Pedestrian Signal (APS) - A device that provides an audible tone to pedestrians that it is safe to cross at a signalized intersection.

Accessible - Features that comply with the ADA and code of federal regulation requirements. People are not discriminated against in the use and operation of a feature or service, having equitable and comparable ability to use the feature and service independently.

Buffer Zone - The space or zone located between the vehicular traveled way and the pedestrian zone.

Concern, Question, Comment, or Request (CQCR) - A process where individuals can inform ODOT about a concern, question, comment, or requests related to ADA. It provides an informal process, rather than a formal complaint, to address an ADA concern on or along the state highway system and a plan to track those CQCRs and their responses.

Crosswalk - Portion of a roadway designated for pedestrian crossing, marked or unmarked. Unmarked crosswalks are the natural extension of the shoulder, curb line or sidewalk.

Crossing - The place on public right of way where the pedestrian facility is interrupted by another mode of transportation and may cross the transportation facility to reach a destination.

For example, a rail crossing is one type of crossing where the pedestrians crosses the facility at a planned improved areas. See the ODOT Traffic Manual for definitions of pedestrian crossings.

Closed Crosswalk - (ORS 810.080) A crosswalk where a road authority places and maintains signs giving notice of closure. Pedestrians are prohibited from crossing a roadway at a closed crosswalk (ORS 810.080, ORS 814.020). See the Traffic Manual for more information on crosswalk closures.

Marked Crosswalk - (ORS 801.220) Any portion of a roadway at an intersection or elsewhere that is distinctly indicated for pedestrian crossing by lines or other markings on the surface of the roadway that conform in design to the standards established for crosswalks under ORS 810.200. OAR 734-020-0005 adopts the Manual on Uniform Traffic Control Devices (MUTCD) as those standards. Decorative pavement treatments such as brick, concrete pavers, stamped asphalt, or coloring are not crosswalk markings (see the Traffic Manual for more information on textured and colored crosswalk treatments)

Unmarked Crosswalk - A crosswalk that does not have markings on the surface of the roadway that conform in design to the standards established for crosswalks under ORS 810.200. Sometimes called a crossing in project development.

Curb Zone - The curb zone is the transition between a sidewalk to the roadway at a crosswalk or intersection. It channelizes storm water and discourages vehicles from parking on the sidewalk.

Grade - The steepness of a roadway, bikeway, or walkway, expressed in the ratio of vertical rise per horizontal distance, usually in percent; e.g. a 5% grade equals 5 feet of rise over a 100 feet of horizontal distance.

Frontage Zone - The portion of the pedestrian realm located between the pedestrian zone and the right of way; adjacent to the business or private property.

Furniture Zone - The furniture zone is synonymous with "buffer zone" or "furnishing zone".

Hardscape - Solid, hard elements in landscape design that stay the same for years. This includes things like walkways, retaining walls, pavers.

Jurisdictional Transfer (JT) - An action whereby ODOT transfers a state highway section to another jurisdiction.

Micro Mobility - Transportation over short distances provided by lightweight, usually single-person devices (such as bicycles and scooters).

Mode (Modal) - A means of moving people or goods. Modes such as rail, transit, carpooling, walking, and bicycling that provide transportation alternative to single- occupancy automobiles are sometimes called “alternative modes”.

Operable Part - A component of an element used to insert or withdraw objects, or to activate, deactivate, or adjust the element.[1] An example of an operable part is a pedestrian push button used to activate the signalized pedestrian crossing.

Pedestrian - A person on foot, using a personal assistive mobility device, or walking a bicycle.

Pedestrian Access Route - A continuous and unobstructed path for the use of pedestrians to navigate along the sidewalk, driveway, curb ramps, crossings, and pedestrian facilities that is fully accessible.

Pedestrian Circulation Area - A prepared exterior or interior surface provided for pedestrian travel in the public right-of-way.2

Pedestrian Friendly - Design qualities that make walking attractive, including places people want to go and good facilities on which to get there.

Pedestrian Realm - That portion of a street right of way which is dedicated to uses other than moving and parking vehicles. It includes primarily the sidewalk, plantings, and street furniture. The pedestrian realm consists of the buffer/furniture zone, frontage zone, and the pedestrian zone/sidewalk. Curbing is a part of the Transition Realm.

Pedestrian Zone - The portion of sidewalk available for pedestrians to traverse, free of obstructions and contains the pedestrian access route for ADA.

Planting Strip - That portion of the sidewalk area which accommodates street trees, shrubs, grass or other organic materials.

State Highway System - The state highway system is defined as all public roads and highways under ODOT ownership or jurisdiction. This definition includes those frontage roads and other public roads that may not squarely fall under the statutory definition or the Oregon Highway Plan definition of the state highway system. The state highway system may reside over another's right of way (e.g. United States forest land) and ODOT has a permanent easement.

Shared Use Paths - An all-weather prepared surface for a pedestrian, bicycle, or a personal wheeled device enabling locomotion for leisure and transportation. Pedestrians and bicyclists utilize the shared space equally and can intermingle in opposing directions of movement. Shared use paths are physically separated from motor vehicle traffic by an open space or barrier. Combinations of the words "shared use" and "multi use," are used interchangeably.

Sidewalks - The portion of a street between the curb line, or the lateral line of a roadway, and the adjacent property line or on easements of private property that is paved or improved with

1 2010 ADA Accessibility Standards, Section 106 Definitions

2 PROWAG, Section R105 Definitions.

an all-weather hard surface and intended for use by pedestrians. Sidewalks are designed for preferential or exclusive use by pedestrians and meets ADA standards.

Softscape - A material that, unlike hardscaping, does not have a long term or permanent quality and may be a living part of the landscape. Softscape consists of elements such as soil, loose rock, sand, bark, plants & shrubs, and turf.

Streetscape - The combination of planters, planting strips, sidewalk, street trees, street lights and other pedestrian amenities.

Temporary Pedestrian Access Route Plan (TPARP) - A plan describing the details of how pedestrians can get through or around construction work zones.

Trails - A prepared firm surface for pedestrian, bicycle, or a personal wheeled device enabling locomotion for leisure and recreation activities including but not limited to bicycling, hiking, horseback riding, and walking. Trails may be designated for exclusive use by a mode of travel such as horseback riding.

Transition Plan - A United States Title II requirement for an agency with 50 employees or more that identifies the agency's outstanding accessibility issues and provides a schedule for eliminating those barriers, both physical and programmatic. These plans are required to be updated on at least a 5-year interval.

Walking - Use of human-powered forms of transportation, including, but not limited to travel to a destination by foot or wheelchair.

Walkways - A transportation facility built for exclusive use by pedestrians, including persons walking or using a personal assistive mobility device. Walkways include sidewalks, shared use path, trails, and paved shoulders.

Walking Distance - The distance covered walking at an easy pace. This is the distance that most people will walk rather than drive, providing the environment is pedestrian friendly.

Wheelchair - A manually-operated or power-driven device designed primarily for use by an individual with a mobility disability for the main purpose of indoor, or of both indoor and outdoor locomotion.[3]

801.3 Acronyms

A list of acronyms specifically introduced in Part 800 is listed below. Acronyms that are defined in other Parts of the Highway Design Manual are not repeated in this section.

CQCR Concern, Question, Comment, or Request

[3] 28 CFR Part 35 Section 35.104 Definitions

OCR	Office of Civil Rights
PROWAG	Public Right of Way Accessibility Guidelines
FRA	Federal Rail Administration
US DOT	United States Department of Transportation
US DOJ	United States Department of Justice

Section 802 Approval Processes

Any deviation from a design standard which falls outside the standard range requires design exception approval by the State Traffic-Roadway Engineer. A design exception requires signature by both the Engineer of Record (EOR) and State Traffic-Roadway Engineer. The design exception process is address in Part 1000 of the HDM. Design exceptions may also require approval by the Federal Highway Administration (FHWA).

Design guidance has evolved over the years to be more context sensitive and to integrate flexibility, but these features are often underutilized. Additionally, design guidance now considers the various modal needs of a transportation system. This evolution reflects the shift from nominal safety (subjective) to substantive safety (objective). Transportation professionals strive to use guidance and standards to support evolving needs and provide a safe and efficient network.

Refer to Part 100 for discussion on how the Blueprint for Urban Design and Practical Design is applied, determining the context for the roadway classification, and ODOT procedures for determining S.C.O.P.E. For example, the scope of a project on a 45 mph state highway on the urban fringe includes construction of sidewalk where none existed. The standard is a 6-foot sidewalk behind a 4-foot buffer, but only 9 of the required 10 feet of right-of-way are available. A practical design approach would be to construct the 6-foot sidewalk with a 3-foot buffer, which is better than a curb tight sidewalk. For more information on the design exception process, refer to Part 1000.

Under the Americans with Disabilities Act, conditions for exceptions to ADA requirements are stipulated in the federal register. When an ADA requirement is infeasible, the burden of proof resides with the agency that constructs the project. Documentation for these ADA exceptions is retained on file using the roadway design exception process discussed in Section 1000. Conditions where an ADA design exception might be considered include:

1. Terrain of the site, when it is technically infeasible to comply with the technical requirements.
2. When a technical requirement causes a change to a protected natural or historic resource under federal or state which alters the function, purpose or the setting of that facility.

Designers should consider all design options before seeking ADA design exceptions. Scope of work cannot justify an ADA design exception where new transportation facilities and amenities for pedestrians do not exist. Alteration of existing pedestrian facilities and features may be limited by the scope of the overall improvements and may be justification for ADA design exceptions.

802.1 Design Concurrence Document

Use the urban design concurrence document form to determine project context, define design criteria, and document design decisions. Authority for approval of the urban design concurrence document will reside in the Region Technical Center. *The Region Technical Center Manager shall provide final approval of design concurrence with collaborative input from Region planning, traffic, roadway, and maintenance.* Pedestrian realm elements contained in the design concurrence document are to be designed in accordance with the standards in Section 800.

802.2 ODOT ADA Curb Ramp Process Document

This document is intended to give designers, developers and local agencies information and guidance on the ODOT pedestrian curb ramp design and construction acceptance process.

In addition to the civil rights requirements under the Federal Americans with Disabilities Act (ADA), Federal and State Law requires that all projects that receive Federal or State funding meet current Federal and State requirements. The document is intended to help guide local agencies or project teams through the process and expectations set by the Oregon Department of Transportation (ODOT) as an obligation to receive such funds. The document provides milestones, detailed instructions, and a checklist to assist you in meeting the requirements of your project.

This ODOT ADA Curb Ramp Process is based on the ODOT Statewide Transportation Investment Program (STIP) project delivery process. The Local Agency process may be different than ODOT's process presented in this document. The intention of this document is not to constrain an Agency to ODOT's format but for the Agency to incorporate Federal and State requirements and expectations into an Agency's process when receiving applicable funds or administering work on the State Highway system.

802.3 CQCR Process for ADA Requests

ODOT established the ADA Comments, Questions, Concerns and Requests (CQCR) program to track and respond to ADA requests from members of the public. The CQCR process facilitates the agency's efforts to address citizen reports of access barriers, ADA accommodation requests for ODOT programs or the state highway infrastructure, and other ADA-based comments, questions, or concerns. The purpose of the CQCR process is to respond to an individual's need to an existing ADA barrier to the transportation system or service provided by ODOT. Requests may include physical amenities on the state highway and services provided by ODOT.

This program is coordinated by the Office of Civil Rights (OCR). ODOT staff from divisions and regional offices across ODOT participate as trained CQCR Coordinators, including regional active transportation liaisons. OCR and the CQCR coordinators strive to provide a customer an initial response within 5 days. Overall, ODOT must communicate the result of a CQCR investigation to the requester within 30 days of submission. If a complex barrier case requires more than 30 days to resolve, the CQCR coordinator will provide updates to the customer as a remediation plan is developed.

Each CQCR inquiry is entered into a central database and a process is in place to evaluate, respond, and find a solution to the request of the individual. The CQCR process documents incremental improvements on the transportation system when full standards are not achieved with the constructed solution. ADA design exceptions are not required for incremental improvements on CQCR projects.

Some solutions may require additional planning, design, and funding to reach a final resolution for individual's accessibility barriers. Project teams need to be aware of locations that have CQCR issues within the project limits. Utilize the FACS-STIP tool to find locations with active CQCR issues. Evaluate CQCR locations and address in the project S.C.O.P.E. and business case development. The regional active transportation liaison is the best resource for additional information on CQCR locations during scoping efforts.

802.4 Crosswalk Location Determinations

When determining where crosswalks are located on the state highway (marked or unmarked), the definition of an intersection is based on the Oregon Revised Statues ORS 801.220 and ORS 801.320 as described below. Crosswalk locations at intersections are often unique with complex geometry. The Traffic Section assists in these circumstances to determine where crosswalks exist on the state highway. Crosswalks are pedestrian facilities that must be useable and designed for all pedestrians. Refer to the Traffic Manual for the procedures in crosswalk location determinations.

An intersection exists where two or more roadways join at any angle (ORS 801.320). This includes T-intersections (where two roadways join and one of the roadways ends).

Intersection is described in one of the following:

1. If the roadways have curbs, the intersection is the area embraced within the prolongation or connection of the lateral curb lines.
2. If the roadways do not have curbs, the intersection is the area embraced within the prolongation or connection of the lateral boundary lines of the roadways.
3. The junction of an alley (ORS 801.110) with a roadway does not constitute an intersection.
4. Where a highway (ORS 801.305) includes two roadways 30 feet or more apart, then every crossing of each roadway of the divided highway by an intersection highway is a separate intersection. In the event the intersection highway also includes two roadways 30 feet or more apart, then every crossing of two roadways of such highways is a separate intersection.

Crosswalks are located:

1. Wherever crosswalk markings conforming to the Manual on Uniform Traffic Control Devices (MUTCD, adopted in OAR 734-020-0005) are on the roadway surface (Installing marked crosswalks on state highways might require approval. See the Traffic Manual for requirements related to marked crosswalks on state highways.), or
2. If not marked, then across every leg of an intersection as follows unless a crosswalk is closed or does not exist as described in the technical bulletin RD21-01(B):

   a. Where curb ramps connect across the leg of an intersection, or

   b. Where a curb ramp connects with a shoulder or sidewalk across the leg of an intersection, or

   c. Where shoulders or sidewalks connect across the leg of an intersection, or

   d. Where shoulders or sidewalks would connect across the leg of the intersection, as if shoulders or sidewalks were present at an intersection.

Unmarked crosswalks only exist at intersections (ORS 801.220).Unmarked crosswalks are 6 to 20 feet wide (ORS 801.220). The connections described above are within the crosswalk and the crosswalk does not extend into the parallel traveled way.

A midblock crosswalk is located where crosswalk pavement markings conforming to the MUTCD are present and the location is not an intersection.

802.5 Crosswalk Closures

Sidewalks provide mobility along the highway, but full pedestrian accommodation also requires frequent, safe and convenient crossing opportunities. Wide highways carrying large traffic volumes can be difficult for pedestrians to cross, making facilities on the other side difficult to access. Crossing opportunities are not limited to marked crosswalks at signals. Mid-block and un-marked crossings need to be considered, as people will take the shortest route to their destination. Prohibiting such movements is counter-productive. The Traffic Manual discusses the procedures to close a crosswalk on the state highway which must be approved by the State Traffic Roadway Engineer. A closed crosswalk must include notice to the public with signage per ORS 810.080 which makes it illegal for all pedestrians to cross at that location.

Safe and convenient pedestrian crossings cannot be considered in isolation from the following issues, which should be addressed when seeking solutions to specific problems. Chapter 5 of Appendix L describes each of the following issues in detail.

1. Volume to Capacity (V/C) and Design Standards (Appendix L, page 5-3)
2. Land Use (Appendix L, page 5-4)
3. Transit Stops (Appendix L, page 5-4)
4. Signal Spacing (Appendix L, page 5-4)
5. Access Management (Appendix L, page 5-5)
6. Out-of-Direction Travel (Appendix L, page 5-6)
7. Midblock versus Intersection Crossings (Appendix L, page 5-6)
8. Maintenance (Appendix L, page 5-7)

Section 805 Pedestrian Needs

Pedestrians have different needs than vehicular traffic. Pedestrian movements and paths of travel are not as predictable as moving vehicles. Pedestrian travel is heavily dependent on human behavior and social norms rather than the rules of the road. Culturally, you may find different behavior of pedestrians when traveling in different communities or countries. People operating a motor vehicle must follow the rules of the road when driving and are generally confined to spaces demarked by lines in the roadway realm. Pedestrians are not confined to rules of the road such as striping but generally follow the path of least resistance and the shortest, most direct route to their destination. Personal choices for safety and risk taking are also dependent on the individual's abilities when using the transportation system.

805.1 Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) of 1990 is a federal Civil Rights law that mandates both the private and public sectors to make their services and facilities accessible for people with all types of disabilities. The ADA requires that transportation facilities accommodate the needs of people with disabilities. That means that sidewalks, shared use paths, street crossings and connections to private properties must be built so people with varying abilities (e.g. limited mobility or low vision) can easily use them.

Pedestrian improvements that improve accessibility result in a high quality system for all users. Accessible infrastructure has been linked to increased business opportunities, social development, health benefits and increased independence among community members. Accessible design benefits all users of the facility and the community. People with disabilities live in both rural and urban communities, and are more reliant on pedestrian infrastructure for transportation.

The sections below talks about the needs of the various populations when navigating walkways. The ADA identifies disabilities based on major life activities. Disabilities protected under the ADA can be either visually apparent or unseen in the average pedestrian encounter. Disabilities might be temporary or permanent for an individual, and may fall on a spectrum of affect. For example, some Blind people may have some functional vision while others may be entirely without sight. Some people may have multiple disabilities on various spectrums. Human sense is how the body perceives an external stimulus and processes information which include sight, smell, hearing, taste, and touch. When one of these senses is impaired, the pedestrian must rely on the other senses to navigate their surroundings. For example Deaf-Blind travelers have more difficultly navigating their surroundings as two of their primary senses are compromised.

805.2 Service Animals under the ADA

Service animals are either highly trained dogs (any breed), or can be a miniature horse under the ADA.[4] Miniature horses generally range in height from 24 inches to 34 inches measured to the shoulders and generally weigh between 70 and 100 pounds. Service animals perform tasks and activities that are essential to their owner's health and safety. The assistance of trained service animal can enhance the independence, community participation and quality of life for a person with a disability. Service animals not only perform tasks related to a disability but they are also permitted in all public places where animals are typically prohibited. Many people first think of a highly trained dog serving a Blind owner as the typical service animal relationship,

4 CFR Part 35 Section 35.136 Service Animals

but many disabilities can be aided by a trained animal. A variety of dog breeds and even a miniature horse may work to support a person with a disability under the ADA. Service animals need space to walk side by side with their handler. Objects such as push buttons or levers should not be located to high so service animals can activate the mechanism.

Service animals include training not only for obedience, but also public access training and specific task training. Emotional support animals (ESA) are not the same as service animals, and can be a wide variety on animals including dogs, cats, rabbits, birds, etc. Public access training involves skills to function public places and service animals are often recognized by their calm and unobtrusive behavior with their focus on their human handler. They should never show disruptive or aggressive behavior. The most commonly recognized service dogs are those who help individuals with vision impairments (low vision or blind) and those who use a wheelchair; however not all disabilities are visible to someone passing by.

For those with vision impairments, service animals assist their handler to safely navigate their surroundings and avoid obstacles. Service animals perform tasking including but not limited to stopping for changes in elevations such as curbs, leading a person around an obstacle such as signs, and finding entrances or exits to buildings. For those who are hard of hearing, service animals alert them to everyday sounds and emergency sounds such as a fire alarm. A hearing dog may be trained to alert them to find an audible pedestrian signal tone People with limited range of motion or using wheelchairs can benefit from service dogs as well. The service animal can provide additional power to propel up a steep slope, may use their paws or nose to activate a push button, automatic door pads, or open/close lever door handles and lights. Service animals may also brace a person who has balance issues and difficultly walking.

805.3 Blind and Low Vision Users

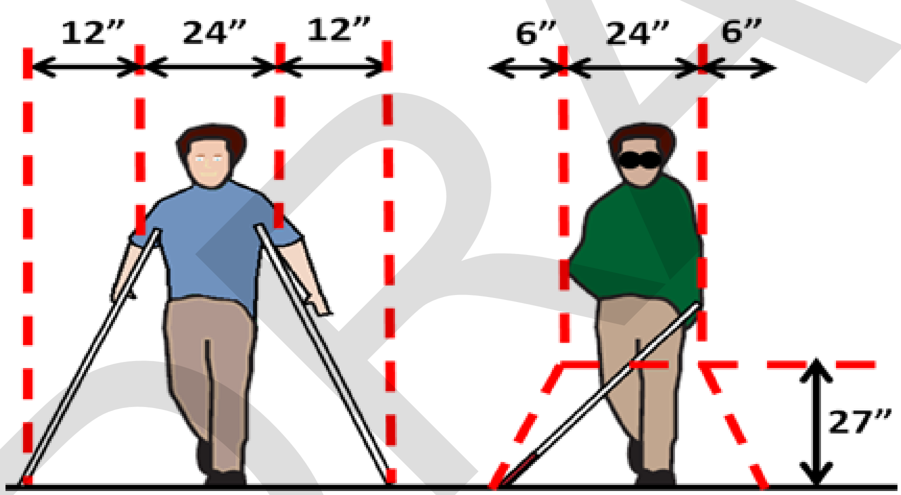
Design pedestrian facilities so people with vision impairments can track their way safely along the sidewalk, across driveway approaches and through intersections. Keeping the sidewalk clear of obstructions is important. Changes to the pedestrian environment can affect their ability to orient themselves.

People with vision impairments may use a variety of aids to help them navigate their trip. They get information from sound, textures and contrast. They benefit from, audible and vibrotactile information, tactile indication of boundaries, clearly defined pathway and high color-contrasts. Some people have Orientation and Mobility Instruction to familiarize themselves with frequent travel locations. People might have assistance from sighted guides including humans or animals, telescopes or other low-vision aids. Service animals and caning techniques aids the low vision community while navigating their environment. Many people with low vision do not use any physical aids at all when walking relying on contrasting color. Echolocation is also used by people with vision impairments in varying degrees based on the person’s abilities.

Service animals help people navigate their environment. They don't know where to go without direction from their handler. Service animals are trained to have intelligent disobedience when performing tasks, and therefore might hold steadfast if the individual is about to enter and oncoming vehicle is approaching. Service animals can also be trained to help the individual find a vacant seat on a bus service when using public transportation.

White canes are used by people who are blind or have low vison to provide them tactile and audible information. Caning techniques detect objects typically by sweeping a cane ahead from side to side. Typically, a person sweeps a cane about 3-feet wide and paces forward about -2 feet during the cane sweep with each step. Objects lower to the ground allow for early detection with a cane and allow for greater perception and reaction time. A cane is intended to detect objects up to 27 inches above ground. Objects above 27 inches that are not detected that protrude in the pedestrian circulation area can cause physical harm or bodily injury to a person's internal organs when their body strikes it. Objects below 80 inches that protrude in the pedestrian circulation area can also cause injury to the head and eyes if adequate vertical clearance or detectable delineation is not provided.

Figure 800-1: Width Requirement for Person with Crutches and for Cane User



Installation of detectable treatments and tactile walking surface indicators (TWSI) provide useful cues for the low vision community to navigate their way along walkways. Detectable treatments include physical edged features such as curbing, landscape materials, fencing, concrete barrier, or similar features. Landscaping can be divided into both hard and soft features. Confusion can occur with a landscape feature that cannot be distinguished underfoot when that area is not intended to be walked on.

Tactile walking surface indicators provide information under foot that can be perceived wearing shoes, but does not impede mobility devices from traversing over them. There are different geometric shapes for TWSI with emerging use in the USA. Truncated dome surface panels are one style of TWSI used on pedestrian facilities in the public right of way. FHWA requires the installation of truncated dome detectable warning surfaces (DWS) on federally funded projects at curb ramps. Detectable warning surfaces are required at railroad pedestrian crossings, and at transit service areas designating the boarding and alighting areas. For information on the installation location of DWS, refer to the latest Oregon Standard Drawings.

Provide "safety" yellow detectable warning surfaces at curb ramps. When detectable warning surfaces are detected underfoot or by cane, the user should be alerted to stop. Detectable warning surfaces are intended to communicate a "stop" message of where the vertical curb line no longer exists (flush connection with the roadway). Detectable warning surfaces are not intended to provide orientation information. While stopped, the user evaluates their surroundings to determine when to proceed with the desired crossing, or to remain stopped and wait to board a transit service. High contrasting color detectable warning surfaces with the surrounding area provides information to people who have some functional vision remaining (low vision) where the curb ramp opening is.

Tactile information is helpful both underfoot and with hand placement on objects. Pushbuttons for signals provide a vibrotactile indicator when the hand rests on the push button and the indicator changes to a walk condition. The arrow symbol on the push button is also a raised symbol so someone feels which direction the arrow is pointing. These are strategies used for effective communication at signals as stipulated under the ADA.

805.4 Users of Mobility Devices

Many people have physical impairments for a short time period, while others live with physical limitations their whole lives. As a result, there is a wide range of operational ability between people. Many people with physical disabilities use assistive devices such as crutches, canes, walkers, scooters, and wheelchairs. Others have prosthetic limbs or healing injuries that impact their ability to walk. As a result, they have limited agility, speed and endurance. Other people with heart disease or otherwise limited stamina prefer stairs to a longer route with a gentle slope. Lips, curbs and stairs are barriers for many people, requiring sloped ramps as an alternative.

They benefit from firm, level surfaces, adequate clear width, and limited cross slope. Adequate space is needed to use these devices on walkways. Pedestrians with mobility impairments are most sensitive to time limits that depend on walking speed. Walking speeds typically vary from 2.5 to 6.0 feet per second by foot, while powered devices can travel up to 10 mph. Walking is slower near intersections and when pedestrian are in groups rather than walking alone. Refer to the traffic signal manual for walking design speed in traffic operations.

There are many styles of wheelchairs including those requiring another person to push from behind, self-propelled manually, power assisted and motorized wheelchairs. Since they are sensitive to grades, some are equipped with 'wheelie bars' to help prevent tipping over backwards. Manually propelled devices may have aftermarket devices installed to provide power assistance when negotiating steep terrain periodically. Motorized wheelchairs and scooters are most impacted by space availability for turning maneuvers. Users are sensitive to imperfections in the ground surface that may vibrate when they roll. Clear space requirements for a common wheelchair are 4-feet in length and 30-inches wide. Many devices including power assisted scooter today are larger and occupy a physical space of 5 feet in length. Wheel distances are typically 2 foot apart.

Figure 800-2: Sample Variety of Wheelchairs (1 of 2)

Figure 800-3: Sample Variety of Wheelchairs (2 of 2)

Service animals help those with mobility issues in performing tasks such as opening or closing a door, delivering or carrying an object, and providing power to physically move or brace the handler. Light duty service animal tasks include guiding or light pulling in a forward direction. Moderate duty service animal mobility tasks include acting as a counter balance for walking in partnership with their handler, or bearing weight for a person to stand or navigate stairs. Heavy duty service animal mobility tasks include pulling a person seated in a wheelchair.

Miniature horses are physically able to perform heavy duty pulling more frequently in comparison to a service dog (depending on breed).

805.5 Deaf and Hard of Hearing

People with hearing disabilities rely more on their vision but may also use tactile information. They benefit from good sight lines for assessing street crossing conditions and information in visual or vibrotactile format. They benefit from the high color contrast and may be more sensitive to the information provided by textures they walk over. The high contrast color of the detectable warning panel and texture underfoot of the truncated domes may also alert someone that is hard of hearing that they are about to enter a street crossing. Count down signal heads provide information for hard of hearing individuals visually so they can prepare to cross the street.

While most people think of service dogs being used for blind travelers, service dogs can also be trained to aid those who are hard of hearing and alert them when certain sounds or words occur. Service animals might be trained to assist the handler find the locator tone on the pushbutton, or alert them to an emergency sounds, or alert them when they drop an object such as keys. At signalized intersections a service animal may be trained on the verbal command to stay in place with the word “wait” until they are released by their handler’s cue. Audible cues such as the repeated word “wait” when the pushbutton is activated could be heard by the service animal to inform their handler to stay in place until the “walk” time is available.

805.6 Cognitive Conditions

Disabilities involving cognition, learning and memory affect the ability for people to perceive and react to information in the surrounding pedestrian environment. Responding to a traffic control device, such as a walk signal requires a perception and reaction time, typically up to 3 seconds before proceeding. People who use mobility devices can require up to 20-feet to react and stop walking.

Features in the pedestrian environment that can affect the ability to travel include: interpreting traffic signs, actuating a pedestrian signal, understanding the configuration of a street crossing and predicting traffic movements. Individuals benefit from straightforward signs with easy to understand picture symbols, reliable wayfinding, consistency between the placement of curb ramps, pushbuttons and other features, direct and uncomplicated street crossing geometry, good sight distance at crossings and otherwise thoughtful design and operation.

Section 810 Walkways

Walkways are a portion of the public right of way located in the pedestrian realm used for locomotion. The pedestrian realm is divided into the buffer zone, pedestrian zone, and the frontage zone. Recreational and transportation needs of pedestrians can be served by walkways. Walkways include sidewalk, shared use path, and trails. Paved shoulders serve pedestrians using rural highways in the absence of walkways in the Travelway Realm. Street crossings or crosswalks serve pedestrians with the pedestrian access route provided in the roadway in the Travelway Realm.

Provide walkways in all urban contexts on state highways. Per ORS 366.514, walkways and bikeways must be provided whenever a roadway is "constructed, reconstructed, or relocated." A walkway is a facility or service to provide people with transportation options. When walkways are constructed, they must be made accessible and meet ADA requirements. **Provide an accessible sloped entrance and exit to transition from the sidewalk or shared used path to the shoulder when the walkway terminates.** Entrance and exits are typically made with curb ramps that cut thru a curb along the roadway. See Section 815 for the requirements of curb ramp design. Entrance and exits connecting the walkway to the paved surface of the shoulder or roadway can also be at grade (without curbing). *Limited access expressways should be evaluated for a possible sidewalk exception, providing a shared use path or separated bikeway along a parallel route.*

Pedestrian facilities with a buffer zone are the preferred facility for pedestrians. Walkways may be separated by a buffer which can include but is not limited to a ditch, landscaping area, rain garden, curb, guardrail, or other barrier. The buffer makes a physical separation from vehicular use and the walkway surface constructed becomes exclusive for pedestrian use.

Sidewalks and shared use paths may also be needed on state highways beyond city limits based on existing and planned land use within the urban growth boundary, or in unincorporated areas. **Projects are not permitted to degrade existing walkways per the Oregon Bicycle and Pedestrian Plan. Modifications and reconstruction of walkways shall not reduce accessibility under the ADA.** This means the final construction conditions cannot be made worse for pedestrians with any given modification to the walkway. Consult the Regional Planner for planning documents including but not limited to Transportation System Plans for planned pedestrian network improvements. New sidewalk construction or infill needs can also be determined through roadside inventory data via the FACS-STIP tool and from local planning documents. See Appendix F for instructions on how to access roadside inventory sidewalk need data through the FACS-STIP tools.

Sidewalks, located along roadways, separated with a curb and/or planting strip or swale, have a firm, stable, and slip resistance surface. Sidewalks can be constructed of many materials and meet the accessibility requirements (see Section 810) required by ADA. Sidewalks can also be used by bicyclists, but cities may ban bicycle riding on sidewalks with a local ordinance.

Figure 800-4: Sidewalks in Urban and Suburban Contexts

Shared Use (Multi- Use) Paths, are typically used by pedestrians, cyclists, skaters, joggers and users of other micro mobility devices. It is not realistic to plan and design a path for exclusive use, as other modes will be attracted to the facility. Shared Use Paths may reside parallel with the highway or have a separate alignment that leaves the highway right of way connecting destinations and recreational areas within the community. **Shared Use Paths are required to be accessible for the full width of the facility, meeting both cross slope and running slope requirements under ADA. Accessible sloped entrances and exits shall be provided where the shared use path ends or crosses a curb.** See Part 900 for additional path design guidelines.

Figure 800-5: Shared Use Path Context

Trails may be unpaved (packed gravel) if they are graded and firm (resist indentation). An unpaved path should not be constructed in lieu of sidewalk. ADA requirements for trails are not intended to change the overall experience of the trail, but to provide useable access to the recreational feature and facility to people with disabilities. ADA requirements for trails are modified from walkways that are used from transportation purposes (sidewalks and shared use paths). Trails may be designated for exclusive use by a mode of travel such as by horseback. *Signs at the trailhead indicating the trails accessibility features such as steepness and distance is encouraged to provide information for users about the trail facility.*

Figure 800-6: Trailhead and Trail in Recreational Context.

Shoulders serve pedestrians where a walking facility is not provided. The shoulder is shared for vehicle recovery area, cyclists and pedestrian usage. Oregon law ORS 814.010 requires that pedestrians who walk along a shoulder face traffic, while sidewalks serve both directions of travel. Mobility devices, power assisted wheelchairs and scooters are permitted to utilize the shoulder rather than the sidewalk under Oregon law (ORS 814.500 and 814.510), and should be traveling with the flow of traffic. **When roadway shoulders include pavement markings or signs that indicate the shoulder is intended for pedestrian use only, the shoulder is now an exclusive pedestrian facility requiring the accessible route standards to be met under ADA.**

Figure 800-7: End of Pedestrian Exclusive Facilities

See shoulder width table in Part 300 for shoulder width guidelines.

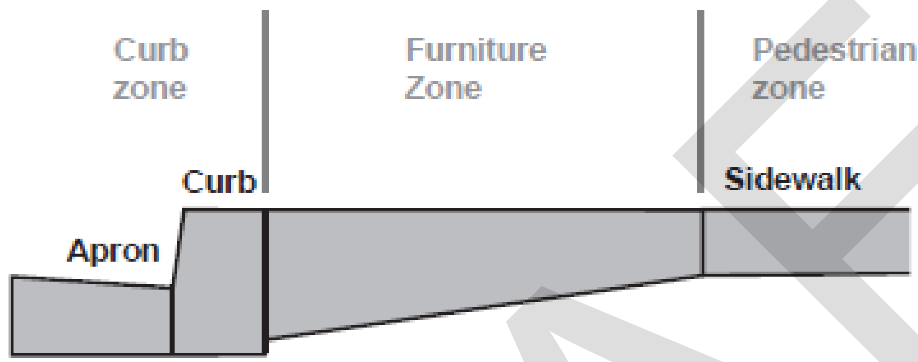
810.1 The Pedestrian Realm

A highway cross section is categorized into Realms as described in Part 300. The Pedestrian Realm is further divided into four zones. These include the Curb Zone, the Buffer Zone, the Pedestrian Zone and the Frontage Zone. The Pedestrian Realm is adjacent to the Transition Realm. On highways with separated bike lanes, the Curb Zone and Buffer Zone may overlap zones within the Transition Realm. See Part 300 for design requirements in the Cross Section Realms. Roadway facilities should be designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. The Pedestrian Realm serves pedestrians and provides access to the land uses. Understanding the pedestrian activity, access to land use, and buffers in this realm can help prioritize the design decisions in the pedestrian realm and support the need to balance the trade-offs amongst the various cross section constraints.

810.2 Curb Zone

Most urban streets with sidewalks are typically curbed. A curb channelizes storm water to a storm water treatment facility and waterway, provides edge delineation from the vehicular or bikeway facilities, and discourages people from parking their cars on the sidewalk. Curbing also provides visual or tactile information to pedestrians. There are several styles of curb including those with a vertical edge, a sloped surface, or a rolled edge. Curbing may also include a concrete gutter pan (apron) to provide additional hydraulic capacity conveyance, control slope construction at a crosswalk, and provide a solid edge for pavement construction and inlays. The curb zone is also where a sidewalk transitions to the street at a crosswalk or intersection. Refer to Part 300, Section 317 Curbs for curb type selection and uses on state highways.

Figure 800-8: Curb Zone Transition from the Street to Sidewalk



Provide a curb zone of within the range of 2.5 feet to 6 inches, see RD700's. **Curb zones less than 6 inches are rare and do not follow ODOT's standards for construction per RD700.** Drainage curbs are generally not the preferred option for the curb zone when creating pedestrian walkways (see discussion on pedestrian lanes in Section 810.7). Where curb and gutter is used and on-street parking is provided or travel lane is directly adjacent to curb, the gutter pan should be included in shoulder/shy or on-street parking measurements. The gutter pan should be included in travel lane, bicycle lane or turn lane measurements only where a smooth transition from gutter pan to roadway surface is provided.

The curb zone introduces a physical barrier for pedestrians with some disabilities and can obstruct a person from entering or exiting the pedestrian facility. A curb ramp is required to provide access to the pedestrian facility including sidewalk and shared use paths. The curb is typically modified to be depressed and flush with the adjacent surfaces along the pedestrian access route on the walkway. Refer to Section 815 for curb ramp design and curb running slope requirements.

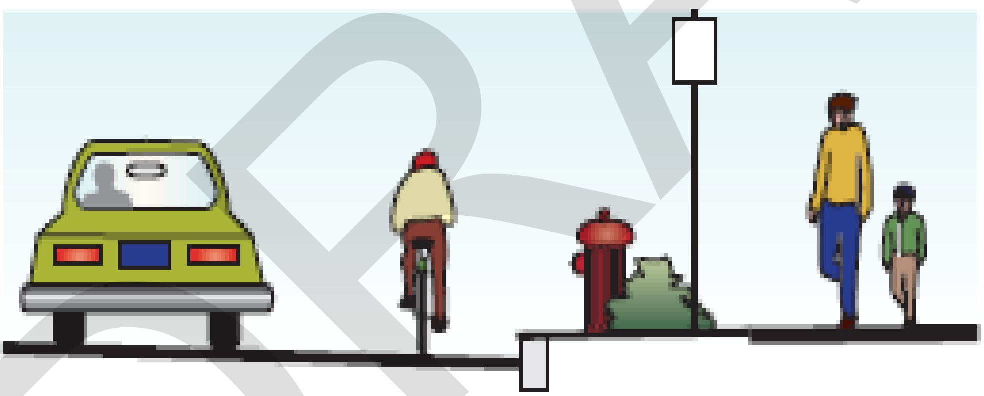
Curb and gutter is a part of the curb ramp system. For splitter islands or other accessible route islands where the curbing (curb zone) is keyed into the pavement, curb and gutter is required as shown on RD710. The curb ramp standard drawings have a basic assumption that the walkway is, or will be a curbed typical section. Many rural locations do not have existing curb in place and will remain rural in character with separation from the travel way realm (for example a grassy sloped surface or ditch). The same basic requirements for slopes and grade apply to the walkway and connection to the crosswalk for the pedestrian access route in these circumstances. *When walkways do not include curbing (a curb zone), curb and gutter is not required in* *this type of corridor*. Where there is no curb zone, the different surfaces adjacent to each other still must be flush and meet the counter slope requirements.

810.3 Buffer Zone

The buffer zone is also known as the furniture zone, or furnishing zone. As noted above, on highways with separated bike lanes, zones within the Transition Realm may overlap zones in the Pedestrian Realm. All walkways should be designed so that a buffer distance separates the pedestrian zone from traffic, unless right of way or other constraints preclude this feature. Buffers may include a planted buffer strip, a shoulder barrier, a parking lane or a bike lane. Refer to standard drawings RD700 series for additional construction details. See Part 300 for Cross Section Realm design guidance.

Provide a buffer zone within the range of 6 feet to zero feet in the traditional downtown/central business district, urban mix, suburban fringe and residential contexts. Provide a buffer zone within the range of 5 feet to zero feet in the commercial corridor and rural community contexts.

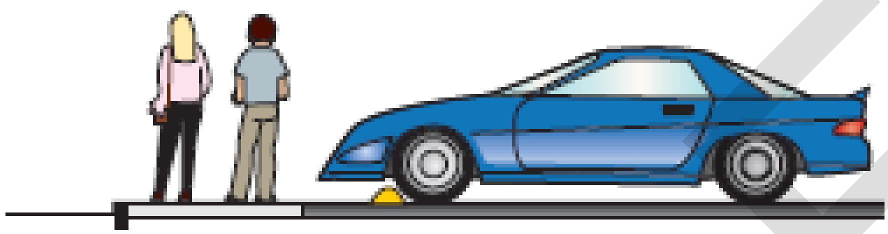
Figure 800-9: Buffer Zone Used for Signs, Utilities, and Decorative Plantings



A buffer strip should be at least 4 feet wide when planted landscaping is desired. Areas less than 12 square feet are difficult to support plant growth. Planted buffers are not recommended in downtown areas with on-street parking because this precludes direct access to the sidewalk at the arrival point and limits the use for people with disabilities. Plantings should be selected based on regional conditions. Select varieties of plant species that require little maintenance and watering, and their roots should not buckle walkways. **Ornamental plantings are not permitted per the DES 20-01 policy without an agreement for maintenance in place with the local agency.** See discussion on walkway surface selection in Section 810.8.

Parked cars encroach into the walkway because there is an overhang distance from the wheels or side mirrors. The amount of encroachment for head in parking in comparison to back in parking is significant (particularly trucks). Cars parked head in on a perpendicular or diagonal alignment encroach a smaller distance into the walkway. **Provide a buffer zone of at least 2.0 feet so cars do not reduce the pedestrian zone and pedestrian access route.** When angle parking is provided check the overhang distance based on AASHTO's parking lane configurations. *Provide anchored (pinned) wheel stops, curbing or other treatments to prevent narrowing of the pedestrian zone from vehicular overhang.*

Figure 800-10: Wheel Stops Reduce Sidewalk Encroachment



Pedestrian amenities are service provided to the public. **Provide a pedestrian access route in the buffer zone or furniture zone to pedestrian amenities so all people can access the service provided.** See discussion on pedestrian amenities in Section 810.10 and the pedestrian access route in Section 810.5. The pedestrian realm should be widened to create a buffer zone for street furniture and other amenities out of the pedestrian zone. Benefits of the furniture zone for pedestrians and other road users are discussed in Appendix L, pages 4-2 to 4-3. Trees, street furniture and other objects should not reduce visibility of pedestrians, bicyclists and signs, especially at intersections.

Provide a continuous buffered walkway in Commercial, Residential, Suburban and Rural community contexts of at least 2 feet. Where constraints preclude the use of a buffer throughout a project, it can be interrupted and then resumed where the constraint ends with gradual transitions. The traveling speed of pedestrians and the mobility devices can vary up to 10 mph along the pedestrian zone, with average walking speeds of 3.0 mph. Transitions rates used for horizontal width changes takes into consideration the traveling speeds of pedestrians. *Transitions rates for horizontal width changes in the pedestrian realm is preferred to be 1:10. When space is constrained a transition rate of 1:5 is permitted.* **Transition rate of 1:3 is the minimum for horizontal width changes.**

810.4 Pedestrian Zone

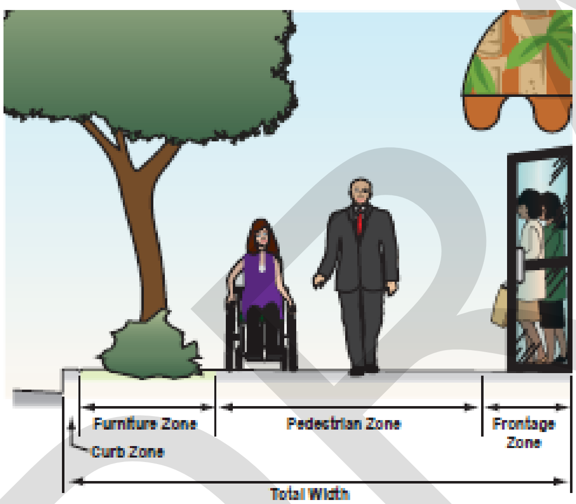
The pedestrian zone is where people walk. All planning, design and construction documents should clearly state the pedestrian zone dimension is to be clear of all obstructions. The pedestrian realm is divided into a zone system. The best way to achieve the goal of a clear walking area is to design pedestrian facilities using the zone system. Each zone is a distinct area. The four zones are:

- The curb zone
- The buffer (or planter or furniture) zone
- The pedestrian (or walking) zone
- The frontage zone.

Each zone has its function, and omitting a zone compromises the quality of the walking experience.

The zone system makes it easier to meet the basic ADA requirements for a continuous, smooth, level sidewalk free of obstructions. The Pedestrian Zone is typically the Pedestrian Access Route. It's easier to keep the sidewalk level across driveways, place ramps correctly, and all potential obstructions (poles, signs, trees, drinking fountains, benches, etc.) can be placed in the buffer or frontage zones. Separation from the roadway also places pedestrians further from traffic, increasing comfort and security.

Figure 800-11: The Pedestrian Realm Zone System in the Urban Context



The pedestrian zone can take on different configurations within the pedestrian realm and based on the six urban contexts. ODOT's urban context includes Traditional Downtown/Central Business Districts, Urban Mix, Commercial Corridor, Residential Corridor, Suburban Fringe, and Rural Community. Refer to Part 200 for more discussion on the urban context and classification identification process. Roadway design has been rapidly changing toward greater flexibility along with inclusion of multimodal, context related design focusing on all road users. Modal considerations are given higher priorities depending on the urban context.

Pedestrian facilities can include sidewalks with or without curbs, behind a ditch or may be provided on a bridge to provide pedestrian transportation. Sidewalks are designed for preferential or exclusive use by pedestrians. Provide ample space for pedestrian activity in Traditional Downtown/Central Business Districts and Urban Mix areas including but not limited to outdoor dining and transit shelters. Select a sidewalk width with sufficient space to accommodate desired level of pedestrian activity.

Walkway widths are exclusive of curb as they are a part of the curb zone. *Provide a pedestrian zone with the width in the range listed in Table 800-2 below.* **At least 5 feet of the pedestrian zone will be continuous meeting pedestrian accessible route requirements.** The pedestrian zone should be designed with the greatest width feasible within the design range. Pedestrian zone is free of obstructions, utilizing the buffer zone for lighting and signs. The frontage zone contains decorative planting boxes and other pedestrian amenities.

Table 800-2: Pedestrian Zone Design Range

Traditional Downtown/CBD	Urban Mix*	Commercial Corridor*	Residential Corridor*	Suburban Fringe*	Rural Community*
10 ft to 8 ft	8 ft to 5 ft	8 ft to 5 ft	8 ft to 5 ft	8 ft to 5 ft	9 ft to 5 ft

*5-foot pedestrian zone requires a paved frontage zone and/or a paved buffer zone. Minimum “walkway” width is 6-feet.

Figure 800-12: Walkway with a Clear Pedestrian Zone

The 6 foot width allows two people (including wheelchair users) to walk side by side, or to pass each other comfortably as pedestrians are permitted to walk in either direction on a sidewalk. Six foot widths also allows two pedestrians to pass a third person without leaving the walkway.

Where it can be justified and deemed appropriate, the minimum width of a walkway may be 62 inches (5.2ft) such as on local streets or where there are physical constraints. Physical constraints might include a building foundation, an historic wall, or a utility poles.

Figure 800-13: 5 Foot Sidewalk is Uncomfortably Narrow

810.5 Pedestrian Access Routes

The fundamental ADA requirement is to create a contiguous link between site arrival and site destination points that is accessible by all people. This link is called the pedestrian access route and is a portion of a pedestrian zone that meets ADA requirements. Pedestrian access routes (PAR) lie within the pedestrian realm or pedestrian circulation area. ***Design at least a 50 inch (4.2 feet) pedestrian access route that is fully accessible meeting ADA requirements.*** *Both the pedestrian zone and pedestrian circulation areas should be fully accessible; the pedestrian zone and PAR should be of equal width.* The entire width of a walkway in the pedestrian realm can be considered a pedestrian circulation area or path when constructed of a hard traversable surface, while a portion of that walkway is the pedestrian access route.

ADA requires wheelchair passing opportunities on pedestrian facilities; constructing a 60 inch (5 feet) pedestrian zone free of all vertical obstructions ensures that standard is met without further analysis. **At no point shall the pedestrian zone be less than 48 inches (4 feet) wide at pinch points; passing opportunities distances will need to be analyzed. In very constrained areas, such as around obstacles that cannot be moved, a minimum passage of 48 inches (4 feet) for the pedestrian access route must be maintained for a maximum length of 200 feet.**

Pedestrian circulation areas include all hard surfaces that are walkable and contiguous with the pedestrian zone or pedestrian access route including the buffer, frontage and furniture zone. **Pedestrian circulation areas are constructed flush adjacent to the pedestrian zone or PAR.**

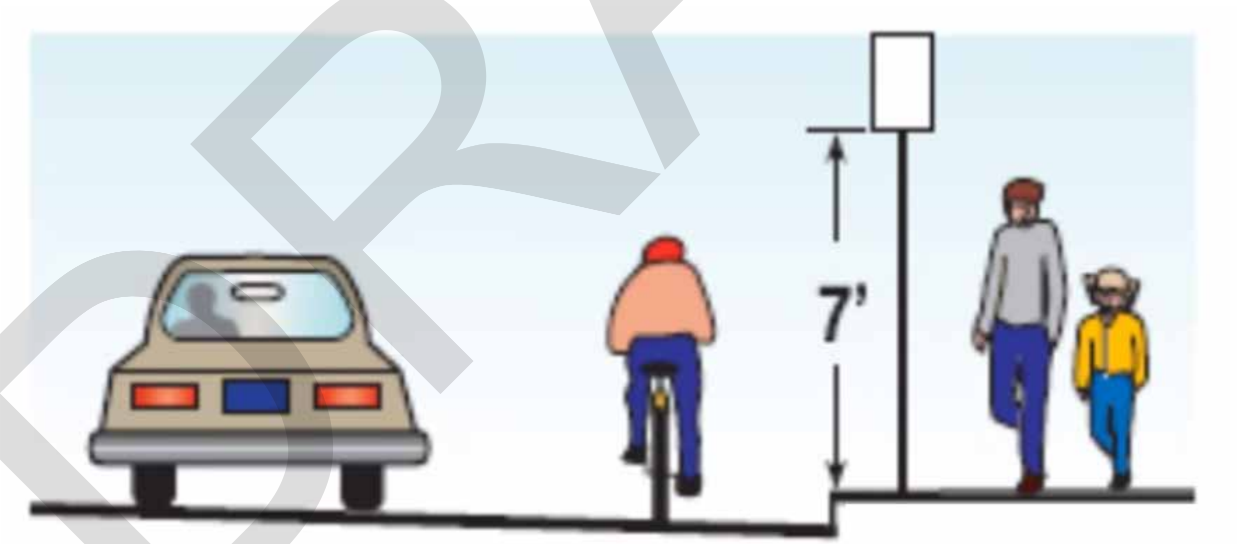
Softscaping elements included in the buffer zone such as planted beds, grass, loose rock and bark mulch are not considered walkable for all people and define the boundaries of where the intended pedestrian facility resides. Able bodied pedestrians might be able to traverse them, but softscaping materials are not accessible surfaces. Accessible surfaces must be firm, stable and slip resistant under the ADA.

The pedestrian access route shall have a smooth surface and be clear of utility poles, signs, signal poles, trees and other obstructions. **The cross slope of a pedestrian access route may not exceed 2.0% at finished construction.** *The PAR is generally designed within the range of 0.5% to 1.5% cross slope.* The balance of the sidewalk width can be used to make up grade differences if necessary with cross slopes exceeding 1.5%.

Provide a vertical clearance at least 7 feet (84 inches) to vertical obstructions (signs, tree limbs, pedestrian signal heads, etc.) in all walkways and pedestrian circulation areas.

Fixed objects that reside in the pedestrian realm reduce the useable walkway width and effective pedestrian zone width. Temporary objects must not block the pedestrian access route. These items might include trash cans, advertising sandwich boards (A frame), feather flag signs, and rental bikes. Select furniture and frontage zones widths that can accommodate these types of amenities for intermittent periods of time without blocking the PAR.

Figure 800-14: Walkway Vertical Clearance



Crosswalks reside in the Travelway Realm and are extensions of the pedestrian access route. Pedestrian access route design width requirements vary at intersection corners with curb ramps or at midblock crosswalks. See Standard Drawings RD700-series for detailed curb ramp construction drawings, and Section 815 for curb ramp design information.

Refer to Section 816 for discussion on accessible routes to public entrances.

Protruding Objects

ADA requires that objects protruding from walls (e.g. signs, fixtures, telephones, canopies) are placed so their leading edge is not more than 4 inches from the wall when the height of the object is between 27 inches and 80 inches above the finished walkway for any portion of the public walkway.

Mailboxes are a common protruding object in walkways that are not attached to a building face. When projects include a buffer zone that is constructed with landscaping and softscape materials, this can provide natural edge detection around the mailbox installation for low vision or blind travelers. Drainage curbing can provide the detectable edging necessary for white cane detection around a mailbox, however it is not the best practice. Drainage curbing on walkways introduces added complexity and considerations for storm water runoff, impacts on the clear zone hazards, and choosing appropriate end treatments such as a curb ending.

Temporary Pedestrian Access Routes

The temporary pedestrian access route (TPAR) details how pedestrians will be directed through or around a construction work zone. The level of detail required for the TPAR depends on the complexity of the project and the volume of pedestrian traffic. Accessible route design criteria is similar to the permanent pedestrian access route, however, the guidance for TPAR design is provided in the Traffic Control Plans Design Manual. TPAR design ensures the pedestrian has a facility that is at least equivalent or better than the pedestrian facility that was in place prior to construction starting. Site destinations such as a business entrance access must be maintained from the TPAR.

Refer to MG Activities 2 for temporary pedestrian access route plans during maintenance work.

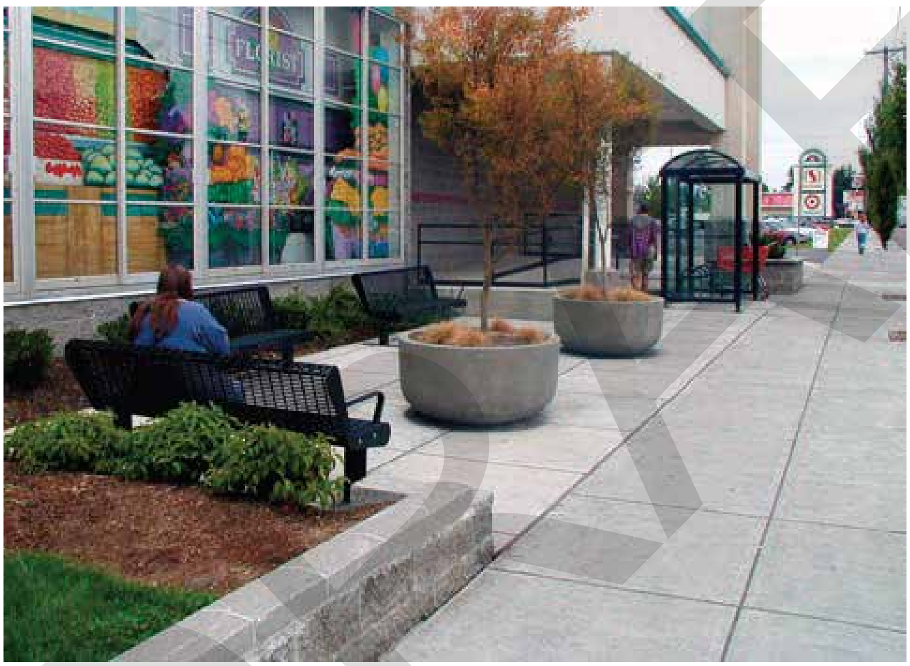
Walkways on Bridges

Coordination with the structural or bridge designer is required to ensure the walkway on a bridge is fully accessible. Details showing the walkway surface connection at the bridge rail and details of the expansion joints is typically required. Ensure a slip resistance surfacing is installed on the walkway at the bridge joint. Transitions over the joint or plate should be designed flush as there cannot be a vertical change exceeding ¼ inch in the PAR. Grout railing pads, decorative lighting, guardrail posts, and bridge rail connections often reduce the clear width of the pedestrian access route.

810.6 Frontage Zone

The frontage zone is located between the pedestrian zone and the right-of-way. It is where sandwich boards, kiosks, bike racks and other street furniture are placed; it is used by window shoppers and for outdoor dining, it's where people enter and exit buildings. **Provide a pedestrian access route to site arrival points and destinations that are available to the public.** These include pedestrian amenities but are not limited to doorways, kiosks, pay stations, water fountains, benches, parklets and transit shelters.

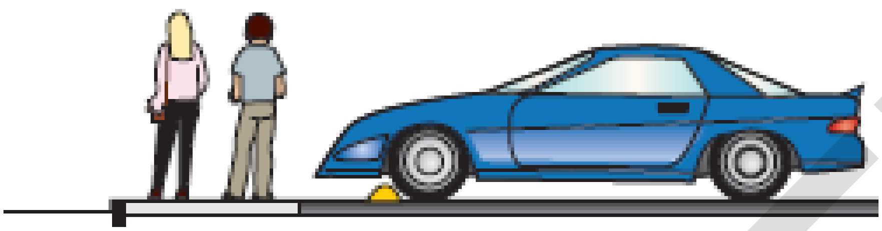
Figure 800-15: A Generous Frontage Zone with Seating and Bus Shelter



Provide a frontage zone that ranges from 4 feet to 2 feet in traditional downtown/central business districts. In Central Business Districts the frontage zone should be 4 feet or wider to provide space for merchandise, sidewalk cafés, and opening business doors, and adjacent parking lots. A 2 foot pedestrian shy distance is needed from vertical barriers such as buildings, sound walls, retaining walls and fences.

Parked cars encroach into the walkway because there is an overhang distance from the wheels or side mirrors. The amount of encroachment for head in parking in comparison to back in parking is significant (particularly trucks). Cars parked head in on a perpendicular or diagonal alignment encroach a smaller distance into the walkway. **Provide a frontage zone of at least 2.0 feet so cars do not reduce the pedestrian zone and pedestrian access route.** When angle parking is provided check the overhang distance based on AASHTO's parking lane configurations. *Provide anchored (pinned) wheel stops, curbing or other treatments to prevent narrowing of the pedestrian zone from vehicular overhang.*

Figure 800-16: Wheel Stops Reduce Sidewalk Encroachment



Provide a frontage zone that is at least 1 feet in all other urban contexts. The width of the frontage zone provides space so there is not encroachment onto public property with permanent objects such as fencing. The space provides maintenance personnel the room to make repairs to sidewalk. *When the pedestrian zone is 5 feet wide, the frontage zone may need to be a hard surface (paved or concrete), see discussion in the Section 804.4 Pedestrian Zone.*

810.7 Walkway Configurations

The total walkway width is the summation of the buffer zone, the pedestrian zone, and frontage zone. Configurations for walkways vary based on the urban context and may require greater widths. The Oregon Highway Plan is a statewide planning and policy document for Oregon with requirements for walkways related to highway designations defined in that statewide policy document.

The Oregon Highway Plan (OHP) is a modal element of the Oregon Transportation Plan (OTP). The OHP addresses efficient management of the system to increase safety, preserve the system, and extend its capacity; increased partnerships, particularly with local and regional governments; links between land use and transportation; access management; links with other transportation modes; and environmental and scenic resources. The OHP also establishes a variety of policies that are directly related to this Expressway Management Plan.

The state highway classification system divides state highways into five categories based on function: Interstate (NHS), Statewide (NHS), Regional, District, and Local Interest Roads. Under OHP Policy 1B.7, the highway segment is designated with community development characteristics. This includes Special Transportation Areas (STA), Commercial Centers, Urban Business Areas, and Urban designations. The designations are defined with characteristics for design outcomes for each segment of highway with modal priorities identified. See Part 200 for more discussion on highway classification and function.

Special Transportation Areas (STA) - The objective is to provide local auto, pedestrian, bicycle and transit movements to the business district or community center and these modes are generally as important as the through movement of traffic. People who arrive by car or transit find it convenient to walk from place to place within the area. Provide sidewalks with ample width which are located adjacent to the highway and the buildings. STAs are not located on freeways or Expressways.

Commercial Centers - The objective is to accommodate pedestrian and bicycle access and circulation and, where appropriate, transit movements. Provide convenient circulation within the center, including pedestrian and bicycle access and circulation. Provisions for transit access in urban areas planned for fixed-route transit service are to be included.

Urban Business Areas - The objective is to balance vehicular accessibility with pedestrian, bicycle and transit accessibility. Safe and regular street connections are encouraged. Transit turnouts, sidewalks, and bicycle lanes are accommodated.

Urban - The objective of an Urban segment designation is to efficiently move through traffic while also meeting the access needs of nearby properties. Although pedestrians are generally not accommodated on Expressways for safety reasons, analyze accommodation on a case by case basis. Curbside sidewalks should be avoided on expressways.

Several conditions within the urban contexts require greater walkway widths in the pedestrian realm:

1. **When signs, mailboxes, or other appurtenances in the walkway become numerous, provide a walkway of at least 8 feet.** The total walkway width of a curbside sidewalk shall be 8 feet in locations, where: design speed is 45 mph and above or where signs, mailboxes, or other appurtenances become numerous.
2. **Provide a total walkway width in Central Business Districts (CBDs), STAs and traditional downtowns at least 10 feet wide where buildings are located at the back of the walkway.** The preferred walkway width in high use business areas is 14-16 feet.
3. **Curbside walkways on bridges shall be at least 7 feet wide, to account for pedestrian shy distance from the outside bridge rail.** In no case shall the bridge walkway width be less than the approaching walkway width on the bridge end. Pedestrian zone widths are equal approaching the bridge, crossing the bridge, and leaving the bridge.
4. **Where a walkway is separated from traffic with a barrier at the curb line, pedestrian zone shall be at least 7 feet wide to account for pedestrian shy distance.**

Table 800-3: 4R Standard Sidewalk Widths Table

Highway Characteristic		Standard Sidewalk	Buffer
Urba n		10'	Paved furniture zone included

	Special Transportation Area (STA), Central Business District (CBD) or traditional downtown	8'	4’-6’ buffer strip
	Urban Business Area (UBA), commercial centers & other developed areas	6'	Curbside*
			4’-8’ buffer strip
	Urban Fringe: 35-45 mph	8’	Curbside
		6’	4’-8’ buffer strip
	Urban Fringe: 50-55 mph	6’	4’-8’ buffer strip
	Expressway: 45 mph	8’	Curbside*
		6’	8’ buffer strip
	Expressway: 50-55 mph	6’	8’ buffer strip
	Bridge Sidewalk	7’	NA
	Sidewalk separated by traffic barrier	7’	Traffic Barrier

Design exceptions are required for sidewalks that are less than the values shown in Table 800-3. Buffer distances less than the values shown do not require a design exception.

Walkway without curb or behind a ditch

Most walkways are separated from the roadway with curbs, which channelize drainage and provide positive separation from traffic. Curb and gutter can increase substantially the construction costs of a project. Where walkways are needed, but the high cost of curb and storm sewer cannot be justified, or where curbs don't fit the character of the street, walkways may be constructed without curb for drainage. See discussion about curb zones in Section 810.2 for additional information.

Walkways may be located at roughly the same elevation of the traveled way. Walkways may also reside above or below the traveled way grade depending on the local terrain. The buffer zone is designed to accommodate storm water conveyance and infiltration. The ditch or earth slope (cut or fill section) are both barriers to access the walkway for all people. When a walkway begins or ends, slope entrances and exits to the walkway are required to be accessible. At grade pedestrian connections are made when the pedestrian realm doesn’t have a curb zone, and these connections are referred to as “at grade” pedestrian connections or pedestrian ramps. See additional requirements in the curb ramp design Section 815.

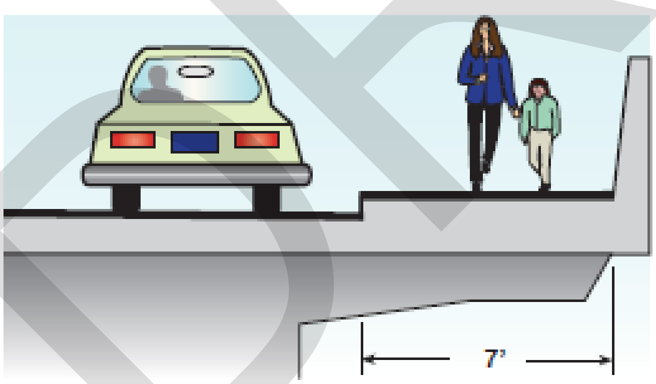
On roads with a rural character, where drainage is provided with an open ditch, and where there is sufficient room, walkways may be placed behind the ditch. **Pave driveways 15 feet back from the back of the pedestrian zone to avoid debris accumulation and maintain and accessible pedestrian path of travel.**

Walkways on bridges

Provide walkways on both sides of bridges where pedestrian use can be expected. When designing walkways for bridges, the design life of a structure is 75 years or more. The walkway width will be in place for generations to come and is difficult to adjust later due to the impacts on the substructure design. Walkways on bridges are often a destination for pedestrian viewing of waterway features including boating, wildlife, and recreational fishing. Wider walkways allows for both the transportation need and occasional or planned recreational usage. See discussion on Shared Use Path design in Section 833.

Provide a pedestrian zone at least 7 feet wide on bridges when the walkway is for transportation use only to account for shy distances. This shy distance is both from moving traffic and from the outside bridge rail, as some people feel uncomfortable walking close to a high vertical drop. Wider sidewalks should be considered in urban settings with high pedestrian use based on the urban context. **The bridge sidewalk must not be narrower than the approaching walkway at the bridge ends. Walkways on bridges with design speeds greater than 40 MPH require a vehicle barrier at the curb zone**.

Figure 800-17: Minimum Bridge Sidewalk Width



Walkway on bridges also have additional pedestrian access route concerns that need to be reviewed in coordination with the bridge designer. Clear widths for pedestrian access routes are measured from the nearest vertical surface exceeding ¼ inch in height or any object/feature that protrudes into the pedestrian zone and excludes the curb zone. Monolithic construction of the curb zone and walkway occurs frequently on bridges for various structural reasons. Grout railing pads, decorative lighting, guardrail posts, and bridge rail connections often reduce the effective width of the pedestrian zone and pedestrian access route. (See discussion on Pedestrian Railing in Section 810.9.) Walkways on bridges include bridge expansion joints that are required to meet the pedestrian access route surface requirements and should be flush.

Walkways with curb

Walkways are not placed directly adjacent to a high-speed travel lane (45 MPH and above); they will be buffered with a planting strip, a parking lane or a bike lane. See discussion on buffer zone and transition realm requirements. Curbside walkways should be avoided on expressways. *In the absence of any separation, walkways next to high-speed roadways should be at least 8 feet wide, as the outer two feet are used for poles, sign posts, etc.* This results in an effective 6 feet wide pedestrian zone and provides 2 feet shy distance from high speed motor vehicle traffic. Greater sidewalk widths are needed in high pedestrian use areas, such as central business districts, where 10 feet is considered necessary, as the walkways are often also used for street furniture and other pedestrian amenities. Walkways with widths 12 feet to 14 feet or greater are common in Central Business Districts.

Figure 800-18: Recommended Curb Side Sidewalk Dimensions

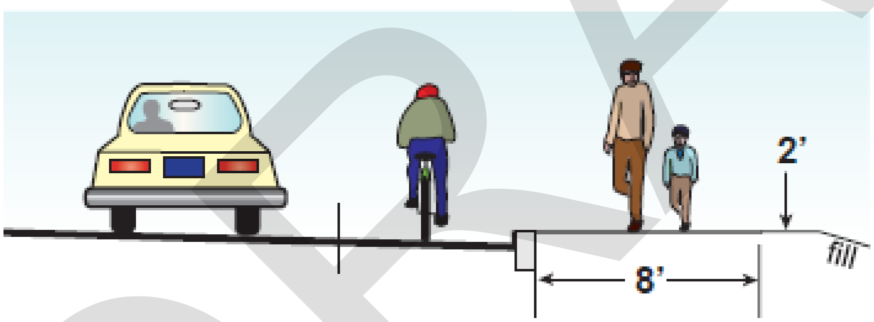
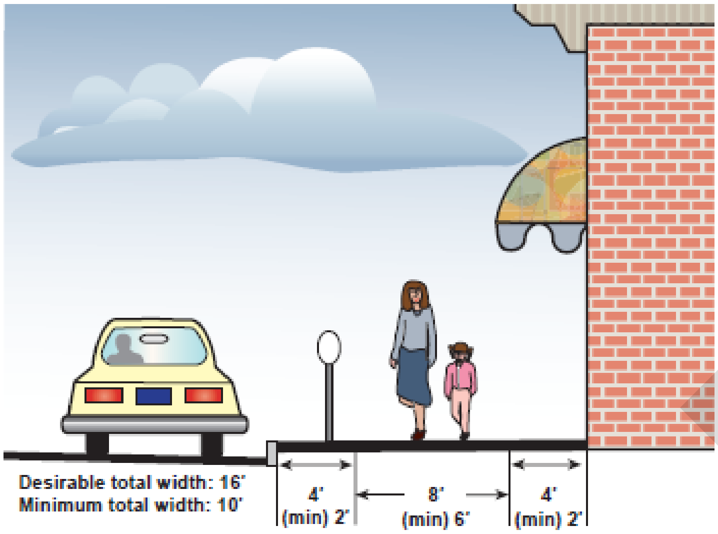


Figure 800-19: Recommended Central Business District Sidewalk Dimensions



Pedestrian lanes

Pedestrian Lanes are a type of walkway that is at the same grade and is contiguous with the travel way realm. It often resembles a travel way shoulder, but it is reserved for pedestrian use only. It is denoted for exclusive use by pedestrians only by the addition of pedestrian only pavement markings/icons, pedestrian only signing, or a raised curb (typically a drainage curb on RD700's) that separates the pedestrian travel mode from vehicular use. When pedestrian lanes are provided they must meet ADA pedestrian access route requirements including cross slope and running slopes.

Pedestrian lanes are not the preferred walkway configuration. Pedestrians are permitted to use on the shoulder under the ORS. Challenges with pedestrian lane design include:

- detectability by people with vision impairments
- undesired use by bicyclists
- ADA cross slope requirements
- maintenance strategies including sweeping and snow removal

Pedestrian lanes are an interim facility, and a full walkway improvement should be planned for future implementation. They are not intended to be an alternative to permanent walkway, but often fill short gaps between higher quality pedestrian facilities. *Regional approval is required on the Urban Design Concurrence Document in the urban contexts for pedestrian lanes.*

Figure 800-20: Example Pedestrian Lane

810.8 Walkway Surfaces

Walkways must provide a surface for the intended pedestrian use considering the long term costs, construction accuracy and maintenance requirements. **Sidewalks and shared use paths must be firm, stable and slip resistant to meet ADA requirements throughout all weather conditions year round.** Firm means that the surface must resist deformation or indentation. Slip resistance is not defined by a coefficient friction value, rather agencies must determine what is best practice based on engineering principles and construction practices for slip resistance. Slip resistance is historically provided with a broomed surface finish on Portland cement concrete on walkways. Trails must provide a stable and slip resistant walking surface to meet ADA requirements.

Concrete is the preferred material for walkways, sidewalks, share use paths and the pedestrian access route. It provides a smooth, durable finish that is easier to grade, repair and meet ADA surface requirements. Concrete surfaces are finished to smooth and uniform texture by troweling, floating and cross brooming to provide slip resistance. Industry construction for concrete is more precise making it easier to achieve ADA slope requirements during finishing. Concrete's service life can easily span several decades requiring little to no maintenance of the surface.

Asphalt pavement is not the preferred material for sidewalks and shared use paths as slopes are more difficult to control and the life span of the material is shorter. Asphalt walkways are more susceptible to cracking and irregularities due to freeze thaw conditions, tree root growth, and poor compaction of the foundation material. Asphalt is typically a lower cost alternative that can meet the ADA surface requirements however compaction tools create greater variability in the finished slopes.

Bricks and ornamental landscape pavers (often beveled or "pillowed") should not be used as the primary walking surface or in the pedestrian access route. They can be used for aesthetics or providing contrast in the buffer and frontage zones. Walkway embellishments can also be achieved by treating concrete with dyes or with decorative scoring. Bricks and pavers installed with a great degree of smoothness (flush, no horizontal gaps and with no beveled edges) and which also have a slip-resistant surface when wet a can meet the ADA surface requirements. Long-term maintenance costs should be recognized. Bricks and pavers overtime are more likely to become displaced as a result of freeze and thaw conditions, or tree roots which create vertical discontinuities (lips) in the pedestrian access route and pedestrian circulation areas.

Bricks and pavers are a type of hardscaping that is considered walkable and can with great care during installation meet the ADA surface requirements. They should not be installed in the vicinity of curb ramps in lieu of flares without additional treatments. See additional discussion in Section 815 for curb ramp design. Low vision and blind travelers cannot distinguish the difference underfoot and confuse these type of surfacing materials as something that is intended to be walked on in many situations in other places. Bricks and pavers can create vibrations for mobility device users when traversing the surface which can be aggravating and painful for some spinal cord injury and other conditions.

An alternative to pavers is stamped and dyed concrete. This alternative provides much of the aesthetic value of bricks with the durability and smooth surface of concrete. Decorative treatments in the street or crosswalk which consist of concrete color or scored patterns are not a marked crossing. See the traffic manual for pavement markings at crosswalks. Colored concrete provides contrast which may assist with wayfinding for people with vision impairments when used on the edges of the pedestrian zone or pedestrian access route. **Do not use stamped concrete patterns that create rough surfaces in the pedestrian access route or pedestrian circulation areas. Treatments such as grouted durable rock required approval for installation.** *Use of stamped concrete pattern area in the vicinity of curb ramps will require concurrence from the Senior ADA Standards Engineer.*

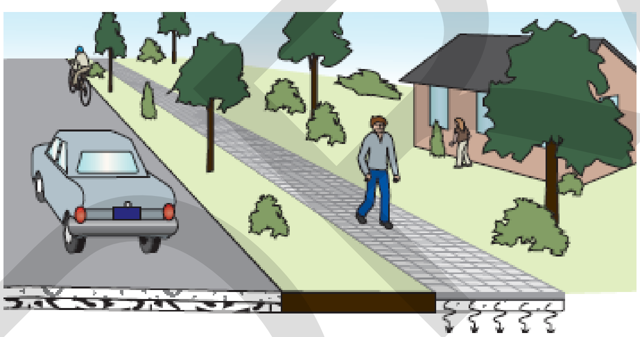
Pervious Walkway Surfaces

The concern over adding more impervious surfaces has led to the creation of a variety of permeable surface materials: pervious concrete and asphalt, pavers, and other innovative designs. The pedestrian zone is usually separated from the roadway with a bio-swale in the buffer zone.

Pervious walkway surface technology is evolving, and long-term maintenance is a concern. The concrete mix design is of particular importance, to avoid the "rice crispy" result. If used, pervious walkway surfaces must still meet accessibility standards: firm, stable, slip-resistant, without vertical discontinuities or horizontal openings. While meeting the minimum ADA criteria, pedestrians with spinal injuries can still experience vibration when rolling over pervious walkway surfaces. Pervious surfaces consisting of geo-grids filled in with aggregates or vegetation do not meet the accessibility requirements for the pedestrian access routes. They can be considered for the other areas of the pedestrian realm or buffer zone.

Walkways built out of conventional impervious materials (concrete) contribute little to runoff if they are separated from the roadway with a buffer zone: most of the precipitation that lands on the sidewalk can be absorbed by the native soil in the buffer zone. Concrete mix design is critical in pervious sidewalk to avoid a rough surface.

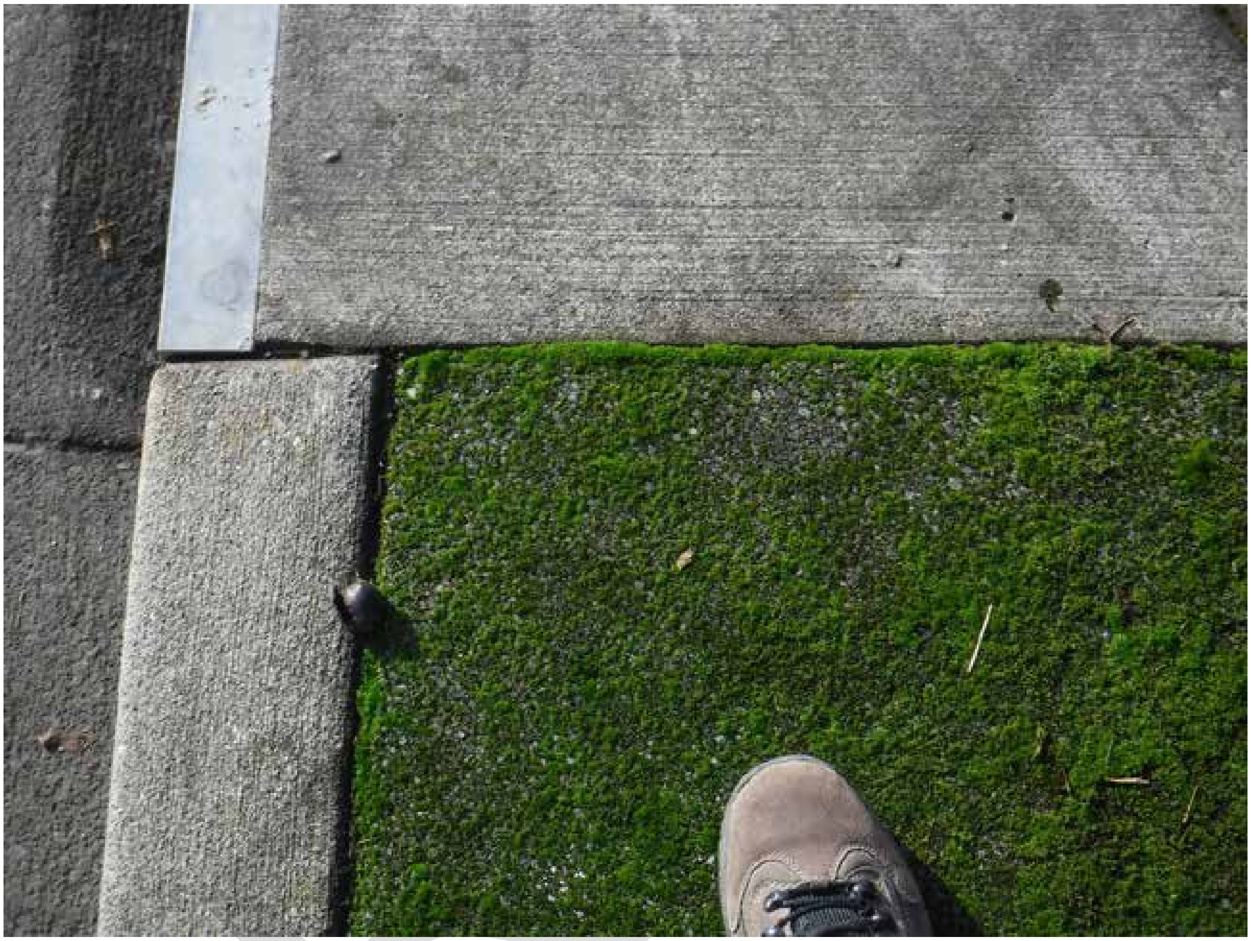
Figure 800-21: Pervious Sidewalk



Consider the natural local environment when a pervious sidewalk is constructed. Wet conditions can promote moss and mildew growth, and if not properly drained become slippery for all users therefore not meeting the ADA surface requirement for slip resistance. Pervious asphalt pavements in the walkway can trap water and freeze during winter events creating a slippery surface. Freeze thaw events degrade the life span of the asphalt pavement from surface cracking as a result of ice formations within the asphalt pavement. The walkway must be accessible all year.

1 Figure 800-22: Porous Pavement Installed Next to PCC Walk Illustrating Mossy Growth

Figure 800-23: Porous Pavement Installed Next to PCC Walk Illustrating Mossy Growth



.. Surface Thickness

Sidewalks with foot traffic only are normally constructed with at least 4 inches of PCC on top of a compacted base of crushed aggregate. When vehicular traffic is expected to occur over the walkway at driveways the thickness of PCC is increased based on the design vehicle. **Typical driveway construction consists of 6 inches of PCC, while heavily used industrial driveways need to have a pavement loading analysis performed to determine the surface material thickness.** Consult the Pavement Design Unit for additional guidance on industrial driveway design. Refer to the Oregon Standard Drawings RD700's for details on surface construction requirements on walkways.

Depth of asphalt construction of a walkway is shown in the RD600 series for shared use path pavement details. Shared use paths occasionally need to allow access for maintenance vehicles which will increase the asphalt pavement foundation and final surfacing depths.

810.9 Walkway Design

With new construction of pedestrian facilities where they did not previously exist, the desire is to create a walkway and buffer zone that is fully accessible when hard surfaces are constructed for the entire width. This ensures that over the life span of the walkway, pedestrian access routes requirements are met and have the most flexibility to ensure ADA access when pedestrian amenities and features are improved or disturbed, temporarily or permanently. The key principal is that between arrival points and destination points, there is a fully accessible route (PAR) per the ADA year round.

When a roadway has already been established in the built urban environment, roadway cross section reconfigurations may be altered to provide improved pedestrian experiences in the pedestrian realm. Particularly in the traditional downtown and central business districts, the pedestrian access route and pedestrian zones are influenced by the existing elevation of building entrances. In these circumstance, walkways that have been disturbed or reconstructed are required to meet the PAR requirements with the improvement. *The design should aim to provide a fully accessible walkway for the full width as best practice with any alteration of the walkway.*

.. Horizontal Alignment

The pedestrian zone should be straight, or parallel to the adjacent road when the road naturally curves. Attempts to create meandering pedestrian zone usually fail because they do not serve the needs of pedestrians, who want to walk in the most direct route possible. The only exceptions should be when a walkway is substantially separated from a roadway, and the natural contours of the pedestrian zone are different from the alignment of the roadway, or to avoid large obstacles such as mature trees, or other pinch points. Care must be taken to insure the pedestrian zone is free of obstructions.

Figure 800-24: The Buffer Zone May Be Eliminated or Reduced At Pinch Points

Meandering pedestrian zones may be used to wrap around large obstacles, such as a mature tree or power pole. Though it adds some aesthetic value, and offers possibilities to add creative landscaping touches, the results are often quite different. Most pedestrians prefer to walk directly, in a straight line. Meandering pedestrian zones can cause increased stress and make navigating difficult for the low vison and blind traveler as they are continually having to reassess their direction of orientation for walking. Meandering pedestrian zones are often the object of ridicule and even resentment when the public realizes funds were spent on a sidewalk that doesn't serve users well. Considerations for designing meandering walkways include:

1. Constructability due to the need for special forms
2. Reasonable transition rates for pedestrians to deviate from their walking path. *1:10 is the preferred taper rate as users speeds vary to accommodate the casual bicyclists, motorized wheelchairs, and pedestrians on foot running or walking. Use a 1:5 taper rate when constraints are in the available right of way*. **Provide a 1:3 taper as a minimum rate change.**
3. **Grade breaks are required to be perpendicular to the path of travel in the pedestrian zone.**
4. It is critical to maintain a straight pedestrian access route across driveways, curb ramps and road approaches (in crosswalks, marked or unmarked). The following techniques can be used to maintain across slope requirements at driveways and prevent exaggerated warping and cross-slopes:
    1. Reduce the number of accesses, thereby reducing the need for alterations at every driveway
    2. Separate the pedestrian zone from the curb with a buffer; this allows the pedestrian access route to remain at the same slope of the roadway, with the driveway apron slope elevation change occurring in the buffer zone;

3. Where constraints don't allow a buffer zone, meandering the pedestrian zone to the back of the driveway has a similar effect;

Figure 800-25: Meandering Sidewalk

The most critical areas for the low vision community and blind are locations where street crossing points may not be readily apparent to motorists, for example at a corner with a large radius. Complex intersections with many turn lanes, skewed angles and slip lanes with free-flowing traffic are particularly confusing to the blind traveler and low vision community. Right turn channelization islands are particularly challenging for people with vision disabilities. Techniques that can help reduce confusion and simplify the navigation task:

1. Keep the radius as tight as possible and place the crossings in areas where they are expected; in a straight line with the approaching sidewalks and curb ramps. See Part 200, Section 222 and Part 500, Section 506.9 for discussion of intersection radii.
2. Provide a clear and straight path through raised islands, pointed straight at the crossings;
3. Keeping intersections tight and square to limit long and skewed crosswalks;

4. Placing crossings in areas where they are expected - in line with receiving curb ramps and approaching walkway in the pedestrian zone;
5. Keeping crossings straight across the street;
6. Providing accessible and audible pedestrian signals;
7. Install detectable warnings at curb ramps to identify the transition from the sidewalk to the street.

Vertical Alignment

Walkway are to be designed with the same profile slope of the roadway. A pedestrian with disability might find that the roadway surface in the transition realm is the preferential path of travel when a walkway is visibly disjointed with multiple profile changes and is steeper than the roadway profile, or has multiple sloped ramps when crossing driveways. Dipping the entire sidewalk or pedestrian access route along the pedestrian zone in a series to maintain the cross-slope on curbside sidewalks is not preferred or desirable as this creates a rollercoaster experience for the pedestrian.

Stairs are not permitted along the primary access route on sidewalk walkway as this is a vertical change exceeding ½ inch. **Vertical changes exceeding ½ inch must be ramped with a sloped surface along the pedestrian access route under the ADA.** Stairs can be utilized on an additional route for pedestrians when the primary access route is constructed and is fully accessible. Ramps are a required and critical design element to allow pedestrians to traverse to each point of service when there are vertical changes along the pedestrian access route. See discussion in Section 805 for curb ramps and Section 816 for building ramps design.

Elevation changes to elevate or depress a walkway must meet the ADA slope requirements. **When slopes are necessary to change elevation for driveways or to raise/lower the pedestrian zone, the slope surface is to be designed at 7.5 % or less to allow for construction variances** (Finished constructed slope shall not exceed 8.3%). See additional discussion on driveway design in Section 810.9. **Grade breaks are required to be perpendicular to the path of travel in the pedestrian zone when there is a change in the profile (running slope)**.

Sidewalks whose running slopes are both steeper than 5% and do not match the grade of the adjacent roadway require an exception. Refer to Section 1005.4 for information about ADA exceptions. *When the walkway profile is steeper than 5%, consider adding level resting opportunities in the available right of way every 200 feet in the pedestrian realm (See RD 721).* This additional level resting area can also serve as the passing opportunity for pedestrians using a mobility device which is a flat and stable surface while waiting rather than sloped which often requires hand braking. The furniture and frontage zones are areas of opportunity to provide additional pedestrian amenities including the level resting area and benches.

Connections to site arrival points such as a building entrance/exit on the walkway, are required to meet the pedestrian access route surface requirements. **Building ramp profile elevation changes are designed with less than or equal to 7.5% surface slopes (finished constructed slope shall not exceed 8.3%). For building ramps, when a change in elevation exceed 30 inches (2.5 feet), a resting area (level landing) is required. For building ramps, a resting area (level landing) is required with any change in direction on the horizontal alignment.** Changes in horizontal alignment are typically very prominent and are designed at angles in increments of 90 degrees to conserve space along the pedestrian access route for building ramps. Pedestrian handrails are required on building ramps in most circumstances, see additional discussion about pedestrian railings in the pedestrian rail section. See Section 816 on building ramps.

.. Cross Slope

Cross slope of a walkway is the grade of a surface perpendicular to the running slope or traversed surface in the direction of pedestrian travel. **The cross slope of a pedestrian access route may not exceed 2.0%** at finished construction. *Cross slopes are designed at a slope ranging from 0.5% to 1.5% to allow for normal finish surface variability during construction. Standard hydraulic practice typically requires 0.5% to properly convey storm water on a surface.*

When a roadway has already been established in the built urban environment, roadway cross section reconfigurations may be altered to provide improved pedestrian experiences in the pedestrian realm. Particularly in the traditional downtown and central business districts which are very constrained, the pedestrian access route and pedestrian zones are influenced by the existing elevation of building entrances. *A level area should be provided at the building entrance to meet the pedestrian access route site requirements for ADA*. Cross slopes in the frontage or buffer (furniture) zones may need to exceed the desired 1.5% cross slope to meet the building entrance requirements.

Elevation changes in the cross section are easiest to handle in the buffer zone where signs and trees are most likely to be placed. When choosing to alter the cross slope in the walkway review clear zone requirements and best practices in Part 400. Cross slope changes in the frontage zone have added complexity due to the proximity to building foundations and basements. A common example where the cross slope of the walkway in the pedestrian realm has a steeper cross slope is in the driveway apron. Driveway apron slopes are designed for vehicular access to the property bridging the curb elevation change to the pedestrian zone, and the cross slope is greater than 1.5%. The driveway apron is useable for pedestrians to walk on if desired, but it is outside the pedestrian access route and pedestrian zone. See Standard Drawings RD700-series for detailed driveway construction drawings.

Crosswalks reside in the traveled way, in the Travelway Realm and are extensions of the pedestrian access route.

Intersections controlled by stop signs or yield sign shall have a 2% maximum cross slope within the crosswalk. The cross slope in crosswalks is permitted to equal the grade of the highway at midblock crosswalks. When the crosswalk traffic operations is signalized or uncontrolled by a traffic control device, the maximum cross slope is 5.0%.   The counter slope of the highway or gutter at the curb ramp opening of a curb ramp shall be 5.0% maximum.

Clear Width

The clear width of a walkway is the narrowest width found within the walkway that is fully accessible for pedestrians. **Surfaces with cross slopes exceeding 2.0 %, vertical obstructions or vertical discontinuities are not fully accessible and are not included in the PAR.** The pedestrian accessible route and temporary pedestrian accessible routes are both defined in the Oregon Standard Specifications. Clear width is measured anywhere within the pedestrian realm and are measured along pedestrian accessible routes. Clear width is also required for temporary pedestrian access routes and temporary curb ramps. The minimum clear width for acceptance varies based on the walkway configuration and pedestrian zone requirements.

Clear widths are reduced by objects that are less than 7 feet above the walking surface along the pedestrian accessible route. Objects such as pushbutton pedestals, signals, signs, utility poles, fire hydrants, etc. are frequently in the buffer and frontage zones. There may be a mailbox in the path or guy-wires above the walkway. These could be the controlling feature for the clear width measurement in addition to the cross slope. Guardrail is another common obstruction restricting the clear width of the PAR and pedestrian zone where the bridge connection to the bridge rail is installed. Review RD400s and RD500s for the width of the thrie beam and concrete barrier.

Refer to the RD100's and RD 700's for additional details on clear width when there are objects in the walkway. Mailboxes and the supports are located in the buffer zone of the walkway and must meet United States Postal Services reach height and reach distance from the pavement surface. The back sides of the mailbox receptacle is a protruding object in the walkway; best practice is to install in softscaped buffer strip to address this ADA requirement.

Pedestrian Rail

Pedestrian rail is a safety device for pedestrians and bicyclists on walkways. Pedestrian rail may be required at locations other than bridges, including building ramps and at back-of-walk locations. Typical pedestrian rail consists of handrail and pedestrian fencing. Other features can also be installed which provide an equivalent function of pedestrian railing. Some types of barriers including bridge rails and concrete barrier on a walkway can be integrated in the structure providing pedestrian protection and separation from another travel mode. Chain link fencing (see RD800's) may also serve the same function of pedestrian rail in some locations. Remove the top rail where fencing can be struck by errant vehicles in the clear zone.

Handrail is used for pedestrian access routes meeting the ADA requirements along a pedestrian access route to navigate elevation changes on a building ramp. ADA requires that building ramps with a rise greater than 6 inches include handrail. Details are provided in RD770 & RD771. RD770 handrail is sufficient for these conditions.

Pedestrian rail is at least 42 inches and is used for areas with elevation drops. Details are provided in RD 780's for aluminum pedestrian fencing which has been crash tested under MASH criteria (see discussion in Section 401 on roadside clear zones.). The need for a pedestrian rail at the back of the sidewalk depends on the combination of several factors. Mitigating for one factor may remove the need for a rail. Consider the combined effects of the following when determining the need for a rail, but it is not limited to these conditions. A singular condition might warrant pedestrian rail. Consider any OSHA requirements for areas that maintenance employees may need to occupy to perform work.

1. **Height:** A vertical drop of 2.5 feet or more would normally require a pedestrian rail.
2. **Steepness of slope:** A slope steeper than 1:2 would normally require a pedestrian rail particularly for very tall embankments.
3. **Material of slope:** Riprap or other hard and sharp materials stabilizing slopes may trigger a need for pedestrian rail.
4. **Shy distance:** A shy distance of 2 feet or greater at the same plane as the walkway may be sufficient to mitigate the need for a pedestrian rail.
5. **Object at bottom of slope:** Moving traffic, deep or fast-running water would normally require a pedestrian rail.
6. **Users:** A preponderance of elderly, disabled or very young pedestrians would benefit from a pedestrian rail if there is a higher likelihood they would lose their balance if they wandered off the sidewalk.

For example, a walkway on a 10 foot high fill, with a 1:1 side-slope made up of rip-rap, at the edge of a deep river, a pedestrian rail should be installed. However at a location with 10 foot high fill, with a grassy side-slope, at the edge of a field, could be mitigated by ensuring there is at least a 2 foot additional width of material constructed behind the walkway to create a shy distance beyond the pedestrian zone (see Figure 800-26).

Figure 800-26: Criteria for Pedestrian Rail at Back of Walk

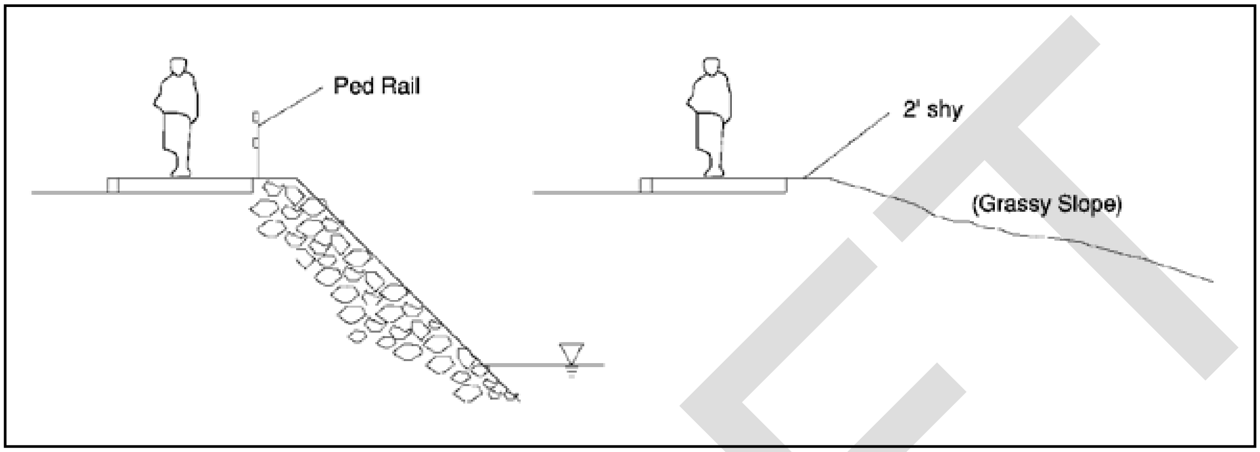
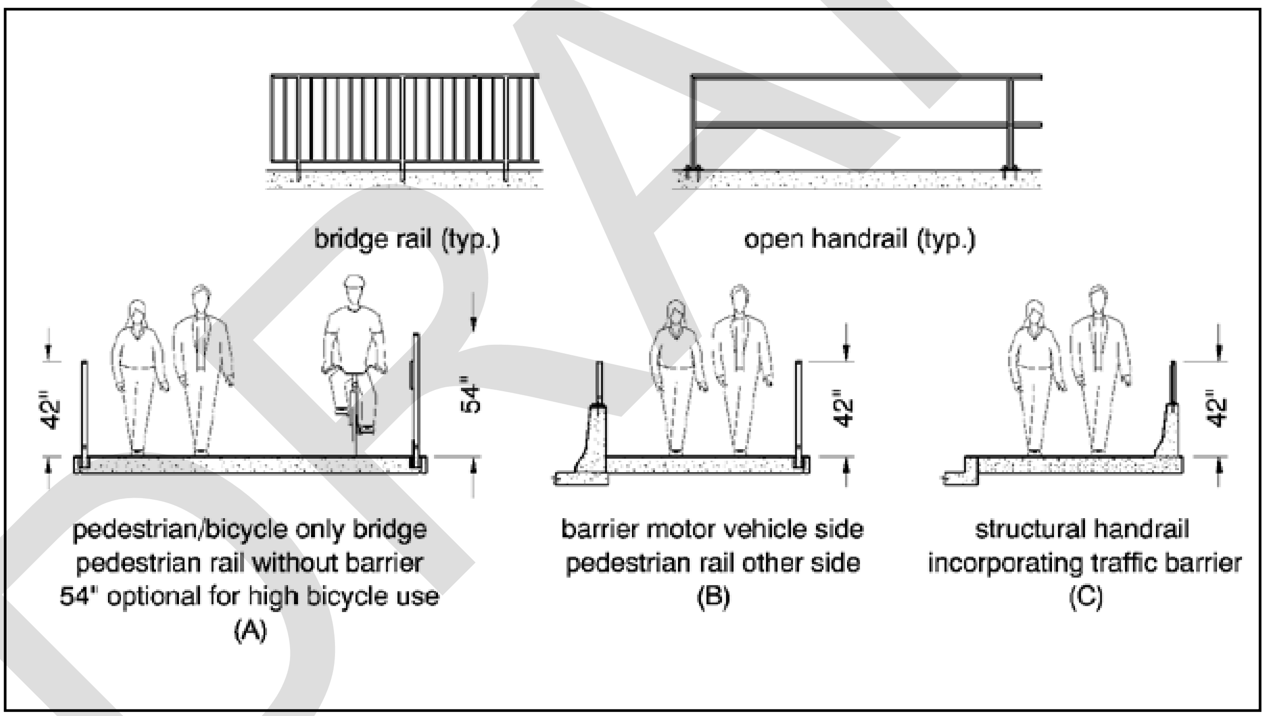


Figure 800-27: Pedestrian Rail at Bridges and Vertical Drops greater than 5'



Provide rail with a height between 48 and 54 inches when the walkway is a shared use path and high volumes of bicyclist traffic is expected. A 12-inch wide rub rail is recommended from 30 inches to 42 inches. When a rub rail is installed, the pedestrian zone width is measured from the outside edge of the rub rail, as it is not useable by pedestrians. Ensure the pedestrian zone and pedestrian access route clear width requirements are met. See discussion in the previous subsection.

Driveways

Driveways provide vehicular access across the pedestrian realm to private property. The geometrics of driveway are illustrated in the RD700s series. Driveway design is based on studies including National Cooperative Highway Research Program (NCHRP) Report 659. A pedestrian access route must be provided on the driveway where pedestrians cross the driveway when utilizing the walkway for transportation.

Design at least 50 inch pedestrian access route along a driveway approach thru the walkway. The best practice is to plan walkways with buffer zones with a width that allows the pedestrian zone to be a straight continuous alignment along the walkway across the driveway and equal to the desired pedestrian zone width selected for the urban context. This allows the PAR to be at the same elevation as the general walkway and easily achieve the ADA requirements minimizing the roller coaster effect along the walkway. See RD 700s for Option A, Option B, Option D, and Option E for design requirements on ODOT facilities.

A pedestrian access route must be provided on driveways which are connected at street grade typically with asphalt construction and radius returns. The pedestrian crosses the roadbed in this situation along the street grade (See RD 715). In many circumstances the existing driveway is not built in compliance with ADA standards. Reconstruction of the driveway must provide a fully accessible PAR. The PAR must reside on public right of way or a permanent easement to ensure a private property owner does not affect the ADA accessibility improvements in the future.

Hydraulics

Walkways should be free from debris and divert storm water captured from the impervious area to the storm water treatment facility. **ADA requires that pedestrian walkways are free from debris and standing water.** Typically walkways are sloped toward the curb zone and travel way where storm sewers collect both the storm water from the travel way and walkway. *Cross slope is designed at 1.5% in most circumstances.* When the profile grade (running slope) of the walkway is steeper than the cross slope, the flow path of water changes directions and in some cases no cross slope is required at all. The storm water will runoff to the travel way adequately. *Best practice is to divert the storm water off of the pedestrian zone as soon as practical with a cross slope of 1.5%*.

Walkways may also have a reversed cross slope away from the curb zone in some configurations. Consider reversed cross slope walkway design on roundabouts where storm water can be collected in an open ditch rather than a closed storm sewer system. This reduces the size of the storm sewer system lines under the roadbed. Urban roundabouts should consider utilizing a steeper cross slope in the buffer zone to facilitate drainage conveyance along the buffer zone particularly when constructed with a hard impervious surface.

Inlets should not be in the pedestrian access route in any new construction of a walkway. When an inlet must remain in the pedestrian access route on an existing walkway, the inlet grate shall not exceed the horizontal opening dimension of ½ inch which allows a ½ sphere to pass thru in the direction of pedestrian travel. When the direction of pedestrian travel is not well defined, the ½ inch opening shall not be exceeded in any direction. Contact the Senior Standard Engineer and Senior ADA Standards Engineer when an accessible inlet grate is required for the project.

Inlets are required to be placed directly upstream of a curb ramp for a crosswalk when there is a curb zone. **Addressing drainage and ponding is an ADA requirement.** *Other measures to capture storm water can be provided when the walkway does not have a curb such as constructing a ditch channel in the buffer zone.* Trench drains with an accessible grate can reduce ponding at the curb ramp opening in very flat locations to divert storm water; advantages of trench drains is that a subsurface trench can be designed with independent flow line slopes to connect to the trunk line. Refer to the Hydraulics Manual for determining the design storm, depth of water, and width of the spread at curb ramps and driveways. Ensure the design storm does not overtop the sidewalk or driveway onto private property per Oregon Drainage Law. See Section 1211 Hydraulics for additional information.

.. Pedestrian and Wayfinding Signs

Walkways generally require little signing. Most regulatory and warning signs are directed at motor vehicle traffic. See chapters on street crossings and intersections for signs required in those situations, and the Sign Design Manual.

Signs intended primarily for motorists often do not serve pedestrians well. For example directional signs are typically large, mounted fairly high, and indicate destinations relatively far away. On one-way streets, street name signs are often mounted only in the direction facing motor vehicle traffic, yet pedestrians approach from all directions.

Most street signs adequately serve pedestrians. But street signs on one-way streets often face only motor vehicle traffic. Adding lower level streets signs facing both ways helps pedestrians walking against the direction of traffic, so they can see the names of cross streets. On two-way streets, signs mounted high on mast arms over the roadway should also be supplemented with conventional, smaller signs on the street corners.

Most walking trips are short and the pedestrian's line of sight is different than a motor vehicle. Developing pedestrian-scale wayfinding signs that lead to destinations within walking distance can improve the walkability of an area. Signs can assist pedestrians new to the area, or residents who may not realize that the best route on foot is shorter or different than what they are used to driving. Examples of key destinations to include are libraries, schools, museums, recreation centers, shopping districts, city services, etc.

Example Sign Guidance on wayfinding.

Figure 800-28: ODOT Sign OBD1-3c

The objective of any wayfinding sign network is to comfortably, safely, and efficiently guide users to their destinations. Signs should be unobtrusive, cohesive, visible, legible, intuitive and aesthetic. Signs for the use of bicyclists and pedestrians may use distance in miles and/or bicycle travel times.

810.10 Pedestrian Amenities

Many people use the public walkways for short destinations, exercise, and as alternative forms of transportation. For people with disabilities, the public walkway may be their only option that they can use independently. Pedestrians are exposed to the weather and use their own energy to move, and several low-cost improvements can be made to provide a better environment. In all cases these features must be located outside of the pedestrian zone, in either the buffer or the frontage zones. Temporary objects must not block the pedestrian access route. These items might include trash cans, advertising sandwich boards (A frame), feather flag signs, and rental bikes.

.. Benches

People walking want to sit down and rest occasionally. In an urban setting, wide sidewalks, buffer zones and curb extensions provide opportunities for placing benches out of the walking zone. *Provide space for companion seating and accessible clear space for those with mobility devices.* Provide a pedestrian access route to the front of the bench seating area. Benches with back rests and arm rests provide a stable support for those with mobility issues to lower/raise themselves to/from the bench seat, or to bear weight on when standing and resting.

Figure 800-29: Bench in Buffer Zone

.. Awnings

Where buildings are close to the sidewalk, awnings protect pedestrians from the weather and can be a visual enhancement to a shopping district. **A vertical clear height of at least 80 inches must be provided for the pedestrian realm and in pedestrian circulation areas where awnings are installed.** Building code requirements may be more stringent. Contact the local agency and building department for additional requirements.

Figure 800-30: Awning Shades Sidewalk Cafe

Shelters

At bus stops, transfer stations and other locations where pedestrians must wait, a shelter makes the wait more comfortable. People are more likely to ride a bus if they don't have to wait in the rain and have a place to rest. Providing shade at transit stops improve the user experience during the wait for a transit connection. **Provide a pedestrian access route to the front of the bench seating area and a clear space for mobility devices to use the shelter. Companion seating, a clear space, and turning space for a mobility device is required when installing shelters for the general public.** Trash cans and other advertisements permanently secured to the shelter need to be accessible and shall not infringe on the clear space, turning space and pedestrian access route. **See Section 805.3 for additional considerations for boarding and alighting areas.**

Figure 800-31: Bus Shelter in Buffer Zone

Landscaping

Landscaping can greatly enhance the aesthetic experience for pedestrians, making the walk less stressful or tiring. Landscaping provides information to the vision impaired community where the intended walking route is. The contrast, textures, and sounds assist people with wayfinding along the walkway. The effective use of a planting strip can provide a buffer between travel lanes and sidewalks, as well as mask features such as sound walls. Choosing appropriate plants and ground preparation are important. The following guidelines should be considered:

1. Plants should be adapted to the local climate and fit the context. Plantings should survive without protection or intensive irrigation, and should require minimal maintenance, to reduce long-term costs.

2. Plants must have growth patterns that do not obscure pedestrians from motor vehicles, especially at crossing locations, nor must they obscure signs.
3. Plants should not have roots that could buckle and break sidewalks (root barriers can prevent buckling); the soil should be loosened and treated with mulch deep enough so plants can spread their roots downward, rather than sideways into the walk area.
4. Plants should not have limbs that protrude into the pedestrian zone or pedestrian access route. Vertical clearance under limbs must be maintained in the walkway to be fully accessible.
5. Planting strips should be wide enough to accommodate plants grown to mature size.

Figure 800-32: Landscaping Provide Storm Water Treatment

.. Drinking Water Fountains & Public Restrooms

Drinking water fountains and public restrooms make it easier for pedestrians to be outdoors for a long time and to walk long distances without worrying about where to find a business that will accommodate their needs. Drinking water foundations need to the meet the ADA requirements for installation, operating heights and parts. A pedestrian access route must be provided to navigate to the fountain with a 3 ft x 4 ft clear space to approach, activate, and use the water fountain. The clear space does not have to be level when located in the public right of way walkway adjacent a roadway. The clear space must be of clear of objects and free from any lips or vertical discontinuities. A turning space may also be needed depending on the water fountain type and installation. *Best practice is to make the clear space level if feasible.*

¨ Parklets and Outdoor Dining

Outdoor dining is being used more in urban areas for a variety of reasons. See ODOT's maintenance and operation policy (MG 14-04) for the permitting process and considerations on state right of way. Pedestrian access routes must be provided and maintained with outdoor dining whether it's seasonal or permanent.

¨ Pedestrian Stairways

Stairways are not permitted in the pedestrian zone or along the primary pedestrian access route, but may be provided as an alternative route to building entrances or other destinations. The requirements for the design of stairways is based on ADA requirements and the Oregon Building Codes. See RD100's for details. Handrail shall meet the ADA gripping requirements and installation heights. Contrasting strips on the edge of the step provide information to pedestrians of the elevation change, particularly those with vision impairments or have loss sight in one eye. "When both eyes see clearly and the brain processes a single image effectively, it is called stereopsis. People who rely on vision primarily in one eye (called monocular vision) may struggle with depth perception."[5] The extension of the handrail provides a surface to bear weight when negotiating the first and last steps of the stairway per the ADA.

Section 815 Curb Ramps

Curb ramps allow pedestrians with varying abilities to enter and exit the sidewalk or other similar pedestrian facilities. Curb ramps are built for use by pedestrians of all ages. They assist those experiencing permanent as well as temporary disabilities to access the sidewalk. Curb ramps are designed for pedestrians with diverse and varying abilities. A curb ramp is a system that typically provides a transition between the sidewalk and the street. It cuts through or is built up to the curb. Review the curb ramp process in Section 802 and included in the HDM Appendix for additional discussion on how curb ramps are incorporated in the design development and construction contract process.

There are multiple components that are constructed to build a curb ramp. Curb ramp components include the curbing and gutter pan at the entrance/exit to the travel way, or other similar facilities in the curb zone. Components of the curb ramp include areas that cross the buffer zone and tie into the pedestrian zone where pedestrians walk. Curb ramp design is based on the unique site constraints and features at each corner. No matter what the physical

5 Kierstan Boyd, "Depth Perception," American Academy of Ophthalmology, https://www.aao.org/eye-health/anatomy/depth-perception

constraints are at a site, there are geometric requirements that curb ramps must meet under the ADA.

The underlying design principles are the same for curb ramps and building ramps as they provide access to a pedestrians with varying abilities. The ADA regulations however treat them differently resulting in some variations in design requirements. Under the ADA, private and public facilities must provide accessible routes to services from each site arrival and destination points. Points of service include but are not limited to parking lots, on street parking, transit stations, bus stops, building entrances, kiosks, signal push buttons, the sidewalk, and street crossings where accessible routes are required. These points of service may overlap jurisdictions and cross private property.

Both curb ramps and building ramps are a required and critical design element to allow pedestrians to traverse to each point of service when there are vertical changes along the pedestrian access route. Vertical changes exceeding ½ inch must be ramped with a sloped surface along the pedestrian access route under the ADA. Stairs can be utilized on an additional route for pedestrians when the primary access route is constructed and is fully accessible. See Section 810 on walkway design.

Figure 800-33: Curb Ramp System with a Curb Ramp for Each Street Crossing

815.1 Curb Ramp Definitions

Curb ramp - A system of geometric components that are built up to or through a curb to access the walkway or street crossing in the public right of way or on building sites.

Building ramps - A system of geometric components which serve both private and public buildings developments to allow pedestrians to access the business and entry and exit points, and both interior and exterior spaces. Building ramps must connect to the Pedestrian Access Route externally and internally for pedestrian facilities such as exterior sidewalk on the business site or a hallway inside.

Clear Width - the narrowest width found within the curb ramp system that is fully accessible for pedestrians.

Cross Slope - The grade of a surface perpendicular to the running slope or traversed surface in the direction of pedestrian travel.

Directional Curb Ramps - Curb ramps that align parallel with intended crosswalk.

Gutter Flow Slope - The grade at the gutter flow line at the bottom of a Ramp Run 1. It is immediately parallel to the curb or street edge where water is conveyed to a drainage system.

Ramp Run - A sloped surface within a curb ramp system designed to bridge vertical elevation changes in the pedestrian access route.

Ramp Run Number - The number assigned to the ramp run for the curb ramps system.

Curb Running Slope - The surface slope on the top of the curb that is cut thru or depressed to connect to the ramp run, directional curb, gutter pan, or travel way roadway surface.

Pedestrian Ramp - An accessible sloped connections along the walkway, most often at grade with the roadway serving the crosswalk along the pedestrian access route.

Pedestrian Pad - A level area that is constructed to provide accessible access to a pedestrian features such as a pedestrian signal push button at a rural signalized intersection, or other pedestrian features.

Lip - A vertical discontinuity along the pedestrian access route, walkway, or pedestrian circulation areas less than 4.0 inches.

815.2 Curb Ramp Triggers and Scoping

Refer to the Engineering for Accessibility webpage for resources about curb ramp triggers in the current directives, bulletins, advisories, operational notices and Curb Ramp Process Document. Triggering activities occur when an alteration occurs that effects the usability of a pedestrian crosswalk or walkway, and therefore presents the opportunity to construct a curb ramp to the ADA standards. When the concrete material (or other surfacing), or curb and gutter pan of the curb ramp system is disrupted, the curb ramp has been altered and requires reconstruction to the standard.

Right of way shall be planned for projects with curb ramp improvements per TSB18-03(D). The ADA requires upgrading curb ramps in alteration projects. The US DOT and US DOJ recently issued a memorandum of joint technical assistance to define when resurfacing projects are considered to be an alteration, which triggers the need to upgrade curb ramps. As a result, all 1R projects need to address curb ramps, except projects that only include chip seals. See Maintenance and Operational Notice MG 100-107-1 for direction on what is considered a maintenance pavement activity. See Maintenance and Operational Notice MG 144-03 for direction on what is considered a signal maintenance activity for accessibility features on the pedestrian signal.

Locations of curb ramps that do not comply with the ODOT standard shall be upgraded when triggered by a project activity. Consult the ODOT's ADA Transition Plan for other ADA project needs that are to be incorporated in the project scope. Consult with the Active Transportation Liaison for CQCR requests that are addressed with the project scope.

(More content to follow in next version of HDM)

815.3 Curb Ramp Configurations

Curb ramps and blended transitions must be wholly contained within the pedestrian street crossings or crosswalk served; see **Criteria Q** on the curb ramp checklist. **Curb ramps must not be blocked by legally parked cars as the curb ramp serves as the entrance and exit point for pedestrians to use both the crosswalk and sidewalk.** Typically, two curb ramps must be provided at each street corner. In alterations where existing physical constraints prevent two curb ramps from being installed at a street corner, a single diagonal curb ramp is permitted at the corner with a design exception; see **Criteria A** on the curb ramp checklist.

One of the greatest factors determining the safety of a pedestrian crossing is visibility. Every effort should be made to remove or relocate objects that could obscure the view of and by pedestrians. These include signs, traffic control boxes, tall vegetation, kiosks, etc. When possible, efforts should also be made to ensure that objects located on private property, such as neon and other illuminated signs, that could be a distraction to drivers are not located close to a crosswalk or curb ramp.

Provide a curb ramp for each crosswalk on or along the state highway with vertical curbing in the curb zone. This includes T- intersections. This corresponds to the curb ramp design checklist **Criteria A**. Typically a roadway intersection will have two curb ramps per corner that connects directly to pedestrian zone of the walkway. If one crossing is officially closed at a corner, it is recommended to design the remaining curb ramp in such a way that it guides users to the open crossing and provides physical and visual cues that discourage pedestrians from using the closed crossing. Curb ramps that align parallel with intended crosswalk are called "directional" curb ramps. A single diagonal style perpendicular curb ramp on an intersection corner direct users into the intersection and requires a turning maneuver in the roadway to utilize the crosswalk. Ensure **Criteria M** is met which provides a 4 foot x 4 foot clear space free from vehicular travel when using the either crosswalk.

When two curb ramps are not able to be provided for the corner, a single curb ramp configuration that accommodates both crosswalks may be necessary to retain operations of both crosswalks for the pedestrian. A single diagonal curb ramp can be missed interpreted that it serves both street crossing to low vision, blind, or deaf-blind travelers of the sidewalk since they may not have cues or information to tell them otherwise. US national guidance for public right of way permits diagonal curb ramps under alterations for street crossings; however the use and application is not uniform throughout the United States. A curb ramp that serves each street crossing provides a clearer and more uniform message to all individuals. *Providing curb ramps that have ramp run centerlines parallel to the intended street crossing is preferred.*

When a crosswalk is closed, it must be signed per the ORS. See the Traffic Manual for the crosswalk closure process and requirements, and refer to Section 802.5 for more discussion. **When a crosswalk is officially closed, the approval letter from the STRE serves as the decision document in lieu of the ADA Curb Ramp Design Exception to provide a single curb ramp that serves two crosswalks.** For local street systems, the approving authority for a crosswalk closure follows the local jurisdiction's process and documents. **Curb ramp details are required to identify the crosswalk closure number in the contract.** Review the details of the approval as other items may be specified which need to be incorporated into the contract documents and may require coordination with other technical disciplines (typically traffic and sign designs).

Crosswalk closures should be limited during design, and are not in intended to be used to avoid construction of a curb ramp. Curb ramps are intended to provide access for all pedestrians to enter and exit the sidewalk and connect to the crosswalk. Pursue a location determination with the Traffic Roadway Unit if the presence of a legal crosswalk is in doubt (See Section 802.4).

Combination Curb Ramps

Combination curb ramps provide the most flexibility for design in meeting the ADA standards and reducing the footprint of the improvements. The elevation difference for the curb height is stretched over two separate ramps runs (one perpendicular and one parallel to the crosswalk) with a level area and turn space to change directions. This style of curb ramp can also facilitate larger or irregular shaped level areas to meet ADA requirements at signalized intersection with push buttons. This style of curb ramp is good for providing connections to the building entrances and adjoining walkways to private property/businesses. This style of curb ramp allows for directional curb ramps that align parallel with the intended crosswalk. Directional curb ramps are the preference for design.

Curb Ramp Driveway Combination

As discussed in the walkway design section (Section 810), curb ramps provide pedestrian access to the sidewalk. Providing positive separation between the vehicular access driveway throat and curb ramp opening is needed. Each site will need a design based on the existing site topography, property boundary, and access management considerations. Coordination with the Region Access Management Engineer is required when developing the project's Access Management Strategy or modifying a driveway. **Details are shown for new driveway construction with horizontal separation distances for accessible routes which include 5 feet**

between ramp runs of the curb ramp system and the driveway system (see RD700s). This is **Criteria P** on the ADA curb ramp design checklist.

Driveway design includes a certain amount of off tracking by a vehicle identified as the "p" distance on the standard drawings for driveway construction. Off tracking simulation software should be used to evaluate the design of a curb ramp driveway combination configuration based on the design vehicle. The available lane widths and shoulder widths vary with each corridor and impact the space for vehicles off tracking and approach speeds of drivers while turning. Creativity is key in designing a curb ramp driveway combo that meets all accessible route requirements (examples below) and functions for the design vehicle.

Designs that utilize a raised curb section to physically separate the curb ramp opening and driveway throat are evolving. Provide at least 5 feet of separation between the driveway throats and curb ramp turn space or level area. *Provide constant curb exposure height (denoted "E") between 4 inches to 6 inches in height on the curbing. This would replace what would otherwise be a flared wing or flared side to ensure white cane detectability, conspicuity, and depth perception of the area.* Softscape materials included in the interior of the small raised island provides the best performance of all desired attributes for pedestrians: detectability, conspicuity, contrast, visual appeal and space for vegetation. **A minimum area of 3 feet by 3 feet from face of curb to face of curb may be considered when horizontally constrained in either direction (see Section 800 on buffer zone requirements, RD721).** To be effective the size should be as large as practical. Smaller areas will require additional mitigation measures (i.e. white tubular markers) and will require approval as described in the Traffic Line Manual.

Identify the system limits of both the curb ramp and driveway on the plan set details to reduce confusion during contract administration. *Consider deeper concrete surface thickness for ease of construction and conforming to the driveway performance needs.*

.. Parallel Curb Ramps

Parallel curb ramps should be reserved for constrained public right of way in curb ramp alterations where there are building foundation conflicts, large existing retaining walls, or bridge rail constraints. The elevation difference for the curb height is stretched over one ramp runs parallel with the vehicular travel way with a level area and turn space at the bottom of the ramp runs. This style of curb ramp tends to separate the curb ramp opening for each crosswalk distance significantly at an intersection. This results in poor alignment with the receiving curb ramps and orientation cues for low vision and blind travelers.

Perpendicular Curb Ramps

Perpendicular curb ramps typically result in the largest footprint to make up the elevation difference for the curb height. The change in elevation is stretched over one ramp run perpendicular with vehicular travel way with a level area and turn space at the top of the ramp run. Perpendicular ramp runs are where cross slope warping occurs to meet a given gutter flow slope requirement (see Section 815.4). Single ramps on a diagonal alignment at the corner requires pedestrians to turn and reorient in the travel way. Clear space must be made available for mobility devices at the bottom of the single diagonal curb ramp and is required to be free from the vehicular travel ways. This is corresponds to **Criteria M** on the design checklist.

Pedestrian Ramps and Pedestrian Pads

Pedestrian Ramps are similar to curb ramps, except they do not cut thru a curb along the pedestrian access route. They are accessible connections along the walkway, most often at grade with the roadway way serving the crosswalk in the PAR. Pedestrian Pads are level areas that are constructed to provide accessible access to a pedestrian features such as a pedestrian push button at a rural signalized intersection. The same geometric requirements for curb ramps including but not limited to running slope, cross slope, counter slope, level areas, and installation of detectable warning surfaces are utilized for design.

Unique Curb Ramps

Unique curb ramps styles are typically parallel style curb ramps that are missing ramp run components. This could include either Ramp Run position 2 or Ramp Run position 3, or both of them. A pedestrian pad is a unique curb ramp for inspection and inventory purposes as both Ramp Run 2 and Ramp Run 3 are missing.

Blended Transitions

Blended transitions are surfaces with running slope surfaces under 5.0% located at the street entrance for the crosswalk. Crosswalk surfaces should not have running slopes exceeding 5.0% along the PAR beginning at the curb zone and entering the travel way. This does not preclude running slopes less of less than 5.0% on ramps runs 2 and ramp run 3. *A design value not to exceed 4.0% for both the curb running slope and directional curb is recommended in most circumstances.* The top of the curb when designed less than 4.0% is a blended transition surface as shown in DET1752. See RD900's for blended transition curb ramps styles.

Truck aprons are designed with a blended transition running slopes in the PAR and are not a part of the curb ramp system. The pedestrian crosswalk stops at the curb ramp system and when the pedestrian crosses the truck apron they are in the street crosswalk. **Design the truck apron with a running slope not to exceed 4.0% in the PAR connecting to the curb ramp system for the walkway.** This is illustrated in RD170.

Shared Use Paths are often designed with blended transitions to cross the curbing as shared use paths should not have profiles exceeding 5% along the centerline.

815.4 Geometric Controls for Curb Ramps

Curb Ramp Design Checklist

The ADA Curb Ramp Design Checklist (ODOT Form No. 734-5184) is a companion for curb ramp design. This is an aid for designers in determining when design exceptions are needed on the design. This form is available on the Engineering for Accessibility webpage with the latest updates.

Refer to the ADA Inspection Guide for Curb Ramps and Push Buttons as an additional resource about curb ramps that is critical to understand, and it will aid in your design of the curb ramp system.

When an ADA Design Exception is approved for a curb ramp system, acceptance of the curb ramp component a construction tolerance will be applied that is equal to the same margin for error that is used in the design of the curb ramp. See Table 800-4 below for the slope allowances on curb ramp systems with approved design exceptions.

Table 800-4: Construction Allowance for Slopes

From Roadway Tech Bulletin RD19-02B, 12/16/2020:

Curb Ramp Criteria		Approved Design Exception Value Exceeds	Construction Tolerance	**Example** Approved Design Exception Value	**Example** Allowed Inspection Value
Running Slope		7.5%	+0.8 %	7.7%	8.5% max
Curb Running Slope		7.5%	+0.8%	8.0%	8.8% max
Counter Slope		4.0%	+1.0%	4.8%	5.8% max
Cross Slope		1.5%	+0.5%	1.8%	2.3% max
Gutter Slope	Stop/Yield Controlled	1.5%	+0.5%	2.5%	3.0% max
Gutter Slope	Uncontrolled	4.5%	+0.5%	6.0%	6.5% max
Gutter Slope	Midblock	Roadway Profile Grade	+0.5%	5.5%	6.0% max
Flare Slope		10%	+0.8%	11.5%	12.3% max

Another fundamental concept in the enforcement of ADA by the US DOJ is that the standards have absolute minimums or maximum values, or sometimes ranges. Rules of rounding during inspection are applied differently than what is used in mathematical calculations. As an example when the requirement is to provide a ramp run of at least 15.0 feet, a constructed measured length of 14.9 feet is not equivalent to 15.0 feet therefore failing the design requirement. To ensure the minimum ADA standard is meet, designers need to specify a value such as 15.5 feet that incorporates some margin of error during construction larger than 15.0 feet.

Table 800-5: Inspectors Rounding Guide for Curb Ramp Inspections

Rounding Guide:

Rounding to the nearest tenth	Round up	Round down
Ramp Runs	√	
Turn Space/Push Button Clear Space		√
Push Button Height (3.8 and up)	√	
Push Button Height (under 3.8)		√
Push Button Reach Range	No rounding, measure to hundredths	
FT Between Flares, Ramps, Driveways		√

.. Clear Width

Clear width is a critical component of any pedestrian access route. The clear width of a curb ramp is the narrowest width found within the curb ramp system that is fully accessible for pedestrians. **Surfaces with cross slopes exceeding 2.0%, vertical obstructions or vertical discontinuities are not fully accessible and are not included in the PAR clear width. Curb ramp flares, curbs and obstruction are not a part of the clear width.** Clear width is measured anywhere within the curb ramp system and determines the width of the pedestrian accessible route. Clear width is also required for temporary pedestrian access routes and temporary curb ramps. The minimum clear width for acceptance varies based on the curb ramp type. The design criteria for clear width of the PAR is listed on each curb ramp style in the standard drawings RD900 series.

Provide at least a 4.5 ft clear width through the pedestrian access route (flares and curbs are excluded from pedestrian access route) on the entering ramp run of a curb ramp. This corresponds to the **Criteria F1** on the ADA curb ramp design checklist. When the back of the ramp is obstructed, additional space is required to complete the crossing at the level area and turn space. **The PAR and clear width connecting to the level area and turn space is required to be wider; at least 5.5 feet in the direction of the crosswalk with a vertical obstruction.** This corresponds to **Criteria J3** on the curb ramp design checklist. *Best practice is to design the PAR equal to the pedestrian zone from the sidewalk, with matching clear widths at the turn space and along the ramp run entering the street crosswalk with a constant clear width. This will simplify the curb ramp design, and provide a higher quality pedestrian facility.*

Curb ramps located at intersections corners are places where utilities and objects are often competing for space. Objects such as pushbutton pedestals, signals, signs, utility poles, fire hydrants, etc. are frequently in the curb ramp system. There may be a mailbox in the path or guy-wires above the walkway. These could be the controlling feature for the clear width measurement in addition to the cross slope**. Clear widths are reduced by objects that are less than 7 feet above the walking surface along the pedestrian accessible route.** The picture below illustrates an example of clear width measurement locations that are necessary to find the smallest value to be recorded on the inspection form for curb ramps.

Figure 800-34: Pedestrian Access Route Clear Width

Provide a clear width through a cut-through island at least 5.5 feet. This corresponds to **Criteria F2** the curb ramp design checklist. Accessible route islands are often marked with crosswalk markings. **When the crosswalk is marked, the curb ramp opening must be wholly contained within the crosswalk (Criteria Q).** *Curb ramp cut thru at in medians islands are therefore not to exceed 9 feet in width; the standard crosswalk marking is 9 feet when continental markings are used. Coordinate with the striping designer, when the clear width exceeds 9 feet to ensure ADA compliance for any marked crosswalk as larger markings may be permitted.*

When pedestrian volumes are expected to be high for a particular cut thru crosswalk, widths above 5.5 feet are recommended and provide for greater pedestrian capacity in the PAR. *The clear width for the accessible island should match the pedestrian zone width for the walkway it connects to. Clear widths exceeding 9 feet at a cut thru median needs to be evaluated with engineering judgement to ensure drivers don't abuse the opening to perform illegal traffic operations such as U-turns or misconstrue the space as a narrow roadway entrance to an adjacent property along the highway.* Bollards are not recommended as a treatment to mitigate this concern.

Roundabout splitter islands typically introduce geometrics in the cut-thru of the crosswalk alignment to discourage vehicles from entering it. Crosswalks at roundabouts must accommodate bicycle traffic thru the splitter island and wider widths may be necessary based on the design user. Consult the Bicycle Pedestrian Engineer for additional guidance on selecting design bicycle vehicles, and see Part 900.

Curb ramps designed for shared use paths shall have a minimum width equal to the approaching path width. When the accessible route island is serving a shared use path, the curb ramp opening must be equal to the shared us path it serves. This corresponds to **Criteria F3** on the curb ramp design checklist. The shared use path is fully accessible to both pedestrians and bicyclists, and efforts to segregate modes with painted striping is not effective communication for the low vision and blind populations.

Gutter Flow Slope and Inlets

The gutter flow slope is the grade at the gutter flow line at the bottom of a Ramp Run 1 where storm water is collected. It is immediately parallel to the curb or street edge where water is conveyed to a drainage system. Water cannot pool in front of curb ramps. Install inlets or provide another approved drainage receptacle upstream of any new curb ramp constructed. Refer to the hydraulics design manual for designing inlets, calculating the spread distance, and depth of water during a design storm event. *Best practice is design a gutter flow slope of at least 0.5% to convey storm water; however some circumstances including crests and high sides of super elevated roadways can utilize a gutter flow slope of 0.0%*.

The maximum design gutter flow slope is variable based on the intersection control type. The intersection control type is based on the traffic operations control for vehicles. The intersection control type is determined during the design of the curb ramp system and determines the permissible measurement at the bottom of the curb ramp. You will need this information to complete the design of the curb ramp. Use the ODOT's Exhibit D in Figure 800-35 and Figure 800-36 to help determine common Intersection Control Types. Refer to Technical Bulletin RD21-01(A) for discussion on strategies to meet the gutter flow slope requirements on existing curb ramps that are altered and reconstructed.

The maximum design gutter flow slope for the three intersection control conditions are defined:

1. 1.5% at stop/yield intersections (SY)
2. 4.5% at signalized/uncontrolled intersections (SU)
3. Profile slope of the roadway at mid-block crosswalks (MB)

Design exceptions are required under **Criteria D** on the curb ramp design checklist, when gutter flow slopes are not achieved at the curb ramp. **Criteria D1 pertains to intersections in the SY condition, Criteria D2 pertains to the SU condition, and Criteria D3 pertains to the MB condition.** This closely correlates to **Criteria C1, C2 and C3** for cross slope on the curb ramp checklist.

Figure 800-35: ODOT Exhibit D for Design Gutter Flow Slope Conditions

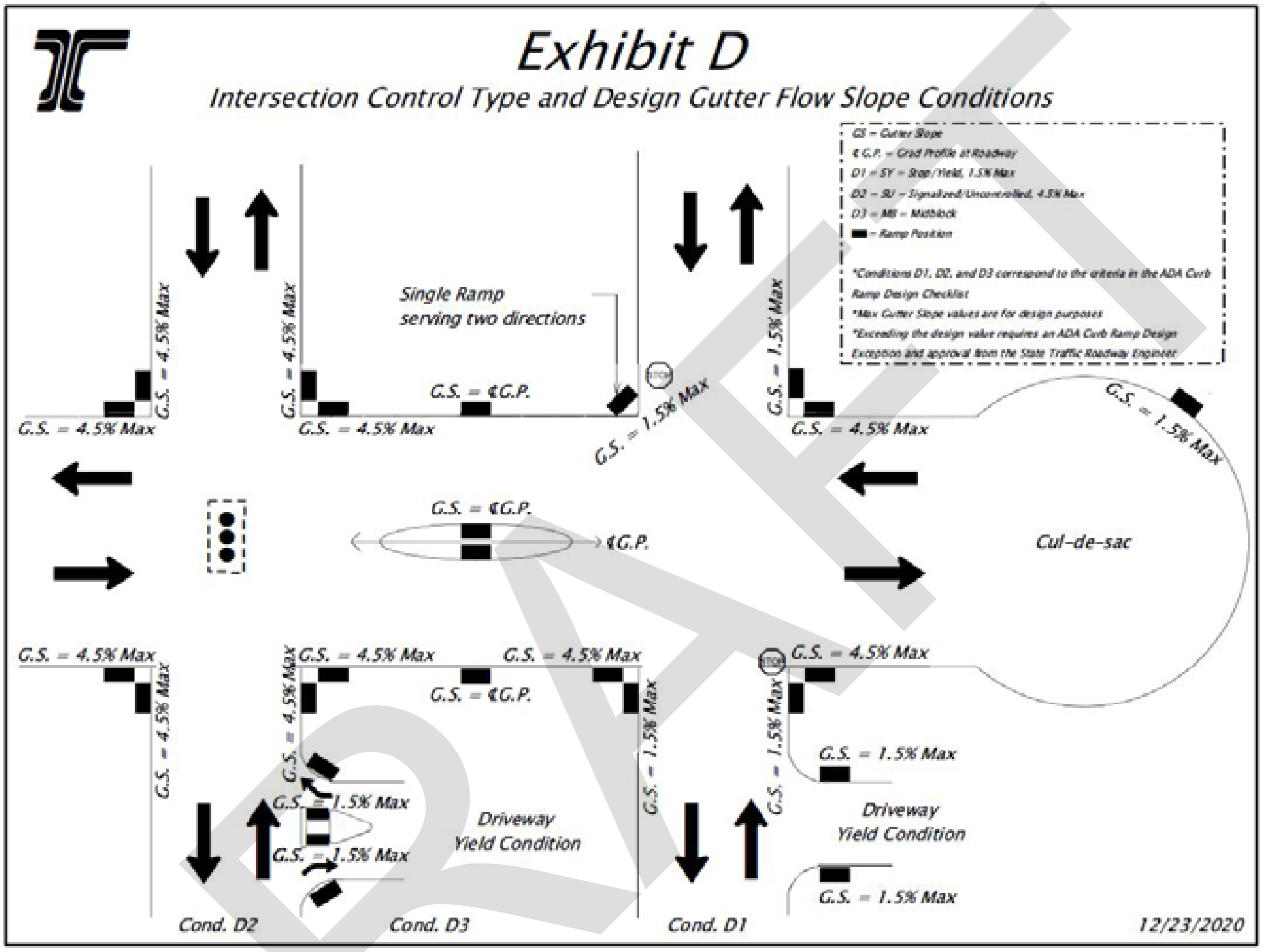
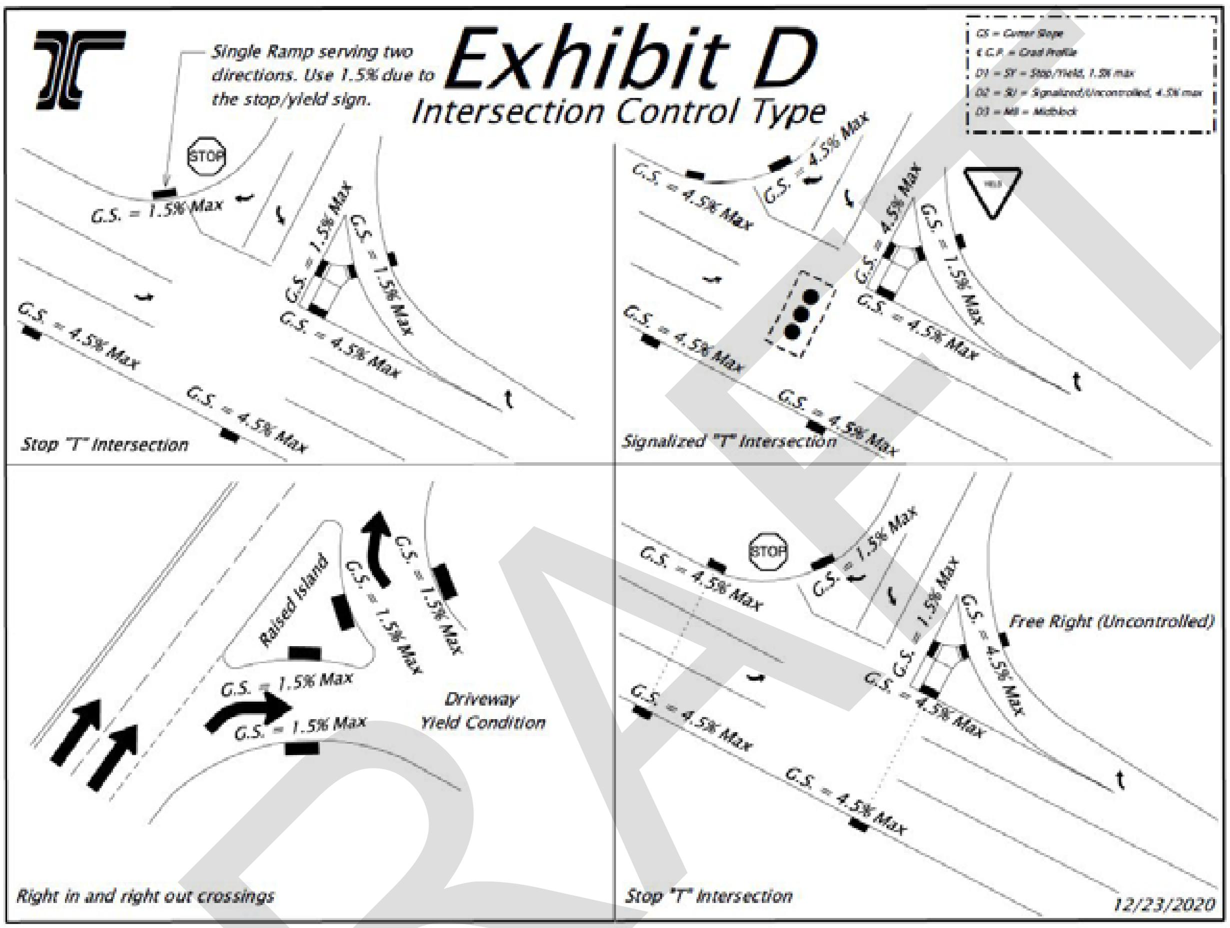


Figure 800-36: ODOT Exhibit D for Design Gutter Flow Slope Conditions for Right Turns



Provide an inlet upstream of the curb ramp or other approved drainage mitigation. **Inlets and drainage grates are not permitted in the PAR for new construction of intersections.** This corresponds to **Criteria H**. Alterations of existing roadways may be constrained on a rare occasion and an inlet may need to remain in the crosswalk. When an inlet cannot be relocated upstream of the curb ramp, installing an ADA accessible grate may be considered as mitigation.

Pedestrian access routes or circulation areas are not permitted to have horizontal openings exceeding ½ inch, allowing a ½ sphere to pass thru in the direction of pedestrian travel. Accessible drainage grates are available, but not a standardized in the Oregon Standard Drawings. Contact the Senior ADA Standards or Senior Standards Engineer in the Traffic Roadway Unit for further guidance. Addressing water conveyance and ponding at curb ramps is an ADA requirement. Coordination with the hydraulics designer for storm water collection is required for curb ramp design.

Cross Slope

The cross slope is the grade of a surface perpendicular to the running slope of traversed surface in the direction of pedestrian travel. **The cross slope of a pedestrian access route may not exceed 2.0%. Cross slopes exceeding 1.5% requires design exception approval.** This corresponds to **Criteria C1** on the curb ramp checklist. Design cross slopes for ramp runs in the curb ramp system between 0.0% and 1.5% for drainage conveyance. See discussion in Section 810.5 for pedestrian access routes. Specified cross slopes shall be compliant anywhere along the ramp run surface.

Design exceptions are required and often interdependent for cross slope and gutter flow slope. See the Table 800-6 for the criteria needing design exceptions listed on the curb ramp design checklist **Criteria C** and **Criteria D**.

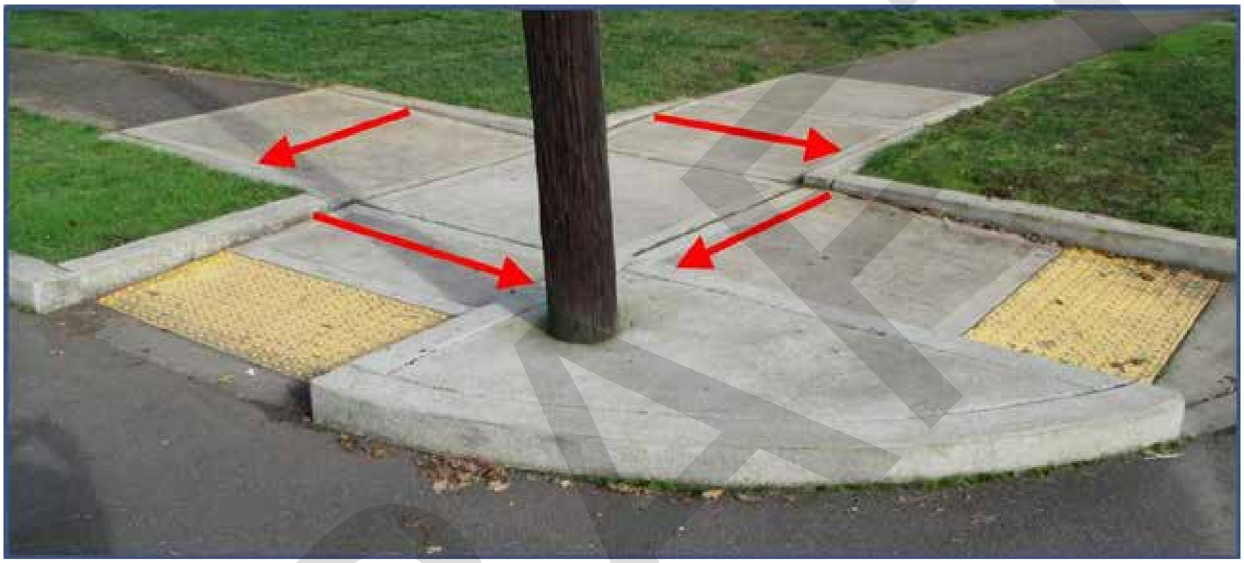
Table 800-6: Cross Slope 1 and Gutter Flow Slope Interdependencies

Gutter Flow Slope (Criteria D)	Ramp Run 1 Cross Slope (CriteriaC1)	Mitigation	ADA DE Needed & Criteria
D1 - Stop Yield (1.5%)	0-1.5%		No
	1.5% - 4.5%	Warping of Cross Slope Up to 4.5%	Need DE D1 and C1 >1.5%
	greater than 4.5%	Warping of Cross Slope > 4.5%	Need DE D1 and C1 >1.5%
D2 - Signalized & Uncontrolled (4.5%)	0-1.5%		No
	1.5% - 4.5%	Warping of Cross Slope Up to 4.5%	No
	greater than 4.5%	Warping of Cross Slope > 4.5%	Need DE D2 > 4.5% and C1 >4.5%
D3 - Midblock, Grade of Road 0% - 1.5%	0- 1.5%		No
	>1.5%		Need DE D3 and C1 >1.5%
D3- Midblock, Grade of Road 1.5% - 4.5%	0- 1.5%		No
	Exceeds 1.5% & Less Than Grade of Road	Warping of Cross Slope Up to 4.5%	No
	Exceeds 1.5% & Exceeds Grade of Road	Warping of Cross Slope > 4.5%	Need DE D3 > 4.5% and C1 >4.5%
D3 - Midblock, Grade of Road greater than 4.5%	0- 1.5%		No
	Exceeds 1.5% & Less Than Grade of Road	Warping of Cross Slope Up to 4.5%	No
	Exceeds 1.5% & Less Than Grade of Road	Warping of Cross Slope > 4.5%	Need DE C1 only > 4.5%
	Exceeds 1.5% & Exceeds Grade of Road	Warping of Cross Slope > 4.5%	Need DE D3 & C1 >4.5%

At islands across an intersection crosswalk without yield or stop control, the maximum cross slope is 5.0%. **Design the cross slope less than or equal to 4.5%.** This is **Criteria C2** on the design checklist. These islands are typically used for right turn channelization shown in RD700s, and refer to Figure 800-36 for other examples.

The cross slope of the pedestrian access route for islands at mid-block locations shall not exceed the street or highway grade (roadway slope). This corresponds to **Criteria C3** on the curb ramp design checklist. **Criteria C1,** and **Criteria C2** and **Criteria C3** are interdependent with the gutter flow slope and intersection control type.

Figure 800-37: The Arrows in the Photo Show How the Cross Slope is Oriented Perpendicular to the Ramp Run



Intersection traffic operations determine the design gutter flow slope value permitted for the intersection control type. When the intersection control is not a stop control with a stop sign or yield sign, the gutter flow slope is permitted to exceed 1.5% (See the Gutter Flow Slope and Inlets subsection in Section 815.4). When this condition occurs, the cross slope transitions from the level area or turn space to the gutter line in a gradual manner by warping the cross slope. A directional curb may be present on curb ramps on a radius. See RD905 for examples of the directional curb. Where present, the maximum cross slope of the directional curb is the gutter flow slope. In some cases, the directional curb may have a warped cross slope designed. When warping is required, use the same technique to warp the panel as described for perpendicular ramp runs.

Warping cross slope on ramp run 1 to meet the gutter flow slope design requirement is permitted in this circumstance for some styles of curb ramps. This warping occurs on the perpendicular ramp run at the curb ramp entrance/exit. The standard warp rate for cross slope changes is 0.5% per foot of length on the ramp run. **Warp rates exceeding 0.5% are not permitted when a new pedestrian facility or roadbed did not exist prior to construction of the curb ramp. Warping rates exceeding 1.0% per foot are not desirable and require further justification and documentation.** *Warp rates between 0.5% and 1.0% may be considered when site conditions are constrained with a curb ramp alteration on an existing roadbed.*

A transition panel is constructed to transition walkway segments when cross slopes exceed 2.0% at the match point on existing non-conforming sidewalk or street crossings. Utilize the warping standards to transition cross slope when warping the cross slope is required for the curb ramp system design. See RD 700's for transition panel requirements. Transition segments of walkway are not a component of the curb ramp system and should meet accessibility standards for new construction to the extent feasible. **Transition segments cannot make the overall pedestrian access route worse than pre-existing conditions under the ADA.** Utilize the warp rates discussed above for transition panels. *Transition panels are typically at least 6 feet long to account for most construction conditions and irregularities in existing walkway cross slopes, and to keep the concrete panel square.* Square concrete panel are best practice to minimize cracking in concrete construction.

Ramp Run

A ramp run is one of the ramps within a curb ramp system. A ramp run is a sloped surface within a curb ramp system designed to bridge vertical elevation changes in the pedestrian access route. Curb ramp systems can have more than one ramp run. Ramp runs can also occur on driveway surfaces and on building ramps. A ramp run may be parallel to the street, perpendicular to the street, or may be constructed at an angle on a street corner radius. Perpendicular means it is constructed at an angle of 90 degrees to a given line. Parallel means it is constructed side by side along a line. The lines do not intersect each other, and there is a fixed distance between the two lines.

Ramps runs are to be designed in a planar fashion; angle points and frequent grade changes are indicative of curvilinear construction. Ramps run surface construction is to be straight, free of humps or sags, or other irregularities in the final surface. Ramp run alignment should be not be curved as this creates compound slopes similar to super elevation of a travel way. Curved ramp runs make it difficult to meet the cross slope requirements of an ADA pedestrian access route. **Design ramp runs with perpendicular grade breaks at both the top and bottom of the ramp run, free of lips or discontinuities.** This corresponds to the **Criteria T** on the ADA curb ramp design checklist. When the slope of the walkway or ramp run is under 5.0% running slope perpendicular grade breaks are less critical for mobility devices.

The preferred alignment of a ramp run 1 is such that the centerline alignment of the panel is parallel with the intended crosswalk and markings. This is good for all users of the walkway and crosswalk, but particularly important for those with vision impairments. While navigating the walkway, changes in direction along the walkway requires people to reorient themselves to align with the adjacent traffic. While many low vision and blind travelers can use the sounds of traffic, deaf-blind pedestrians cannot rely on the same cues to orient themselves with the crosswalk. Physical cues (i.e. curbing, edge delineation, tactical guide strips) that can be detected typically by white canes are needed for deaf-blind pedestrians. When the ramp run is not aligned parallel with the intended crosswalk

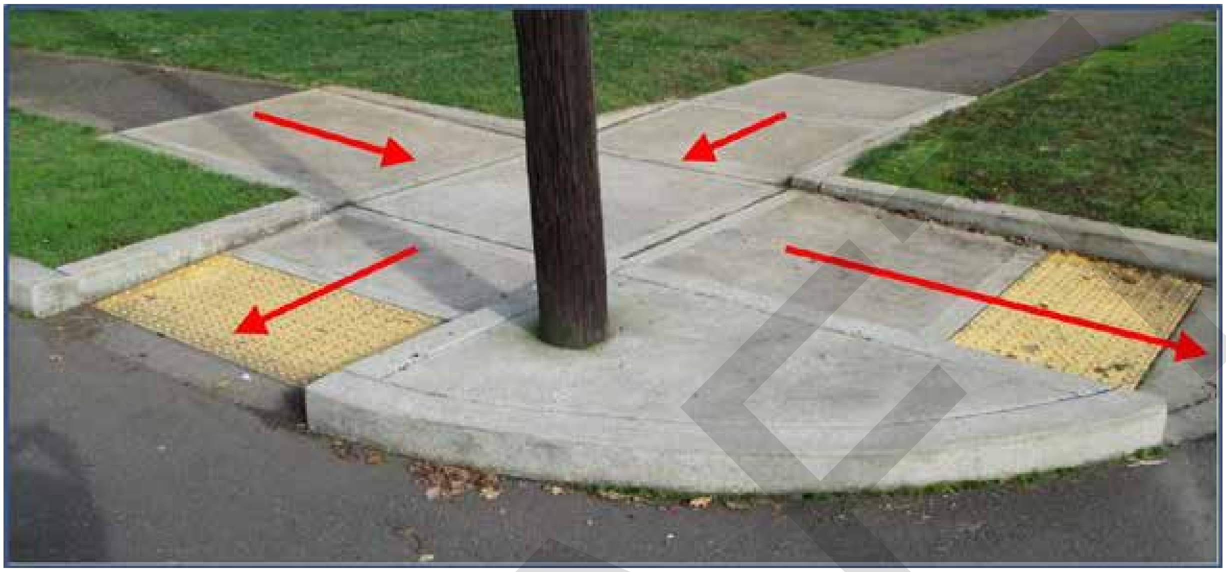
1. this adds complexity for the pedestrians disabilities
2. increases operational crossing distances/time for the pedestrian using the crosswalk
3. requires an additional clear space too reorient in the roadway free from vehicular traffic in the shoulder

Each ramp run is assigned a position number for the curb ramps system. The entry or exiting ramp run to the curb ramp system is assigned the position of 1. The additional ramp runs in the curb ramp system are numbered counter clockwise from the turn space or level landing. The maximum number of ramp run positions for a curb ramp system is three based on ODOT's asset methodology.

Figure 800-38: Image of 4 Ramp Runs on One Curb Ramp System

The ramp running slope is the grade of a surface that is parallel to the direction of pedestrian travel on a curb ramp. Figure 800-39 below has four running slopes. *Ramp running slopes are designed between the slope range of 0.0% to 7.5%.* **A design exception is required for ramp running slope exceeding 7.5%. Ramp running slopes may not exceed 8.3% under the ADA in the final construction of the surface.** This corresponds to **Criteria B1** on the curb ramp checklist. Running slopes can be positive or negative relative to a horizontal plane. Flatter slopes are generally more accessible in that in requires less work or energy by pedestrians to traverse the surface of the ramp run.

Figure 800-39: Image of a Running Slope



The ramp run length is the horizontal distance measured on the ramp run. Each ramp run is measured for length. The longest distance measured is recorded on the inspection form. The ramp run length is used to capture the general length of the ramp run. *While ADA doesn't describe a minimum length for ramps runs, best practice is to construct a ramp run length of at least 3 feet to ensure mobility devices don't span multiple surface planes along the pedestrian access route. Installation of the detectable warning surfaces also requires some nominal distance to install without bridging a grade break, so a distance of at least 2.5 feet is recommended for short ramp runs that meet the travel way (Ramp run position 1 for ODOT). Design the length of the ramp run so it matches an existing sidewalk joint nearby and provides square concrete panels when chasing grade to match into an existing walkway.* **When the running slope exceeds 7.5%, provide a ramp run length of at least 15.1 feet.** This is often the mitigation for ramp runs requesting exceptions under the curb ramp design checklist **Criteria B1**.

Provide at least 5.0 feet between ramp runs and between parallel ramp runs along the pedestrian access route. *Provide 5 feet of separation on reversing sloped surfaces to the extent practical, and evaluate the resulting algebraic grade difference if no separation is provided.* Deviations for the separation distance is requested under the curb ramp design checklist **Criteria P**. Reversing sloped ramp runs create a peak in the pedestrian route which can become a physical barrier for passage by some types of mobility devices. Refer to standard drawing for driveway construction RD700s where this circumstance is mostly likely to occur with curb ramps and driveways that are very close to each other. The 5.0 feet of separation between the parallel ramp runs may also serve as the passing space area for pedestrian access routes, and when the space is level it provides a resting opportunity for people using mobility devices. **Turn spaces (level areas) for curb ramps provide the same function however the standard is to provide at**

least 4.5 feet between the ramp runs in most configurations. See discussion in the Turn Space and Level Landing subsection in Section 815.4.

Directional Curb

A directional curb may be present on curb ramps with a radius. It is the triangular-shaped area between the lower ramp run grade break and the back of curb before entering the travel way. The directional curb is an extension of the typical roadway curbing surface so that ramp runs can be configured and align parallel with the intended crosswalk. This allows for the preferred ramp run 1 alignment to be constructed as discussed in the Ramp Run subsection in Section 815.4.

See RD905 for example illustrations of the directional curb. ODOT gave this area a specific name and this is new terminology to identify a component of the curb ramp system. **Where present, the running slope of the directional curb is required to be less than or equal to 4.9%.** Running slope measurements are taken parallel to the ramp run in the triangular-shaped area. *Design directional curbs with running slope between 1.5% to 4.0% to match the curb running slope of the depressed curb and gutter section, reduced the number of grade breaks along the PAR, to provide drainage conveyance and reduce sediment collection on the curb ramp.* Directional curbs are generally constructed in a manner that resemble a shallow v-ditch. Designers must evaluate the geometrics to ensure ponding does not occur locally on the directional curb.

Figure 800-40: Curb Ramp System with a Direction Curb at the Bottom of the Ramp Run

The length of the directional curb varies based on the geometrics of the intersection corner radius. Avoid long directional curb layouts for curb ramps. The directional curb design provides a connection to the travel way and provides a perpendicular grade break at the bottom of the curb ramp run (Ramp run position 1). This grade break helps facilitate design cross slopes that keep the ramp run planar on the surface that is directly adjacent to it. Lengthen the directional curb in areas where pedestrians using mobility devices may need additional space to remain out of the travel way when there is no shoulder. Lengthen directional curbs when ramps runs are steep due to terrain to provide a relatively flat area for ascent or descent. **Grade breaks are required to be set behind the detectable warning surface panels when flares are constructed with a directional curb.** DWS product installation is not constructible over grade breaks or easy over warped surface planes, determining the location of the grade break at the bottom of the ramp run 1 influences your design footprint. Directional curbs can be designed and constructed monolithically with the curb and gutter if a specific detail is provided in the contract plans, placing the cold joint at the bottom of the gutter pan.

The directional curb cross slope cannot exceed the gutter flow slope requirement at the intersection, see the Gutter Flow Slope and Inlets subsection. Remember, there are three possible intersection control types that determine the acceptable gutter flow slope. In some cases, the directional curb may have a warped cross slope designed. When warping is required, use the same technique to measure the warp panel as described for perpendicular ramp runs.

Curb Running Slope

The curb running slope is the surface slope on the top of the curb that is cut thru and depressed to connect to the ramp run, directional curb, gutter pan, or travel way roadway surface. The curb running slope is the slope of the surface perpendicular to the gutter flow line, excluding any gutter pan adjacent to the street. The curb running slope is the grade expressed as a positive or negative measurement with positive slopes toward the street gutter line.

Utilize the DET1752 for designing curb running slopes on the curb ramp system. Curb running slopes provides the “V” section for drainage in most cases. When the curb ramp running slope is opposite of the ramp running slope and it creates a “v channel” at the back of the curbing, it will fail the curb ramp. Water will not drain and it will pond. Avoid designs with reversing curb running slopes from the gutter flow line. These types of designs should be rare and need to incorporate other drainage mitigation measures to ensure the storm water does not enter the walkway or private property.

Design the curb running slope with a slope of 4.0% for most curb ramp configurations to ensure water does not pond or collect debris at the curb ramp entrance/exit. Curb running slopes that are designed with slopes of 1.5% in most curb ramp configurations creates a trapezoidal channel section at the bottom of the entrance/exit of the curb ramp. This results in poor drainage conveyance and sediment collection at the curb ramp. Design the curb running slope with a slope of 1.5% when building a raised crosswalk or for super elevated crosswalks as ponding is not a concern; additional grade breaks are an inconvenience along the pedestrian access route.

When a curb running slope over 4.0% is desired for the site, monolithic curbing and ramp run section is required. Situations when this may be appropriate include travel ways with profile slopes less than 0.5%. Monolithic curbing and ramp runs are occasionally designed for construction. The grade break is located at the gutter line in these circumstances as constructing two design slopes on the ramp run and curb running slope is not practical. When curb running slopes are designed over 4.0%, the ramp running slope must be equal and constructed monolithically ensuring there is not any inconsistency in the planar surface of the PAR. **The grade break must be a tangent line and perpendicular to ramp run 1; see Criteria T on the curb ramp design checklist.**

Curb running slope over 8.3% will result in a non-compliant curb ramp system. **Design exceptions for curb running slopes over 7.5% should be rare.** This corresponds to **Criteria B3** on the curb ramp design checklist.

.. Counter Slope

Curb and gutter is a part of the curb ramp system. Many rural locations do not have existing curb in place and will remain rural in character with separation from the travel way realm with for example a grassy sloped surface or ditch. The same basic requirements for counter slope apply to the connection to the crosswalk for the pedestrian access route. Where there is no curb zone, the surfaces adjacent to each other still must be flush and meet the counter slope requirements at the edge of roadway/gutter line.

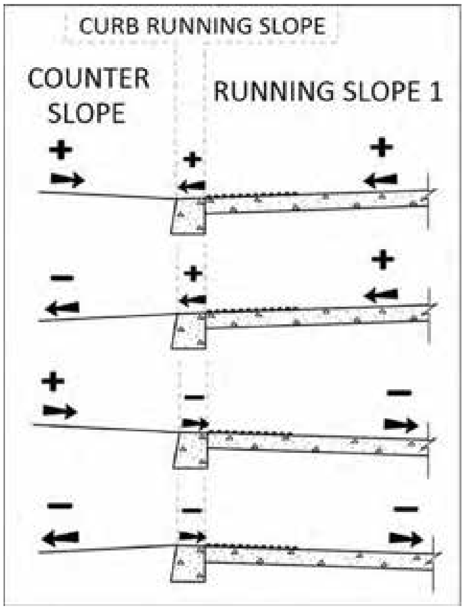
Counter slope is the grade of the street or gutter pan perpendicular to the curb or street edge. Where there is no concrete gutter, measure the counter slope within 2 feet of the curb. Where concrete gutter is present, measure the slope of the concrete gutter pan. Concrete gutter pans may vary in width depending on the curb zone and travel way needs. See discussion on the curb zone in Section 810.2. The measurement will be taken perpendicular to the curb for consistency as the pedestrian path of travel may vary based on the receiving curb ramp location. An unmarked crossing or offset curb ramps at the crosswalk will make it impossible to determine the exact path of travel of a pedestrian. In most cases, it is presumed mobility devices will approach the entrance perpendicular to the grade break at the curb.

On projects where construction only encompasses curb ramps retrofits and remediation, pavement reconstruction is limited to the surrounding area of the curb ramp, in most cases. In that circumstance, the adjacent surface slope for the pedestrian access route/street crossing cannot reduce existing accessibility performance. **The road cross slope of the highway street crossing (counter slope adjacent to the gutter pan) is to be no steeper than 5.0%, except when existing conditions on the roadway already exceed that slope.**

Note, that slope differential calculations may be relevant information when requesting a design exception for counter slope **Criteria E** on the curb ramp design exception to determine the functionality and usability of the PAR.

The positive slope convention is based on a typical curb ramp system that conveys storm water at the gutter line in a “V” section. A “V” section occurs when the counter slope, the curb running slope, and the ramp running slope are configured to collect water with the gutter line as the lowest elevation point. Slope conventions are determined from the gutter line. There is a positive or negative sign convention for slopes. Sloping towards (+) the gutter line is positive. Sloping away (-) from the gutter line is negative.

Figure 800-41: Curb Running Slope Convention

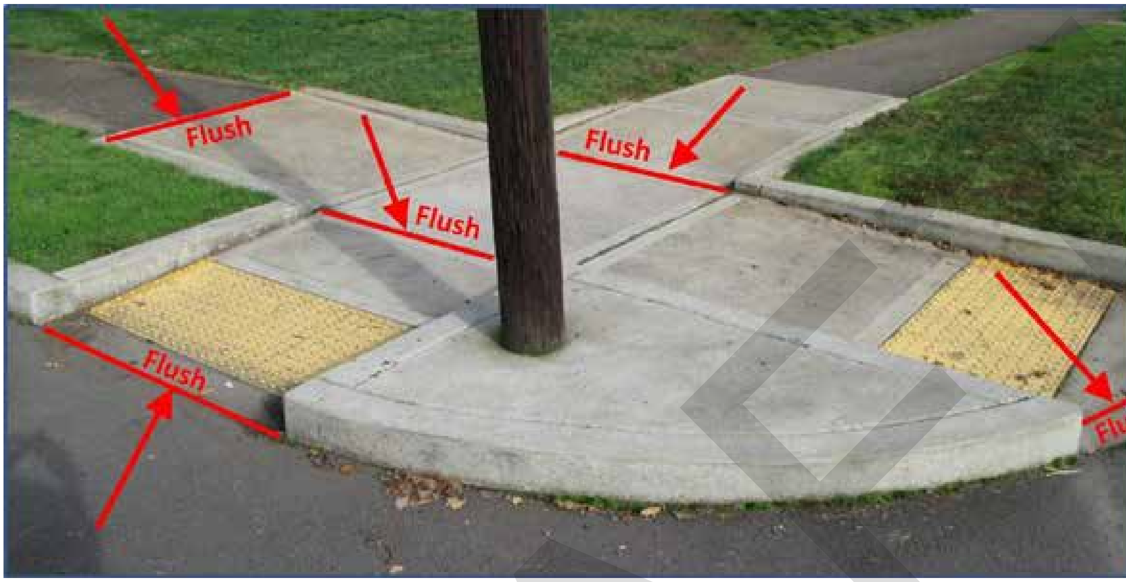


Lips

Flush connections are required at grade breaks along the pedestrian access route and pedestrian circulation areas. Lip height is the vertical difference between two adjacent surfaces, measured within the curb ramp proximity limits. **Curbs for vehicles are a vertical differences of 4 inches or more (See Part 300, Section 308 for curb types).** A "lip" is a vertical discontinuity along the pedestrian access route , walkway, or pedestrian circulation areas. The lip heights are recorded when the surface slopes that meet at a grade break are not flush. Lips can occur as a result from many causes including differential settlement of the concrete panel, where two different surfaces meet, and with poor construction methods.

Lips can be anywhere within the curb ramp system proximity limits that includes ramp runs, level areas, turn spaces, and transition panels on the sidewalk. Note that at grade breaks, the surface is designed to be flush. Grade breaks occurs when there are two different slopes on two different planes that intersect each other.

Figure 800-42: Possible areas where lips may occur



Curb returns have a varying height in the buffer zone adjacent to ramp runs when the buffer zone is not intended to be a part of the pedestrian circulation area. If not properly designed, the curbing would be considered an unexpected “drop off” in the pedestrian path of travel or circulation area.

Flares

Flares are a hard walkable surface that transitions the sidewalk down to the curb ramp opening adjacent to the pedestrian access route. **Curb ramp flares are part of the pedestrian circulation area and shall not have vertical discontinuities or lips.** When present, flares provide a hard surface and increase the pedestrian circulation area for individuals to stand on when waiting to cross the street. Objects such as signs, poles, utility valves and fire hydrants may be installed on a traversable flare. These types of objects are permitted to reside within the flared surface. They do not prohibit a pedestrian from walking across the flare. Flares provide a transitional surface for snow plowing or street sweeping operations when the curbing is obscured. *Flares may be constructed adjacent to a curb ramp run next to the buffer zone when it consists of softscape materials.*

All flare slopes (both traversable and non-traversable) are measured and cannot exceed 10.0% grade under the ADA. This corresponds to **Criteria G1** on the curb ramp checklist. *Design flares with slopes in the range of 9.0% - 9.5% as the upper limit. Flares may be designed within the range of 0.0 to 9.5%.* Measure the flare slope on top of the curb and along the first foot parallel to the curb zone.

Look for lips or vertical discontinuities where the surface of the curb and flare panel meet. ODOT construction practices do not typically call out monolithic construction of curb ramps with the curbing, so top of curbs and flare panels are inspected because they are typically two separate concrete pours. They should be flush at finish construction.

Traversable surfaces are hard surfaces that a pedestrian can walk on and could be constructed as accessible routes. Non-traversable surfaces are not suitable for mobility devices to travel over. Refer to the definition of hardscaping and softscaping to describe the adjacent surface installed or constructed next to a curb return or flare in the curb ramp system. Surface types that might be constructed adjacent to a flare could include but are not limited to loose round durable rock, brick, grass or native seed, asphalt, colored concrete, or planted areas with bark dust.

Curb returns may be used in lieu of a flare if designed appropriately to convey to all users that the area adjacent is not a walkable surface. When a curb return is designed the best practice is to utilize softscape landscape treatments. This corresponds to **Criteria G2** on the curb ramp checklist. Non walkable materials such as bark, wood chips, loose round durable rock,sod and planted areas provide information to the pedestrian that this is not their area to walk on and is a part of the buffer zone; routing the pedestrian along the pedestrian zone and pedestrian access route.

Fixed objects are not desirable in the curb ramp system as this falls within the clear zone for errant vehicles is open sight lines improves pedestrian visibility. *Engineering judgement must be used to determine what fixed objects are utilized in lieu of softscape materials to keep pedestrians walking along the designed, planned, or intended path of travel or PAR.* Fixed street furniture including fencing, railings, and clusters of vertical object such as fire hydrants, signs, and utility poles may be sufficient to deter pedestrian travel over the curb return. Gaps between vertical objects exceeding 24-30 inches can be perceived as a clear opening to continue along their path, and may lead low vision and blind travelers to a sudden unexpected drop at the curb return. The top of the ramp runs when a curb return is planned needs to be delineated as this is where the lip and drop begins in the pedestrian circulation area.

Provide at least 1 foot of constant height curb exposure (reveal) between adjacent flares on curb ramp systems. The minimum curb reveal is 3 inches. This corresponds to **Criteria N** on the curb ramp design checklist. *Recommend design value is 15inches, to ensure 1 feet of separation is achieved during final construction.* This corresponds to **Criteria G3**. **The minimum reveal height or exposure shall be at least 3 inches.** The area provides multiple functions at the intersection including:

- hydraulic drainage conveyance
- pedestrian detectability with a white cane
- visual distinction between the curb ramps
- edge delineation for vehicles turning at the intersection.

.. Turn Spaces and Level Landings

Turn space is an area to allow mobility devices to change direction along the curb ramp or in the PAR, which are designed to be level. Level landings offer a place to rest without the fear of rolling. **Both features are designed with cross slopes 1.5% perpendicular to each other in both directions of pedestrian travel.** This corresponds to **Criteria J1**. **Turn spaces are required to access public building entrances (Section on building ramp design).**

Provide a turn space and level landing at least 4.5 wide and 5.5 feet deep full width in the crosswalk direction in curb ramp design. An obstruction maybe but is not limited to a vertical object such as a curb at the back of sidewalk, signal equipment foundation that is not flush, sign, building, or pedestrian railing. This corresponds to **Criteria J3**.

Provide at least 4.5 ft. wide by 4.5 ft. deep full width of the curb ramp when a turn space and level landing is not obstructed, but has a flush surface adjacent constructed. The flush surface is typically embankment material and at least 1 foot deep, see RD700s. This corresponds to **Criteria J2** on the curb ramp design checklist.

Wheel contact points for a typical power assisted wheelchair comprises of at least a 48 inch circle on a zero turn device (meaning the device pivots about a single point when turning). A turn space cannot be too large for mobility devices, as larger areas provide easier operation and accommodate a wider range of mobility devices. Designs with irregularly shaped enlarged turn spaces and level area can aid in the design of curb ramps and facilitate two separate curb ramps at a corner when the space is shared by each curb ramp. See RD900s. *Turn spaces and level area should be free of obstructions when it serves multiple functions and is enlarged to provide access to the pedestrian push button.*

Level landing must be coordinated with the pedestrian push button range height. The vertical range height for the pedestrian activated push button is between 42 and 48 inches from the center of the face of pedestrian push button. This corresponds to **Criteria K2** on the curb ramp design checklist. Coordination with the signal designer is required to ensure both disciplines are meeting the design requirements for ADA and the curb ramp. *Curb ramp details involving a signal require review from the State Traffic Signal Engineer.* Refer to the traffic signal manual as needed, as there are instances when a lower range height is appropriate and requires documentation. This might include a CQCR request or be a signal in an area serving a high population of children. The reach-range height for children is lower when seated in a wheelchair in comparison to typical adult, and ADA provisions and recommendations when designing for accessible features for children are slightly different. Consult the Senior ADA Standards Engineer when designing for specifically for children.

.. Clear Space

Provide each end of a ramp run at the grade break, a 4 ft. by 4 ft. clear space to ensure the turning maneuver can be accommodated along the PAR. Clear space for the pedestrian access route is not required to be level, although as level as practical is desired. **Provide a 4 ft. by 4 ft. clear space at the bottom of the curb ramp that is outside the parallel vehicular path of travel and within the crosswalk.** This corresponds to **Criteria M** on the curb ramp design checklist. When the curb ramp is designed to be directional, ensure the clear space is available within the marked crossing lines. Single diagonal ramps must also provide a clear space free from vehicular traffic. The shoulder or bike lane may be use to provide the clear space. **When there is no roadway shoulder, the radius of the intersection corner must be designed so that the mobility device can turn in the clear space outside of the traveled way of both streets.**

Clear space for activating a pedestrian push button is required to be on a level landing. See **Criteria K** on the curb ramp design checklist. Design the clear space utilizing the wheelchair design vehicle when design the curb ramp in coordination with the pushbutton. **The horizontal reach distance is not to exceed 10 inches from the center of the pushbutton face along the 4 foot edge of the wheelchair design vehicle.** This corresponds to **Criteria K** on the curb ramp design checklist. The level clear space size varies based on the design for accessing the pedestrian push button as follows:

> Criteria L1: **If wheelchair back-in/head-in maneuver is required, provide 3' x 4' clear space of prepared surface. If wheelchair back-in/head-in maneuver is NOT required, provide 2.5' x 4' clear space of prepared surface.**
>
> Criteria L2: **1.5% maximum design slope in both directions on prepared surface.** Note: Reach and height criteria originate from nearest prepared surface. These may include turning space, sidewalk, paved shoulder or ramp run.

815.5 Curb Ramp Details in Contracts [RD17-02(B)]

More content later, refer to current Technical Bulletin or the ODOT Roadway CAD Drafters Manual

815.6 Curb Ramp Inventory and Inspection

More content later, refer to the ODOT ADA Curb Ramp and Push Button Field Guide and the certification training materials.

Section 820 Building Ramps

"Public entrances" include all entrances except those that are restricted or that are used exclusively as service entrances under the ADA.[6] **Public entrances are required to be accessible.** Building ramps serve as the connection to the walkway when there is an elevation difference with the public entrance. **Directional signs with the international symbol of accessibility are required to be posted at each inaccessible public entrance.** [7]

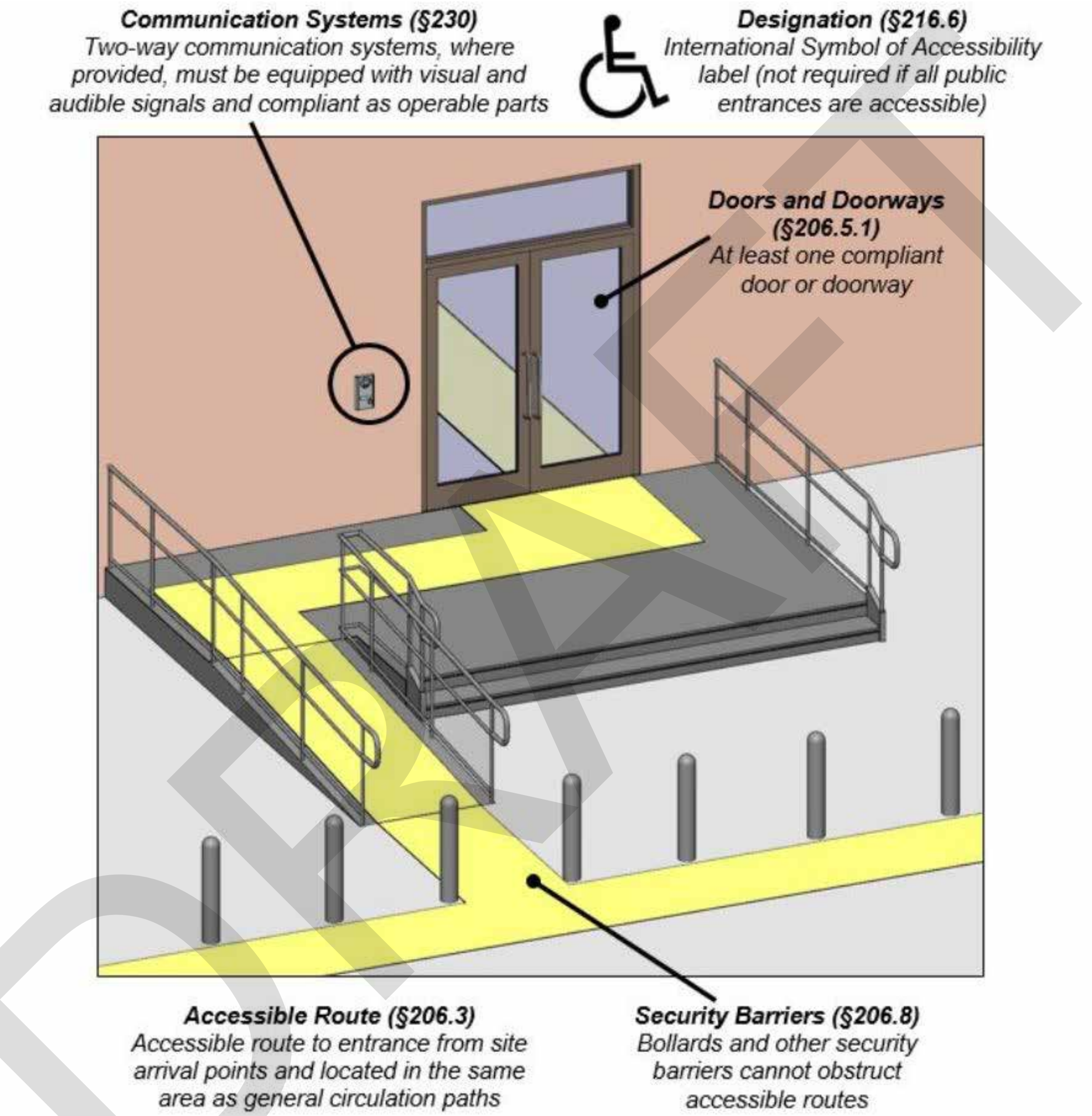
Building ramps have design requirements under the ADA. Building ramps have similar requirement as a curb ramp system. **The cross slope and running slope requirements are the same as curb ramps.** See discussion in Section 815. **Flush connections are required at grade breaks, and grade breaks are to be perpendicular the ramp run. Level turning areas and landings are required at the top of building ramps or when any change in direction occurs.**

Turning and landing areas are designed at least 62 inches square to accommodate a variety of door opening operations and maneuvering clearance, in addition to the space needed to change directions with the handrail obstruction. When space is constrained consult the local building code division for applicable state and local ordinances, and seek advisement from the Sr. ADA Standards Engineer. Documentation for design exceptions on building ramps is captured on the general design exception form to document any ADA exceptions.

6 Section 206.4 2010 ADA Standards

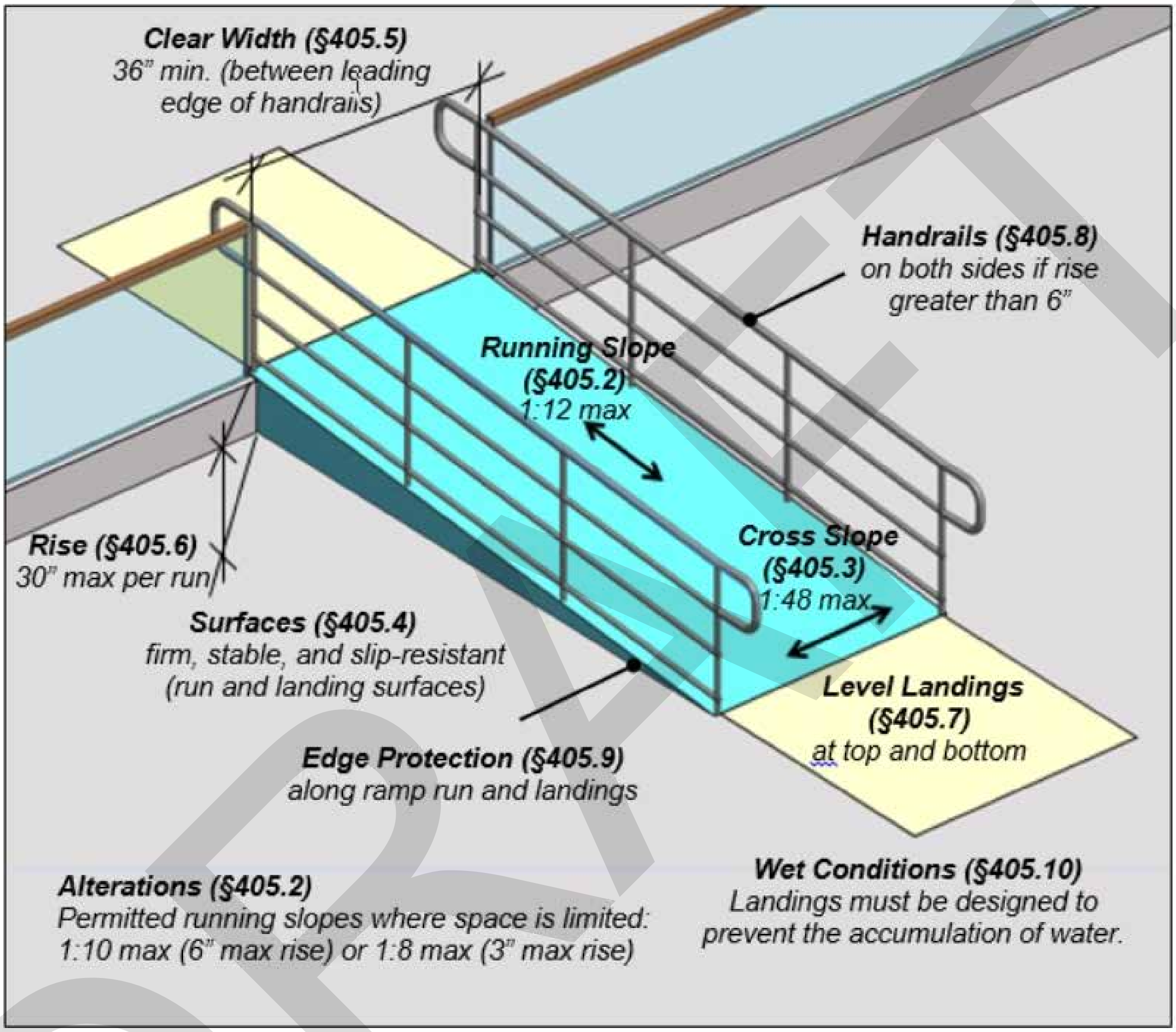
7 Directional Signs an Inaccessible Entrances, see regulation section 216.6

Figure 800-43: ADA building ramps accessible routes illustration, source US Access Board



Handrail is used for pedestrian access routes meeting the ADA requirements along a pedestrian access route to navigate elevation changes on a building ramp. **ADA requires that building ramps with a rise greater than 6 inches include handrail.** Details are provided in RD770 &RD771 for handrails. RD770 handrail is sufficient for these conditions.

Figure 800-44: ADA Building Ramps Illustration, Source US Access Board and CFR



Section 825 Tactile Walking Surface Indicators

More content later. See Section 805.

825.1 Detectable Warning Surfaces

Section reserved for future content. See Section 805, Section 815, Section 830, Section 840, and Section 845.

825.2 Detectable Guide Strips

Section reserved for future content.

Section 830 Crosswalks and Crossings

Sidewalks provide mobility along the highway for transportation, but full pedestrian accommodation also requires frequent, safe and convenient crossing opportunities. Wide highways carrying large traffic volumes can be barriers to pedestrians, making facilities on the other side difficult to access. Crossing opportunities are not limited to marked crosswalks and signals; many other design elements can enhance the pedestrian's ability to cross a highway.

Most pedestrian crashes occur when a pedestrian crosses a road, often at locations other than controlled intersections. Mid-block and uncontrolled intersection crossings need to be considered, as people will take the shortest route to their destination. Prohibiting such movements is counter-productive if pedestrians cross the road with no protection. It is better to design highways that enable pedestrians to cross safely.

Developed, urban state highways should provide a safe and convenient pedestrian crossing no less frequent than every quarter-mile. Crossing improvements should be no closer than 300 feet from the nearest signalized crosswalk. Planning documents may also help identify potential locations for crossings. Note that crossing locations must take into account property access and circulation.

Safe and convenient pedestrian crossings cannot be considered in isolation from the following issues, which should be addressed when seeking solutions to specific problems. Chapter 5 of Appendix L describes each of the following issues in detail.

1. Volume to Capacity (V/C) and Design Standards (Appendix L, page 5-3)
2. Land Use (Appendix L, page 5-4)
3. Transit Stops (Appendix L, page 5-4)
4. Signal Spacing (Appendix L, page 5-4)
5. Access Management (Appendix L, page 5-5)
6. Out-of-Direction Travel (Appendix L, page 5-6)
7. Midblock versus Intersection Crossings (Appendix L, page 5-6)
8. Maintenance (Appendix L, page 5-7)

No one solution is applicable in all situations as the issues will vary on any given section of highway. In most cases, it is best to combine measures to improve pedestrian crossing opportunities and safety. Note that some crossing treatments and curb extensions can trigger freight mobility concerns described in Appendix C.

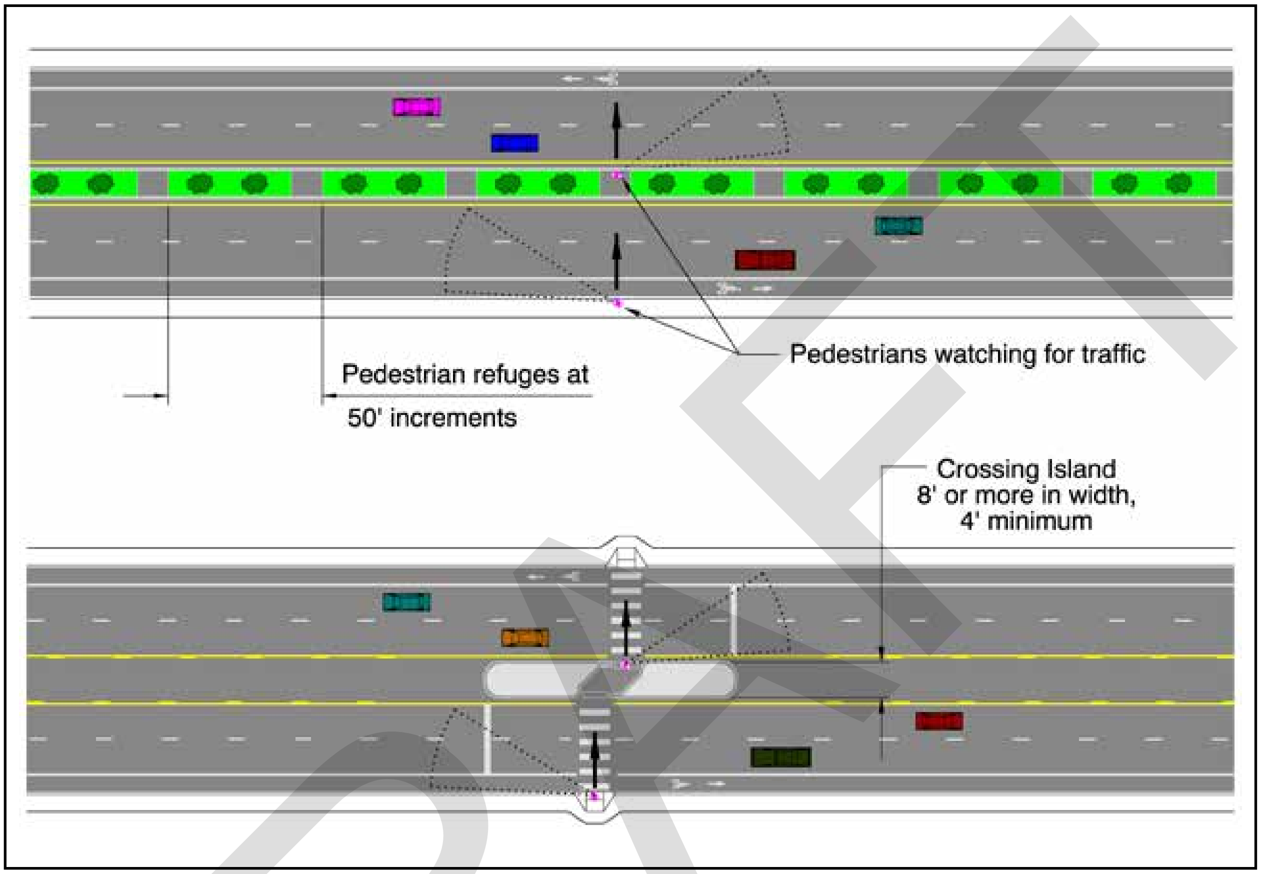
830.1 Raised Median Design and Crossing Islands

Raised medians are a solution in locations where pedestrian crossings are not isolated to a single location and crosswalks are not marked. Raised medians benefit pedestrians on two-way, multi-lane streets, as they allow pedestrians to cross only one direction of uncontrolled traffic at a time. Raised medians should be constructed so they provide a pedestrian refuge by ensuring that they have a smooth level surface. On landscaped medians, plants should be low enough so they do not obstruct visibility, and spaced far enough apart to allow passage by pedestrians. Flat, paved areas can be provided approximately every 50 feet to provide a place to stand and wait (see Figure 800-45).

Where it is not possible to provide a continuous raised median, crossing islands can be created between controlled intersections. These should be located across from high pedestrian generators such as schools, park entrances, senior and disabled residential facilities, libraries, parking lots, etc. An island can also be provided in the middle of an intersection. An island should be at least 4.0 feet wide, preferably more, especially if bicycles are accommodated to be considered useable by pedestrians. See Section 831 for bicycle crossing accommodation. Provide truncated domes in the cut-through if the cut-through length can provide 2 foot of separation between truncated dome panels. The cut-through area may be angled up to 45 degrees to position pedestrians to face oncoming traffic.

The length of an island should be at least 6-feet parallel to the traveled way. It is preferable to extend 30 feet to the advance stop bar. Islands must be large enough to provide refuge for several pedestrians waiting at once. For wheelchair accessibility, it is preferable to provide at-grade connections rather than curb ramps. Poles must be mounted away from curb ramps and out of the pedestrian path.

Figure 800-45: Continuous Raised Median versus Cut-Through Crossing Island



Two stage crossings must be designed wide enough so that users are out of the traveled way. It must accommodate mobility devices which can be up to 60 inches long, and provide detectable warning surfaces (DWS) for low vision users (See RD700's). A fully accessible two stage crossing pedestrian refuge with curbing is typically at least 7.5 feet wide including the curb and construction margins for DWS panel construction. Narrower widths of 6.5 feet can meet the ADA needs if the island design is surface mounted into the roadway (allowing 3 inches for construction errors on each side of the DWS). See DET 1771 for typical midblock RRFB construction requirements.

At wide intersections, there is often a triangular area between the through lanes and right turn lane that is not used by motor vehicle traffic. Placing a raised island in this area benefits pedestrians by:

1. Allowing pedestrians to cross fewer lanes at a time, and to judge conflicts separately;
2. Providing a refuge so that slower pedestrians can wait for a break in the traffic stream;
3. Reducing the crossing distances (which provides signal timing benefits); and
4. Providing an opportunity to place easily accessible pedestrian push-buttons.

5. Simplifying signalization where the right turn lane can be left unsignalized.

830.2 Curb Extensions

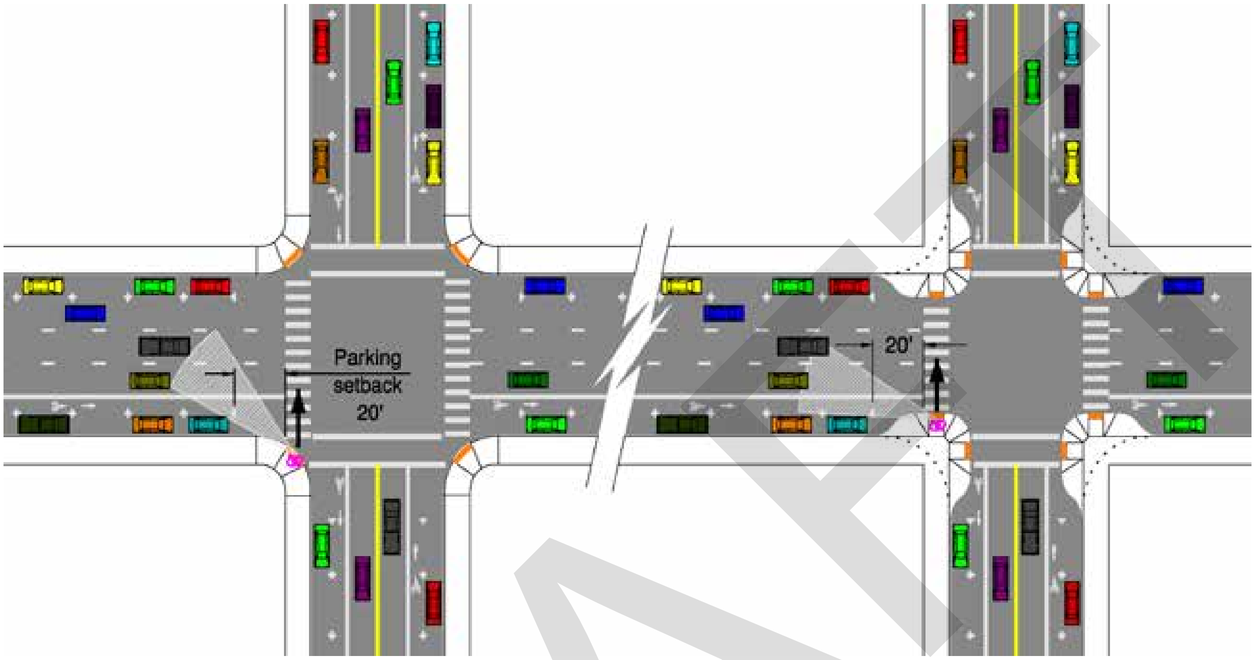
Curb extensions are used in conjunction with on-street parking or wide shoulders. Mid-block curb extensions may be considered where pedestrians frequently cross between midblock generators on both sides of the road. Where parking is not marked in the shoulder, curb extensions enforce the ORS 811.550(17) restrictions which prohibit parked vehicles 20 feet from the crosswalk line.

Curb extensions provide many benefits to the pedestrian and use of the public right of way. Curb extensions can also provide a traffic calming effect, enhance the visual character of the community, and provide increased pedestrian circulation area at the crosswalk. Specific design considerations for the curb extension include street sweeping operations, snow removal operations, large truck off tracking and capturing storm water with drainage design. Curb extensions reduce the pedestrian exposed crossing distance by extending the walkway towards into the transition realm. Curb extensions improve the visibility of pedestrians for motorists. They provide a place for pedestrians to congregate while waiting to cross the street when the pedestrian volumes are large. Curb extensions increases the space available to provide a curb ramp and meet the ADA geometric requirements. Refer to Section 815 for more guidance.

When curb extensions aren't viable due to the need to accommodate larger semi-trucks, a truck aprons have a similar effect for delineating passenger car travel paths. The benefits to the pedestrian are significantly reduced. See Section 830.3 on truck apron design.

Curb extensions can improve signal head alignment and stop sign placement. Reducing pedestrian crossing distance improves signal timing if the pedestrian phase controls the minimum green time for the corresponding signal phase. The time saved is substantial when two corners can be treated with curb extensions. Non-signalized intersections also benefit from curb extensions: reducing the time pedestrians are in a crosswalk improves pedestrian safety and vehicle movement.

Figure 800-46: Sight Lines with Curb Extensions



830.3 Truck Aprons

Truck aprons are designed for occasional large semi-truck to traverse when negotiating an intersection corner. Right turns are typically where large vehicles off track when the radius is not sufficiently sized. Truck aprons delineate the passenger car vehicular travel path most effectively when the truck apron has slight slope, low profile mountable curbing and contrasting pavement markings to discourage use. ADA requires that the pedestrian access route slope requirements is maintained for the crosswalk including the truck apron (See RD100's). **Detectable warning surfaces are installed where the pedestrian enters into the traveled way at the crosswalk at the edge of the walkway (See RD900s).** Truck aprons are not a place for pedestrians to wait to cross the street. See discussion in Section 800 for blended transition curb ramp configurations.

830.4 Marked Crosswalks

All legs of signalized intersections should have a marked crosswalk. Crosswalks may also be considered at other locations. Combined with curb extensions, illumination and signage, marked crosswalks can improve the visibility of pedestrian crossings. Crosswalks send the message to motorists that they are encroaching on a pedestrian area. A traffic study will determine if a marked crosswalk will enhance pedestrian safety. This is usually in locations that are likely to receive high use, based on adjacent land use. Refer to the ODOT Traffic Manual for further details on marking crosswalks.

Crosswalks are typically 10 feet wide, or the width of the approaching walkway if it is greater. Consider high visibility crosswalks to increase their effectiveness.

Textured crossings, using non-slip bricks or pavers, are generally not recommended. They give the initial impression that the visibility of the crosswalk is enhanced, but after time they fade and are barely distinguishable from the roadway surface. The inherent roughness also makes them difficult for wheelchair users, and often does not meet the PAR surface requirements.

830.5 Enhanced Crosswalks and Crossings

For a thorough and detailed discussion on intersection design, see Chapter 8. The following discussion will help the designer understand some of the key intersection design features that help enhance the safety and convenience of pedestrians and bicyclists.

Most conflicts between roadway users occur at intersections, where one group of travelers crosses the path of others. Good intersection design clearly identifies right of way between motorists, pedestrians and bicyclists.

At signalized intersections, pedestrian signal heads should be clearly visible - this requires that they not be placed too far from the nearest safe refuge. Crossing islands and curb extensions should be used to decrease crossing distances. Bicycle lanes should not be placed to the right of a right-turn only lane or to the left of a left-turn only lane, unless conflicting movements are controlled by a traffic control signal. Other intersection design principles for pedestrians and bicyclists are discussed in detail in Part 200, Section 224.1 and in Appendix L, pages 6-1 and 6-5.

Conflicts between motor vehicles, pedestrians and bicyclists often occur at interchange areas. Free-flow ramps should be avoided. Where they exist, "Turning Vehicles Yield to Peds" symbol sign may be considered for unprotected pedestrian crossings. Consider grade separation when there is either two-lane right or left turn lanes or where free flow ramps are utilized. Other interchange design principles for pedestrians and bicyclists are discussed in detail in Appendix L, pages 6-20 to 6-25.

.. Illumination

Providing adequate illumination is essential to increase nighttime safety, especially at mid-block or uncontrolled crossings which are often not expected by motorists. Guidance for illumination at pedestrian crossings is given in Appendix L (pages 5-12 to 5-13), the ODOT

Traffic Manual (Section 310.3), the ODOT Traffic Lighting Design Manual, the IESNA Lighting Handbook (Tables 2 and 3), and the Federal Highway Administration report FHWA-HRT-08-053.

Signing

Review the Traffic Manual and MUTCD for advance warning recommendations. Signs might include advance warning signs, pedestrian crossing signs at the crossing itself, or regulatory signs at intersections to reinforce the message that motorists must yield to pedestrians. Excessive signage leads to signs being missed or ignored by drivers. These signs should only be placed at warranted locations.

Pedestrian Signals, Rectangular Rapid Flashing Beacons, and Hybrid Beacons

A pedestrian activated signal may be warranted where a significant number of people are expected to cross a roadway at a particular location. Anticipated use must be high enough for motorists to get used to stopping frequently for a red light (a light that is rarely activated may be ignored when in use). Additionally, sight-distance must be adequate to ensure that motorists will see the light in time to stop. Warning signs should be installed on the approaching roadway.

Refer to the Manual on Uniform Traffic Control Devices (MUTCD) for pedestrian signal warrants. Pedestrian signals may be combined with curb extensions, raised medians and refuges.

Crosswalks alone do not reliably warn drivers to stop for pedestrians on high speed or high volume multilane highways. Pedestrian-activated flashing beacons warn drivers that pedestrians are intending to cross. Examples of pedestrian activated crosswalk beacons include Pedestrian Hybrid Beacons, Rectangular Rapid Flashing Beacons and circular amber flashing beacons. Pedestrian activated crosswalk beacons may be combined with curb extensions, raised medians and refuges. Refer to the ODOT Traffic Manual, Section 310.3 for further details.

Pedestrian activation of a pedestrian traffic control device is required to be accessible to all pedestrians under the ADA. Pedestrian pushbuttons are a service that activates the traffic control device for pedestrian use. The space to activate the push button is required to be clear and free of obstructions, level, free of lips, and of adequate size to approach the push button under the ADA. The hardware installation of the push button must also meet the operable parts requirements under the ADA. Refer to the Traffic Signal Design Manual and the ADA Curb Ramp Design Checklist (ODOT Form No. 734-5184).

Section 835 Bicycle Crossings

Drivers are required to stop for pedestrians in crosswalks, but are not necessarily required to stop for bicyclists. Bicyclists can use crosswalks to cross the street at pedestrian speed. However, most bicyclists ride within crosswalks. Where bicycles are prevalent, such as bicycle boulevards, crossing islands can be designed to serve bicyclists and pedestrians separately. If the crossing island acts as a diverter to through motor vehicle traffic, include a separate opening in the crossing island 6' to 8' in width, or two openings, each 5' wide. The cut-through area may be angled up to 45 degrees to position bicyclists to face oncoming traffic. The desirable island width is 10 feet or greater to accommodate bicycles with trailers or groups of bicycles. The minimum width to accommodate a single bicycle is 6-feet.

See additional discussion for bicycle design in Part 900. Protected bike lanes add complexity to both the pedestrian design of the crosswalk and bicycle facility to ensure both modes use the facility as intended.

Section 840 Pedestrian Rail Crossings

The Federal Rail Administration categorizes pedestrian crossings as either a "pathway" or "station". Practitioners should refer to the MUTCD for pedestrian railroad crossing treatments and provisions and the FHWA Highway-Rail Crossing Handbook, 3rd Edition for further guidance. Review the Federal Railroad Administrations "Engineering Design for Pedestrian Safety at Highway-Rail Grade Crossings "published report July 2016. All rail crossings improvements or alterations are reviewed by the ODOT Commerce and Compliance Division for approval of a Rail Crossing Order. Coordination is required with the Traffic Section for signalized rail crossings.

Light rail vehicles is commonly known as light rail, streetcars, or trolleys and travel at low speeds (25 mph to 35 mph typically). Railroad crossings include conventional rail used for transporting goods and freight. Streetcars operate in the travel lane used by vehicles in the travel way realm.

Walkways crossing a rail are not typically controlled by the automated warning gates/arms; pedestrians cross behind the gate/arm. **Provide a walkway width across the rail tracks at least as wide as the approaching walkway.** *Pedestrian movements should be designed so pedestrians do not wait between a set of tracks where multiple set of rail tracks are installed at a pedestrian railroad crossing.* [8] **At rail crossings equipped with automatic protective devices,**

8 MUTCD Section 8C.13

the traffic control device support shall be at least 5 feet from the nearest walkway edge to the centerline of the rail signal mast.[9] This separation ensures the counter ballast is not in the pedestrian path of travel obstructing the walkway and prevents rail equipment from becoming a protruding object in the walkway.

Provide a walkway horizontal alignment that is as close to a right angle or 90 degrees to the extent practical at the pedestrian rail crossing. When a walkway crosses rail tracks at a skew, people in wheelchairs are usually able to align themselves at a right angle within the width of a 6 foot sidewalk. Some people prefer to cross at a slight angle, so both caster wheels don't hit the tracks at the same time. Curving the entire sidewalk as shown below to cross tracks at 90º is usually unnecessary.

Figure 800-47: Skewed Walkway and Rail Track Crossing

The vertical profile of the pedestrian rail crossing should remain a constant grade for at least 12 feet beyond the outer most rail of the pedestrian rail crossing. The same vertical grade should extend to include the detectable warning surface or stop line when provided. The vertical clearance of a traffic control device over the walkway shall be have a vertical clearance at least 8 feet about the finished surface of the walkway.[10] When the rail crossing is a shared use path, the vertical clearance shall be at least 10 feet. **Flange way gaps in rail at-grade crossings may not exceed 2-1/2-inches wide in the direction of pedestrian travel on light rail vehicle tracks (non-freight) and may not exceed 3-inches wide in the direction of pedestrian travel on railroad tracks (freight) for accessibility.**

9 OAR 741-120-0025

10 MUTCD Section 8D.03

Detectable warnings are installed full width of the walkway. Refer to the RD900's for additional details. *Detectable warnings should be placed immediately in advance of the walkway stop line if present.* Detectable warnings surfaces must be placed in advance of the sidewalk/track interface, to alert pedestrians with vision impairments of the presence of the rail crossing. Place detectable warnings at:

1. **In between range of 12-feet plus 8-inches to 15 feet from the nearest rail track for heavy (freight) rail.**
2. **At least 6-feet from the nearest rail track for light rail.**

This is **Criteria R3** in the curb ramp design checklist. *Tactile warnings surface indicators may be used to delineate the dynamic envelope of railway at pedestrian crosswalks.* Consult the Senior ADA Standards Engineer when the project is planned to incorporate tactile warning surface indicators in for this application for approval.

Where the distance between the centerline of two tracks exceeds 38 feet, additional detectable warning surfaces, designating the limits of a pedestrian refuge in between the set of tracks should be installed.

Active rail devices should be considered at pedestrian rail crossings with high pedestrian volumes, high speed trains, extremely wide pedestrian walkways, complex highway-rail crossing geometry, in school zones, inadequate sight distance of the pedestrian at the rail crossing, or when multiple set of rail tracks are crossed. *Pedestrian automatic gates when provided shall be a placed between 2.5 feet and 4 feet maximum above the walkway. However the height will remain the same as prescribed for the cars when the vehicle crossing arm also crosses the walkway. The width of the automatic pedestrian gate shall provide coverage for the full width of the walkway. When automatic pedestrian gates are installed across a walkway for a rail crossing, providing an emergency egress route should be designed to leave the rail track area.*

Pedestrian rail crossing should be channelized to designated pedestrian rail crossing locations that have been engineered at commuter rail and transit areas. Pedestrian fencing should not exceed 3.5 feet in height when use for pedestrian channelization to retain sight lines and obscuring a pedestrian. Pedestrian barriers/fencing in a maze type configuration may improve pedestrian safety by forcing pedestrians to look at rail traffic before proceeding to cross the rail tracks.

Section 845 Shared Use Paths

Shared use paths serve two purposes; one is providing a basic transportation need to get to destinations and the second is providing a place for recreational activity. When the pathway serves both pedestrians and bicyclists together, it is a shared use path. When pedestrians and bicyclists share a sidewalk, appropriate multi-use or shared path guidelines are employed for the design. Shared use paths are designed to be fully accessible for all users for the entire width of the walkway. Combinations of the words "shared use" and "multi use," are used interchangeably. Shared-use paths are used by pedestrians, joggers, skaters, bicyclists and many others for recreation.

Figure 800-48: Shared Use Path

Paths accommodate many users

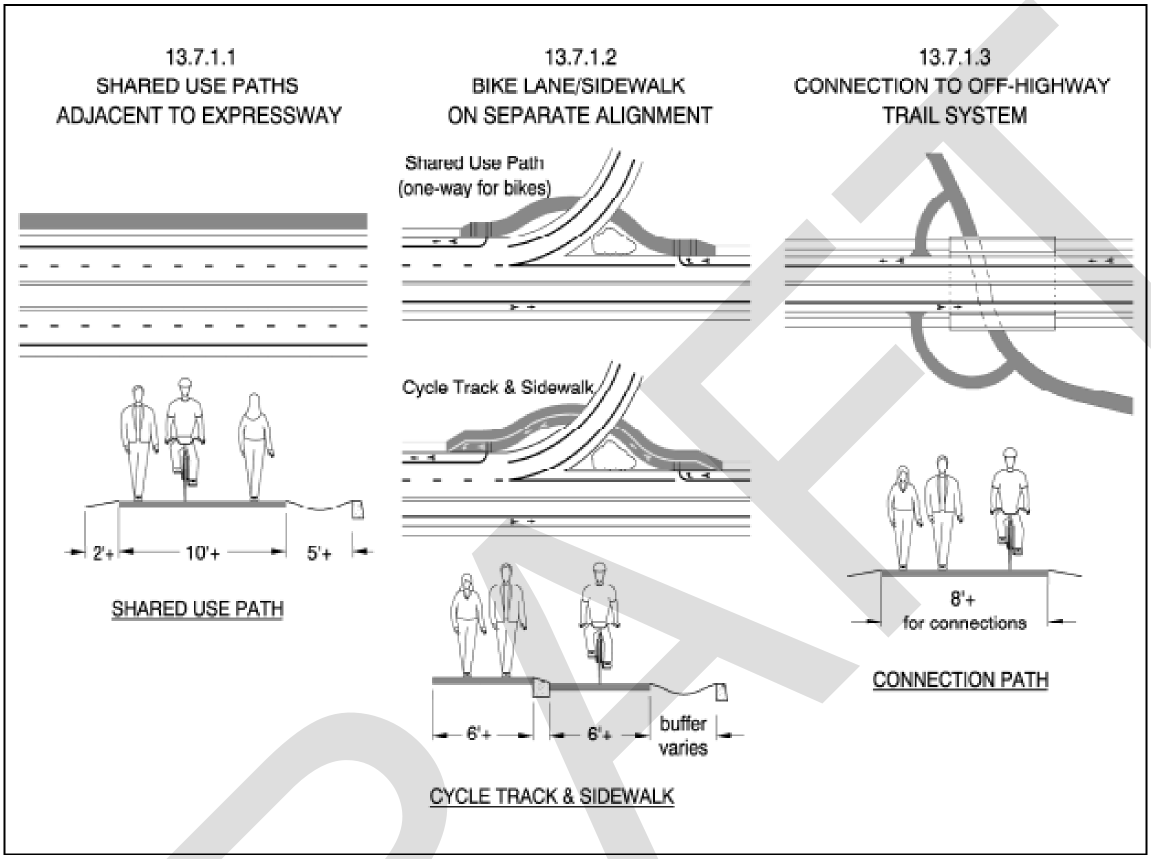
845.1 Shared Use Path Configurations

Shared use paths can parallel the state highway or may diverge on a separate alignment from the mainline onto other public right of way.

Multi-use trails may include accommodation of additional users, such as equestrians (See Section 855).

Separated pathways may be constructed on ODOT facilities in any of the following three contexts:

Figure 800-49: Types of Separated Path



One type of shared use path includes facilities within the highway right-of-way where pedestrians and bicyclists are physically separated from the travel way realm. **A buffer zone with a physical separation of at least 5 feet from the travel realm is required for a shared use path.** Where a path is parallel and adjacent to a roadway, see Section 970.

Where a bicycle lane joins a sidewalk, see Sections 971 and 981.

Where a shared use path is on an independent alignment that may or may not be on public right-of-way, well planned and designed shared use paths can provide access and mobility to pedestrians and bicyclists in areas where the roads do not serve their needs. They can have their own alignment along streams, canals, utility corridors, abandoned or active railroads, and greenways. Many serve as linear parks. Shared Use Paths can serve both utilitarian and recreational cyclists. See also Section 960.

Sections 961 through 968 have design information that apply to all types of shared use paths.

See Chapter 7 of Appendix L for additional information about typical pavement sections, drainage, vegetation, rail requirements, illumination, and structures, preventing motor-vehicle access, bollards and geometric design. In addition to design requirements in this manual, consider guidance in the AASHTO Guide for the Development of Bicycle Facilities for path design.

Path Operational Considerations

Provide a clear width between the range of 10 feet – 12 feet on shared use paths. *10 feet is the standard width for a two-way shared-use path; they should be 12 feet wide or more in areas with high use.* **Provide 8 feet of clear width on a connection paths.** When pinch points occur or where long term usage is expected to be low, 8 feet is the minimum clear width for two way shared use paths through a design exception

When mode separation is desired between pedestrians and bicyclist, additional width is required. **Provide a clear width between 16 feet and 20 feet for mode separated facilities.** *Provide at least 16 feet of clear width comprising of two 5-foot bike lanes and a 6-foot walking area (pedestrian zone). Provide 18 or 20 feet in areas of very high use.* While mode separation is provided typically with striping, low vision and blind pedestrians will need additional tactile cues (TWSI) to guide them to the intended area along the path. The entire width of the facility must still meet ADA cross slope and running slope (grade) requirements. Expect pedestrians to cross over and meander over the entire area, mode separation is best achieved with some grade separation via curb (Refer to Section 900s).

At roundabouts, the walkways become shared use paths, as they operate one-way for bicyclists and two-way for pedestrians. Widen the shared use path width to 10 feet. **Provide at least 8 feet of clear width on a bike ramp to allow bicyclists to merge from the bike lane onto the shared use path 165 feet in advance of the yield line to the circulatory roadway of a roundabout.** See section 8.6 and Appendix L, Figure 1-40.

Parallel to Highway

Combining pedestrians and bicyclists together along one side of a highway on a shared use path, is discouraged on highways without access control, but is a preferred facility option for limited access expressways and urban freeways. Crash potential increases when bicycle traffic rides against the normal flow (reverses flow) of motor vehicle traffic on highways with frequent driveway or street access. Since expressways are designed for access-restriction, many of the conflicts are mitigated. A separated bicycle facility may not be needed when a well-connected network of bicycle facilities parallel to the freeway or expressway provides the same access that bicycle accommodation on the expressway would provide. The wide shoulder would accommodate occasional bicycles as necessary. Guidelines for providing bikeways on parallel routes are given in Section 946.

¨ Roundabout

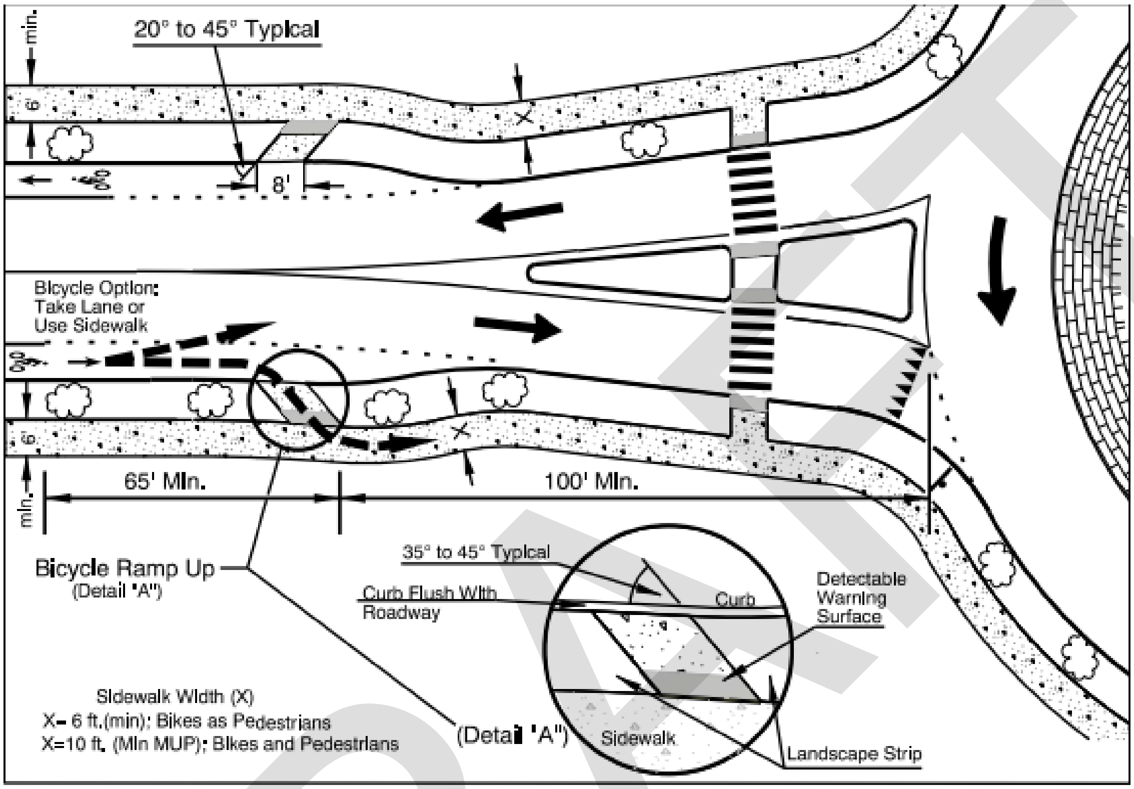
In general, bicyclists will be given a choice to enter a roundabout as a vehicle and occupy a lane until exiting the roundabout, or to use the sidewalks and crosswalks as pedestrians. For these bicyclists, a bike ramp (see Figure 800-50 below) is provided through the curb zone to exit the bike lane on approach to the roundabout and use the walkway and crosswalks in the manner of a pedestrian. This walkway results in a shared use path for a small segment along the central circle. The bike ramp is not required to be fully accessible however many of the geometrics are similar as power assisted mobility devices may travel in the shoulder under the ORS and could enter the shared use path with these sloped ramps. (See Part 900) Bike ramps are not intended for pedestrians and requires additional treatments to communicate to the low vision and blind community it's intended use and function. Bike ramps can be confused with pedestrian curb ramps by vision impaired pedestrians.

Bicycle ramps only serve bicycle traffic. If there is no sidewalk on the approach to a roundabout, the ramp to a path serving the roundabout functions for both bicyclists and pedestrians. Use a pedestrian curb ramp rather than a bicycle ramp in that case.

An important function of bicycle ramps that merge with shared use paths is the interface between people walking and biking. In order to mitigate the potential for sight-impaired pedestrians to inadvertently walk into a bike ramp, a tactile edge detection is needed along the border of the sidewalk or shared use path. One option for a detectable boundary is to use detectable guide strips. See Standard Drawing RD909. A tactical walking surface indicator shall be included adjacent to bicycle ramps (see Section 825.2).

See Section 980 through 983 for more design of bicycle ramps.

Figure 800-50: Bike Curb Cut



845.2 Shared Use Path Design

Sections 961 through 968 describe geometric design standards for sight-distance, horizontal and vertical curves. Additionally, the AASHTO Bike guide should be consulted for geometric design guidelines. Standards applicable to ODOT are summarized in this section. Though shared-use paths are intended for many users, the bicycle is the appropriate design vehicle because of its higher travel speeds. See Section 924.1 for design speeds for pathway segments. If design curve length or sight distance does not meet the value shown in Sections 964 and 965, based on the chosen design speed, consult with ODOT roadway unit in the Region tech center or the headquarters roadway unit to discuss whether a design exception is needed.

Design Exceptions are required for path widths less than 10-feet, or shy distances less than 2 feet **and 1 foot from vertical element such as railings**.

See Chapter 7 of Appendix L for additional information about typical pavement sections, drainage, vegetation, rail requirements, illumination, and structures, preventing motor-vehicle access, bollards and geometric design.

For multiple tread trails that accommodate horses, consult the Equestrian Design Guidebook for Trails, Trailheads and Campgrounds.

Horizontal Alignment

A buffer zone with a physical separation of at least 5 feet from the travel realm is required for a shared use path. Sharp curves should be banked with the high side on the outside of the curve to help bicyclists maintain their balance. The standard design cross-slope is **1.5% (2.0 % finished surface)** to provide drainage, **in a crown section or shed section.** See also Section 965.

Vertical Alignment

When the shared use path is parallel with the mainline alignment and contiguous with the curb zone, the walkway shall not exceed the roadway grade under the ADA. An ADA design exception is required where a vertical grade is steeper than 4.5% (5.0% finished surface) on shared use paths that are not on the same alignments with an adjacent roadway. To meet ADA requirements, the grade of separated shared use path shall not exceed 5.0% See Section 966 for more information. See also Section 966.

Surfacing

The surface material should be packed hard enough to be usable by wheelchairs, strollers and children on bicycles (the roadway should be designed to accommodate more experienced bicyclists). Recycled pavement grindings provide a suitable material. The surface material must be meet ADA surface requirements for the full width of the shared use path.

Refer to Section 810.8 on Walkway Surfacing. Depth of asphalt construction of a walkway is shown in the RD600 series for shared use path pavement details. Shared use paths occasionally need to allow access for maintenance vehicles which will increase the asphalt pavement foundation and final surfacing depths.

Clear Width

The entire width of a shared use path shall be clear of obstructions. Additionally, sidewalks that include bicycle traffic mixed with pedestrian traffic should have feet the sidewalk **clear** width to allow for a minimum width multi-use pathway condition. Clear widths less than 6 feet require a design exception. In locations where bicycle riding on the sidewalk is prohibited by statute, appropriate signage is necessary to inform bicyclists.

Clear Zone

A 2 foot clear zone distance on both sides of a shared-use path is required for safe operation. It is desirable to have 3 feet or more. The clear zone area should be graded level, flush to the path and free of obstructions to allow recovery by errant bicyclists. This applies to cut-sections, where falling debris can accumulate, stimulating weed growth, further restricting the available width.

Vertical Clearance

The standard clearance to overhead obstructions is 10 feet, min. 8 feet where fixed objects or natural terrain prohibit the full 10-ft clearance.

Section 850 Pedestrian Trail Design

More to come, no content for this year. Section Reserved.

Many recreational trails cross the state highway system. Users often use these trail systems as transportation links. Highways that cross these pathways should have access to the trail systems. If a highway has a separate-grade crossing with a pathway, provide a short path connection from the pedestrian and bicycle facilities along the highway to the pathway. See section 13.5 for at-grade path crossings. See Appendix L, pages 7-13 through 7-16 for design guidance on under crossings and over crossings.

A trail is defined as a pedestrian route developed primarily for outdoor recreational purposes. For designing recreational trails in more rural settings, refer to US Access Boards "Accessibility Standards for Federal Outdoor Developed Areas" published May 2014.

Section 855 Emergency Egress Routes

More to come, no content for this year. Section Reserved.

Section 890 References

- Nondiscrimination on the Basis of Disability in State and Local Government Services, 28 CFR Part 35 (2010).

- Department of Justice. (2010). 2010 ADA Standards for Accessible Design.
- Americans with Disabilities Act(ADA) Accessibility Guidelines for Building and Facilities; Architectural Barriers Act(ABA) Accessibility Guidelines, 36 CFR Part 1191, Appendix B and Appendix D.
- Hack, Jennifer (2020). Service Dog Training Guide. Rockridge Press.
- Proposed Public Rights-of-Way Accessibility Guidelines (2011).
- Supplemental Notice Proposed Rulemaking on Public Rights-of-Way Accessibility Guidelines (2013).
- David Kent Ballast Architectural Research Consulting (2011). Dimensional Tolerance in Construction and for Surface Accessibility Research Report for the US Access Board.
- Public Rights-of-Way Access Advisory Committee (PROWAAC) (2007). Special Report: Accessible Public Rights-of-Way Planning and Designing for Alterations.

Part 900 Bikeway Design

Section 901 Introduction

The purpose of this part is to provide design standards for bicycle facilities on State Highways. Other parts address the design of pedestrian facilities, intersections, interchanges, urban design, and public transportation and provide additional and/or similar information on bicycle and pedestrian design considerations. A thorough guide for bicycle and pedestrian design is contained in Appendix L the Oregon Bicycle and Pedestrian Design Guide. Where there is a discrepancy between content in this part and the Bicycle and Pedestrian Design Guide, this part takes precedence. This chapter also stipulates where to refer to portions of Appendix L for additional content since Appendix L also contains design guidance that may only apply to city and county roads.

901.1 Font Key Language

Text within this part is presented in specific fonts that show the required documentation and/or approval if the design does not meet the requirements shown.

Table 900-1: Font Key

Font Key Term	Font	Deviations	Approver
Standard	**Bold text**	Design Exceptions require STRE	STRE or FHWA
Guideline	***Bold Italics text***	Design Decisions Document	Region with Tech Expert input
Option	*Italics Text*	Document decisions	EOR
General Text	Not bold or italics	N/A	N/A

Standard - A statement of required, mandatory, or specifically prohibitive practice regarding a roadway geometric feature or appurtenance. All Standard statements appear in bold type in design parameters. The verb "provide" is typically used. The adjective "required" is typically used in figures to illustrate Standard statements. The verbs "should" and "may" are not used in Standard statements. The adjectives "recommended" and "optional" are only used in Standard statements to describe recommended or optional design features as they relate to required design features. Standard statements are sometimes modified by Options. A design exception is required to modify a Standard. The State Traffic-Roadway Engineer (STRE) gives formal approval, and FHWA approves as required.

Guideline - A statement of recommended practice in typical situations. All Guideline statements appear in bold italicized type in design parameters. The verb "should" is typically used. The adjective "recommended" is typically used in figures to illustrate Guideline statements. The verbs “provide” and “may” are not used in Guideline statements. The adjectives “required” and “optional” are only used in Guideline statements to describe required or optional design features as they relate to recommended design features. Guideline statements are sometimes modified by Options. While a formal design exception is not required, documentation of the decisions made by the Engineer of Record in the Design Decision documentation or other engineering reports is required. Region approval, with input from Technical Experts, is formally recorded via the Design Concurrence Document in the Design Decision portion.

Option - A statement of practice that is a permissive condition and carries no requirement or recommendation. Option statements sometimes contain allowable ranges within a Standard or Guideline statement. All Option statements appear in italic type in design parameters sections. The verb “may” is typically used. The adjective “optional” is typically used in figures to illustrate Option statements. The verbs “shall” and “should” are not used in Option statements. The adjectives “required” and “recommended” are only used in Option statements to describe required or recommended design features as they relate to optional design features. While a formal design exception is not required, documentation of the decisions made by the Engineer of Record in the Design Decision documentation or other engineering reports is best practice.

General Text - Any informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. The remaining text in the manual is general text and may include supporting information, background discussion, commentary, explanations, information about design process or procedures, description of methods, or potential considerations and all other general discussion. General text statements do not include any special text formatting. General text may be used to inform and support design exception requests, particularly where narrative explanations show best practices or methods of design that support the requested design exception.

901.2 Definitions & Acronyms

A list of definitions and acronyms introduced in Part 900 is listed below. Acronyms that are defined in other Parts of the Highway Design Manual are not repeated in this part.

In addition to the terminology used in other parts of the HDM, the following terms are used primarily or exclusively in this chapter. Terms described in this chapter are listed below.

- Bikeway Tier - defined in Section 940
- Bike Bill - defined in Section 912.1
- Bike Ramp - defined in Section 980
- BMX - defined in Section 923.1
- Buffered Bike Lane - defined in Section 945.1

- Critical Transportation Link - defined in Section 930.2
- Floating Bus Stop - defined in Section 984
- Highly Confident Bicyclist - defined in Section 922
- Interested, but Concerned User - defined in Section 922
- Multiway Boulevard - defined in Section 946
- Side Path –defined in Section 901
- Somewhat Confident Bicyclist - defined in Section 922

901.3 Comparison to Other Bikeway Guides

The organization of this chapter corresponds with the chapter outline in the proposed AASHTO Bike Guide, 5th edition.

Table 900-2 Comparison between outline of HDM and AASHTO Bike Guide

HDM Section		HDM Appendix L Bike/Ped Design Guide	Proposed AASHTO Bike Guide	
910's	Design and Regulatory Considerations	Chapter i (introduction)	Chapter 1	Intro & Regulatory Considerations
920's	Design Users, Vehicles	Chapter i (introduction)	Chapter 2,	Design Users, Vehicles
930's	Bikeway Networks	Chapter i (introduction)	Chapter 3	Bikeway Networks
940's	Transition Realm and Zones Bikeway Selection Process	Chapter 1 (Bikeway Types) Chapter 2 (Road Diets)	Chapter 4, Chapter 7	Selection Process Bike Lane Zones
950's	Intersection Design Bikeway Crossing Design	Chapters 5 & 6	Chapter 5, 7, 9, 10, 11	Intersection Design, Bikeway Crossings
960's	Shared Use Paths	Chapter 7 (Separated Paths)	Chapter 6	Shared Use Paths
970's	Sidepaths and Two-way Separated Bike Lanes	Chapter 7 (Separated Paths)	Chapter 7	Side Paths and Separated Bike Lanes
980's	Bicycle Ramp Design Bikes at Transit Stops	Chapter 1	Chapter 5 Chapter 7	Bike Ramps Transit Stops
990's	Parking and Trip End Facilities	Chapter 3	Chapter 16	Parking and Trip End Facilities

Section 910 Design and Regulatory Considerations

There are state and federal statutes, regulations, laws, rules or other high level requirements that must be considered, regardless of project type or funding. These include federal rules and policy, as well as Oregon statutes and planning policy. The federal requirements include code of federal regulations (CFRs) including civil rights laws, policy statements and memoranda from the USDOT, and the Manual on Uniform Traffic Control Devices (MUTCD). Oregon statutory requirements includes ORS 366.514, commonly known as "the Oregon Bicycle Bill". Oregon Administrative Rules include the Oregon Transportation Planning Rule. Planning policy requirements include the Oregon Highway Plan, the Oregon Bicycle and Pedestrian Plan and the Oregon Transportation Safety Action Plan.

Improvements for walking and bicycling can be done under a variety of conditions or project scenarios. Most commonly, improvements are made as part of a construction project. Projects can be administered through ODOT, local public agencies or by private parties, such as a developer. Minor improvements to walking and biking facilities can also be made outside of project scenarios during routine maintenance operations. The requirements for a project are different, based on factors such as funding, which road authority is contracting the project and whether or not any part of the project is located on state owned right-of-way. For each of the different scenarios, ODOT's role may differ slightly, while state and federal requirements are the same. ODOT's process for ensuring ADA compliance is outlined in Chapter 800.

Section 911 Federal Requirements

911.1 Civil Rights Laws

The Americans with Disabilities Act (ADA), the Architectural Barriers Act and the Rehabilitation Act are federal Civil Rights laws. The combination of these laws mandates both the private and public sectors to make their facilities accessible. For ODOT, that means that all provided services must be built so people with mobility, visual or cognitive limitations have access to use them. Facilities for bicycle travel that share the space with pedestrians (i.e. shared use paths) are required to meet pedestrian accessibility standards. Where pedestrian travel is provided apart from bicycle travel, these ADA requirements for pedestrian facilities (e.g. slopes) do not apply to the bicycle facility. However, the ADA still requires consideration to be provided for the needs of all people who use the bicycle facility. Many people with disabilities ride bicycles, adaptive bicycles and adult tricycles. General ADA requirements for pedestrian accessibility are described in Part 800. The ADA regulation (28 CFR 35-36) also requires that some projects include pedestrian accessibility improvements in addition to the baseline scope of work. See Part 800 for these requirements. The Oregon Department of Transportation entered into a Settlement Agreement to improve curb ramps, traffic signal pushbuttons and accessible work zones on or along the state highway system. In addition to the work triggered for inclusion in a project, accessibility improvements may be included in a project in order to move toward achieving the scope of improvements in the Settlement Agreement and in ODOT's Strategic Action Plan equity priority goal.

911.2 Federal Funding Regulation

Federal law regarding the administration of federal aid for highways is established in 23 CFR, subchapter G, part 652.5. Included in this regulation is the following policy statement: "The safe accommodation of…bicyclists should be given full consideration during the development of

Federal-aid highway projects, and during the construction of such projects…Where current or anticipated…bicycle traffic presents a potential conflict with motor vehicle traffic, every effort shall be made to minimize the detrimental effects on all highway users who share the facility…where a bridge deck is being replaced… shall be reconstructed so that bicycles can be safely accommodated when it can be done at a reasonable cost. Consultation with local groups of organized bicyclists is to be encouraged in the development of bicycle projects."

In 2010, the United States Department of Transportation issued a policy statement declaring support for going beyond minimum requirements to provide improved pedestrian and bicycle facilities. Their 2010 policy statement said that "every transportation agency… has the responsibility to improve conditions and opportunities for…bicycling and to integrate…bicycling into their transportation systems. Because of the numerous individual and community benefits that…bicycling provide - including health, safety, environmental, transportation, and quality of life - transportation agencies are encouraged to go beyond minimum standards to provide safe and convenient facilities for these modes." This memorandum encouraged road authorities to go beyond accommodation to improving the conditions for people walking and riding bicycles.

The FHWA issued a related memorandum in 2013 suggesting that current design references should be supplemented with various innovative guides and resources "…to help fulfill the aims… to go beyond the minimum requirements, and proactively provide convenient, safe, and context-sensitive facilities that foster increased use by bicyclists…of all ages and abilities." This memorandum affirmed support for design flexibility through the utilization of innovative designs that build upon the flexibility provided by current design standards in order to achieve improved conditions for bicycling.

In 2015, ODOT issued a letter of support that encourages engineers, planners and designers to reference the growing library of resources that help fulfill ODOT's mission "…to provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians…" and "…to be at the forefront of the integration of sustainable intermodal transportation…to help form sustainable solutions to today's ever-increasing intermodal transportation challenges…" A growing list of resources is available from AASHTO, FHWA, NACTO, and ITE.

911.3 Federal Standards

Federal law 23 CFR 655 Subpart F requires that all traffic control devices on public highways be in substantial conformance with the national standard established by the Manual on Uniform Traffic Control Devices (MUTCD). Oregon Administrative Rule OAR 734-020-0005 establishes an Oregon Supplement to the MUTCD that contains approved deviations from the federal manual in order to be in conformance with Oregon laws or other approved reasoning. Other deviations from MUTCD standards are permitted when following FHWA experimentation procedures or interim approvals. Some bikeway facility types are not likely to function effectively unless accompanied with appropriate traffic control measures.

The design standards in Part 900 reflect ODOT's adherence to national and statewide policy and applicable laws that require accommodating bicycle travel and supports going beyond minimum requirements to provide improved facilities.

Section 912 Oregon Statutory Requirements

912.1 "The Bike Bill"

ORS 366.514, known as "The Bike Bill" imposes requirements on projects that include any portion of modernization work. It requires that ODOT, cities and counties provide walkways and bikeways wherever a highway, road or street is being constructed, reconstructed, or relocated.

The terms: New Construction, Reconstruction and Relocation are defined in Section 102. "Being constructed, reconstructed or relocated" usually means that the project is categorized as 4R. However, as ODOT implements performance-based practical design, the purpose and need for a project may target specific modernization improvements without bringing the whole project into the 4R category. Isolated modernization improvements may include any work that constructs, reconstructs or relocates a portion of a highway. For example, a portion of a project can trigger the statutory requirement to provide walking and biking facilities if the improvements include adding a turn lane, through lane, widening a shoulder, or replacing a bridge deck. Significant intersection improvements and realignments such as a roundabout or construction of a new or replaced traffic signal also require pedestrian and biking facilities to be considered and evaluated.

Accommodating context-appropriate walkways and bikeways is required. The burden is on the governing jurisdiction to show the lack of need to provide facilities; the need is legislatively presumed but can be rebutted. The three statutory exemptions are listed below; they say that improvements are not required if:

1. Scarcity of population or other factors indicate an absence of any need;
2. Costs are excessively disproportionate to need or probable use; or
3. Where public safety is compromised.

Providing walkways and bikeways means that the project's scope is required to ensure that people are able to walk and bike on that highway segment. First, determine whether the highway segments in the project currently have complete, context-appropriate pedestrian and bicycle facilities and curb ramps. If so, the statutory requirement is met. If not, provide improvements to the project scope unless one of the statutory exemptions applies. The level of improvement required to be included with a project is related to the project's scope. For example, a project that fully reconstructs a traffic signal might be located where the approach streets do not have walking and biking facilities. The project would be required to ensure that pedestrians and bicyclists are accommodated at the intersection and any approaches within the project limits. It would not be required to address the disconnected biking and walking network up to the intersection, that are outside the project limits.

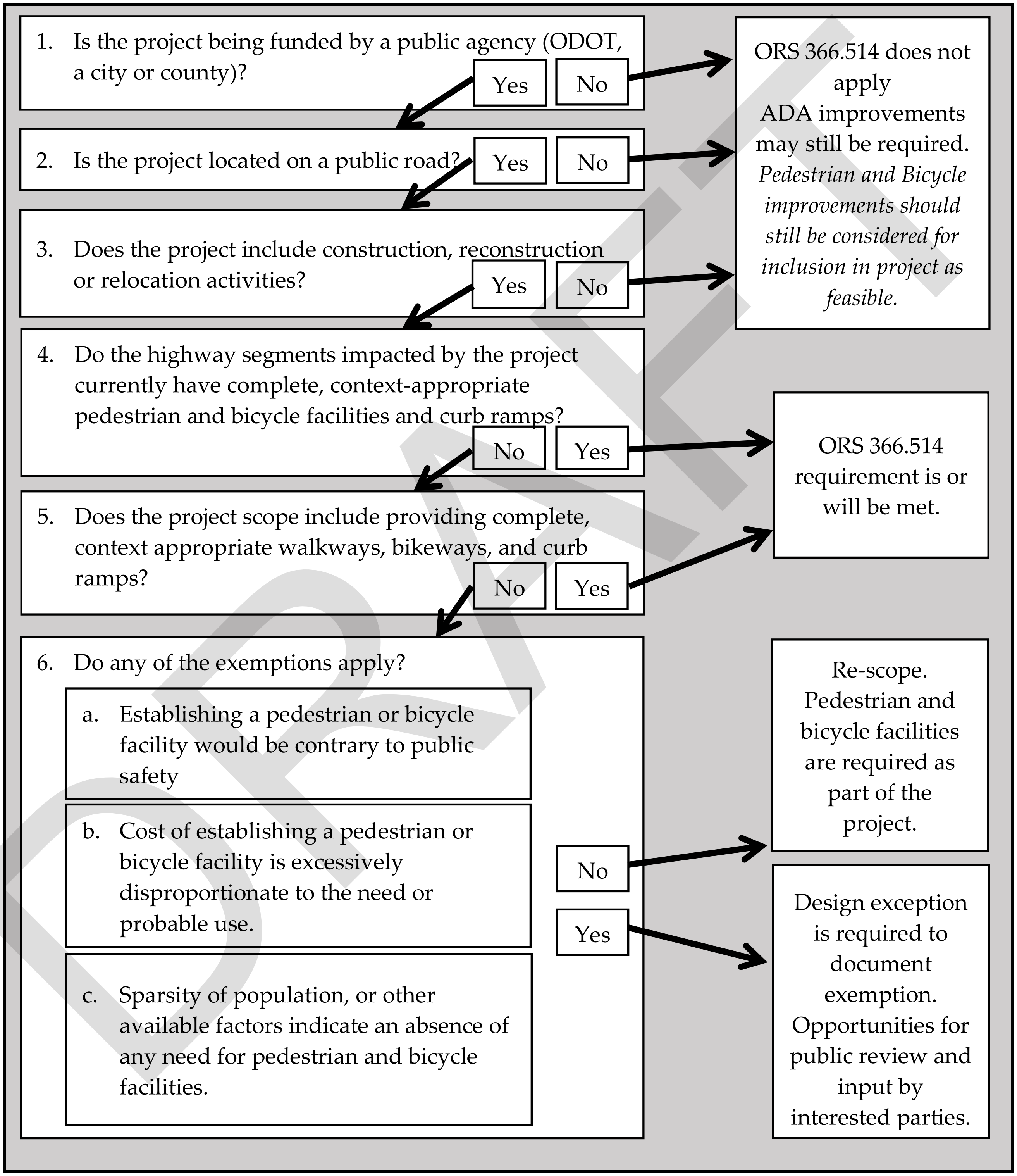
Appropriate walking facilities are generally considered to be present when sidewalk exists on both sides of a highway for urban areas, shoulders in rural areas, paths or a connected network of low-stress local streets parallel to freeways and expressways. Appropriate biking facilities is discussed in Section 901.

Seek an exemption only where it is obvious that one of the three statutory exceptions applies. Also reference planning documents to see if prior efforts have already established that sidewalks or bikeways are needed. The law provides for reasonable exemptions. The determination that one or more exemption is met requires documentation through a design exception. As support for the design exception, a letter is required to ensure that the exemption allowed opportunities for public review and input by interested parties. The letter may come from an organization that represents bicycle and pedestrian needs for the local agency or from the Oregon Bicycle and Pedestrian Advisory Committee (OBPAC). OBPAC is a governor appointed committee, which advises ODOT on the regulation of bicycle and pedestrian traffic, the establishment of bikeways and walkways and other statewide bicycle and pedestrian issues. Review time is needed in order for the bicycle and pedestrian organization to review any proposed exemption.

The statute addresses the source of funds for bicycle and pedestrian improvements. "Out of the funds received…reasonable amounts shall be expended as necessary to provide [walkways and bikeways] as part of the project." The lack of funding from a leveraged funding category does not negate the requirement to include improvements for walking and biking if the project triggers the requirement under the statute.

Figure 900-1 provides a flowchart to help determine when a project requires walking and biking improvements to be included. The ODOT Bicycle and Pedestrian Program Webpage includes additional resources including another, more thorough version of this flowchart[10] with guidance on each step of the process, including legal interpretations for the three exemptions and a section-by-section legal interpretation[2] of the statute.

Figure 900-1: ORS 366.514 Screening Flow Chart



912.2 Transportation Planning Rule

[Note that the Transportation Planning Rule is being amended in 2022. This section will be revised for 2023 update.]

In Oregon, transportation planning is governed by Oregon Administrative Rule 660, Division 12. This is also known as the Transportation Planning Rule (TPR). Excerpts from the TPR are listed below with some commentary:

Part 660-012-0000 identifies the role of bicycle facilities in the planning process: "(1) …The purpose of this division is to direct transportation planning in coordination with land use planning to… (b) Encourage and support the availability of a variety of transportation choices for moving people that balance vehicular use with other transportation modes, including…bicycling…in order to avoid principal reliance upon any one mode of transportation…(c) Provide for safe and convenient...bicycle access and circulation." Thus, transportation planning efforts should be cognizant of the land use around it and examine how transportation networks enable people to realistically use the bicycling network if they choose to avoid relying on automobile travel. This analysis could include the selection of appropriate bicycle facilities within those networks in order to accomplish that goal.

Part 660-012-0020 talks about Transportation System Plans (TSP): "(2) A TSP shall include the following elements…(d) A bicycle…plan for a network of bicycle…routes throughout the planning area. The network and list of facility improvements shall be consistent with the requirements of ORS 366.514…(3)…shall contain…(c) A description of the location of planned facilities, services and major improvements, establishing the general corridor within which the facilities, services or improvements may be sited. This shall include a map showing the general location of proposed transportation improvements, a description of facility parameters such as minimum and maximum road right of way width and the number and size of lanes, and any other additional description that is appropriate." This section suggests that an understanding of the appropriate bicycle facility would be known during the development of a TSP in order for the TSP to include a description of the parameters and a range of dimensions. However, if a completed TSP did not go into detail to evaluate each bicycle facility in the network, the lack of a specified appropriate bikeway type could be a barrier to implementing that bikeway in a project, particularly if the appropriate bikeway dimensions would require acquisition of right-of-way.

Part 660-012-0045 talks specifically about governments implementing TSPs and provides direction about adopting regulations for bicycle travel that include the types of facilities and where they are required. *"(3)(b) On-site facilities shall be provided which accommodate safe and convenient…bicycle access from within new subdivisions, multi-family developments, planned developments, shopping centers, and commercial districts to adjacent residential areas and transit stops, and to neighborhood activity centers within one-half mile of the development…(B) Bikeways shall be required along arterials and major collectors. Sidewalks shall be required along arterials, collectors and* *most local streets in urban areas, except that sidewalks are not required along controlled access roadways, such as freeways;…(c) Where off-site road improvements are otherwise required as a condition of development approval, they shall include facilities accommodating convenient pedestrian and bicycle travel, including bicycle ways along arterials and major collectors; (d) For purposes of subsection (b) "safe and convenient" means bicycle and pedestrian routes, facilities and improvements which: (A) Are reasonably free from hazards, particularly types or levels of automobile traffic which would interfere with or discourage pedestrian or cycle travel for short trips; (B) Provide a reasonably direct route of travel between destinations such as between a transit stop and a store; and (C) Meet travel needs of cyclists and pedestrians considering destination and length of trip; and considering that the optimum trip length of pedestrians is generally 1/4 to 1/2 mile."* This section presumes that the appropriate bikeway uniformly corresponds with the street types (arterial, collector, local) and that the bikeway network should proceed along the same street network with motor vehicles. In describing bicycling facilities as 'safe and convenient', the rule suggests that bikeways are intended to be separated from motor vehicle travel. Another assumption in this section is that trip lengths are only ½-mile, which considers both pedestrian and bicycle modes, but underrepresents trip lengths that bicyclists travel.

Section 913 Statewide Policy

913.1 ODOT Mission Statement

ODOT's mission statement[3] is that "We provide a safe and reliable multimodal transportation system that connects people and helps Oregon's communities and economy thrive". Many ODOT highways operate as the "Main Street" in a community. Business districts with the most comfortable and pleasurable pedestrian walking environments have shown to be the most successful. These include places where people work, shop and live in close proximity so they can walk to destinations. Therefore, comprehensive pedestrian design, rather than basic accommodation should be considered in these contexts. See urban context discussion in Part 200. Bicycle tourism is a significant industry in Oregon that also impacts Oregon's livability and economic prosperity. Comprehensive bicycle facility design, rather than basic accommodation should be considered along designated bicycle routes. Research has also shown that pedestrian and bicycle safety improvements result in improved safety outcomes for all highway users.

913.2 Performance Based Design

ODOT adopted a policy of context sensitive design to establish project scopes that meet specific needs that may omit unrelated improvements in order to systematically prioritize improvements that optimize the transportation system. Practical Design, Context Sensitive

Design and Performance-Based Design have application where ideal conditions do not exist, thus permitting non-standard roadway sections that meet the intent of the design to the maximum extent feasible, often through a design exception.

In order to achieve a transportation system that functions for people to use bicycles for transportation, it is important to provide context-appropriate facilities. When the purpose and need for a project does not include an upgrade to the bicycle facility, an incremental improvement to the bikeway can be considered. The design standards in this chapter reflect ODOT's commitment to the US Department of Transportation policy statements, issued on March 11, 2010 and August 10, 2013, recommending that states accommodate bicyclists and pedestrians while accommodating motorized vehicles and declaring support for going beyond minimum requirements to provide improved pedestrian and bicycle facilities and affirmed support for design flexibility through utilization of innovative designs that build upon the flexibility provided by current design standards in order to achieve improved conditions for walking and bicycling. See discussion in Section 810 and Section 920 for Accommodation and Design for Pedestrians and Bicyclists.

Section 914 Statewide Planning

914.1 Oregon Bicycle & Pedestrian Plan

The Oregon Bicycle and Pedestrian Plan[1] has nine goals, a number of policies within those goals, and a number of planning strategies identified for achieving each of those policies. Many of those policies and strategies pertain to bicycle facility design. The role of strategies in the statewide Bicycle and Pedestrian Plan is intended to be comparable to a should-statement in the MUTCD. Designers should aim to achieve the strategies in the plan or document if it is not attained.

Within Goal 1 (safety), Policy 1.1 has 14 strategies to "provide safe and well-designed streets and highways". The first strategy (1.1A) contains directions for updating the Highway Design Manual: "Continue to update the ODOT Design Guidelines and Highway Design Manual to identify appropriate pedestrian and bicycle design features (e.g. type of separation, buffers, or crossing designs) suitable for different contexts, including consideration of: vehicle speed, roadway characteristics and constraints, planned land uses, users and uses, areas of pedestrian and cyclist priority, and latent demand." Additional strategies include: 1.1B (selecting the roadway cross-section and type of separation), 1.1C (improved illumination), 1.1F (intersection design considerations) and 1.1H (design treatments to control speed). Policy 1.4 is to improve bicycle users' perceived safety.

Within Goal 2 (connectivity), Policy 2.1, Strategy 2.1B says: "When local planning processes have, in consultation with ODOT, identified a local parallel bike route, and a bikeway on the state highway is determined to be contrary to public safety, is disproportionate in cost to the project cost or need, or is not needed as shown by relevant factors and therefore justified to be exempt from ORS 366.514 based on one of those statutory exemptions, ODOT will work with the jurisdictions to support the development of the parallel route and assure reasonable access to destinations along the state highway. ODOT and the local jurisdiction may enter into an agreement in which ODOT helps to fund, in negotiation and partnership with the local jurisdiction, construction of the bikeway in the vicinity of the state highway project that serves as an alternative or parallel route to the highway project." Policy 2.5 says: "Support off roadway…bikeways that help to connect communities, provide alternatives to motorized travel, or promote and support…biking tourism."

Within Goal 3 (mobility and efficiency), Policy 3.3, Strategy 3.3A says: "Research best practices and integrate into design guidelines innovative design treatments that both safely accommodate bicyclists and pedestrians and maintain appropriate freight carrying capacity. Promote opportunities for separation that does not constrain the mobility/accessibility of either mode." Strategy 3.2F says "When an existing roadway is realigned, restriped, or a cross-section modified, pedestrian and bicycle capacity should not be degraded; the width of bike lanes or sidewalks will not measure any smaller than the original width of such facility prior to roadway realigning, restriping, or cross-section modification. Develop an exception and appeal process."

Within Goal 8 (strategic investment), Policy 8.2, Strategy 8.2A gives priorities for identifying investments in bicycle projects. Among the priorities, it says: *"Elaborate the system through increased network connectivity, such as … more costly user comfort features." Strategy 8.2B says: "Be opportunistic in acquiring right-of-way for future potential…bicycle facilities…"* Part of the policy is to strategically improve the statewide bicycle network by addressing those locations where the existing bikeway type underserves the need or is not sufficiently comfortable for potential users to choose to ride under existing conditions. Elaborating the system would be to improve the bikeway type to something appropriate for its context. In many cases, the appropriate facility requires right-of-way and/or extra cost.

In order to achieve the goals stated within the Oregon Bicycle and Pedestrian Plan, an Implementation Work Plan is in place that contains near-term actions in order to put the policies into action. One of the key initiatives identified is "Defining the network" which is summarized: *"Establish design and function expectations. Provide clarity on appropriate infrastructure, design, and treatments given unique contexts. Identify needs."*

914.2 Oregon Highway Plan

The provision of bicycle facilities is addressed in a statewide perspective in statewide planning documents, including the Oregon Highway Plan[5] and the Oregon Bicycle and Pedestrian Plan[1].

The Oregon Highway Plan has two actions related to bicycle facilities: Action 1B.10 "Continue to develop and implement design guidelines for highways that describe a range of automobile, pedestrian, bicycle or transit travel alternatives" and Action 2F.3 "In identifying solutions to traffic safety problems, consider solutions including, but not limited to: Constructing appropriate bicycle and pedestrian facilities including safe and convenient crossings."

914.3 Oregon Transportation Safety Action Plan

The Oregon Transportation Safety Action Plan (TSAP)[7] is a statewide strategic highway safety plan that provides a framework to accomplish a vision to eliminate fatalities and serious injuries by 2035. To achieve that vision, it has six goals and a number of policies and strategies within those goals. A couple of these policies can relate to the selection of bikeway facilities.

Within Goal 2 (infrastructure), Policy 2.3 says: "Plan, design, construct, operate, and maintain the transportation system to achieve healthy and livable communities and eliminate fatalities and serious injuries for all modes." Strategy 2.3.4 says: "Educate transportation planning and design professionals on how to incorporate safer context-sensitive designs into community projects." Since different bicycle facilities may be appropriate in different contexts, this strategy and policy direct the consideration of context-sensitivity in bikeway selection.

Within Goal 3 (Livable Communities), Policy 3.4 says: "Invest in transportation system enhancements that improve safety and perceptions of security for people while traveling in Oregon." Strategy 3.4.1 says: "Enhance perceptions of bicycling, walking, and transit safety and security by identifying and implementing appropriate facility design, lighting, and other changes to the built environment to improve personal security for pedestrians, bicyclists, and transit riders." Thus, the selection of bikeways influences users' perception of safety, and facilities that promote the perception of safety should be selected.

914.4 Transportation System Plan Guidelines

An interactive website[10] helps guide transportation system plans toward needs determination, including a specific application for bicycles. The application has descriptions for actions that shall, should and could be included.

Shall: At a minimum, the assessment of the bicycle infrastructure shall include:

- Identification of the local, regional, and state standards for adequacy
- Evaluation of deficiencies in the bicycle network, including gaps/missing bike lanes, narrow bike lanes, poor surface conditions, roadway hazards, etc.

Should: In addition to the items listed above, the assessment of the bicycle infrastructure should include the following elements when locally appropriate and when funding allows:

- Analysis of bicycle connectivity along key study corridors using one of two methodologies:
  - Conduct a Qualitative Multimodal Assessment of the bicycle network (see ODOT's Analysis and Procedures Manual[1] for technical guidance)
  - Conduct a bicycle level-of-traffic stress analysis of the bicycle network (see ODOT's Analysis and Procedures Manual[1] for technical guidance)
- Evaluation of gaps in bicycle access to destinations including transit stops, schools, shopping, medical, civic, recreational uses, and trails
- Analysis of bicycle crash data and risk-based safety issues (see ODOT's Bicycle Safety Implementation Plan for additional information)
- Evaluation of high bicycle fatality and serious injury crash locations

Could: Although not typically required or critical to the development of most TSPs, the assessment of the bicycle infrastructure could include the following elements when locally appropriate and when funding allows:

- Evaluation of bicycle design standards (e.g. Central Business District, residential standards, etc.)

The TSP Guidelines also have an application for developing solutions. The guidance also details shall, should, and could, and includes many specific bicycle solutions.

Section 920 Design Principles for Bikeways

Bicycle accommodation is required on all highways, except where riding is prohibited by administrative rule described in OAR 734-020-0045. Rules of the road govern how people may use bicycle facilities. See also the Oregon Bicyclist Manual[10]. The following principles discuss how the rules of the road are interrelated to the design of bikeways.

920.1 Right to the road (ORS 814.400)

People have the right to bike on the road as a vehicle. By statute (ORS 814.400), bicycles are vehicles and can use the roadway. This includes electric-assisted bicycles. Bicycles are vehicles and should be accommodated as roadway users where possible. Safe on-street bicycle accommodation includes bicycle-safe drainage grates and adjusting manhole covers to street grade. People riding bicycles are subject to obeying traffic control devices (ORS 811.260, 811.265, 811.360).

920.2 Shared Lane – Keep Right (ORS 814.430)

Notwithstanding the legal right to operate in the road, bicycles cannot operate the same as motor vehicles. Bicyclists are affected by steep grades more than motorists are. Understanding how bicycle riding is affected by grades gives insight as to why people choose to ride how they do. Depending on the grade of a roadway, many bicycles can reach downhill speeds in excess of 30 mph, while uphill speeds can sometimes be comparable to walking speeds. A person riding a bicycle typically uses the momentum gained going downhill to help climb uphill. Thus, it is undesirable to create a stop condition at the bottom of a hill. Ensuring a bicycle's momentum is an important design principle particularly at street crossings. The center of gravity for a person riding a bicycle is often above the bicycle. When going fast, a sudden stop can cause a bicycle rider to lose control and fall over the handlebars. People are more vulnerable in a crash on a bicycle than in a motor vehicle.

Oregon Statute ORS 814.430 affects shared lane conditions. It requires people to ride as close to the curb or edge of roadway of a road if the person cannot ride at the normal speed of traffic. Since the ability for a person on a bike to travel at the normal speed of traffic is affected by the road geometry – this should influence decision on the appropriateness of a shared lane condition.

920.3 Other Users of Bike Lanes (ORS 814.500, 510)

Per ORS 814.500 and ORS 814.510, people with wheelchairs, scooters and other mobility devices may legally use bike lanes. Additionally, the bike lane can be used for a wide range of micro mobility users including segways, scooters, skateboards and roller blades.

Designs should also accommodate bicyclists of lesser abilities. Many individuals prefer to ride away from motor vehicles. Individuals vary in how well they are able to handle their bicycle, their agility, their confidence and comfort with traffic, their decision-making ability in traffic situations, their physical attributes, their familiarity with laws, location, infrastructure and behavior of other road users.

920.4 Use of Pedestrian Facilities (ORS 814.410)

Only in rare cases should bicyclists be required to proceed through intersections as pedestrians. When bicycle users are directed to use a sidewalk – there are operational disadvantages. Oregon law (ORS 814.410) requires bicyclists to yield to all pedestrians on the sidewalk and to ride at the speed of a pedestrian at various locations along the sidewalk including crosswalks, driveways and curb ramps.

Another disadvantage of sidewalk riding is the traffic control at an intersection. For example, if through motor traffic can go straight on a green light, while bikes and pedestrians must push a button and wait for a walk indication – the delay may result in bicyclists using the road.

Many individuals choose to ride on sidewalks, rather than the roadway in order to be further apart from motor vehicle traffic as a sense of safety and comfort. Separated bike lanes can provide the advantages of sidewalk separation, while allowing users to proceed through intersections as vehicles.

When designing bicycle facilities apart from the roadway that are not shared with pedestrians, designate the facility as a separated 'bicycle lane' rather than 'path' in order to ensure that bicyclists are not subject to the operational disadvantages described above.

920.5 Continuity of Bicycle Lanes (ORS 801.155)

Bicycle lanes are defined in ORS 801.155. In addition to the bicycle lane along a street, a bicycle lane also exists in an intersection if the bicycle lane is marked on the opposite sides of the intersection in the same direction of travel. Ensuring that a bike lane exists across an intersection enables bicyclists to ride rather than walk or proceed at the speed of a pedestrian.

The path for bicyclists should be direct, logical and close to the path of motor vehicle traffic, making bicyclist movements visible and predictable to motorists.

Many bicyclists do not limit trips to places within a completed bicycle network. In an incomplete network, where a bicycle facility ends, bicyclists continue the trip in a variety of ways. Where a bicycle facility is not provided, it can be difficult for people driving to know where people on bikes will be. These include riding against traffic on a street, riding on a sidewalk, traveling through property lots and crossing streets at random locations to reach better riding conditions. Connecting gaps in a bikeway network improves the likelihood that people will ride where motorists can expect them and reduces the overall number of conflict points.

A bikeway does not have to be uniform along a corridor. Riders can switch between types of bikeway facilities as long as they are direct and intuitive. When designing for motor vehicles, it can be desirable to maintain a uniform roadway cross section by minimizing changes to the driving environment. In contrast, adding variety to the built environment is desirable to users because bicycling and walking are perceived at human-scale. This includes switching between riding in a bike lane to riding on a shared use path to riding in a shared lane as long as users are able to handle the skill of riding on each of the individual facilities.

920.6 Bike Lane, Bike Path or Bike Trail (ORS 801.160)

While Oregon law has statutory definitions for Bicycle Path (ORS 801.160), Bicycle Lane (ORS 801.155), Bicycle Trail (ORS 366.514(5)) and Sidewalk (ORS 801.485), these statutory definitions do not align with how these terms are commonly used. The Highway Design Manual does not use these terms in the same way as the statutory definitions. This section summarizes the differences in how these terms are used in order to discuss how laws affect people riding bicycles on these facilities.

The statutory definition of a Bicycle Trail is a general term synonymous with the term 'Bikeway' – that means any lane or way designated for use as a bicycle route. The statutory definitions for a Bicycle Path, Bicycle Lane and Sidewalk all define the facility by relating it to the location within or outside of a highway. According to the statutory definition of a Bicycle Path, it is a public way that is not part of a highway. The statute defines a Bicycle Lane as that part of the highway, adjacent to the roadway that is designated for bicycle travel, while a Sidewalk is that portion of a highway between the outside lateral line of the shoulder and the adjacent property line capable of being used by a pedestrian.

Shared Use Paths are not defined in statute. Multi-Use Path and Multi-Use Trail are common synonyms. It is common for shared use paths to exist outside of a highway as well as paths along a highway. A shared use path that is outside of a highway right-of-way is similar to a Bicycle Path, but a shared use path along a highway (Side Path) is similar to a Sidewalk. As noted in Section 920.4, there may be disadvantages to bicycle travel along a sidewalk. One way to ensure that bicyclists are able to ride rather than proceed as pedestrians – is to designate a facility as a Bicycle Lane even if it is separated from the roadway

While Separated Bike Lanes are also not specifically mentioned in statute, they meet the same definition as Bicycle Lanes even if they are adjacent to the roadway with a street buffer in between. The terms 'Cycle Track', 'Protected Bike Lane' and Separated Bike Path' are commonly used synonyms with Separated Bike Lanes. When referring to this type of facility, use the term Separated Bike Lane in order to minimize confusion about a bicyclist's legal rights to ride versus walk in the Bike Lane.

920.7 Requiring Bike Lane or Path (ORS 814.420)

Oregon law (ORS 814.420) requires bicyclists to use a bike path or bike lane, rather than the roadway travel lanes, if a bike path or bike lane is provided. The statute allows a person to move out of the bike lane or path for a variety of reasons.

As noted in Section 920.4, there may be disadvantages to using a separated facility if a bicyclist is required to proceed as a pedestrian. When designing a separated facility, ensure that bicyclists have access to move into the road where needful.

920.8 Both Sides of a Road (ORS 814.400)

Bike accommodation should normally be continuous on both sides of the roadway.

ORS 814.400 requires bicyclists to follow the rules of the road for vehicles. These statutes applicable to bicycling presume that bicycles operate in the same direction with motor vehicle traffic. The lateral position of bicyclists should normally be on the right side of a roadway.

There may be instances where a bicycle facility may be considered on the left side of the road or a two-way facility on one side. Transitions to the beginning and end of the left-side bike facility are critical to safe operation. If the transitions are not done properly, bicyclists are unlikely to cross to the other side of a road to use a path, bike lane or sidewalk, particularly if it the length of the left-side bike facility is short. Many users are likely to use a lane on the roadway a short distance rather than cross twice. Additionally, some users will continue to ride on the "wrong side" of the road for long distance beyond the end of the left-side bicycle facility.

Section 921 Design Strategies to Reduce Crashes

Highways should be designed to reduce or eliminate the potential for crashes. Appropriate roadway design can reduce crashes that occur between motor vehicles and bicycles, bicycles and pedestrians, or bicycles and fixed objects.

[Placeholder for additional content – refer to Highway Safety Manual, ODOT process for ARTS projects, etc.]

This section will also discuss using the Pedestrian & Bicycle Safety Implementation Plan.

921.1 Crashes with Motor Vehicles

[Placeholder for section]

This section will discuss design considerations

- Portion of bike crashes that involve motor vehicles
- The most prevalent types of bike crashes
- Design strategies to reduce crashes between bicyclists and motorists
- Risk factors

921.2 Non-Vehicle Crashes

According to the National Transportation Safety Board (NTSB) Safety Research Report[26], 80% of bicyclists who were treated at a hospital for injuries from bicycling from 2014 to 2017 were not involved in a crash with a motor vehicle. Among those incidents, 27% were head injuries and were typically the most severe. While the cause of each non vehicle-related injury can vary, each incident was likely to have involved falling off a bicycle or colliding into a fixed object. The following are design factors to mitigate the probability of fixed object crashes and individuals falling off bicycles.

♦ Bollards

Bollards may be used to limit vehicle traffic on paths. However, they are often hard to see, cyclists may not expect them and injuries result when cyclists hit them. Overuse of bollards is a serious hazard to bicyclists and may prevent path use by trailers, wheelchairs and other legitimate path users. In a group of riders, the riders in front block the visibility of those behind, setting up cyclists in the back of the pack for a crash.

Bollards should only be used when absolutely necessary. **When used, space bollards apart a minimum of 5 feet.** This provides for easy passage by cyclists, bicycle trailers and adult tricycles as well as wheelchair users. A single bollard is preferred, as two may channelize bicyclists to the middle opening, with a potential for collisions. They should not be placed right at the intersection, but set back 20 feet or more, so users can concentrate on motor vehicle traffic conflicts rather than on avoiding the bollard. They should be painted with bright, light colors for visibility, illuminated and/or retro-reflectorized. A striped envelope around the bollard will direct path users away from the fixed object hazard. Flexible delineators, that collapse when struck by a bicyclist, should be considered.

♦ Offset Fencing

Placing railing or other barrier part way across a trail makes it possible for intended users to accesses the trail; maintenance vehicle operators are provided with keys to unlock the fences when they need access. The fences, like bollards, can be hazards to bicyclists and can restrict certain trail users from gaining access to the trail. They should be coated with retroreflective material and well-lit.

♦ Drainage Grates

Care must be taken to ensure that drainage grates are bicycle-safe, as required by ORS 810.150. If not, a bicycle wheel may fall into the slots of the grate causing the cyclist to fall. Replacing existing grates (A, B, preferred methods) or welding thin metal straps across the grate, perpendicular to the direction of travel (C, alternate method) is required. These should be checked periodically to ensure that the straps remain in place.

Note: grates with bars perpendicular to the roadway must not be placed at the bottom of curb cuts, as wheelchairs could get caught in the slot.

If a street-surface grate is required for drainage (ODOT types G-1, G-2, CG-1 and CG-2), care must be taken to ensure that the grate is flush with the road surface. Inlets should be raised after a pavement overlay to within 1/4 inch of the new surface. If this is not possible or practical, the pavement must taper into drainage inlets so they do not cause an abrupt edge at the inlet.

The gap between the grate and the inlet should be kept tight, no more than ¾ inch, to prevent bicycle wheels from getting trapped. The most effective way to avoid drainage-grate problems is to eliminate them entirely with the use of inlets in the curb face (type CG-3). The cross-slope of the outer 3 feet or so of the bike lane should stay constant, with no exaggerated warping towards the opening. This may require more grates per mile to handle bypass flow; but this is the most bicycle-friendly design.

Another bicycle-friendly option is to ensure the inlet grate is entirely contained in the gutter pan.

♦ Railroad Crossings

Special care must be taken wherever a bikeway intersects railroad tracks. The most important concerns for bicyclists are smoothness, angle of crossing and flange opening.

The combination of smoothness, angle and flange opening create conditions that affect cyclists. By improving smoothness and flange opening, the angle becomes less critical. A common mistake is to overcorrect for the angle, as the resulting sharp reversing curves needed to create a right angle crossing can be more difficult for cyclists to negotiate than the crossing itself. Sometimes all that is needed is a slight widening of the shoulders to allow cyclists to align themselves better at the track crossing.

By statute, all public highway, bikeway, shared use paths, and sidewalk crossings of a railroad in Oregon are regulated by the Rail Division of the Department of Transportation. The Rail Division must approve, by issuance of an Order, the construction of new crossings or alterations to existing crossings, to include the approaches to these crossings. Crossing Orders specify construction details, installation of traffic control devices, and assign maintenance responsibilities to the road authority and the railroad, who are parties to the application.

The four most commonly used crossing surface materials, in descending order of preference, are:

- Concrete: Concrete performs best under wet conditions and, when laid with precision, provides a smooth ride.
- Rubber: Rubber provides a ridable crossing when new, but they are slippery when wet and degrade over time.
- Asphalt: asphalt pavement must be maintained in order to prevent a ridge buildup next to the rails.
- Timber: Timbers wear down rapidly and are slippery when wet.

The risk of a fall is kept to a minimum where the roadway (or bikeway portion of the roadway) crosses the tracks at 90°. If the skew angle is less than 45°, special attention should be given to the bikeway alignment to improve the angle of approach, preferably to 60° or greater, so cyclists can avoid catching their wheels in the flange and losing their balance. OAR 741-115-0070 specifies regulations for bicycle lanes and multi-use paths that cross railroad tracks at the same grade. Under OAR 741-115-0070 (3), an engineering study is required whenever bicycle lanes or multi-use paths are proposed to cross railroad tracks at 59 degrees or less.

Efforts to create a right-angle crossing at a severe skew can have unintended consequences: the reversing curves required for a right-angle approach can create other problems for cyclists. It is often best to widen the roadway, shoulder or bike lane to allow cyclists to choose the path that suits their needs the best. On extremely skewed crossings (30° or less), it may be impracticable to widen the shoulders enough to allow for 90° crossing; widening to allow 60° crossing or better is often sufficient.

Creating a separated path to angle the bikeway at 90° degrees is feasible, but special care should be taken to maintain the path regularly.

The open flange area between the rail and the roadway surface can cause problems for cyclists, since it can catch a bicycle wheel, causing the rider to fall. Flange width must be kept to a minimum.

♦ Pavement Seams

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921.3 Using Bicycle Crash Data

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This section will discuss how to use crash bicycle data for design exceptions and other project related scenarios to inform design decisions.

Section 922 Design Users

There are three primary purposes in selecting a design user profile. The design user profile informs a project team whether the target comfort level of the bicycle facilities will suit those who are expected to ride in a project corridor. It also determines whether to design queuing areas for individuals or groups of bicyclists riding together. After a bikeway project is completed, the design of the facility affects how cohesive the highway segment fits into the bicycle network for users within that design user profile.

ODOT design standards are based on the most restrictive design control, which is not always the same design user profile. When deviating from a standard, the effects on the design user profile should be noted.

The following is a list of design user profiles for a bicycle facility.

- Individual highly confident adult bicyclist
- Individual somewhat confident adult bicyclist
- Individual interested, but concerned adult bicyclist
- Individual school-age child bicyclist
- Bicycle group bicycling
- Family group bicycling

922.1 Bicyclist Typologies

Four levels of bicycle user comfort and skill are recognized in transportation research. Bicycle users are categorized in three categories as ‘highly confident’, ‘somewhat confident’, or ‘interested but concerned’. A fourth category describes people who either cannot or choose not to use a bicycle as transportation. The type of bikeway accommodation affects users’ decision whether to ride. The AASHTO Bike Guide elaborates on these typologies and explains how the usability of each type of bikeway is influenced by users’ riding skills, stress tolerance and trip purpose. Users' decisions also vary by the type of bicycle they use, its performance criteria and required operating space.

Accommodating bicycle transportation is required on all highways, while designing for the expected bicycle user typology is a context sensitive consideration. Chapter 14 in the ODOT Analysis Procedures Manual[1] describes the 'Bicycle Level of Traffic Stress' (BLTS) methodology, which is a qualitative assessment how traffic conditions effect bicycle riders. BLTS levels can be used to assess the bicyclist typology provided for on an existing or planned bikeway.

The potential demand for riding varies by user typology. The potential for use by each of the three typologies of bicycle riders depends on individuals' perception of comfort and safety and the amount of land use attractions. 'Interested, but concerned' bicycle riders are likely to choose a different mode of travel if they perceive a bikeway to be stressful or if the trip distance is long. A 'highly confident' bicyclist is less likely to be dissuaded from choosing to ride based on traffic and can ride longer distances.

The six urban contexts generally correspond with land use patterns that result in shorter or longer distances between destinations. The level of demand for 'interested, but concerned' bicycle riders is greatest in a Downtown and Urban Mix settings where close destinations result in shorter trips. Where land use density is lower and the average trip length is longer – there are still some short trips that attract 'interested, but concerned' bicycle riders. Each of the urban contexts has a different mix of user typology demand because of the land use and distance between destinations. Thus, the urban context is used as the indicator to decide the type of bikeway that is appropriate – rather surveying the typology of users along that highway.

Bicyclists who ride on rural highways tend to be highly confident riders. However, there may be latent demand for bicycle trips that are not taken because of traffic conditions. Additionally, rural bikeways that are part of a designated bike route attract a wider variety of users.

Table 900-3: Level of Traffic Stress and Design User Profiles

Level of Traffic Stress	Likelihood that Design User Profile Will Ride[25]					
	Highly Confident Individual	Somewhat Confident Individual	Interested, but Concerned Individual	School-aged Individual Child	Bicycle Group	Family Group
LTS 1	Likely	Likely	Likely	Likely	Likely	Likely
LTS 2	Likely	Likely	Sometimes	Sometimes	Likely	Sometimes
LTS 3	Likely	Sometimes	No	No	Likely	No
LTS 4	Likely	No	No	No	Sometimes	No

922.2 Selecting the Design Users

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922.3 Design Controls Based on Design User

[Placeholder for section]

Section 923 Design Vehicles

[Placeholder for section]

923.1 Design Vehicle Descriptions

[Placeholder for section]

923.2 Selecting the Design Vehicle

[Placeholder for section]

923.3 Design Controls Based on Design Vehicle

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Section 924 Design Speed

Several design requirements are based on a selected design speed. Normally, a design speed is only selected for shared use path projects. Aside from shared use paths, it is generally not necessary to designate a design speed for bicycle lanes. However, there are scenarios where a design speed is necessary. A bikeway should have a design speed designated separate from the roadway design speed in the following facilities:

- All shared use paths;
- Alignment of a separated bike lane if not parallel to the road;

- Passing areas within a bike lane;
- Sight distance calculations;
- Islands at protected intersections;
- Bicycle signals;

924.1 Selecting an Appropriate Design Speed

The ODOT Region Roadway Manager shall assign bikeway design speeds for a project. The AASHTO guide contains factors to consider, but does not dictate design speed. More than one design speed may be selected as it is sometimes advisable to have different design speeds in different segments. Design speeds vary from 8 mph to 30 mph and are given in 2 mph increments.

- The typical recommended shared-use path design speed is 18 to 20 mph for rural paths where there are less pedestrians.
- The typical recommended shared-use path design speed is 14 to 16 mph for urban paths where there are more pedestrians.
- The typical recommended design speed at intersection approaches is 10 to 12 mph.
- The typical recommended design speed at street crossings is 8 mph.

Each of the above design speeds may be adjusted based on whether a path is on level terrain, rolling terrain or on a consistent grade or based on the expected mix of design users.

The typical average cruising speed of a human-powered bicycle on level terrain is 10 mph. Many individuals are capable of riding a road bicycle at a sustained average speed of 15 to 25 mph on level terrain. For every 1% increase in downhill grade, individual adult bicyclists on road bicycles increase speed by 0.53 mph on average. For every 1% increase in uphill grade, the same bicyclists decrease speed by 0.90 mph on average. Bicyclists can reach speeds of 30 mph on sustained downhill grades of 5% or greater. Electric-assist bicycles are capable of riding 20-28 mph and typically ride close to 20 mph. Segways and electric scooters can ride 15 mph.

The design speed need not vary with the grade of a path where the grade remains below 4%. Where rolling terrain frequently surpasses 4% uphill and downhill – the speed of bicyclists will frequently vary between fast and slow. As it becomes more difficult to maintain momentum uphill, bicyclists may increase downhill speeds to compensate for an uphill climb ahead. Design speeds in rolling terrain or on a consistent grade can either be increased based on the downhill grade – or design speeds can vary based on uphill versus downhill direction.

Regardless of the path design speed, approaches to street crossings should be designed at a slower speed than the rest of a path because bicyclists are preparing to come to a stop.

924.2 Design Controls Based on Design Speed

Shared use path design speed affects the following design elements along a shared use path:

- Intersection sight distance
- Stopping sight distance
- Sight triangles
- Horizontal curves
- Vertical curves
- Dashed centerline striping
- Length of a passing zone
- Signal timing

Section 930 Bikeway Networks

[Note that the ODOT Strategic Action Plan[9] has a goal to define a multimodal network. The content below is intended to help in the Bicycle Facility Selection Process to characterize the functional role of the highway in the bikeway network. This section is in development.[14,15,16,18,19,20,]]

Different people can travel on a bicycle in a wide mix of environments. People can ride bicycles on all highways and streets, except where specifically prohibited by administrative rule and indicated with traffic signs. People can also ride bicycles on sidewalks, except where prohibited by a city ordinance. People can also ride bicycles on a variety of facilities apart from highways including paved and unpaved shared use paths and trails, mountain biking trails, skate park facilities, as well as through unimproved land on uneven earth terrain.

Where riding a bicycle is not allowed, people can switch to another mode of transportation by walking the bicycle or taking the bicycle with them on a motor vehicle, train or other transit vehicle.

Notwithstanding the variety of facilities where some specific individuals can ride bicycles, most of these facilities are not usable options by all people who may ride a bicycle. The bicycle facilities that can be used by people of all ages and abilities include only those paved facilities that are specifically designed for bicycle travel and are located where they are perceived to be safe from traffic conflict.

The overall bikeway network within a city or other geographic boundary typically consists of all public streets and paved off-street paths. Each street or path may function as a link for a bicycle trip to destinations within that bikeway network. Wherever an ODOT highway is located within the geographic boundary, it may function to serve bicycle trips. The ODOT highway may function in any of the following roles in the overall bicycle network.

- Essential transportation link
- Destination Route
- Limited Access Route
- Destination Route Alternative
- Limited Access Route Alternative
- Designated Touring Route
- Recreation Route
- School Route
- Off-chute

♦ Essential Transportation Link

If a highway is the only route between two points, it is an essential transportation link.

♦ Destination Route

Where the land use along a highway includes access to businesses, residences, or other services that are potential origin or destination points for a person riding a bicycle – this is a Destination Route.

♦ Limited Access Route

Where the land use along a highway is access controlled and does not include access to businesses, residences or other services, it does not serve as an origin or destination point for bicycle trips. This is a Limited Access Route. Providing a low-stress parallel bicycle route may be an option for this type of facility.

♦ Destination Route Alternative

This network role is any combination of bikeway facilities (typically detouring from the highway) that enables travel between two points along a destination route on the highway. Since the destination route includes origin and destination points, a parallel route must have frequent connections to a destination route and the destination route itself should include some bikeway accommodation.

♦ Limited Access Route Alternative

This network role is any combination of bikeway facilities that enables travel between two points along a limited access route. Typically, this route may be in lieu of bikeway facilities on a freeway or expressway when following the procedure in Section 949.

♦ Designated Touring Route

This includes any route that is designated with a route name or number. Examples are all Scenic Bikeways, the Oregon Coast Bike Route, the Historic Columbia River Highway, National Bike Routes etc.

♦ Recreation Route

Any other recreational path or route that is not designated with an official route name or number.

♦ School Route

Any route that is used by school children is a School Route. This network role overlaps the categories above.

♦ Off-Chute

Any route that is a dead-end to a destination is an off-chute.

930.2 Selecting the Bikeway Network Role(s)

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930.3 Design Controls Based on Bikeway Network Role

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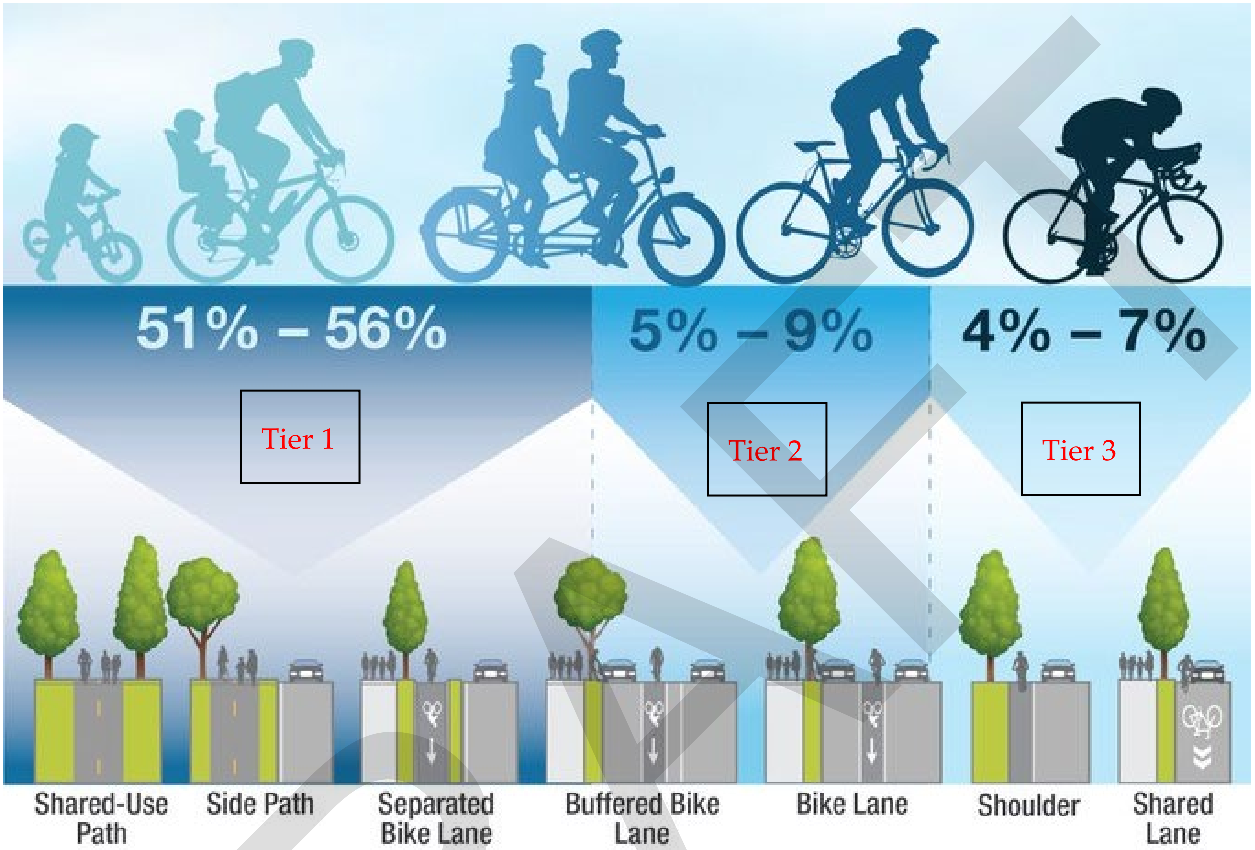
Section 940 Bikeway Tiers

Bicycle travel can be accommodated in three ways or tiers, varying by the level of separation with motor vehicles. It can be accommodated (Tier 1) in in a space physically separated from motor vehicle traffic. This may be either a separated bicycle lane or a shared use side path. A separated bicycle lane is a designated lane that is apart from the roadway and has either curb or physical objects between the bicycle lane and motor vehicle traffic. A shared use side path is separated from motor vehicle traffic in a similar way, but the space for bicycle travel is shared with pedestrians. The second way bicycle travel can be accommodated (Tier 2) is where pavement markings delineate space on the road for bicycle travel apart from motor vehicle lanes. A paved shoulder delineated with a longitudinal stripe can serve bicycle travel, but is not reserved exclusively for bicycle travel. A Bicycle Lane is reserved exclusively for bicycle travel. A buffered bicycle lane is a bicycle lane within a wider shoulder where an additional striped portion of the shoulder is marked to provide a horizontal space between bicycle travel and motor vehicles. The third way (Tier 3) is by having bicycle traffic share the same travel lane on the roadway with motor vehicles.

Figure 900-2: Bikeway Tiers[17]

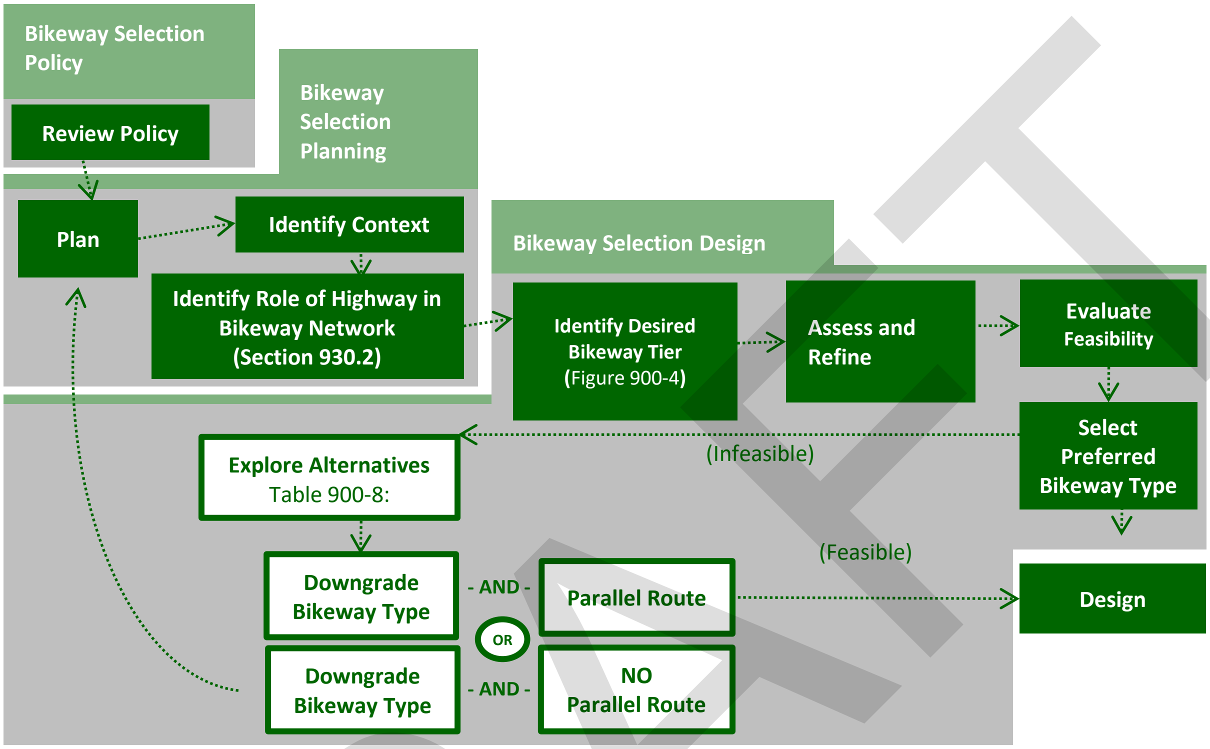


Section 941 Urban Bikeway Selection Process

The appropriate tier to accommodate bicycle travel varies by many factors including road context and traffic condition. Within each bikeway tier, there is a range of potential design cross sections. Determining the space to be allotted in the cross section of the bike lane zones is described in detail in Section 941.

Figure 900-7 is a flowchart that outlines the steps necessary to select the appropriate bicycle facility.

Figure 900-3: Bicycle Facility Selection Process[17]



The flowchart is divided into three parts: policy, planning and design.

941.1 Establish Policy

The first part is to review the applicable policies in effect in the location where the bicycle facility will be. Some bikeway selection policy is already established in the Oregon Bicycle and Pedestrian Plan. 912.2 and Section 914 discuss those policies and plans which are applicable statewide. There may also be local policies for an individual road jurisdiction such as mode share targets, which should be considered in choosing the bicycle facility.

941.2 Bikeway Selection Planning

The second part of the flowchart is to review planning documents. Two goals in reviewing the planning documents are to determine the highway context and the role of the highway in the overall bikeway network. Bikeway selection planning includes efforts to identify and designate connected bicycle networks of “low-stress” bicycle facilities at the transportation system plan level. These networks represent the community’s vision for how to provide comfortable and safe access to key destinations for people riding bicycles. Planning efforts should identify

ODOT highway contexts as well as the role of the ODOT highway in the bikeway network. If the planning documents do not specify this information, these should be determined for an individual project.

When the highway context and role in the bikeway network are know, these are parameters for determining the cross section alternatives. More information on determining highway context is provided in Part 300. The highway context determines the design users, design vehicles, and required design controls as discussed in Section 922 and Section 923.

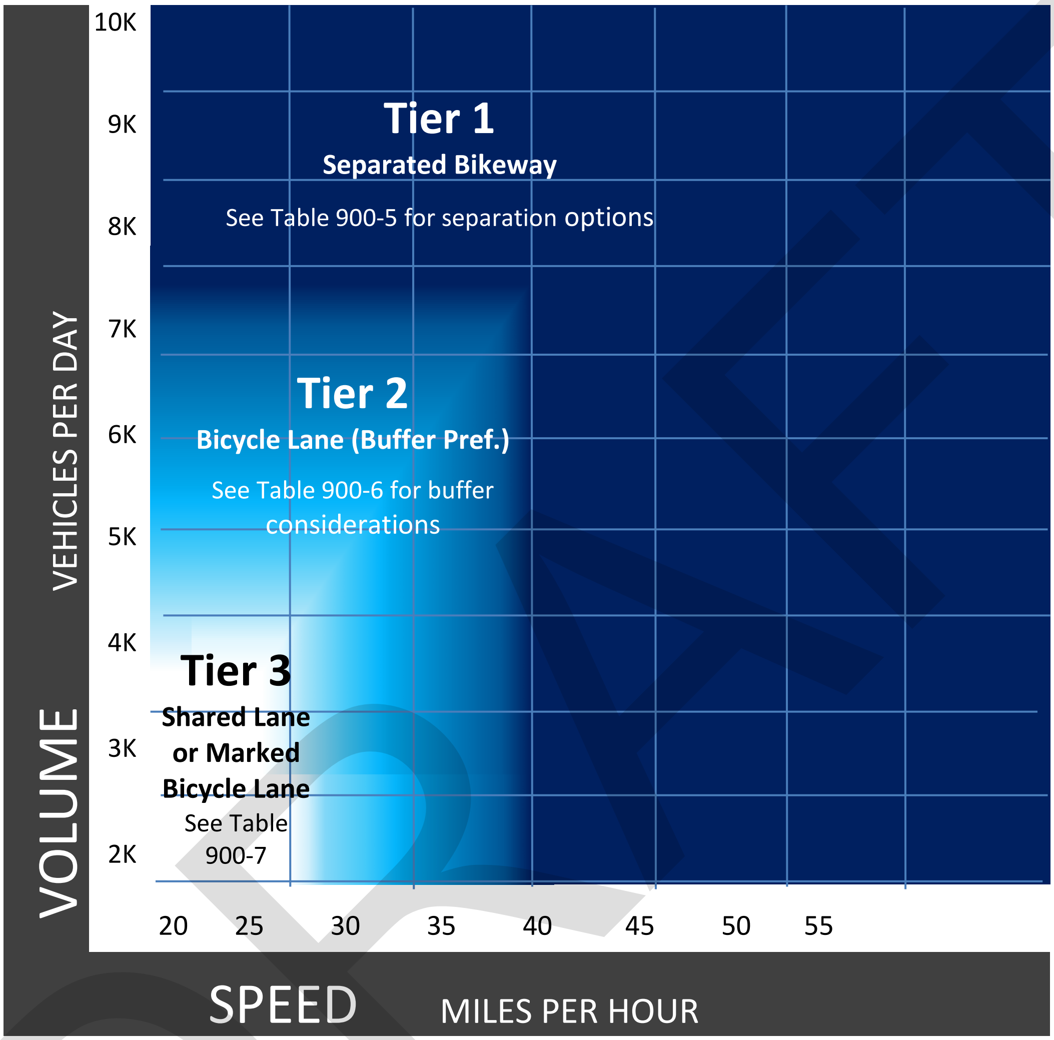
The role of the highway in the overall bikeway network affects how much an improvement to the bike facility might affect bicycle ridership. When the highway is the only route for bicyclists to a destination, it is more critical that the bikeway is context appropriate. When the highway is inside of a comprehensive bike network, such as a street grid, there may be alternative routes to a destination.

The role of the highway segment in the bike network also determines whether the standard bikeway may be downgraded due to its relative importance within the larger network and the availability of alternative routes.

941.3 Identify Desired Bikeway Tier

The third part of the flowchart has several steps. The first step is to identify the target bikeway tier using Figure 900-8. This is a nomograph that uses posted speed and traffic volume to indicate which bikeway tier is appropriate for a given highway segment. The colors in the nomograph gradually blend, which reinforces the point that the determination of the appropriate bikeway type should consider more than speed and traffic volume. After the Tier is identified, each tier refers to a Table for key planning level information to refine the bicycle facility.

Figure 900-4: Bikeway Tier Identification Nomograph[17]



941.4 Assess and Refine Desired Bikeway

Within each bikeway tier, there is a range of potential bikeway types. After identifying the bikeway tier, the next step is to determine the options within that bikeway tier and then to refine the list by determining which of the recommended options is viable.

The standard range in widths for each zone in a bikeway is in Table 900-4. When reviewing the tables, the higher end of the dimension range should be the starting point, as shown first in the tables. Widths within the standard range should be refined to fit the conditions for the highway segment. Zones wider than the standard range do not require a design exception. Where the lower number in the standard width range is not attainable, see Section 941.6.

Table 900-4 Standard Width Range for Desired Bikeway

Urban Context	Tier 1				Tier 2			Tier 3
	Sidewalk Buffer Zone	Bike Lane Zone	Street Buffer Zone	Rigth Side Shoulder*	Sidewalk Buffer Zone	Bike Lane Zone	Street Buffer Zone	Bike Lane Zone
Downtown	6′-0′	8′-7′	3′-2′	2′-0′	6′-0′	6′-5′	3′-0′	Included in travel lane width
Urban Mix	6′-0′	8′-7′	4′-2′	2′-0′	6′-0′	6′-5′	4′-0′	
Commercial Corridor	5′-0′	8′-7′	5′-2′	4′-0′	5′-0′	6′-5′	5′-0′	
Residential Corridor	6′-0′	8′-7′	5′-2′	4′-0′	6′-0′	6′-5′	4′-0′	
Suburban Fringe	6′-0′	8′-7′	5′-2′	6′-0′	6′-0′	6′	5′-0′	
Rural Community	5′-0′	8′-7′	4′-2′	6′-0′	5′-0′	6′-5′	4′-0′	
Rural	See Section 946							

*If the travel lane is directly adjacent to the curb, the overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), the gutter typically serves as the right-side shoulder. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs.

On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

♦ Tier 1 Separated Bike Lanes

When the traffic volume and speed result in a Tier 1 bicycle facility, a Bike Lane should be provided that includes a Street Buffer Zone. Table 900-5 identifies which options may be used within the Street Buffer Zone based on the context of a highway. ‘X’ indicates that the delineation option may be used in the urban context. Blank indicates that the delineation option is not allowed in the context. **A design exception is required to use a buffer option that does**

not have an X in the corresponding urban context. A striping buffer is not included in this table because it results in a Tier 2 bicycle facility.

Table 900-5 Tier 1 Options in the Street Buffer Zone for Separated Bike Lanes and Side Paths

Delineation Options in the Street Buffer Zone	On-Street Parking	Raised Island	Landscaping	Delineator Posts	Traffic Separator Curb	Planter Boxes	Concrete Barrier or Guardrail	Irrigation Ditch	Bio-swale
Downtown	X	X	X	X	X	X			X
Urban Mix	X	X	X	X	X	X			X
Commercial Corridor		X	X	X			X	X	X
Residential Corridor		X	X	X			X	X	X
Suburban Fringe		X	X	X			X	X	X
Rural Community	X	X	X	X		X	X	X	
Rural			X				X	X	

Refer to the design requirements for each of option considered to determine the required cross section width and any other design considerations. See Section 945 for the Street Buffer Zone standards of each delineation option. Additionally, refer to Bike Lane Zone and Sidewalk Buffer Zone requirements.

♦ Tier 2 - Bike Lanes and Buffered Bike Lanes

When the traffic volume and speed result in a Tier 2 bicycle facility, a Bike Lane should be provided. A striped separation from traffic in the Street Buffer Zone may be preferred. Refer to Table 900-6 for considerations whether to provide additional buffer width for a bicycle lane. Additional details are given on page 24 of the FHWA Bikeway Selection Guide.

Table 900-6 Tier 2 Considerations – Refining Bike Lanes and Buffered Bike lanes

Consideration	Need for Separation (Bike Lane versus Buffered Bike Lane)	
	Bike Lane	Consider Buffered Bike Lane
Traffic Volume	Evenly distributed	Above 10% of ADT at peak hour
Vehicle Mix	Low heavy vehicle percentage	High percentage of heavy vehicles
Curbside activity	Low curbside activity	Conflicts with parked cars or other activity requires frequent merging
Driveway frequency	Frequent driveways	Driveways are spaced further apart
Schools	Not used as a school route	Used as a school route
Continuity	Doesn't connect to separated facility	Connects to separated facility
Transit Considerations	Infrequent transit stops	Frequent transit stops

♦ Tier 3 - Shared Lanes

When the traffic volume and speed result in a Tier 3 bicycle facility, bike lanes are not required. Bicyclists can ride in the travel lane with motor vehicles. The painted stripe can be omitted from the required minimum shoulder width to result in a shared lane, wider than a typical travel lane. However, not all bicyclists are comfortable in traffic, especially children. Consider improved bicycle accommodation where riding is prohibited on sidewalks.

Where motor vehicles and bicycles share a lane, there are two ways that road users can share the road. Some bicycle riders move into the center of the travel lane in line with motor vehicles and try to ride at a speed close to that of traffic. Others ride as far as practicable to the right, allowing motor vehicles to pass by keeping left. Where approaches have shoulder or bike lane that drops, many riders may have difficulty transitioning from the shoulder into the travel lane.

See ODOT Traffic Line Manual for standards regarding the use of shared lane markings. Where used, shared lane markings alert drivers that bicyclists may be in the travel lane and also indicate the position in the shared travel lane where bicyclists are likely to ride. This helps enable bicyclists to transition from the shoulder to the shared lane. The combination of the shared lane marking with a wider outside travel lane of 14' to 15' may help drivers to acknowledge riders who keep right and help facilitate vehicles safely passing bicycles at a low speed.

Table 900-7 Considerations Whether Shared Travel Lane is Appropriate

Consideration	Need for Separation (Shared Lane versus Bike Lane)	
	Shared Lane	Consider Bike Lane
Proximity to urban center	Urban center	Further away, suburban areas
Building set back	Buildings at back of walk	Parking lots front street
On-street parking	Low turnover	High turnover
Block length	Short block length	Long block length
Traffic signal coordination	Timed below posted speed	Timed above posted speed
Traffic Volume	Evenly distributed	Above 10% of ADT at peak hour
Number of Travel Lane	Two or less	More than two
Grade	Downhill	Uphill
Schools	Not used as a school route	Used as a school route
Continuity	No bike lanes on approach	Connects to bike lanes
Other high-use indicators	No indicators	Indications of high use

Narrow bridges, tunnels, and other locations that reduce the width of a highway require bicyclists to ride in the travel lane with motor vehicles. Often, these conditions occur on high-speed roads. Full width shoulders should be provided. However, when structural widening is beyond the scope of a project, high speed shared lanes can be treated with traffic control such as advance signing and active warning beacons. See the ODOT Traffic Manual.

941.5 Evaluate Feasibility

Reviewing various options using a decision-making framework can help prioritize trade-offs, refine decisions, and lead to a solution that supports the project needs.

When considering decisions about bicycle facility selection, keep in mind the maintenance needs with each facility type. The answer to the question, "What will be the maintenance issues and how will we mitigate them with this design?" is an important aspect to the final facility choice. If a bicycle facility is being added to an existing cross-section by simply restriping the existing design elements, care must be taken to ensure removal of the exiting striping does not leave "ghost" lines that may confuse both drivers and bicyclists. The final striping layout must be clear and understandable to roadway users. Discussion will be needed to determine the best method to remove or obliterate the striping (e.g. hydro blasting) to not leave behind ghosting of the original striping. Consider adjustments to lane configurations when scoping and designing pavement preservation projects.

In many cases, implementation of bicycle facilities on ODOT streets in urban areas is completed through a retrofit project, in which additional space for bicycle facilities require weighing trade-offs compared to other uses for the space.

941.6 Explore Alternative Bikeway Designs

In some cases, upon evaluating alternatives, it is possible that none of the preferred alternatives are viable. In that case, additional alternatives should be explored that are the next best option the recommended bikeway type. When a bikeway is provided on a highway that is a lower tier than what is recommended, the potential usage is reduced because some of the users will not be comfortable using that bicycle facility.

Sometimes, the role of the highway in the overall bikeway network is such that the recommended bikeway type is not necessary due to a parallel bicycle route that functions for most of the bicycle demand. Identify whether parallel bicycle routes serve the bicycle demand. If so, basic bicycle accommodation is still required; refer to Table 900-8.

Design Concurrence Documentation is required to approve using an alternative bikeway design from Table 900-8 as the selected bikeway type. **A design exception is required to justify the width of a bikeway that is less than a design option in Table 900-8.**

In order for one of these designs to be approved by concurrence or a lesser design via design exception, the documentation must document how the preferred bikeway type was not viable – or that the bikeway network supports a parallel bike route.

Table 900-8: Alternative Bicycle Facility Design– With Identified Lower Stress Parallel Route

Highway Characteristics	Bikeway Type	Min. Width
Traditional Downtown	Bike Lanes with on-street parking	6′
	Bike Lanes with no on-street parking	5′
	Shared travel lane (20 - 25 mph)	Included in travel lane width
Urban Mix, Commercial Corridor, or Residential Corridor	Shoulder Bike Lanes	5′
	Shared travel lane (25 mph)	Included in travel lane width
Suburban Fringe: 35-45 mph	Shoulder	4′
	Bike Lanes	5′
	Shoulder	8′

Suburban Fringe: 50-55 mph or Expressway: 45 mph	Bike Lane or Buffered Bike Lane	8′
Expressway: 50-55 mph	Shoulder	8′
Freeway	Shoulder	10′

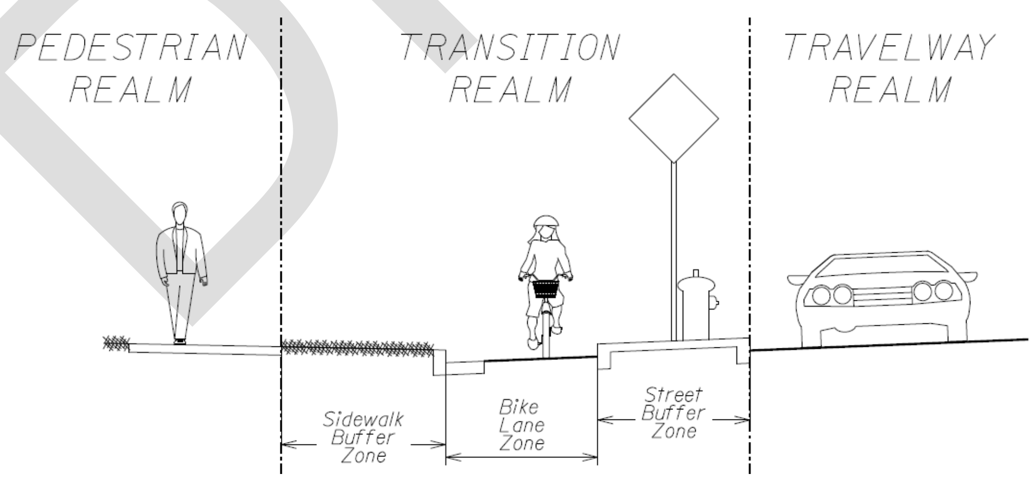
Section 942 Transition Realm and Zones

Cross Section Realms describe the highway's cross section. The portion of the highway between the Travelway Realm and the Pedestrian Realm is the Transition Realm. Not every highway includes a space between the Pedestrian Realm and the Travelway Realm. Assume that a Transition Realm always exists and can have a width of zero where the typical components of the Transition Realm are not included. The components that can make up a Transition Realm are a bike lane, on-street parking and a buffer strip.

As described in Section 940, bicycle traffic can be accommodated in three ways. Tier 3 bicycle facilities (shared lanes) exist where bicycle traffic is in the Travelway Realm. Tier 1 and Tier 2 bicycle facilities lie within the Transition Realm.

The Transition Realm is subdivided into three zones: The Bike Lane Zone, the Street Buffer Zone and the Sidewalk Buffer Zone. Every type of bikeway can be described in terms of these three zones.

Figure 900-5: Transition Realm and Bike Lane Zones



Section 943 The Bike Lane Zone

The portion of the road cross section designated exclusively for bicycle travel is the Bike Lane Zone. Where bicycle lanes are provided on the shoulder of a road, the entire bike lane is equivalent to the Bike Lane Zone. Where buffered bike lanes or separated bike lanes are provided, the Bike Lane Zone includes only the portion of the bike lane designated for bicycle travel. In a shared use path, the Bike Lane Zone overlaps the Pedestrian Zone within the Pedestrian Realm.

The surface of the bike lane zone shall be paved. The standard width for the Bike Lane Zone varies by Bikeway Tier. Tier 1 and Tier 2 bikeways are described below. Since Tier 3 bicycle facilities are shared with motor vehicles, bike lane zone requirements do not apply. *A concrete gutter pan may be included as part of the bike lane zone if there is 4 feet of pavement beyond the longitudinal joint in the gutter pan.*

♦ Tier 1 (Separated Bike Lane)

Typically in a shoulder bike lane, a bicyclist who wishes to pass another bike will use part of the adjacent vehicle lane to do so. However, when bike lanes are constrained between curbs or other objects, passing may be restricted if the bike lane is not wide enough. Therefore, the bike lane zone must consider the ability for a bike to be passed or for two bikes to travel side-by-side. The ability for two bikes to travel alongside each other is also influenced by whether curbs are sloped or straight. The minimum dimension for a bike to pass another bike is 6.5-feet. The range in width for a bike lane zone depends on whether the street buffer is traversable.

The range in width for a separated bike lane zone between standard curbs shall be 8 to 7 feet wide, exclusive of curbs. Where a separated bike lane has a sloped bike lane curb on either or both sides, the bike lane zone width includes the width of the 0.5-foot sloped curb(s). Where a separated bike lane has softscape on either or both sides that is flush with the bike lane, the bike lane zone width shall be 8 to 6.5 feet wide. *Where the surface adjacent to the bike lane zone is flush pavement with intermittent objects in the street buffer, it is consistent with a Tier 2 bikeway (Buffered Bike Lane). Refer to the standard width for a shoulder bike lane rather than a separated bike lane when the surface adjacent to either side of the bike lane zone is flush pavement.* **Where available width is constrained, the bike lane zone may be narrower than the standard width range for short segments up to 200 feet. A design exception is required if a segment of a bike lane zone is narrower than 5 feet.** In constrained areas, bicycles may not be able to pass each other. Ensure that passing opportunity is provided on each side of the constrained space.

Separated bike lanes have the potential to attract more riders than do shoulder bike lanes. Where the expected volume of bicyclists is 150 to 750 per hour, the width should be at least 8-feet. Where the expected volume of riders is less than 150 in the peak hour, the 6.5-foot width is acceptable. Where higher volumes are expected (over 750 bicyclists per hour) or to provide more comfortable side-by-side riding, a bike lane zone of 8 to 10 feet is preferred.

Shared use paths combine the widths of the Bike Lane Zone and the Pedestrian Zone. Refer to Section 960 for Shared Use Path widths.

♦ Tier 2 (Shoulder Bike Lane)

Shoulders are usually striped as bike lanes in urban areas; this designates the shoulder as an area for preferential travel by bicyclists. Low potential bicycle use is not a reason to not provide a shoulder bikeway. The decision to designate shoulders as bike lanes is made by the Region Traffic Manager/Engineer and should be based on anticipated bike use, local transportation plans and/or bicycle plans, posted speed, inventory data of bikeway need and other factors. See Appendix F for instructions on how to access roadside inventory bikeway need data through the FACS-STIP tools.

When a bike lane is located immediately adjacent to a motor vehicle through travel lane, the standard width for the bike lane is 6 feet. ***In constrained areas, narrower lanes as narrow as 5-feet may be acceptable through a design concurrence documentation.*** **A design exception is required to justify a bike lane zone that is less than 5 feet.**

Bike lanes may also be wider than the standard 6 feet in areas of very high use or on high-speed facilities. However, a wider lane could be mistaken for a motor vehicle lane or parking area. Additional roadway width can indicate bicycle use by marking a painted buffer.

A raised bike lane is a type of one-way bike lane that generally does not include a horizontal street buffer from the motorized vehicle lanes. Raised bike lanes may be curbed on both sides. The curb adjacent to traffic is generally 2-6 inches in height. A buffer shy distance of 1-foot is required for each side of the bike lane adjacent to a curb. The minimum width for a raised bike lane is 7 feet, including curb and striping.

Section 944 The Sidewalk Buffer Zone

The Sidewalk Buffer Zone is the space between the sidewalk and the Bike Lane Zone. It may be the same as the Buffer Zone or Curb Zone within the Pedestrian Realm. The intent of the Sidewalk Buffer Zone is to minimize encroachment of pedestrians in the bike lane and bicycles in the sidewalk. Separating modes improves each user's sense of comfort and safety. The primary design objective is to address potential conflicts between pedestrians with vision disabilities and bicyclists.

If a bike lane is at the same elevation as a sidewalk, the sidewalk buffer zone is a critical consideration that affects usability between pedestrians and bicyclists. If the separation between modes is ineffective, pedestrians with vision disabilities can inadvertently walk from the sidewalk to the bike lane and continue into the street. This is particularly a concern where a separated bike lane continues as a shoulder bike lane.

There are two acceptable ways to ensure that these potential conflicts are addressed. A fundamental design decision needs to be made as to which separation method is used for bicycle travel on a corridor. The design separation method should be consistent for as long a corridor as feasible. **At a minimum, the design separation method must extend from one intersection or major driveway crossing to another.** The two separation methods between bicycle lanes and pedestrians are:

- Bikes and pedestrians are allowed to mix; or
- Bikes and pedestrians are not intended to mix.

♦ Pedestrians and Bicycles Allowed to Mix

Where the width of the Sidewalk Buffer Zone is zero, pedestrians and bicycles should be expected to mix. There are three scenarios where bicycle traffic mixes with pedestrians.

- A shoulder or bike lane on a street that does not have a sidewalk.
- A shared use path that does not separate modes.
- A sidewalk-level separated bike lane or mode-separated shared use path.

Where sidewalks have not been provided on a street, pedestrians may use the shoulder or bike lane. No additional signing, marking or tactile indication is require to distinguish a bike lane or shoulder as a pedestrian facility.

Shared use paths shall be designed to serve pedestrians by meeting pedestrian accessibility requirements and including detectable warning surfaces at all street crossings. See Section 960 for more information. Most shared use paths do not separate pedestrians from bicyclists within the path. The expectation is that path users yield one to another within the path surface.

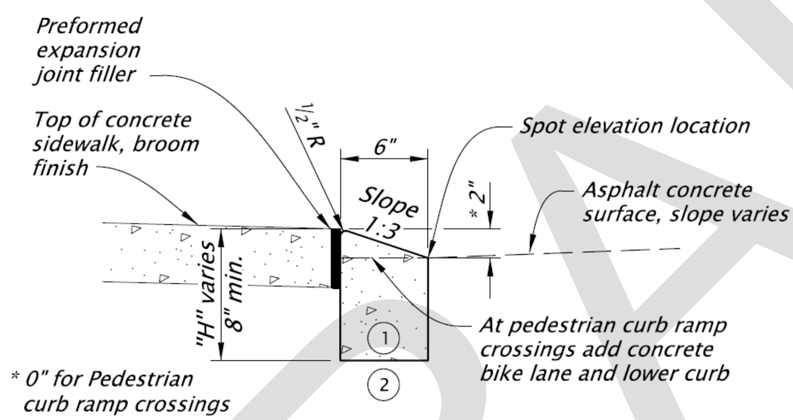
Some shared use paths may be designed with separate lanes for bicyclists from pedestrians. Sidewalk-level separated bike lanes can be equivalent to the mode-separated shared use path. Mode-separated paths can exist either where modes are allowed to mix, or where modes are not intended to mix. Where there is no physical separation between modes, the bike lane zone and adjacent pedestrian zone establish preferred places for users, while the expectation is that users may use the entire space and yield one to another, the same as the scenario of the shared use path without mode separation. These mode-separated paths are required to meet pedestrian accessibility requirements within the Pedestrian Zone. **Detectable warning surfaces are required at all street crossings for both the Pedestrian Zone and the Bike Lane Zone of Mode-Separated Paths where the Sidewalk Buffer Zone is zero.**

♦ Pedestrians and Bicycles Not Intended to Mix

Design the Sidewalk Buffer Zone so that the sidewalk and bike lane are distinct from one another. This is best accomplished when it is at a different elevation from the sidewalk. Normally, a curb separates the Pedestrian Zone from the Bike Lane Zone. In lieu of a curb, a horizontal buffer strip may be used to separate modes.

Where curb is used to separated modes, provide at least a 2-inch elevation difference between the pedestrian zone and the bike lane zone. See Standard Drawing RD702 for bike lane curbs.

Figure 900-6 Bike Lane Curb



Ideally, a buffer of softscaping should separate sidewalks from the bike lane. A buffer zone of street furniture can be effective if the treatment makes cross travel unlikely. Where a driveway crosses the sidewalk and sidewalk-level bike lane, there is a possibility for pedestrians to veer from the sidewalk to the bike lane if the separation between them is too narrow. **Where a buffer zone is used to separate modes (without curb), provided a minimum 2-foot landscape strip of softscaping or street furniture. At driveways, the width of the buffer zone should be at least 6-feet wide if no tactile edge is provided.**

Where the bike lane and sidewalk are side-by-side and there is no curb or buffer zone with physical separation between them, path users can be expected to intermix within that space. Since the design intent is to prevent inadvertent intermixing, a detectable edge treatment is necessary. **Work with ODOT's ADA staff to ensure that edge treatments are detectable for persons with vision disabilities.**

Section 945 The Street Buffer Zone

The street buffer is comprised of the space that separates the bike lane zone from the travelway. Tier 1 bicycle facilities and some Tier 2 bicycle facilities have a Street Buffer Zone. Other Tier 2 and all Tier 3 facilities do not. The role of the street buffer is to place a physical obstacle between moving traffic and bicycle riders. The obstacle is not to create a roadside hazard, but a visible barrier that separates bicycle and motor vehicle travel. The presence of an obstacle between traffic modes improves the sense of comfort and safety for bicycle riders while maintaining visibility and reducing traffic noise. The ideal width of the street buffer should be at least 6-feet in most urban settings regardless of the type used. ***The width of the Street Buffer Zone can be reduced to as little as 2-feet wide in constrained areas with Design Concurrence Documentation.*** If the street buffer is eliminated altogether, a Bikeway Tier is typically reduced from a Tier 1 facility to a Tier 2 facility.

Wider street buffers improve bicyclists' sense of comfort and safety, reduce noise and at night reduce headlight glare.

Table 900-9: Minimum Street Buffer Widths

Delineation Options in the Street Buffer Zone	Striping	On-Street Parking	Raised Island	Landscaping	Delineator Posts (stripe to stripe)	Traffic Separator Curb (Stripe to	Planter Boxes (Stripe to stripe)	Concrete Barrier or Guardrail	Irrigation Ditch	Bio-swale
Downtown	0′	8′	2′	3′	X	X	X	NA	NA	X
Urban Mix	0′	8′	2′	4′	X	X	X	NA	NA	X
Commercial Corridor	0′	NA	2′	5′	X	NA	NA	X	X	X
Residential Corridor	0′	NA	2′	5′	X	NA	NA	X	X	X
Suburban Fringe	0′	NA	5′	5′	X	NA	NA	X	X	X
Rural Community	0′	8′	2′	4′	X	NA	X	X	X	NA
Rural	0′	NA	5′	5′	NA	NA	NA	X	X	NA

Separated bike lanes introduce a physical separation between moving traffic and sidewalks. Features that are typically located in a sidewalk buffer, such as mailboxes and hydrants, which are necessary to be accessed from the travel lanes, should be placed in the street buffer.

Where pedestrian crosswalks cross a separated bike lane, the street buffer acts as a median island. In order to provide two sets of detectable warning surfaces, the minimum width of a street buffer island is 6-feet. If the street buffer is less than 6-feet wide, it cannot be used as a pedestrian refuge and street crossings should include the bike lane with the rest of the street crossing.

There are twelve types of separation that can be used in a street buffer. The width of the street buffer varies by the type of separation.

945.1 Striping Buffer

Where traffic striping is used to separate the Bike Lane Zone from the travelway and the bike lane is not located immediately adjacent to a motor vehicle travel lane, but remains within the paved travel way is a Buffered Bike Lane. 4-feet is the width recommended to buffer a bike lane. The sum total width for a Street Buffer Zone and Bike Lane Zone can be as narrow as 8 feet. The painted buffer can separate bikes from high-speed vehicles to the left, or it can be used to separate bikes from parked cars.

Buffered bike lanes are Tier 2 bicycle facilities. When physical objects are added to the street buffer, they become Tier 1 bicycle facilities. See Section 945.5, Section 945.6 and Section 945.7.

945.2 Parking Lane

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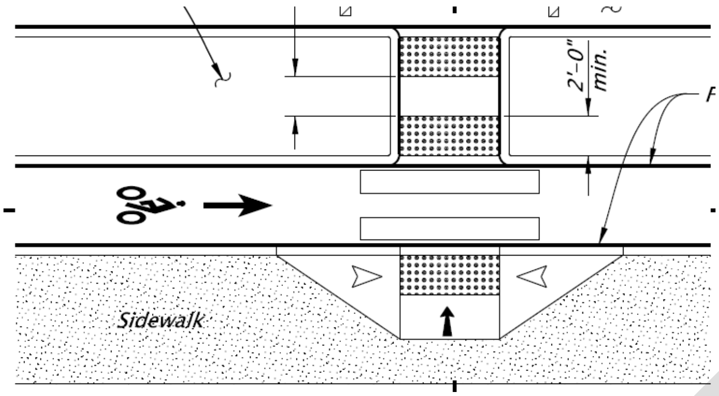
945.3 Raised Island Buffer

[Placeholder for section] See Standard Drawing RD1140.

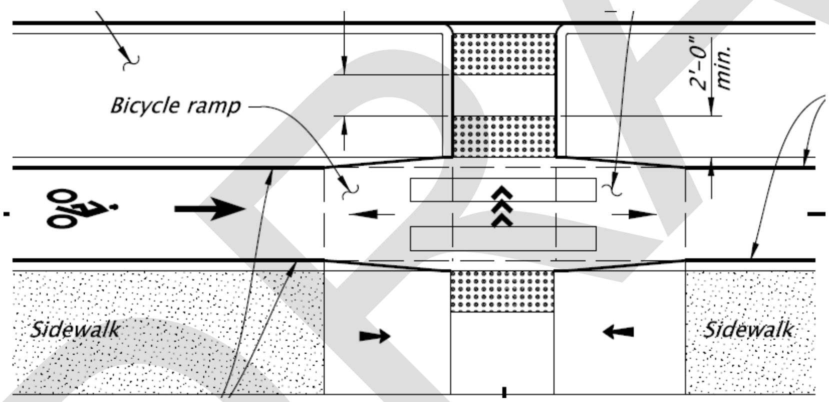
Figure 900-7: Island Buffer Cross Section at Street Crossing



945.4 Landscape Buffer

[Placeholder for section] See Standard Drawing RD1140.

Figure 900-8: Landscape Buffer Cross Section at Street Crossing



945.5 Delineator Post Buffer

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945.6 Traffic Separator Curb Buffer

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945.7 Planter Box Buffer

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945.8 Concrete Barrier Buffer

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945.9 Guardrail Buffer

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945.10 Irrigation Ditch Buffer

[Placeholder for section]

945.11 Bio-swale Buffer

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Section 946 Rural Bicycle Accommodation

In the majority of rural highway projects, the paved shoulder widths are sufficient to accommodate occasional bicycle travel. The occasional pedestrian using a rural highway is also served by paved shoulders.

Where bicycle use is higher, consideration should be given to increase the shoulder width to a minimum width of 4 feet on open shoulder and an additional foot when in-between lanes of traffic or for each side that is next to curb, guardrail or parking.

946.1 Shoulders

Shoulders provide for safety, capacity and maintenance area along highways. Standard shoulder widths in 4-R projects are listed in Table 900-8 and minimum shoulder widths in 3-R projects are listed in Table 900-9

Table 900-10: 4R Shoulder Widths

Highway Characteristics	Min. Width
Collector <400 ADT	2′
Arterial <400 ADT	4′
Collector 400 -1500 ADT	5′
Arterial 400-1500 ADT	6′
1500-2000 ADT	6′
>2000 ADT	8′
Mountainous 4-lane Expressway	8′
Other expressways	10′

Table 900-11: 3R Shoulder Widths (Based on AASHTO Minimums)

<table>
<tr><th rowspan="2">Average Running Speed</th><th colspan="3">Design Year Volume (ADT)</th></tr>
<tr><th><750</th><th>750–2000</th><th>>2000</th></tr>
<tr><td>50 mph or over</td><td rowspan="2">2′</td><td>3′</td><td rowspan="2">4′</td></tr>
<tr><td>Under 50 mph</td><td>2′</td></tr>
</table>

946.2 Designated Bikeways in Rural Areas

Rural (or urban) highways designated as Scenic Bikeways, National Bike Routes or other recognized bikeways should have greater attention to bicycle accommodation. Designated bikeways attract a wide range of users who vary in age, experience and ability. As noted in Section 922, three levels of bicycle user comfort and skill are recognized to affect users' decision whether to ride. It is important to provide bikeways that serve the 'interested but concerned' users along designated bikeways. Section 901 has a thorough discussion about bikeway types and a process to recommend the type of bikeway appropriate for the design user profile based on traffic conditions.

Usually, rumble strips should not be included on sections of highway that are designated bikeways, but may be included where their impact on cyclists is sufficiently mitigated. See the ODOT Traffic Manual. Ongoing maintenance to keep shoulders clear should be a priority on these routes. Construction activity on shoulders of designated bikeways should make provisions to accommodate cyclists during construction or consider signed detours that may be different from motor vehicle detour routes.

Bicycle tourism is a significant industry in Oregon. Cyclists from across the nation and many other nations come to Oregon to ride on designated bikeways for recreation. Information and maps for promoted recreational bikeways are provided in Appendix E. A list of milepoints, corresponding to currently designated bikeways can be found in Appendix E.

Section 947 Configuring Cross Section Space

The configuration of travel lanes on a highway may be modified to provide bike lanes within a highway cross-section that did not previously include them. This can be done by reducing the number of travel lanes, eliminating on-street parking or changing the median treatment. Reconfigured roadways from 4-lanes to 3-lanes with center turn lane and bike lanes show a significant crash reduction. Any reconfiguration of travel lanes requires Region Traffic Engineer/Manager approval and a freight mobility review as described in Appendix C. See Chapter 2 of Appendix L for specific examples of road lane reconfigurations.

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Evaluating Design Alternatives and Trade-offs to select a Bikeway & Hierarchy for Selecting the Next-Best Alternative

947.1 Prioritizing Widths Between Zones

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♦ Variability in Zone Widths

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This section will talk about:

- Passing spaces
- On-Street Parking
- Intersections

Section 948 Two-way Bikeways

Three types of bikeways serve two-way bicycle travel. The first type is a shared use path that does not run parallel to a roadway. The second is a shared use path that does run along a road and usually replaces the need for bike lanes on that road. This type of shared use path is referred to as a Side Path. The third type of facility is a two-way separated bike lane. A side path and a two-way separated bike lane operate similarly. The distinction is that side paths are designed to serve pedestrians, while two-way separated bike lanes are bikeways apart from pedestrian walkways.

In lieu of providing bike lanes on each side of a road, a two-way bicycle facility may be provided on one side of a road. To determine if a two-way bikeway is appropriate, evaluate if a bi-directional facility is appropriate for the location. Shared use paths that are not along a road do not need to be evaluated for one-way versus two-way operation.

Bike lanes on one-way streets are typically only in the direction of motor vehicle traffic. In areas of high bicycle demand, the left shoulder may be marked as a contra-flow bicycle lane when approved by the Region Traffic Manager/Engineer.

Typically, bikes are accommodated on each side of the roadway rather than together on the same side. Two-way shared use paths are a preferred bicycle facility for limited access expressways or urban freeways and may be discouraged in other areas. Separated paths are discussed in Section 961.

Although one-way separated paths may be intended for one direction of bicycle travel, they will often be used as two-way facilities, especially by pedestrians. Caution must be used in selecting this type of facility. If needed, they should be designed and signed to ensure one-way operation by bicyclists.

948.1 Evaluating One-way versus two-way

Two-way bicycle lanes or shared use paths on one side of a street are discouraged in areas with frequent driveway or street access. When bicycle traffic rides against the normal flow of motor vehicle traffic, conflicts can occur at driveways and cross streets. Crash risk is higher where cyclists ride facing traffic. At night, headlight glare is a concern. As a result of discouraged use, few two-way separated bike lanes exist. However, in the last decade, there has been an increase in the installation of two-way separated bike lanes. Some preliminary crash data suggests that while crash rates for two-way separated bike lanes are worse than one-way separated bike lanes, they are still safer than a shared travel lane condition (Lusk, 2011). Survey results indicate that separated bike lanes are preferred over shared lanes or on-street bike lanes by both cyclists and motorists (Monsere 2014). Another research report concludes that two-way separated bike lanes are preferable on one-way streets on the right side, rather than the left (Zengenehpour, 2015).

Section 949 Parallel Routes

As described in Section 912.1, by Oregon statute, bicycle facilities are required to be included wherever a public agency constructs, reconstructs or relocates a highway unless one of three exemptions is applicable. The third exemption is when other available factors indicate the absence of any need for bicycle facilities. **Where triggered by the scope of work, a design exception is required to omit a bicycle facility altogether from a highway segment cross section in favor of routing bicycle traffic onto a parallel route.** If criteria in this section are met, the exception can be supported. Supporting information must include documentation of public acceptance affirming that bicycle travel is not needed along the highway corridor and that a parallel route is suitable to be used instead. When approved, ODOT can invest in improving the parallel route in lieu of improvements on the mainline highway.

Normally, bicycle travel is accommodated with motor vehicle travel on the same highway roadbed. Where bicycle travel is accommodated on a parallel route apart from motor vehicles, this can be within the highway right-of-way or on a separate street's right-of-way. A design exception is not required where the parallel route is within the highway right-of-way.

One example is a Multiway Boulevard, which is a highway facility where medians are used to separate through travel lanes from local access lanes. The local access lane is a separate frontage road with a different speed that provides the pedestrian and bicycle facilities, and may include access to businesses, transit, or on-street parking. Bicycle lanes are not required to be duplicated on both the through facility as well as the access lane.

A Shared Use Path may function as a bicycling route that is generally parallel to a highway for transportation purposes even when it includes portions that are not in the highway right-of-way. Typical examples are paths that run along riparian corridors. If portions of path within ODOT right-of-way are intermittent, because the continuation of the path is outside of ODOT right-of-way, and the connected path as a whole functions to serve the transportation needs, a redundant bicycle facility within ODOT right-of-way is not required.

There are two conditions where parallel routes may be considered on another street right-of-way. First, where the role in the bikeway network is that of a limited access route, typically, bicycle travel is better served on a route parallel to expressways and freeways than on the shoulder. Second, there are occasions when it is infeasible or impractical to provide bike lanes on a busy thoroughfare, or the thoroughfare does not serve the mobility and access needs of bicyclists.

In both these cases, bicyclists should not be precluded from the state highway or signed onto other local routes because of constraints. However, in some locations, bike lanes do not function well and bicyclists may prefer to travel on alternate routes. Tier 2 and Tier 3 bikeways are not ideal on roads with travel speeds greater than 45 mph. If a well-connected parallel on-street bike network is provided, the highway shoulder may be sufficient to accommodate the occasional cyclist, without requiring a separate bicycle facility. A shoulder is still required to facilitate bicyclists to access businesses. A well-connected parallel on-street bike network can serve the bicycle trips if access to the highway is provided.

The following are conditions to determine if it is appropriate to provide facilities on a parallel local street in lieu of the mainline:

- A bicycle facility on the state highway falls into one of three categories:
  1) Conditions exist such that it is not economically or environmentally feasible to provide adequate bike lanes on the mainline; OR
  2) Mainline does not provide adequate access to destinations; OR
  3) Bike travel on mainline would not be considered safe.
- Parallel route must provide continuity and convenient access to facilities served by the mainline;
- Costs to improve parallel route should be no greater than costs to improve the mainline; and
- Proposed facilities on parallel route must meet state standards for bike facilities.

The above criteria should be satisfied and considered along with other factors when considering parallel routes for the provision of bike access and mobility.

If a parallel route is determined to be the best alternative, determine whether a parallel route already exists or whether improvements would be necessary to meet the needs for bikeway access and bicycle network connectivity. Determine whether providing bike lanes on the parallel route requires acquiring right-of-way.

Strategy 2.1B in the statewide Oregon Bicycle and Pedestrian Plan allows ODOT to invest in infrastructure in lieu of improving bicycle facilities on a state highway under certain circumstances. It says:

When local planning processes have, in consultation with ODOT, identified a local parallel bike route, and a bikeway on the state highway is determined to be contrary to public safety, is disproportionate in cost to the project cost or need, or is not needed as shown by relevant factors and therefore justified to be exempt from ORS 366.514 based on one of those statutory exemptions, ODOT will work with the jurisdictions to support the development of the parallel route and assure reasonable access to destinations along the state highway. ODOT and the local jurisdiction may enter into an agreement in which ODOT helps to fund, in negotiation and partnership with the local jurisdiction, construction of the bikeway in the vicinity of the state highway project that serves as an alternative or parallel route to the highway project.

949.1 Parallel Route Design

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This section will include design treatments to be provided onto parallel city streets (off-highway) to ensure that the bikeway meets the connectivity and access needs to replace the transportation function of the mainline.

The content may simply reference the Bike & Ped Design Guide for Bike Boulevard design.

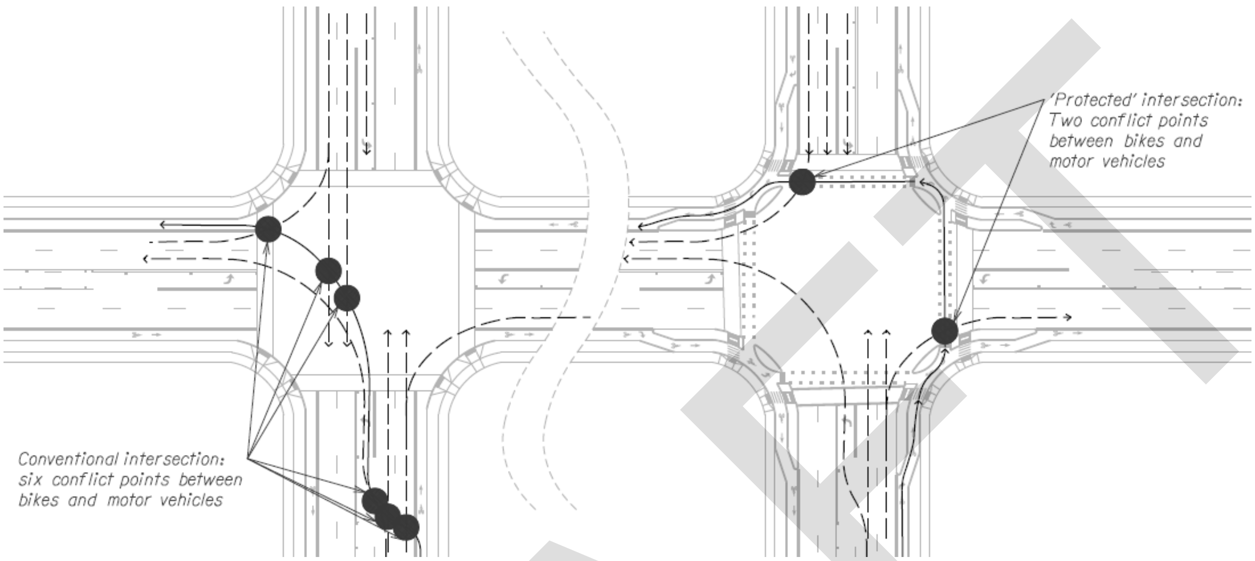
Section 950 Intersection Design

For a thorough and detailed discussion on intersection design, see Part 500. The following discussion will help the designer understand some of the key intersection design features that help enhance the safety and convenience of bicyclists.

Section 951 Interaction Between Modes

Most conflicts between roadway users occur at intersections, where one group of travelers crosses the path of others. Good intersection design clearly identifies right of way between motorists, pedestrians and bicyclists. The way that bicyclists execute a left turn affects the number of conflict points at an intersection. Intersections can be designed per section 13.6.1 to accommodate bicycles in a distinctly separate track from motor vehicles to reduce conflicts and enable space for two-stage left turns.

Figure 900-9: Conflict Points at Conventional versus Protected Intersection



The complexity of an intersection also affects the ability for vision-impaired pedestrians to orient themselves using traffic sounds. Where possible, it is best for intersection legs to connect at as close to 90-degrees and with a radius as small as feasible. The radius should safely accommodate turning movements for a design vehicle that is expected regularly at the intersection. Truck aprons can be used where larger vehicles may be expected. Where channelized right turn lanes are used, it often creates an unprotected crossing and the skew angle can reduce driver yielding to pedestrians that can be difficult for vision-impaired pedestrians.

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Section 952 Intersection Sight Distance

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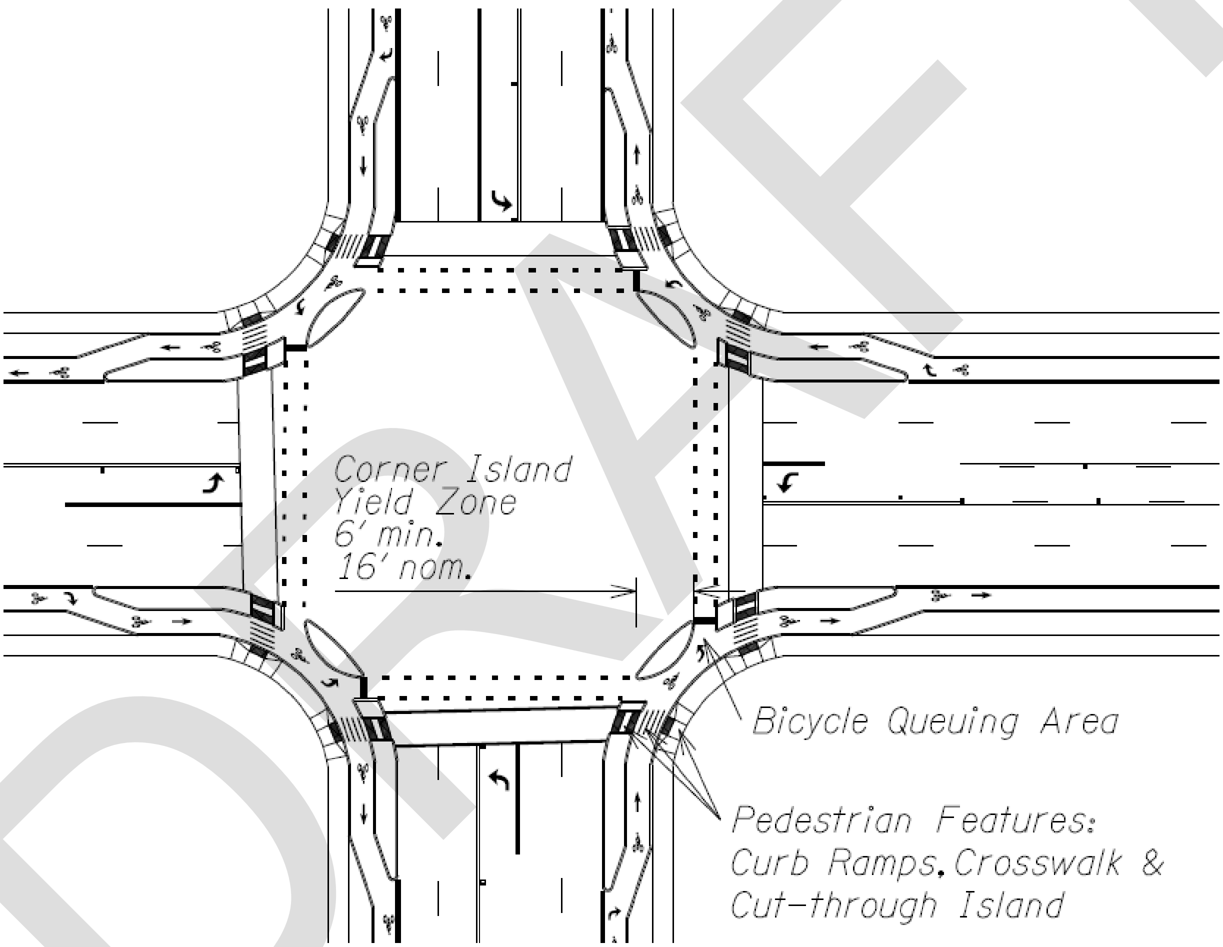
Section 953 Protected Intersections

A 'protected' intersection uses traffic islands between bicycle and motor vehicle lanes to segregate conflicts and facilitate two-stage left turns where bicyclists would not be comfortable entering the left turn lane. It clearly designates the right-of-way between modes and improves predictability. Bicyclists travel parallel to pedestrians in bicycle lanes that are separate from the pedestrian crosswalk and separate from the motor vehicle lane. 'Protected' intersections are the preferred intersection configuration where approaching bike lanes are separated or buffered from motor vehicle traffic. Where approaching bike lanes are not separated or buffered, a transition at the intersection can enable this configuration. When an intersection includes the elements that define a 'protected' intersection, the number of potential conflicts and the area of the potential conflict zone between bicycles and motor vehicles is reduced. These defining elements include: (1) a corner island that creates a motorist yielding zone; (2) a bicycle queuing area that is in front of the stop bar for motor vehicle traffic; and (3) features that ensure pedestrian accessibility and manage conflicts between pedestrians and bicyclists.

Figure 900-10: Protected Intersection



953.1 Corner Island Yield Zone

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953.2 Bicycle Queuing Area

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953.3 Pedestrian Features

[Placeholder for section]

Section 954 Retrofitting with Protected features

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Figure 900-11 Option B – Protected Intersection with 7-foot Street Buffer

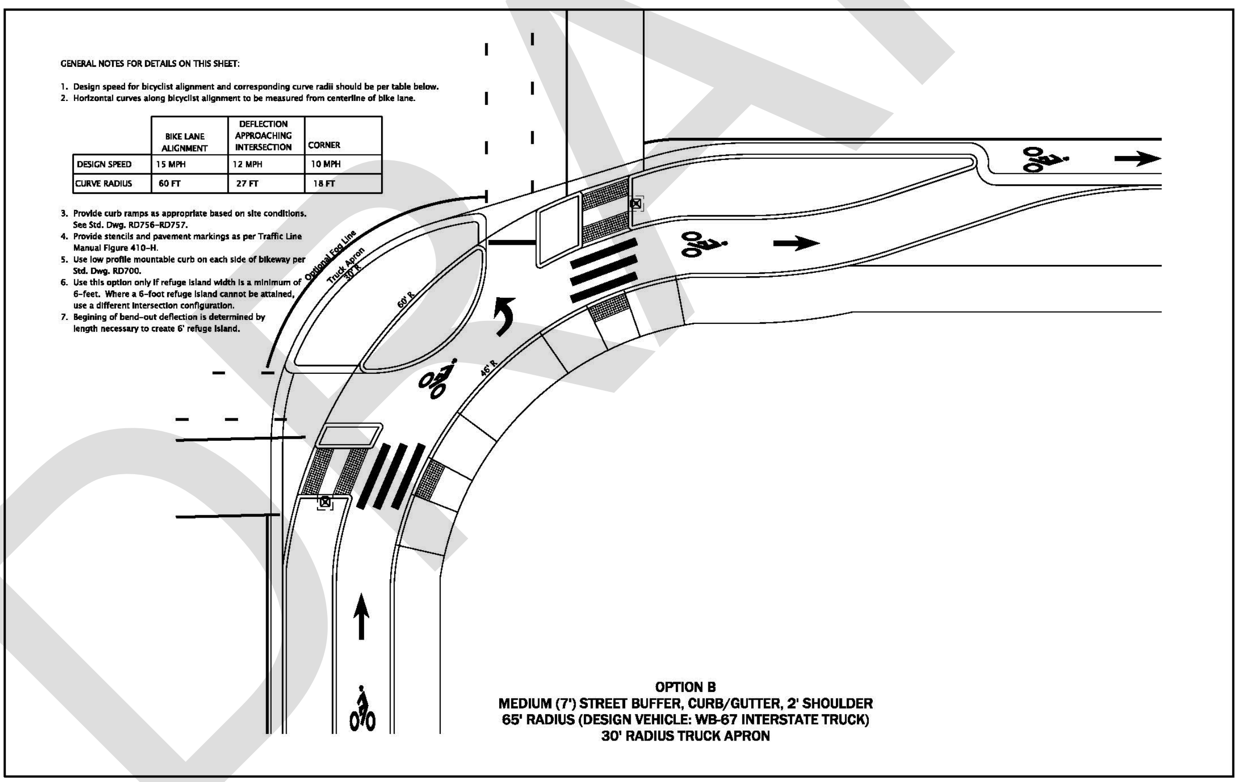


Figure 900-12 Protected Intersection with Narrow (2′) Street Buffer

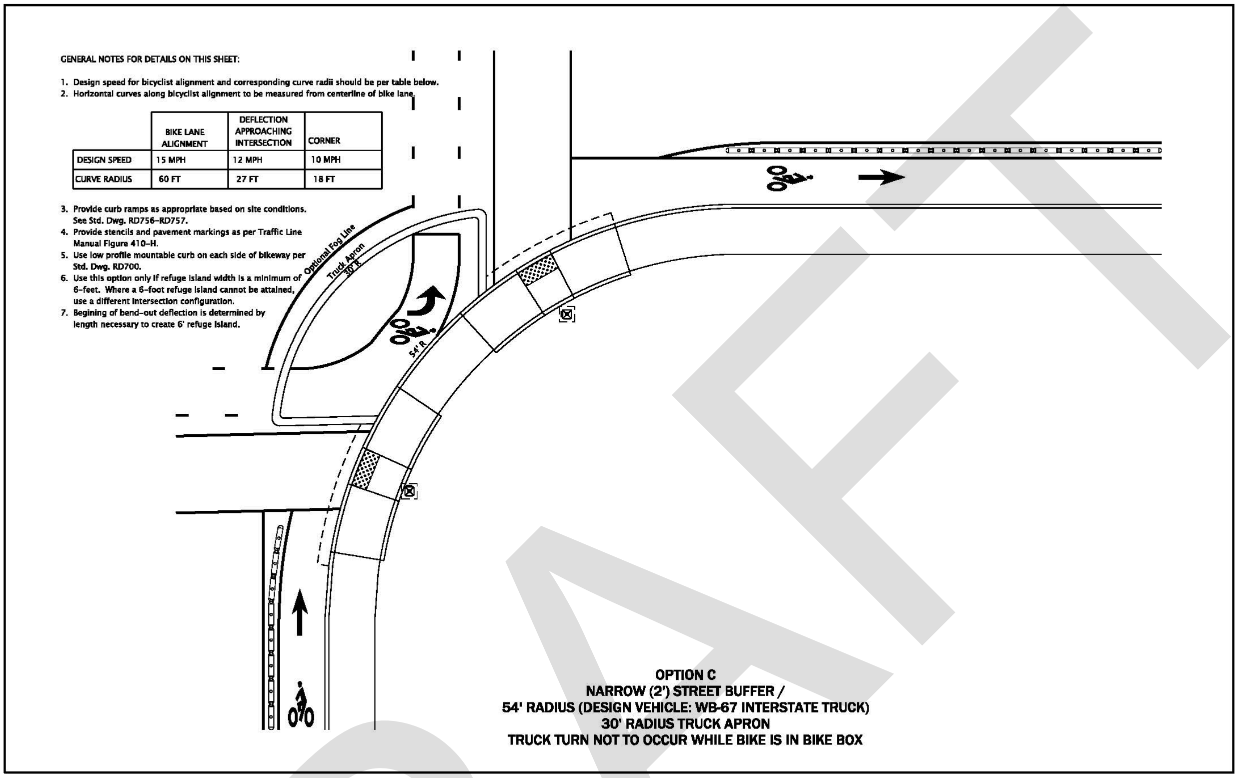
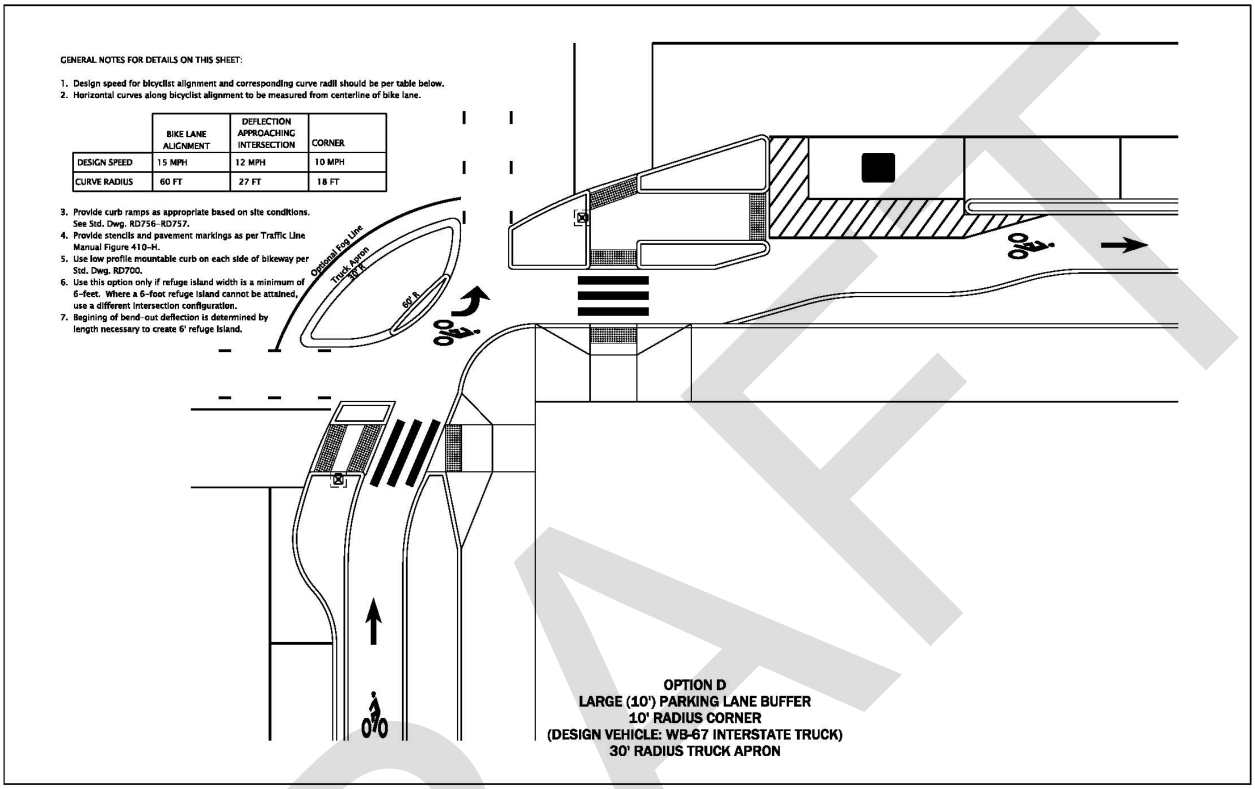


Figure 900-13 Protected Intersection with Parking Buffer



Section 955 Right Turn Lanes

At signalized intersections, pedestrian signal heads should be clearly visible - this requires that they not be placed too far from the nearest safe refuge. Crossing islands and curb extensions should be used to decrease crossing distances. Bicycle lanes should not be placed to the right of a right-turn only lane or to the left of a left-turn only lane, unless conflicting movements are controlled by a traffic control signal. Other intersection design principles for pedestrians and bicyclists are discussed in detail in section 2.3.1-2.3.2 and in Appendix L, pages 6-1 and 6-5.

Conflicts between motor vehicles, pedestrians and bicyclists often occur at interchange areas. Free-flow ramps should be avoided. Where they exist,, “Turning Vehicles Yield to Peds” symbol sign may be considered for unprotected pedestrian crossings. Consider grade separation when there is either two-lane right or left turn lanes or where free flow ramps are utilized. Other interchange design principles for pedestrians and bicyclists are discussed in detail in Appendix L, pages 6-20 to 6-25.

Section 956 Freeway Ramp Crossings

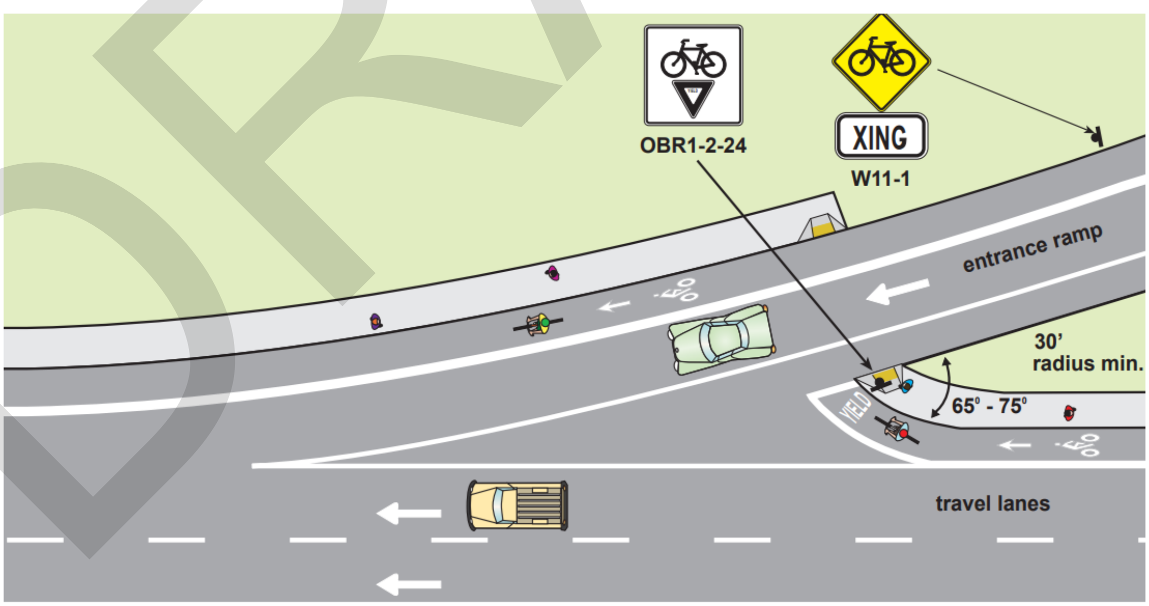
While bike lanes and sidewalks are not appropriate on limited access freeways, they are common on urban parkways, which often have freeway-style designs such as merging lanes and exit ramps rather than simple intersections. Traffic entering or exiting a roadway at high speeds creates difficulties for bicyclists and pedestrians. The following designs help alleviate these difficulties.

♦ Right Lane Merge

It is difficult for cyclists and pedestrians to traverse the undefined area created by right-lane merge movements, because the acute angle of approach reduces visibility, motor vehicles are accelerating to merge into traffic and the speed differential between cyclists and motorists is high.

The design should guide cyclists and pedestrians in a manner that provides: a short distance across the ramp at close to a right angle; improved sight distance in an area where traffic speeds are slower than further downstream; and a crossing in an area where drivers' attention is not entirely focused on merging with traffic.

Figure 900-14: Bicycle Lane across Merge Area

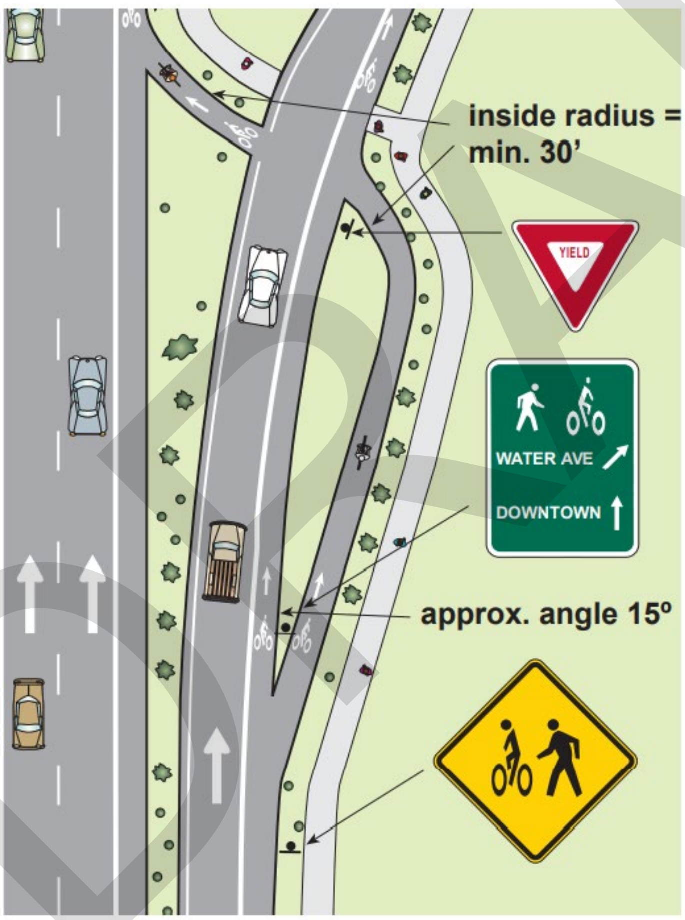


♦ Exit Ramps

Exit ramps present difficulties for bicyclists and pedestrians because motor vehicles exit at fairly high speeds, the acute angle reduces visibility; and exiting drivers who don’t use their turn signal confuse pedestrians and cyclists seeking a gap in traffic.

The design should guide cyclists and pedestrians in a manner that provides: a short distance across the ramp, at close to a right angle, improved sight distance in an area where traffic speeds are slower than further upstream; and a crossing in an area where the driver's attention is not distracted by other motor vehicles.

Figure 900-15: Bicycle Lane across Exiting Lane



Section 957 Bikeway Street Crossings

[placeholder for intro to section]

957.1 Side-street Bike Route Crossings

[placeholder for section]

957.2 Off-Highway Trail Crossings

Many recreational trails cross the state highway system. Users often use these trail systems as transportation links. Highways that cross these pathways should have access to the trail systems. If a highway has a separate-grade crossing with a pathway, provide a short path connection from the pedestrian and bicycle facilities along the highway to the pathway. See Appendix L, pages 7-13 through 7-16 for at-grade path crossings. See Appendix L, pages 7-13 through 7-16 for design guidance on under crossings and over crossings.

957.3 Grade-Separated Crossings

Though grade-separation appears to offer greater safety, the excessive added travel distance often discourages pedestrians who want to take a more direct route. A gradeseparated crossing must offer obvious advantages over an at-grade crossing.

A structure that is unused because it is inconvenient or feels insecure creates a situation whereby pedestrians are at greater risk when they attempt to cross the road at-grade; drivers don't expect pedestrians to be crossing the street if they see an overcrossing.

The additional distance is substantial: 17.5 feet of clearance is required over some highways; the added depth of the structure results in a 20 feet high bridge. ADA requires ramps to not exceed a 5% grade. Twenty feet of rise at 5% requires a 400 feet ramp in level terrain, for a total additional distance of 800 feet for both sides. This can be mitigated with stairs, or a 1:12 rise with a level landing for every 2.5 feet in rise. Overcrossings are more successful where the roadway to be crossed is sunken.

Undercrossings introduce two other issues that must be addressed: security and drainage. Security can be addressed by ensuring generous dimensions, good visibility and lighting. Drainage often requires a sump pump to ensure year-round operation. Undercrossings are more successful where the roadway to be crossed is elevated. In both cases the pedestrian crossing is level. Undercrossing should be at least 10 feet high and 14 feet wide.

957.4 Crossbikes

[Placeholder for section]

Section 960 Shared Use Path Design

Separated paths are facilities for people to walk, run, stroll, skate, bike, and use any of various mobility devices while being physically separated from the roadway. When a pathway is intended to serve bicycle travel together with pedestrian travel, it is a shared use path. Combinations of the words “shared use” and “multi use,” or “path” and “trail” are used interchangeably. Some multi-use paths may include accommodation of additional users, such as equestrians.

Shared use paths serve two purposes; one is providing a basic transportation need to get to destinations and the second is providing a place for recreational activity. When the pathway serves both pedestrians and bicyclists together, it is a shared use path. When pedestrians and bicyclists share a sidewalk, appropriate multi-use or shared path guidelines are employed for the design. Shared use paths are designed to be fully accessible for all users for the entire width of the walkway. Combinations of the words “shared use” and “multi use,” are used interchangeably. Shared-use paths are used by pedestrians, joggers, skaters, bicyclists and many others for recreation.

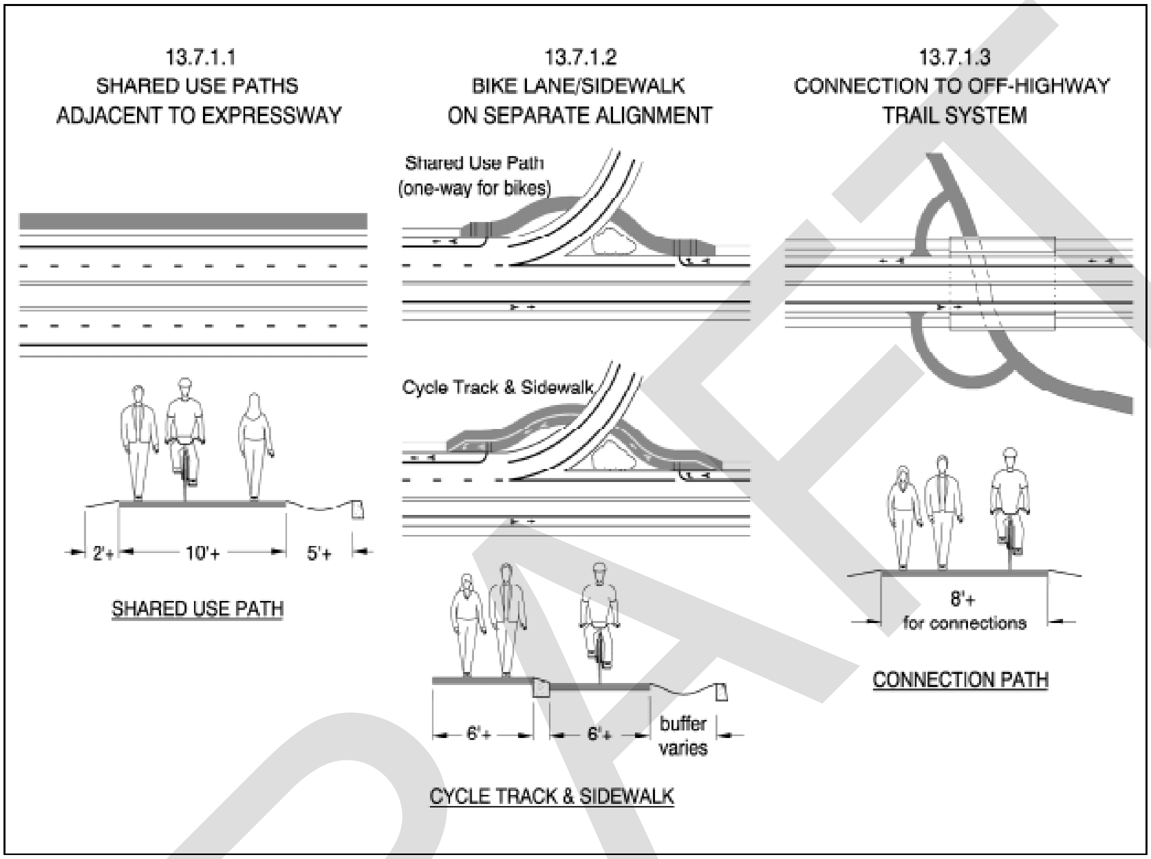
960.1 Shared Use Path Configurations

Shared use paths can parallel the state highway or may diverge on a separate alignment from the mainline onto other public right of way.

Multi-use trails may include accommodation of additional users, such as equestrians (See Section 855).

Separated pathways may be constructed on ODOT facilities in any of the following three contexts:

Figure 900-16: Types of Shared Use Path



One type of shared use path includes facilities within the highway right-of-way where pedestrians and bicyclists are physically separated from the travel way realm. Shared use paths parallel and adjacent to a road are described in Section 970.

Where a bicycle lane joins a sidewalk, see Sections 971 and 981.

Where a shared use path is on an independent alignment that may or may not be on public right-of-way, well planned and designed shared use paths can provide access and mobility to pedestrians and bicyclists in areas where the roads don't serve their needs. They can have their own alignment along streams, canals, utility corridors, abandoned or active railroads, and greenways. Many serve as linear parks. Shared Use Paths can serve both utilitarian and recreational cyclists.

Sections 961 through 968 have design information that apply to all types of shared use paths.

See Chapter 7 of Appendix L for additional information about typical pavement sections, drainage, vegetation, rail requirements, illumination, and structures, preventing motor-vehicle access, bollards and geometric design. In addition to design requirements in this manual, consider guidance in the AASHTO Guide for the Development of Bicycle Facilities for path design.

Section 961 Path Width

10 feet is the standard width for a shared-use path; *they should be 12 feet wide or more in areas with high use*. Table 900-12 gives recommended shared use path widths based on anticipated volume of users. The minimum width for a path, through a design exception, is 8 feet; only to be used at pinch points or where long-term usage is expected to be low.

Table 900-12 Recommended Shared Use Path Widths

Shared Use Path Peak Hour Volume	Recommended Width (feet)
Less than 50	8*
50 to 150	8 to 10*
150 to 300	10 to 12
300 to 500	12 to 15
500 to 600	16 to 20
Over 600	Over 20

*Design Exception required where width is less than 10 feet.

Design Exceptions are required for path widths less than 10-feet or shy distance less than 2 feet. An ADA Exception is required where a path grade is steeper than 5% for paths that are not on the same alignments with an adjacent roadway.

The entire width of a shared use path shall be clear of obstructions. Additionally, sidewalks that include bicycle traffic mixed with pedestrian traffic should have feet the sidewalk **clear** width to allow for a minimum width multi-use pathway condition. Clear widths less than 6 feet require a design exception. In locations where bicycle riding on the sidewalk is prohibited by statute, appropriate signage is necessary to inform bicyclists.

Provide a clear width between the range of 10 feet – 12 feet on shared use paths. *10 feet is the standard width for a two-way shared-use path; they should be 12 feet wide or more in areas with high use.* **Provide 8 feet of clear width on a connection paths.** When pinch points occur or where long term usage is expected to be low, 8 feet is the minimum clear width for two way shared use paths through a design exception

When mode separation is desired between pedestrians and bicyclist, additional width is required. **Provide a clear width between 16 feet and 20 feet for mode separated facilities.** *Provide at least 16 feet of clear width comprising of two 5-foot bike lanes and a 6-foot walking area (pedestrian zone). Provide 18 or 20 feet in areas of very high use.* While mode separation is provided typically with striping, low vision and blind pedestrians will need additional tactile cues (TWSI) to guide them to the intended area along the path. The entire width of the facility must still meet ADA cross slope and running slope (grade) requirements. Expect pedestrians to cross over and meander over the entire area, mode separation is best achieved with some grade separation via curb (Refer to Section 900s).

At roundabouts, the walkways become shared use paths, as they operate one-way for bicyclists and two-way for pedestrians. Widen the shared use path width to 10 feet. **Provide at least 8 feet of clear width on a bike ramp to allow bicyclists to merge from the bike lane onto the shared use path 165 feet in advance of the yield line to the circulatory roadway of a roundabout.** See Section 981 and Appendix L, Figure 1-40.

Section 962 Path Users

Though shared-use paths are intended for many users, the bicycle is the appropriate design vehicle because of its higher travel speeds. The design speed for pathway segments shall be assigned by the ODOT Region Roadway Manager. See Section 924.1. Design speeds for shared use paths impact other design elements including sight distance and horizontal and vertical curves.

For multiple tread trails that accommodate horses, consult the Equestrian Design Guidebook for Trails, Trailheads and Campgrounds.

Section 963 Path Clear Zone, Lateral Clearance and Shy Space

The space on each side of a paved path surface affects how much of the path people use. Where steep side slopes, or objects are placed alongside the path, users tend to shy away from using the entire path width. Additionally, where obstructions such as signs or poles exist alongside a path, the shoulder functions similar to the clear zone that is necessary for a road to enable vehicles to recover without crashing into an object.

The purpose of a path's clear zone is to preserve the functionality of the entire path width and to minimize the likelihood of injury if users run off the path. The clear zone consists of the path shoulder and the side slope and regulates how close objects may be placed on the sides of the path. The space abutting the paved path should enable path users to step on it without ankle twisting or ride on it without losing balance. The space alongside a path that is clear of obstruction functions as shy distance. Where shy space alongside a path is not clear of obstruction, the useable width intended for path users and their level of comfort is reduced.

A 2 foot shy distance on both sides of a shared-use path should be assumed as the minimum physical space requirement to achieve the required lateral clearance when scoping a path project. *It is necessary to have 3 feet or more at locations where signs or other objects are planned alongside the path.*

The first 3-feet on each side of a paved path function as shy distance for the path. However, it is not necessary that the entire 3-foot space be included within right-of-way so long as the space does not hinder the clear shy space with objects such as bushes, trees, or other vertical obstructions. The path should be abutted with graded material, such as gravel, flush to the path. At least the first 1-foot shall be graded at 1:6 or flatter. The entire shy space should be as level as practical to allow recovery by errant path users. **The maximum side slope in the first 3-feet of the path's shoulder shall be 1:2**. This applies to cut-sections, where falling debris can accumulate, stimulating weed growth, further restricting the available width. **Poles or sign posts shall be placed a minimum distance of 2-feet away from the paved path edge**. Objects, other than protective barrier, placed less than 2 feet from the path edge may be acceptable through a design exception. **Protective barriers, such as bicycle railings or fences shall be placed at least 1-foot from the path edge.** *In constrained conditions, in lieu of a gravel shoulder, the pavement may extend up to the constraint with a portion of the paved path marked with a white edge line to delineate some lateral clearance on that side*.

The standard clearance to overhead obstructions is 10 feet, **min. 8 feet** where fixed objects or natural terrain prohibit the full 10-ft clearance.

Where a path is parallel and adjacent to a roadway, there should be a 5-foot or greater width separating the path from the edge of roadway, or a physical barrier of sufficient height should be installed.

Section 964 Stopping Sight Distance

Stopping sight distance for bicyclists is the distance necessary for a bike to come to a full stop. Most objects along a shared use path segment do not encompass the entire width of the path and would not require complete stopping. The most common reason that stopping sight distance is necessary along a path is when groups of bicyclists ride together side-by-side. They can move into single-file to avoid a hazard when they are able, but when the limited space is occupied by opposing path users, someone may have to come to a full stop to avoid collision.

Determination of stopping sight distance is based on a bike coming to a stop on wet pavement from the design riding speed and having taken 2.5 seconds to react prior to applying the brakes. The distance to stop is less when people travel at lower speeds, are on dry pavement, or react quicker than 2.5 seconds. Since the risk of injury is related to bicyclist speed, it should be noted that the need for a bicyclist to come to a full stop rather than travel around an obstruction is disparate from the likelihood that the bicyclist would be traveling a faster design speed. An adult cyclist riding alone typically rides faster than an adult riding with children or a group of adults riding together, while the need for stopping is most common with group riding since an individual might weave around an object within the available width of the path.

Design exceptions are required to justify stopping sight distance around horizontal and vertical curves.

$$S = 3.67V + \frac{V^2}{30(f + G)}$$

Where,

S = stopping sight distance (ft)

V = design speed (mph)

f = friction factor (assume 0.16 for a typical bicycle)

G = grade in (ft/ft)

Section 965 Horizontal Alignment

Typically, simple horizontal curves shall be used on shared use paths. Curve radii are measured from the center of the shared use path. There are two ways to calculate the minimum radius of curvature along a shared use path. One way is to calculate based on the lean angle. The other way is to calculate based on superelevation rate.

Bicyclists lean to prevent falling outward due to forces associated with turning movements. Two-wheeled bicycles are typically the fastest users on a shared use path. Twenty degrees is the typical maximum lean angle for most riders of two-wheeled bicycles. The deflection angle (Δ) is another factor affecting the safe travel of bicycles on a horizontal curve. Deflection angles greater than 90 degrees require additional caution as inertial forces begin to act in the opposite direction from the beginning of the curve. Bicyclists entering these curves at higher speeds could risk running into opposing path traffic, riding off the outside edge of the path or falling over from turning forces.

Some bicycles (cargo bicycles, tricycles and bikes with trailers) have three or four wheels and are not able to lean. Users of these types of bicycles tend to be slower. In order to check that these users are accommodated, the superelevation method should be used at a speed 2 to 4 mph slower than the design speed.

Superelevation rate is equivalent to the cross slope of the path. Because a shared use path is also a pedestrian facility, paths must not exceed 2% cross slope in order to meet accessibility requirements per the ADA. **The maximum superelevation rate (design cross slope) on a shared use path (shared with pedestrians) is 1.5%.** If a shared use path is separated with different tracts for pedestrians and bicyclists, the superelevation allowed for the bicycle-portion of the path may be increased up to 8 percent. **The maximum superelevation rate (design cross slope) for a bicycle-only path is 8.0%.**

Equation 965-1 - Radius of Curvature Based on Lean Angle

$$R = \frac{0.067V^2}{\tan\theta}$$

R = radius of curvature.

V = design speed. See Section 924 for selecting the appropriate design speed;

Θ = the lean angle, typically 20 degrees.

Equation 965-2 –Radius of Curvature Based on Superelevation Rate

$$R = \frac{V^2}{15 \times (e + f)}$$

R = radius of curvature.

V = design speed. See Section 924 for selecting the appropriate design speed;

e = cross slope, expressed as decimal (e.g. 1.5% = 0.015)

f = coefficient of friction

Where the deflection angle of the horizontal curve is 90-degrees or less, the ODOT design standard for minimum radius of curvature is based on a lean angle. Where the deflection angle of the curve is greater than 90 degrees, the ODOT design standard for minimum radius of curvature is based on the superelevation rate using the design cross slope. The minimum radius recommended for shared use paths is provided in . A design exception is required to justify where the minimum radius of curvature is not achieved.

Table 900-13: Minimum Radius of Curvature for Horizontal Curves

Design Speed (mph)	8	10	12	14	16	18	20	22	24	26	28	30
Minimum Curve Radius (feet) at 20° Lean Angle	12	18	27	36	47	60	74	89	106	124	144	166
Minimum Curve Radius (feet) at 1.5% superelevation	12	20	30	42	57	74	96	122	151	184	222	267
Minimum Curve Radius (feet) at 5.0% superelevation*	11	18	27	37	50	65	86	108	132	161	194	231
Minimum Curve Radius (feet) at 8.0% superelevation*	10	17	25	34	46	60	78	98	120	145	174	207
Friction factor (f)	0.33	0.32	0.31	0.30	0.29	0.28	0.26	0.25	0.24	0.23	0.22	0.21

*Superelevation above 1.5% only to be used on paths not shared with pedestrians.

If design curve radius does not meet the design standard, based on the chosen design speed, consult ODOT roadway unit in the Region tech center or the headquarters roadway unit to discuss whether a design exception is needed.

If the minimum radius of curvature is not achieved using the standard method, the alternative method in may be checked and used as support for a design exception. The lean angle method typically yields a smaller radius, except when the superelevation is above 5%. Back-calculating the speed for which bicyclists may safely travers a curve is another way to support a design exception when the radius is not achievable. Another strategy to mitigate sharp horizontal curves is to straighten the horizontal alignment by adding tangent sections between curves so that deflection angles are under 90-degrees. Sharp horizontal curves can be mitigated by adequately informing path users to be cautious and slow around the curves. Typical mitigations include a centerline stripe and warning signs.

965.1 Horizontal Sightline Offset

People bicycling need a clear line of sight around obstructions that may reduce the sight line in a horizontal curve. **Evaluate stopping sight distance throughout the alignment of a horizontal**

curve. The lateral clearance to an object alongside a path is a Horizontal Sightline Offset (HSO). The equations below check whether an object impedes the sight distance of a horizontal curve and indicates the minimum clearance for horizontal curve line-of-sight obstructions based on curve radius and stopping sight distance. If keeping this line of sight clear is not practical, consider widening the path through the curve, installing a centerline stripe, installing warning signs or a combination of these alternatives

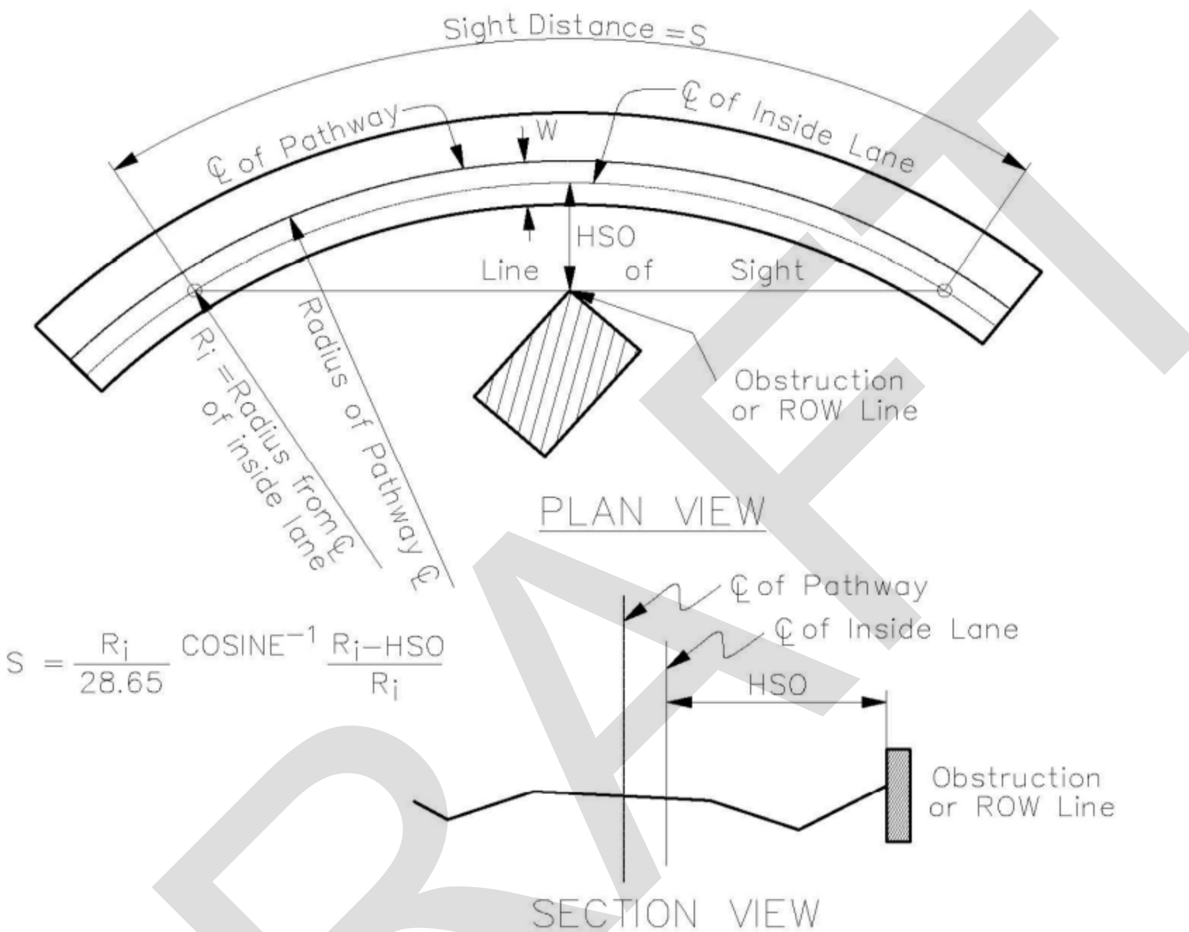
Equation 965-3 Horizontal Sightline Offset (HSO) for Horizontal Curve

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

Equation 965-4 Back-Calculation of Stopping Sight Distance from Horizontal Sightline Offset

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

Figure 900-17: Horizontal Sightline Offset



(*Figure taken from Colorado Roadway Design Manual[13], Figure 14-32)

Section 966 Vertical Alignment

The minimum length of a crest vertical curve is based on the distance needed to provide minimum stopping sight distance. Below are the formulas to calculate the curve length needed based on stopping sight distance on crest vertical curves. This formula is based on a person's eye height of 4.5 feet on a standard bicycle. It is preferred to use a recumbent bicycle as the recommended design vehicle for vertical curves because the 3.8-foot eye height of a person using a recumbent bicycle is lowest among bicycle types, which in turn limits the sight distance over crest vertical curves.

Equation 966-1

$$S = 30\sqrt{\frac{L}{A}}\, OR\, S = \frac{L}{2} + \frac{2025}{A}$$

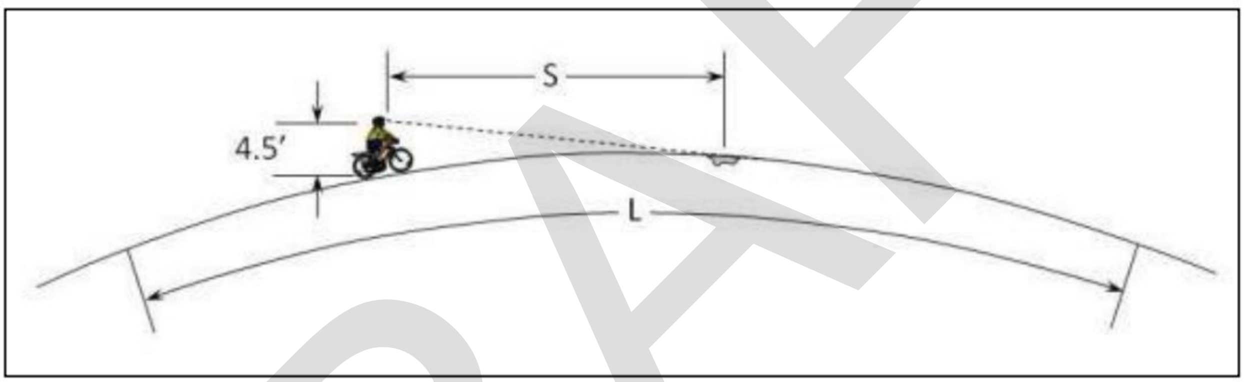
Where:

S = stopping sight distance (feet)

L = length of crest vertical curve (feet)

A = algebraic difference in grades (%)

Figure 900-18: Sight Distance on Crest Vertical Curve



(*Figure taken from Colorado Roadway Design Manual[13], Figure 14-33 – need to replace with recumbent)

966.1 Path Grade

When the shared use path is parallel with the mainline alignment and contiguous with the curb zone, the walkway shall not exceed the roadway grade under the ADA. An ADA design exception is required where a vertical grade is steeper than 4.5% (5.0% finished surface) on shared use paths that are not on the same alignments with an adjacent roadway. To meet ADA requirements, the grade of separated shared use path shall not exceed 5.0%.

Sharp curves should be banked with the high side on the outside of the curve to help bicyclists maintain their balance.

Where right-of-way and geometric constraints make the provision of a continuous grade less than 5 percent impractical, grades should be minimized and require a design exception for justification. Where potential grades exceed 5 percent, intermittent level resting intervals should be considered. Where provided, resting intervals shall be full width of the shared use path and

60 inches long. Alternatively, a 36-inch wide resting interval may be located adjacent to the shared use path. Recommended maximum distance between resting areas is 200 feet.

Shared use paths located along roadways may follow the grade of the road. Where grades exceed 5 percent, resting intervals should be provided. Where sustained grades exceeding 4 percent in excess of 300 feet in length are required, an increased design speed should be used. Additionally, consider providing mitigating measures including hill warning signs, wider clear recovery areas adjacent to the shared use path; and additional width to allow some users to dismount and walk their bicycles. Alternatively, consider installing a series of switchbacks to reduce the longitudinal grade. Transitions between grades with more than 2 percent algebraic difference can be made with vertical curves. The minimum length for a vertical curve on a shared use path is 3 feet.

Section 967 Path Surface

The surface material should be packed hard enough to be usable by wheelchairs, strollers and children on bicycles (the roadway should be designed to accommodate more experienced bicyclists). Recycled pavement grindings provide a suitable material. The surface material must be meet ADA surface requirements for the full width of the shared use path.

Refer to section ** on Walkway Surfacing. Depth of asphalt construction of a walkway is shown in the RD600 series for shared use path pavement details. Shared use paths occasionally need to allow access for maintenance vehicles which will increase the asphalt pavement foundation and final surfacing depths.

Section 968 Path Cross Slope and Superelevation

Sharp curves should be banked with the high side on the outside of the curve to help bicyclists maintain their balance. The standard design cross-slope is **1.5% (2.0 % finished surface)** to provide drainage, **in a crown section or shed section**.

Section 969 Path Transitions

[Placeholder for section]

Section 970 Side Path Design

Combining pedestrians and bicyclists together along one side of a highway on a shared use path, is discouraged on highways without access control, but is a preferred facility option for limited access expressways and urban freeways. Crash potential increases when bicycle traffic rides against the normal flow (reverses flow) of motor vehicle traffic on highways with frequent driveway or street access. Since expressways are designed for access-restriction, many of the conflicts are mitigated. A separated bicycle facility may not be needed when a well-connected network of bicycle facilities parallel to the freeway or expressway provides the same access that bicycle accommodation on the expressway would provide. The wide shoulder would accommodate occasional bicycles as necessary. Guidelines for providing bikeways on parallel routes are given in Section 946.

Combining pedestrians and bicyclists together along one side of a highway on a shared use path, is discouraged on highways without access control, but is a preferred facility option for limited access expressways and urban freeways. Crash potential increases when bicycle traffic rides against the normal flow of motor vehicle traffic on highways with frequent driveway or street access. Since expressways are designed for access-restriction, many of the conflicts are mitigated. A separated bicycle facility may not be needed when a well-connected network of bicycle facilities parallel to the freeway or expressway provides the same access that bicycle accommodation on the expressway would provide. The wide shoulder would then provide bicycle accommodation as necessary. Review Part 200 for design of urban expressways. Guidelines for providing bikeways on parallel routes are given in Appendix L, page 1-15.

Section 944 discusses the Street Buffer Zone. The required width of a street buffer zone applies to separated bike lanes. However, if a shared use path is provided in lieu of a separated bike lane, there is a minimum street buffer width of 5-feet. **Where a path is parallel and adjacent to a roadway, there should be a 5-foot or greater width separating the path from the edge of roadway, or a physical barrier of sufficient height should be installed**.

[placeholder for side path design]

Section 971 Mode-Separated Paths and Two-way Separated Bike Lanes

The minimum total width required for a mode-separated path is described in Section 961. The 16 feet is comprised of two 5-foot bike lanes and a 6-foot walking area. 18 or 20 feet are needed in areas of very high use.

A mode-separated side path is equivalent to a two-way separated bike lane alongside a sidewalk. This type of facility is sometimes referred to as a cycle track. They are used extensively in Europe on major arterials and are characterized by a physical separation from both motor vehicle traffic and pedestrian traffic. Both vertical and horizontal elements are used to separate modes. Sidewalk must be present in order for the separated bike lane to serve bicyclists only. Two-way separated bike lanes require special attention to traffic operations at intersections such as bicycle signals and two-stage left turn devices.

Section 944 discusses two alternatives, how to design a facility where bicycle and pedestrian traffic are side-by-side. The design is dependent on the fundamental decision whether Pedestrians and Bicycles Allowed to Mix or Pedestrians and Bicycles Not Intended to Mix. A two-way separated bicycle lane is a

Section 901 discusses considerations for one-way versus two-way bicycle travel on one side of a road.

Sections 961 through 968 include design standards for shared use paths.

Section 980 Bicycle Ramp Design

Sections 981, 982, 983 discuss where to use Bicycle Ramps, configurations.

[placeholder for section discussing slopes, etc.]

Section 981 Bike Lane to Shared Use Path

[placeholder for additional content in section]

A bike lane may separate from motor vehicle lanes onto a separate alignment to bypass obstacles such as merging lanes, transit stops, a parking lane or the circulatory roadway of a roundabout, but rejoin as an on-road bikeway. Bike lanes may also be separated from the roadway as speed, volume and heavy vehicle percentages increase, in order to partially mitigate the speed differential between modes. Means of path separation include horizontal and/or vertical elements. A bike lane may also diverge from the travel way beyond the edge of pavement and join the sidewalk. It serves bicyclists in one-direction, but it serves pedestrians in both directions. In each of these scenarios, a bicycle ramp is required to transition bikes into a pedestrian area.

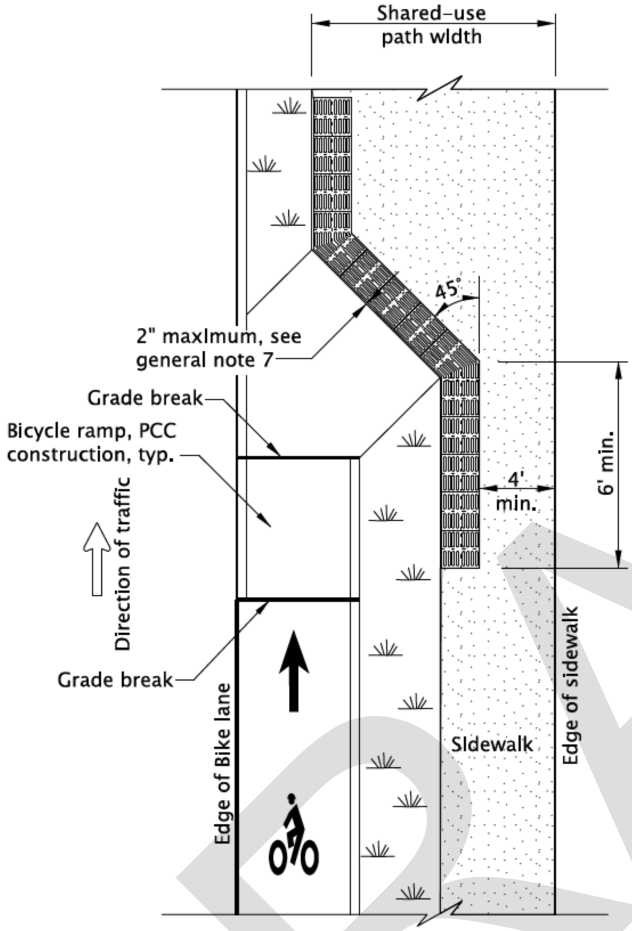
In general, bicyclists will be given a choice to enter a roundabout as a vehicle and occupy a lane until exiting the roundabout, or to use the sidewalks and crosswalks as pedestrians. For these bicyclists, a bike ramp is provided through the curb zone to exit the bike lane on approach to the roundabout and use the walkway and crosswalks in the manner of a pedestrian. This walkway results in a shared use path for a small segment along the central circle. The bike ramp is not required to be fully accessible however many of the geometrics are similar as power assisted mobility devices may travel in the shoulder under the ORS and could enter the shared use path with these sloped ramps. Bike ramps are not intended for pedestrians and requires additional treatments to communicate to the low vision and blind community it's intended use and function. Bike ramps can be confused with pedestrian curb ramps by vision impaired pedestrians. A tactical walking surface indicator shall be included adjacent to bicycle ramps. At roundabouts, add a bike ramp to merge from the bike lane onto the shared use path 165 feet in advance of the yield line to the circulatory roadway of a roundabout. See Part 500, Section 509 and Appendix L, Figure 1-40.

Bicycle ramps only serve bicycle traffic. If there is no sidewalk on the approach to a roundabout, the ramp to a path serving the roundabout functions for both bicyclists and pedestrians. Use a pedestrian curb ramp rather than a bicycle ramp in that case.

An important function of bicycle ramps that merge with shared use paths is the interface between people walking and biking. In order to mitigate the potential for sight-impaired pedestrians to inadvertently walk into a bike ramp, a tactile edge detection is needed along the border of the sidewalk or shared use path. One option for a detectable boundary is to use detectable guide strips. See Standard Drawing RD909. A tactical walking surface indicator shall be included adjacent to bicycle ramps (See section 825.2).

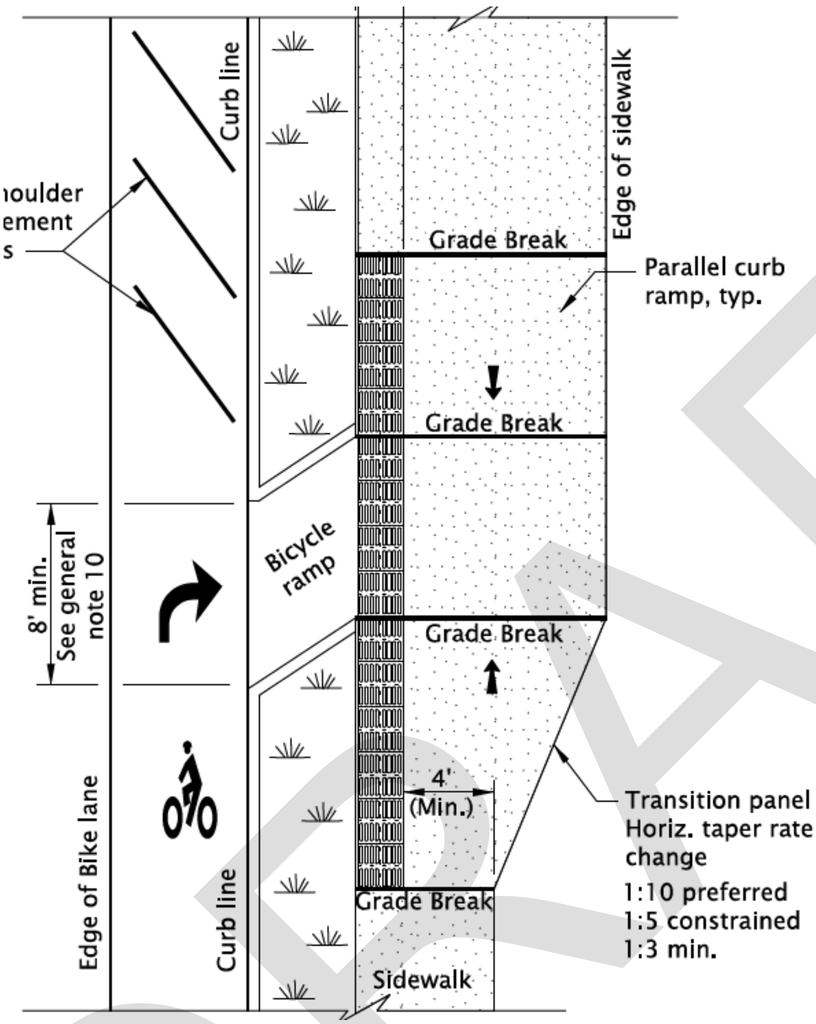
Where a bike ramp is in line with the approaching bike lane, the bike ramp may be equal in width to the approaching bike lane. See Figure 900-16

Figure 900-19 Bicycle ramp to Shared Use Path (Bike Lane Drops)



Where a bike ramp requires bicycles to move parallel to the bike lane, **Provide an 8′ wide ramp from the bike lane to the path.**

Figure 900-20 Bike Ramp Parallel to Path



Section 982 Bike Lane to Raised Bike Lane

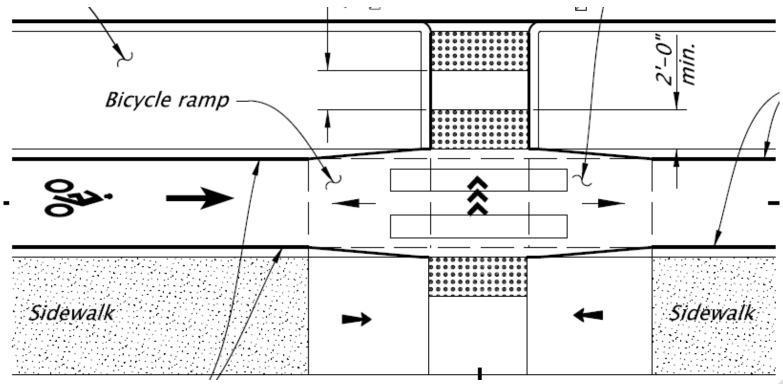
[placeholder for section] See Standard Drawing RD1140.

Section 983 Bike Lane at Raised Crossings

[placeholder for section]

See Standard Drawing RD1140. Raised crosswalks and raised intersections

Figure 900-21 Bicycle Ramp at Street Crossing



Section 984 Bike Lanes at Transit Stops

Transit trips begin and end with a walk or bike ride. Pedestrian and bicycle facilities in transit corridors make transit systems more effective. Therefore, high priority should be given to providing sidewalks and bikeways on transit routes and on local streets feeding these routes. Bus stops should provide a pleasant environment for waiting passengers, with shelters, landscaping, adequate buffering from the road and lighting. Bus stop design should minimize conflicts with other non-motorized users, such as bicyclists on bike lanes or pedestrians walking past passengers waiting to board.

Due to the dwell time at transit stops, the average running speed of a transit vehicle can be very similar to the average speed of a bicycle rider. As a result, people on bikes often experience a leapfrog effect, where they pass a transit vehicle while it is stopped, are passed by the transit vehicle shortly afterward, and then pass it again having caught up to its next stop. This cycle can continue as long as they continue along the same corridor. Even if a bicyclist stops and waits for the boarding and alighting, the bicyclist will typically catch up to the transit vehicle at the next stop to have the same dilemma repeat itself.

A typical conflict along such a transit corridor occurs when a bus stops in the bike lane. While the bike lane is blocked, bicyclists can either stop behind the bus and wait or attempt to pass on the left. On high speed or high traffic facilities, passing opportunities might be stressful and risky. When the bus re-enters traffic, a bike could be in the bus driver's blind spot. Since bicyclists are vulnerable users, there's more risk of personal injury at stake with a sideswipe crash than there is between two motor vehicles.

There are two transit stop configurations that minimize the leap frog effect. Either pull out across the bike lane or a 'floating bus stop'.

[placeholder for more content]

Section 990 Parking

All modes of transportation, except walking, utilize a transportation vehicle that can be used insofar that the vehicle can continue traveling or be left alone at the user's destination. Once the vehicle is parked, the user becomes a pedestrian and requires accommodations to serve pedestrians.

Section 991 Vehicle Parking

On-street parking is part of the Transition Realm. Where on-street parking is permitted, the bike lane may be placed between parking and the travel lane or between the parking lane and sidewalk. Separated bike lanes with on-street parking as a buffer are described in Section 945.2.

Motorists are prohibited from using bike lanes for driving and parking, but may use them for emergency avoidance maneuvers or breakdowns.

Diagonal parking can cause conflicts with bicyclists: drivers backing out have poor visibility of oncoming cyclists and parked cars obscure other vehicles backing out.

This is mitigated by the slower traffic speeds found on streets with diagonal parking, and cyclists ride close to the center of the adjacent travel lane. Bike lanes may be placed next to diagonal parking if the following recommendations are implemented:

- The parking bays are long enough to accommodate most vehicles, or long vehicles are prohibited;
- A 4 inches stripe separates the bike lane from parking; and
- Enforcement actively cites or removes vehicles encroaching into the bike lane.

Consider back-in diagonal parking: Back-in diagonal parking creates conditions advantageous to all traffic, including bicyclists: drivers can pull into the traffic stream with a good view of oncoming traffic, including bicyclists.

Note: approval from the State Traffic Engineer is required for diagonal parking.

Section 992 Bicycle Parking

Bicycle parking is necessary for people on bicycles to access destinations. Peoples' decision whether to bicycle can be greatly influenced by the presence of secure bicycle parking. While most bicycle parking may be outside of the highway right-of-way, bicycle parking within the public right-of-way is often desirable in STA and traditional downtown areas. Bicycle parking should either be in clear sight from the bikeway or directional signage should be used so that people park in the designated bike parking rather than tied to appurtenances in the sidewalk buffer zone. Many bicyclists use a series of transportation modes. Consider installation of bicycle parking at park and ride lots and transit stops.

Bicycle racks must be designed so that they:

- Don't bend wheels or damage other bicycle parts;
- Accommodate high security U-shaped bike locks;
- Allow users to secure the frame and both wheels;
- Don't obstruct pedestrians (especially when bikes are parked);
- Are covered where users will leave their bikes for a long time; and
- Are easily accessed from the street and protected from motor vehicles.

The simplest, easiest to install and most effective bike rack is the "inverted U" or "staple." Both fulfill all of the above design requirements. To establish a theme or motif, "art racks" are often created to add whimsical and artistic touches to otherwise perfunctory bike racks. In many cases they function well for bike parking, and don't interfere with pedestrian travel. But some racks have features that make it difficult to lock a bicycle securely, or protrude too far into the pedestrian's path of travel. The best art racks are variations of the commonly accepted inverted U or staple designs.

When providing bicycle racks for Elementary School sites, use a child bicycle or BMX bicycle as a design vehicle. Ensure that the front and rear wheel of these smaller bicycles are close enough to the two bars of the bicycle rack to properly secure both wheels and frame to the rack. Ensure that some adult-sized bicycles can be secured as well.

Bicycle parking areas within a site may include signs that teach users best practices how to securely park their bicycle.

Curb extensions create good opportunities to provide bicycle parking out of the pedestrian zone, especially in areas where sidewalks are narrow. They also benefit from the proximity of a curb cut at the corners. The parking should be placed where it will not obscure visibility of pedestrians crossing the street, or motorists waiting to enter a street.

Where there is insufficient room on the sidewalks to provide sufficient bicycle parking without cluttering the pedestrian zone, bicycle parking can be provided in the street. One parallel car parking spot can provide parking for up to 12 bicycles. It must be buffered by bollards, curb extensions or other forms of positive protection.

For additional bicycle parking design criteria, see Chapter 3 of Appendix L.

Section 993 Parking Other Micro Mobility Devices

People who travel using segways, skateboards, longboards, scooters and other small devices may bring them into their destinations. However, some businesses do not allow them inside and providing parking may enable people to use these other modes of transportation. Conventional bike parking may not function well for other devices. Where a known demand exists for another mode of transportation, parking may be considered in the right-of-way to serve that transportation mode.

[Placeholder for details for design criteria to provide parking for each device]

Section 994 Bike and Scooter Share Stations

Bike share and scooter share services are characterized as systems where people generally rent a bicycle or a scooter from a docking station or hub and ride to another hub near their destination. Dockless systems allow users to stow the self-locking shared transportation device anywhere the user decides. This relies on the plentiful provision of adequate unused space on sidewalks to be used as potential bike share or scooter share parking. These systems can make trips on mass transit more viable when transit stops are not located as close to destinations as users prefer.

Where docking share systems exist, a docking station or hub can be designed similar to bicycle parking. In addition to the siting criteria for bike parking, a docking station may also require electrical power and may include information kiosks and pay stations.   Pay stations need to meet ADA requirements for operable parts: they require a clear space a minimum of 2.5′ x 4′ with a maximum 2% cross slope and controls within a 10-inch horizontal reach from a height between 15″ and 48″ above the ground. Docking stations may be located in an on-street parking space or within the sidewalk buffer zone. A minimum 6-foot clear space outside of traffic is needed for people to pull a bicycle out of a docking station.

Section 995 Trailhead Design

[placeholder for section]

Trailheads are locations where recreational bicycle trips begin, but may have initiated with a motor vehicle. Design features include design for automobile parking, bicycle parking and amenities for bicycle travel such as restrooms, repair stands, water fountains, information kiosks, etc.

Section 996 References

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Part 1000 Design Exceptions

Section 1001 Introduction

The information in this section describes the design exception process for planning studies and project development. In addition, this section details the design elements and features that require design exceptions as well as the information needed to justify approvals of design exceptions. The design standards are generally described in Part 100 and further defined for particular highway classification and environments throughout the HDM.

1001.1 Font Key

Text within this subsection is presented in specific fonts that show the required documentation and/or approval if the design does not meet the requirements shown.

Table 1000-1: Font Key

Font Key Term	Font	Deviations	Approver
Standard	**Bold text**	Design Exceptions require STRE	STRE or FHWA
Guideline	***Bold Italics text***	Design Decisions Document	Region with Tech Expert input
Option	*Italics Text*	Document decisions	EOR
General Text	Not bold or italics	N/A	N/A

See Part 100 for more information about standards, guidelines, options, and general text. The font key does not apply to text within a table or figure.

Section 1002 Definitions

General Design Exception - An engineering report documenting the request for an exception from a standard of practice for roadway design that requires State Traffic-Roadway Engineer approval or Federal Highway Administration documentation. General Design Exception form requires a professional engineering seal from both the Engineer of Record (EOR) and the State Traffic-Roadway Engineer.

ADA Curb Ramp Design Exception - An engineering report documenting the request for an exception from a standard of practice for curb ramp design that requires State Traffic-Roadway Engineer approval or Federal Highway Administration documentation. ADA Curb Ramp Design Exception form requires a professional engineering seal from both the Engineer of Record (EOR) and the State Traffic-Roadway Engineer.

Standard - A statement of required, mandatory, or specifically prohibitive practice regarding a roadway geometric feature or appurtenance. All Standard statements appear in bold type in design parameters. The verb "provide" is typically used. The adjective "required" is typically used in figures to illustrate Standard statements. The verbs "should" and "may" are not used in Standard statements. The adjectives "recommended" and "optional" are only used in Standard statements to describe recommended or optional design features as they relate to required design features. Standard statements are sometimes modified by Options. A design exception is required to modify a Standard. The State Traffic-Roadway Engineer (STRE) gives formal approval, and FHWA approves as required.

Guideline - A statement of recommended practice in typical situations. All Guideline statements appear in bold italicized type in design parameters. The verb "should" is typically used. The adjective "recommended" is typically used in figures to illustrate Guideline statements. The verbs "provide" and "may" are not used in Guideline statements. The adjectives "required" and "optional" are only used in Guideline statements to describe required or optional design features as they relate to recommended design features. Guideline statements are sometimes modified by Options. While a formal design exception is not required, documentation of the decisions made by the Engineer of Record in the Design Decision documentation or other engineering reports is required. Region approval, with input from Technical Experts, is formally recorded via the Design Concurrence Document in the Design Decision portion.

Technical Concurrence Memo - A written communication, which may be via email, between the Engineer of Record and technical subject matter experts documenting consultation regarding a specific design element incorporated in a design that is retained within the project records. Concurrence may be from the State Traffic Roadway Engineer, State Roadway Engineer, or technical resource subject matter expert that has been delegated authority.

Section 1003 General

It is the designer's responsibility to design from the best practices perspective to incorporate design elements that optimize the operation and safety of the system but stay within constrained funding limits. This is the intent of practical design, getting the most out of limited funds for the benefit of the entire system not just the project. In the context of the project, if the proposed impacts from the design are deemed too great then, with proper justification, a design exception can be entertained. The S.C.O.P.E. elements as outlined in Part 100 provide context for conflicting parameters to coexist.

It is important to keep project and corridor context in mind. While any one solution may be appropriate in a rural setting, this does not automatically mean that the solution is to be used statewide in complex urban contexts. A right of way impact in one context may mean a purchase of property and in a different context a design exception is used to avoid any right of way impacts. Consultation with Roadway Engineering Unit staff in Technical Services will assist the design engineer in evaluating the specific context of the project and when a design exception is required. Consultant designers should also consult with Region Roadway staff.

Design exceptions typically originate during the project development process through Project Teams, or in some instances, during the planning process. Design exceptions should originate as early as practical in the project development process. The intent of design exceptions are to determine and justify that good engineering decisions are made involving design standards in constrained areas. Design exceptions in high-density urban areas can be more common due to the constraints in an urban setting, such as right of way impacts and construction costs.

New ideas often require stepping outside of standards, so follow the process to document the decision and seek FHWA approval when required for experimental treatments. The design exception is also used for documentation on roadway treatments that ODOT is evaluating efficacy of its use.

1003.1 Approval Authority

The Chief Engineer has delegated authority for determination of design standards on State and Federal-Aid projects.

The State Traffic-Roadway Engineer, through delegations from the Chief Engineer, has authority to approve exceptions to design standards for ODOT projects.

Federal Highway Administration (FHWA) approves design exceptions on projects that involve the National Highway System (NHS). FHWA limits review to design exceptions for the 10 controlling criteria shown in Table 1000-3. If the design exception does not include any of the 10 criteria, FHWA does not need to approve the exception.

1003.2 Planning Design Exceptions

Design exceptions formally obtained in writing during the Planning, Environmental or Survey phases need not be requested again unless significant changes have been made to the design. A review of the approved design exception needs to be made prior to the Design Acceptance Package (DAP) to ensure that the exception is still valid for the project. A list of the design standards that must be considered in the exception process, depending on the type of project, can be found in Figure 1000-2.

1003.3 Planning Projects

Planning studies may require design exceptions to standards. Transportation System Plans, Refinement Plans, Facility Plans, Transportation Growth Management studies, Access Management Plans, or Corridor Plans should not be adopted with nonstandard highway features unless the State Traffic-Roadway Engineer has approved a design exception or has indicated in writing that a design exception would likely be approved. Typically, corridor studies are not developed with a level of detail that involves an exception for design standards. Transportation Growth Management (TGM) funded projects and refinement plans may have enough detail and information that would support design exception requests. As with normal project development projects, the appropriate background information and justification must be obtained or be available to initiate the design exception process.

For a project that may be constructed within five years, the planner or project leader in charge of the planning project should contact the Region Roadway Manager to assist in putting together the design exception request. The design exception request should be processed in the same manner as a project development design exception, which is listed in Section 1004.

For projects that may be constructed within five to ten years, the design exceptions should be identified, and the State Traffic-Roadway Engineer should give a written indication that a design exception is warranted and would probably be approved.

For projects anticipated beyond 10 years to construction, consultation with Roadway Engineering Unit staff in Technical Services about non-standard items should be made, but no formal action is required on these types of projects. Non-standard design items should not be shown on plans or maps when the project is more than ten years to construction. A change of context can occur such that proposed justification would no longer be valid at the time of construction.

1003.4 Project Development Projects

Exceptions to design standards should be first discussed at project scoping, project team meetings, or during reconnaissance studies. When enough data is available, agreement on standards, and from which standards to request exceptions, should be reached at these meetings. Requests for design exception require justification. Some considerations which may cause a request for an exception to the design standards are listed below:

- Excessive construction cost or cost/benefit
- Compatibility with adjacent sections
- No plans for improvement of adjacent sections in the foreseeable future

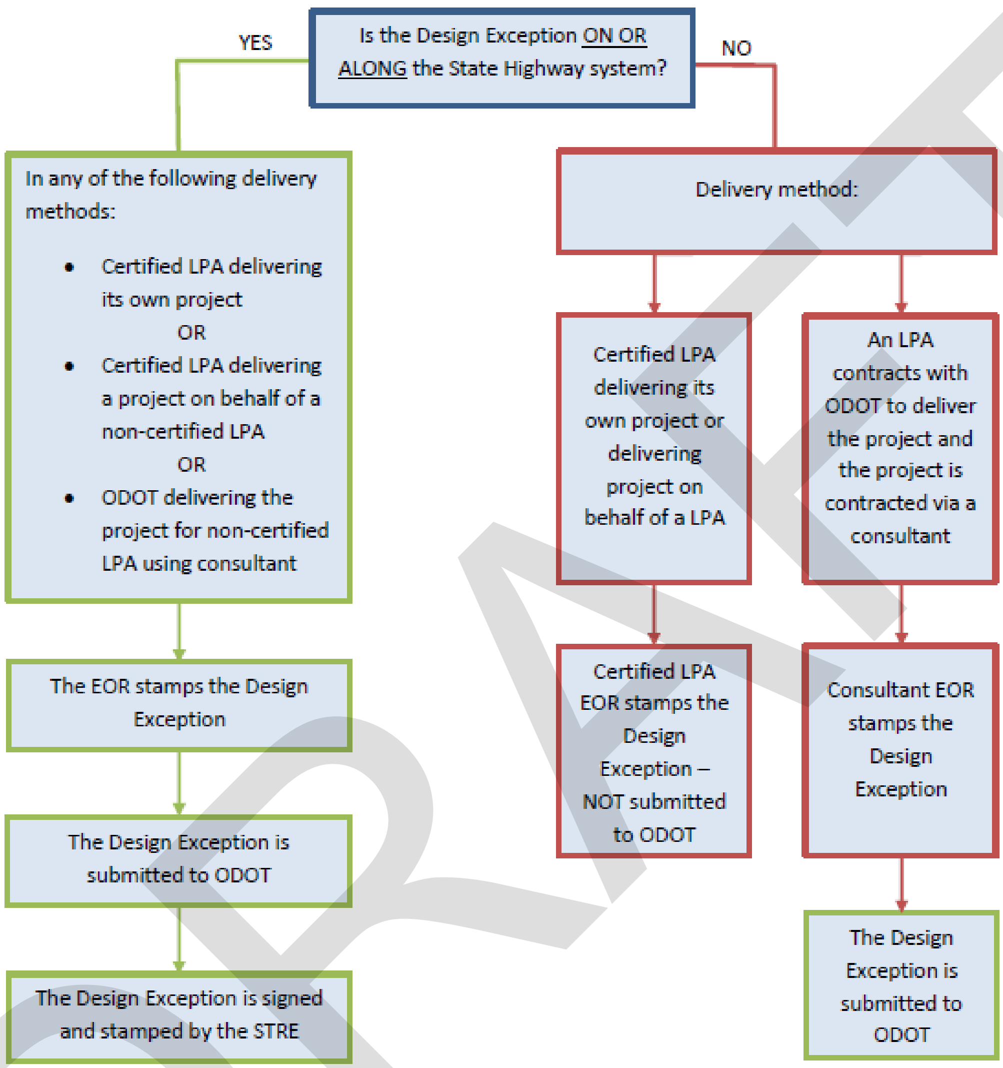
- Proposed improvements or changes in standards for the highway corridor
- Preservation of historic property or scenic value
- Additional right of way requirements
- Environmental impacts
- Low crash history and/or crash potential
- Low traffic volumes

Simply making a request for a design exception is not assurance that the request will be granted. Therefore, early submittal of the request is paramount to a smooth design process. Unless an exception from the requirements of Project Delivery Operational Notice PD-02 has been acquired, design exceptions shall be submitted and approved prior to or at the Design Acceptance Package (DAP) milestone.

1003.5 Local Agency Projects

For all projects on State Highways or NHS roads, any design element that does not meet HDM or AASHTO standards, respectively, must be justified and documented by means of a design exception. Generally, ODOT is the agency with authority to approve design exceptions; but FHWA also needs to review and approve design exceptions for all projects subject to Full Federal Oversight. However, the local government may process and approve design exceptions in the following cases.

Figure 1000-1: LPA Project Design Exception Approval Process



♦ Federally Funded Certified Local Agency Projects on Local Agency Jurisdiction Roads

Certified local agencies approve design exceptions on federally-funded projects, except those on bridges and state highways. The ODOT Regional Local Agency Liaison uses an established audit process for Certified Local Agencies to ensure consistent design quality.

♦ Federally Funded Projects on (non-certified) Local Agency Jurisdiction Roads

For all federally-funded projects on NHS and non-NHS local agency jurisdiction roads, contract plans and design exceptions are processed through the ODOT Regional Local Agency Liaison who then reviews with the Region Tech Center to ensure consistent design quality.

♦ Non-Federally Funded Projects on NHS Local Agency Jurisdiction Roads

For non-federally funded projects on local agency jurisdiction NHS roads, certified and non-certified local agencies may process and approve design exceptions, and ODOT ensures design quality by means of an audit process. The contract plans and design exceptions for all non-federally funded projects on local agency jurisdiction NHS roads are provided to the ODOT Technical Services Roadway Engineering Unit either on a project by project or annual basis. In addition, a list of all projects is to be submitted on an annual basis. Some of these projects are then selected for review. ODOT works with FHWA and local governments to correct any issues as needed. See Appendix Q for information on roles and responsibilities and lane width requirements.

Section 1004 Design Exception Request Process

In order to obtain timely State Traffic-Roadway Engineer and FHWA approvals, design exception requests should be recommended by the Region Roadway Manager and Area Manager (or equivalent) and forwarded to the State Traffic-Roadway Engineer as soon as the need is identified. Unless an exception from the requirements of Project Delivery Operational Notice PD-02 has been acquired, design exceptions shall be submitted and approved prior to or at the Design Acceptance Package (DAP) milestone. For design exceptions critical to the project design, approval should be obtained as early as possible. Requests for design exceptions must be accompanied by justification documentation and should include mitigation. Processing of exceptions to design standards will be undertaken as soon as agreement is reached in the Region. Figure 1000-2 shows the design exception request form.

Local Agency project design exceptions not on a State Highway follow a slightly different process. For projects being delivered by certified local public agencies, design exceptions are not submitted to ODOT. For projects delivered by ODOT, or by an a consultant through ODOT, the approval of design exceptions is under the authority of the State Traffic-Roadway Engineer, but the steps between the request and approval may differ from the standard design exception process. Designers involved in local agency contracts should contact the Local Government Section Manager.

Requests for exceptions to design standards with justification and mitigation shall be submitted to the State Traffic-Roadway Engineer and approved prior to or at the DAP milestone and prior to incorporation of design features into project plans and/or other documents.

1004.1 Draft Design Exception Reviews

The review of the Design Exception is accomplished by ETSB Roadway Engineering staff. A formal recommendation is made to the State Traffic-Roadway Engineer for approval or rejection. Early informal consultation with Roadway Engineering staff is encouraged. Draft Design Exceptions are accepted and formal reviews are conducted. When submitting final Design Exceptions, please include the names of Roadway Engineering staff that was involved in preliminary discussions or draft reviews. This will assist in having the same reviewer throughout the process.

A best practice is to develop a draft design exception as a Word document, and place the draft in the ProjectWise folder for the project. The draft document should contain the information for the request, and be named using ODOT's ProjectWise naming conventions. For general roadway design exceptions, the ODOT form may be used to create a draft document to review. Drafts of ADA Curb Ramp Design Exceptions can use any word document, or the template provided by Roadway Engineering Staff. Draft reviews should not be done in the automated ADA Curb Ramp Design Exception form for a variety of reasons, including potential to corrupt the file, lack of track changes, and limited text editing functionality.

1004.2 Design Exception Procedures

Step 1 Project Teams determine justification for design exception(s) at scoping, design phases, or planning process.

Step 2 Roadway Designer prepares design exception with supporting justification with review from Region Roadway Manager. The data should include the information shown in Table 1000-2 and described in Section 1005.1. If the Designer is the Engineer of Record, the Designer digitally signs and seals the design exception request and digitally signs the "Prepared By" line, otherwise the Engineer of Record digitally seals and signs the exception request. (See Technical Directive TSB21-01(D) for ODOT digital seal and digital signature requirements.) Consultation with Technical Service's Roadway Engineering staff is encouraged during the preparation of the request and prior to signing by the Engineer of Record.

Step 3 The program manager is the ODOT Area Manager, District Manager, or Urban Mobility Unit (UMO) Manager. The program manager reviews request and consults with Engineer of Record to assure that the request accurately describes the conditions that warrant a design exception. The Program Manager then digitally signs the design exception request on the "Concurred by" line and forwards to the ODOT Region Technical Center Manager or the Region Roadway Manager.

Step 4 The ODOT Region Technical Center Manager or the Region Roadway Manager reviews the request and consults with the engineer of record and other applicable groups in Region, such as Traffic or Safety. The Region Technical Center Manager or the Region Roadway Manager digitally signs the design exception if they concur with the request.

NOTE: Design exceptions formally obtained in writing during the Planning, Environmental or Survey phases need not be requested again. A list of the design standards that must be considered in the exception process, depending on the type of project, can be found in Figure 1000-2.

Step 5 The design exception, or ProjectWise link to the design exception, is submitted by email to the ODOT Design Exception inbox at ODOTDesignExceptions@odot.oregon.gov, which will forward to the State Traffic-Roadway Engineer in ETSB. On Full Federal Oversight (FFO) projects and projects on the Interstate Highway System, the State Traffic-Roadway Engineer submits the request letter to FHWA for exceptions on nonconforming geometric standards (see Figure 1000-2). The Design Exception is assigned to a member of the Design Exception Review team for review and a formal recommendation is prepared by the member. This team meets weekly to review exceptions and discuss the merits of all Design Exceptions. Informal reviews are completed as required based upon the complexity of the project.

Step 6 The State Traffic-Roadway Engineer reviews the design exception request and recommendation from the Design Exception Review team. The State Traffic-Roadway Engineer digitally signs and seals the request if sufficiently justified.

Step 7 The State Traffic-Roadway Engineer receives FHWA approval (if necessary) for design exceptions and forwards copy to the signers of the Design Exception. The State Traffic-Roadway Engineer maintains the original request in approved design exception file

Step 8 Where agreement between the Region Technical Center Manager and the State Traffic-Roadway Engineer cannot be reached, the State Traffic-Roadway Engineer forwards the request to the Chief Engineer. The Chief Engineer makes the final decision on approval or denial of the design exception request.

1004.3 Clear Zone Approval Authority

The Engineer of Record is responsible for determining the clear zone issues. For 4R projects the clear zone design exception will follow the same procedure as all other design exceptions with approval being granted by the State Traffic-Roadway Engineer. This will be shown on the Design Exception Request form where "Clear Zone" is specifically listed next to the check box.

For 3R, 1R and Single Function projects, clear zone design exception will be the responsibility of the Region Technical Center. Contact the Region Roadway Manager for exact procedures to be followed.

♦ 4R Standard or New Construction

For 4R projects, when an unmitigated hazard will remain within the project clear zone distance required, as prescribed in Part 400 in Table 400-1: Clear Zone Distance and Table 400-2: Horizontal Curve Adjustment, a design exception will be processed. The clear zone design exception will follow the same procedure as all other design exceptions with approval being granted by the State Traffic-Roadway Engineer and when appropriate, FHWA. This will be shown on the Design Exception Request form where "Clear Zone" is specifically listed next to the check box.

♦ 3R Standard

For 3R projects, clear zone design exceptions are the responsibility of the Region Technical Center. Specifically, approval is granted by the Region Roadway Manager using the same form shown in Figure 1000-2. When an unmitigated hazard will remain within the project clear zone distance required, as prescribed in Part 400 in Table 400-1: Clear Zone Distance and Table 400-2: Horizontal Curve Adjustment, a design exception will be processed. The State Traffic-Roadway Engineer and FHWA will not be formally involved with clear zone design on 3R projects. Clear zone must be evaluated and improved as appropriate The Region Roadway Manager will keep on file all 3R clear zone design exceptions that they approve. The process for these specific regional exceptions closely follows the standard method, with only the approval and filing being modified.

1004.4 ADA Exceptions

There are two conditions that will be considered for design exceptions on ADA features; technical infeasibility, and undue financial and administrative burdens. Both of these types of exceptions should occur infrequently.

♦ Technical Infeasibility

Technical infeasibility is when the physical constraints do not allow for a solution, or there are conflicting interests that do not allow for a solution. Sometimes the designer is unable to place the geometric requirements for the feature without adverse impacts to historic or archeological artifacts. While it might be technically infeasible to meet full ADA standards, a design exception does not give relief to addressing ADA concerns where some improvements can still be made.

When a feature is technically infeasible, the design exception is processed with no changes to the process outlined in this part of the HDM.

♦ Undue Financial and Administrative Burden

Undue financial and administrative burden is when the cost of proceeding with the ADA solution will put such a burden on the agency that it cannot meet its obligation to perform its duties. This is when the ADA solution will take most of the agency's total financial resource, beyond just the funding for the project. This type of a design exception is extremely rare and should be discussed with the Roadway Engineering Unit staff when consideration is given to its use.

An undue financial and administrative burden exception to ADA will follow the process outlined in this chapter and in addition must be agreed to in writing by the head of the public entity or their designee. For ODOT, the designee is the Highway Division Administrator. The memorandum for the head of the public entity's signature will include the design exception that gives justification for the decision that the ADA feature is an undue burden financially for that public entity.

For ODOT projects use the following memorandum and for local agency projects use the same text as appropriate.

Oregon

Kate Brown, Governor

Department of Transportation
Roadway Engineering Services
4040 Fairview Industrial Dr, MS #5
Salem, Oregon 97302-1142
Phone: (503) 986-3568

To:
Highway Division Administrator

From:
State Traffic-Roadway Engineer

Project Key Number:
Section Name:
Highway Name:
County Name:

Declaration of Financial and Administrative Burden
For ADA Non-compliance

In accordance with the Code of Federal Regulation 28 CRF §35.150 it is determined that the agency can not include the specific ADA feature(s) with this project because of the financial and administrative burden that inclusion would cause to this public entity.

The specific ADA feature(s) not included in the project: <insert the specific feature that will not be constructed here.>

The documentation for the justification of this declaration is included in the design exception for this project and attached to this memorandum.

I concur with this declaration.

_______________________________ Date: ____________________
Highway Division Administrator
Oregon Department of Transportation

♦ CQCR ADA Accommodation Improvements

Concerns, Questions, Comments, or Requests (CQCRs) are incremental improvement projects on the transportation system to address a specific concern or barrier for an individual along a specific route traveled. Documentation related to the design and construction of the solution for the customer is retained in the Office of Civil Rights database. ADA design exceptions are not produced for construction features in these specific cases when the standard cannot be achieved; however some roadway geometrics may still require review and approval on the general design request form. Consult the technical resource for the item that may not be achieving other engineering discipline standards.

Section 1005 General Design Exception Requests

1005.1 Informational Needs

Prior to submitting a request for a design exception, a sufficient amount of information gathering and design work is required to justify the design exception. Again, the purpose of design exceptions is to determine that a professional engineering decision has been justified and documented involving engineering standards and practices in constrained locations.

The information required to justify an exception includes the following items:

- Roadside Inventory
- Local Plan Coordination
- Traffic and Crash Analysis
- Impacts and Right of Way
- Cost
- Incremental Improvements
- Proposed Mitigation
- Conflicts with other Federal, State, or Local Laws

♦ Roadside Inventory

A roadside inventory is typically completed as part of project information gathering. The roadside inventory provides valuable information on existing roadside features and can be used to help justify design exceptions. Identification of roadside appurtenances, both man-made and natural, that are not crash worthy is important to the overall safety of the facility. While the item may not be removed with the current project, the man-made items are placed into the database and scheduled for upgrade. Particularly barrier systems that are in place and were developed prior to NCHRP – Report 230 crash criteria need to be inventoried for replacement. Roadside Inventory information is outlined in Part 400.

♦ Local Plan Coordination

Due to the constrained environment of urban areas, design exceptions are frequently required on downtown urban projects. In these urban environments, there may be transportation system plan elements or goals that relate to the roadway design. The design exception justification process should take into consideration local planning efforts. For example, local plans for projects such as Transportation System Plans (TSP) may provide a context for the future highway corridor that can be used in looking at non-standard roadway elements. The local plan vision should be in alignment with the vision of the statewide transportation system. As projects are developed, these assumptions must be reevaluated in light of the current context of the developed highway and can be used in the design exception process if appropriate.

♦ Traffic and Crash Analysis

A traffic analysis is required. The level of information and analysis will need to be sufficient to assure that the proposed design exception will not significantly affect safety. Generally, the traffic analysis required for the specific project type will be sufficient to evaluate the merits of proposed design exceptions. However, in some situations, additional analysis and detail may be required, such as:

- Long term (20 year) volume/capacity and operational analysis
- Vehicle classifications
- Peak hour and daily turning movements
- Detailed operational analysis (i.e., intersection, interchange, weaving, etc.)
- Other analyses as deemed necessary for the particular action

Proper designs on all projects should always consider the crash potential and history, and its relationship to the improvements proposed. Generally, the crash analysis required for the specific project type is sufficient to evaluate the potential ramifications of a particular design exception. However, in some situations, more detailed analysis is required. This could include a more detailed review of crash history over a longer timeframe, greater research into cause and effect, and even discussing existing safety deficiencies with local emergency provider agencies such as state police, local police, county sheriff and local fire officials. The proposed design exception needs to be evaluated to document the potential impacts to the safety of the highway users. Various predictive models are available to assist the designer analyzing multiple combinations of cross sectional elements. Making an incremental increase in safety predictions can be included in the justification for a design exception.

Crash data should include:

- Number and type of crashes
- Crash rate and comparison to the average rate for that type of facility
- The Safety Priority Index System (SPIS) sites and their ranking

♦ Impacts and Right of Way

The design should be completed to a sufficient degree to determine with reasonable certainty what the potential impacts are if the proposed exception is not approved. These impacts could include residential displacement, commercial displacement, and environmental impacts to wetlands, streams, historic properties, 4f and 6f resources, threatened and endangered habitat, etc. Other impacts could require additional right of way. Community goals and livability impacts should also be determined where applicable as well as impacts from planning and policy documents such as the Oregon Highway Plan.

Generally, to determine these levels of impacts, the design should be developed to concept level plans. This generally is sufficient to determine approximate right of way footprints for the specific project.

♦ Costs

The design should be completed to sufficient detail to estimate project costs with and without the proposed design exception(s) being approved. The cost information can also be used to calculate approximate cost/benefit ratios related to the proposed design exception. Cost is not the only justification for approving design exceptions. Other items include compatibility with other sections, environmental impacts, additional right of way and other items listed in Section 1003. Costs to improve the deficiency while not meeting full design standards should be considered and evaluated, if appropriate.

♦ Incremental Improvements

While not meeting full standards, the design engineer can use a lower cost solution as an incremental step to address legitimate safety concerns. Multiple alternatives should be assessed using various techniques including the use of prediction models. Lower cost treatments such as rumble strips or signs have a proven record of offering a reduced level of crashes when implemented at strategic locations. Incremental improvements are to be recited in the design exception request as either justification or mitigation as an improvement based outcome for inclusion in the project.

♦ Proposed Mitigation

The project team should evaluate potential mitigation measures that could be implemented as part of the project that could offset the potential safety reductions of the proposed design exception. Mitigation actions can range from very small and inexpensive to large scale options. Each design team will need to evaluate, on a project by project basis, if cost effective mitigation strategies are to be included as part of the design exception request. Each project team should use the creative abilities of the team members to strategize the range of potential mitigation measures. Identifying standard practice mitigation items (replaced striping, replacing signs, etc.) in the design exception under the category of proposed mitigation needs to be separated from the enhanced mitigation items that are included in the project (upgraded striping, new signs, new rumble strips, etc.)

1005.2 General Design Exception Request Form

The General Design Exception Request Form is used to document and justify the design exception. See Table 1000-2 for a list of data needed for exception justification.

Table 1000-2: Data Needs For Exception Justification

1. Summary of the proposed exception
2. Project description and/or purpose/need statement from the project charter
3. Impact on other standards
4. Cost to build to standard
5. Crash history and potential (specifically as it applies to the requested exception)
6. Reasons (low cost/benefit, relocations, environmental impacts, etc.) for not attaining standard
7. Compatibility with adjacent sections (route continuity)
8. Probable time before reconstruction of the section due to traffic increases or changed conditions

9. Mitigation measures to be used. These can include low cost measures such as lane departure detectable warning devices (rumble strips or profiled pavement markings) or additional signs. Mitigation needs to be appropriate to the site conditions and installed correctly to be effective in reducing crashes.
10. Plans, Cross Sections, Alignment Sheets, Plan Details and other supporting documents.

NOTE: Any data omitted from the submittal package can cause a delay in the processing the request.

See figures Figure 1000-2 through Figure 1000-4 for the Design Exception Request Form. Some fields within the form have been numbered, with additional information provide below the figures.

Figure 1000-2: General Design Exception Request Form (Page 1 of 3)

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

For Roadway Section Office use only	
Control No:	

Section Name:						Route No.:	
Highway Name:						Highway No.:	1
County Name:		Region:		Key No.:	2	EA No.:	3
Begin MP:		RDWY ID:	1 ☐ 2 ☐ 4	Mileage Type: 5			0 ☐ Z ☐
End MP:		Mileage Overlap Code:		0 ☐ 1 ☐ 2 ☐ 6			

PROJECT DATA

Functional Classification:	7				
Current ADT (Year):				Design ADT (Year):	
% Trucks:		Vertical Clearance Route:	☐ Yes ☐ No 8		
Posted Speed:		Design Speed:	9	Bid Date:	
Funding:					
Current Estimate:		Additional Cost to Meet Standard:			

Federal Highway Approval Required: 10	Yes ☐ No ☐	Design Category	3R ☐ 1R ☐ 4R ☐ SF ☐	NHS: Non NHS:	☐ ☐	Top 10% SPIS Site: 11	Yes ☐ No ☐

Design Exceptions (FHWA Controlling Criteria for all NHS facilities in **BOLD**. FHWA Controlling Criteria for "high-speed" NHS roadways (interstates, freeways, and design speed ≥ 50 mph) in *Italics*.)		
☐ **Design Speed** 12	☐ *Vertical Clearance*	☐ Median Width
☐ **Structural Capacity**	☐ ADA Standards 12	☐ Parking Width
☐ *Lane Width*	☐ Bike Lane/Shared Use Path Width 13	☐ Pavement Design Life
☐ *Shoulder Width/Shy Distance*	☐ Bridge Rail 12	☐ Sidewalk Width
☐ *Horizontal Alignment*	☐ Bridge Width	☐ Spiral Length
☐ *Superelevation*	☐ Clear Zone	☐ Superelevation Runoff
☐ *Stopping Sight Distance*	☐ Design Life and V/C Ratio	☐ Vertical Alignment
☐ *Grade*	☐ Diagonal Parking	☐ (Other)
☐ *Pavement Cross Slope*	☐ Interchange Spacing	

1 <u>State Highway Number</u>: The ODOT, 3-digit number given to each state highway for identification purposes. Generally, this is not the same as the route number. If the project is off the State Highway System, use "Local" for the highway number.

2 **Key Number:** The ODOT unique 5-digit number given to each project.

3 **EA Number and Sub-Job**: The ODOT internal account number for the project including the sub-job number.

4 **Roadway ID**: In ODOT's GIS, the roadway identifier code determines the alignment when there is a separated highway alignment such as a freeway. Code 1 is for the primary alignment that increases with the mile point. Code 2 is for the alignment with the decreasing mile points. Note: state highway 001 (I-5) is opposite to this rule.

5 **Mileage Type**: In ODOT's GIS, the mileage type code is for when there are unique mile points along a highway. The Z code indicates an overlap in the mile points. During realignment that lengthens the highway, an overlap in the mile points will result. The Z code indicates the repeated mile points.

6 **Mileage Overlap Code**: In ODOT's GIS, the mileage overlap code is used when the "Z" code is used to indicate each unique occurrence of duplicate mile points. A code of 1 is use for the first occurrence, a code of 2 for the second occurrence, etc.

7 **Functional Classification**: The functional classification for State Highways can be found in ODOT's Highway Design Manual (HDM) in Appendix A.

8 **Vertical Clearance Route**: These specific routes designated for high loads are listed in ODOT's Highway Design Manual (HDM) in Appendix C.

9 **Design Speed**: The design speed is a critical design component that defines multiple design standards. It is not necessarily the same as posted speed. Part 200 of the HDM and AASHTO's "A Policy on Geometric Design of Highways and Streets" in the chapter titled Design Controls and Criteria, discuss the design speed at great length. The selection of design speed is made by the Regional Roadway Manager with consultation given by Technical Services Roadway Engineering Unit.

10 **Federal Highway Approval Required:** FHWA and ODOT have an agreement document known as the Stewardship Agreement. In the agreement, FHWA must approve exceptions to standards on pre-selected projects. For projects on National Highway System facilities, all design exceptions for design speed or structural capacity (shown as bold on the form) must be approved by FHWA. For projects on "high-speed" National Highway System facilities (interstates, freeways, and roadways with design speed ≥ 50 mph), design exceptions for the controlling criteria must be approved by FHWA. Those controlling criteria are lane width, shoulder width/shy distance, horizontal alignment, superelevation, stopping sight distance, grade, pavement cross slope, and vertical clearance (all shown in italics on the form).

11 **SPIS Site:** The Safety Priority Indexing System (SPIS) rates specific location of crashes. Safety funding may be available to correct locations that are in the top 10%. This information is available from the ODOT Traffic Management Section.

12 **Design Speed, ADA Standards, and Bridge Rail**: These are items that are the most difficult to justify. These will only be considered in extreme situations with mitigation measures included.

Design Speed effects many other design standards that can have unintended reductions in inappropriate locations.

ADA standards get into civil rights issues. Documentation of specific project decisions is required for these sensitive designs. Physical inability to comply with prescribed design standards requires a design exception. Fiscal constraints for not complying with standards require an additional letter signed by the agency head or designee.

The Bridge Rail exception refers to the NCHRP Report 350 crash test level requirement or the AASHTO MASH test level requirements. Variations from the Bridge Standard Drawings are considered Deviations granted by the State Bridge Engineer.

13 **Bike Lane/Shared Use Path Width or Sidewalk Width**: When a project contains new construction, reconstruction, or relocation, the statutory requirement to provide bike facilities and walking facilities is required. If the statutory requirements are triggered, and the project does not provide the facilities at all, this type of design exception is held to a higher standard. As support for the design exception, a letter is required to ensure that the exemption allowed opportunities for public review and input by interested parties. The letter may come from an organization that represents bicycle and pedestrian needs for the local agency or from the Oregon Bicycle and Pedestrian Advisory Committee (OBPAC).

The letter is not required for design exceptions when a Bike Lane/Shared Use Path or Sidewalk does not meet standard widths.

Figure 1000-3: General Design Exception Form (Page 2 of 3)

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

Description of Exception: **14**

Description of Project (From Project Charter):

Location of Design Feature:

Crash History & Potential: (Specifically as it applies to requested exception) **15**

Reasons For Not Attaining Standard: (Such As Cost/ Benefit, Crash History, Environmental, Etc.)

Effect on Other Standards: **16**

Compatibility with Adjacent Sections:

Probable Time before Reconstruction of Section:

Mitigation for Exception Included In Design: **17**

Supporting Documentation (Include the appropriate Plan Section, Cross Section, Alignments Sheets & Plan Details): **18**

14 **Description of Exception**: Limit the number of exceptions to 3 types per form. The use of multiple forms helps to segregate the issues.

When multiple exceptions are being requested, grouping like items on the same form is encouraged. For example, horizontal alignment, vertical alignment, and super elevation share closely related issues.

When multiple exceptions are contained in one form, number the exceptions beginning in this section and keep consistent numbering through the document's remaining sections. Provide a clear description of each exception, including the proposed design, the standard requiring an exception, and existing conditions if applicable.

15 **Crash History & Potential**: Evaluation of the Safety Priority Index System (SPIS) for specific locations within the project limits that are in the top 10% of the index. SPIS sites include funding from the Safety Investment Program. This information is available from the Traffic Management Unit. Compare crash rates to average crash rates for similar highways in this section. Discuss the potential for increase or decrease in crash rates. Include the types of crashes and the relationship to the design exception.

16 **Effect on Other Standards:** Does compliance with a requirement conflict with federal state, or local laws? Regulatory conflicts may include preserving threatened or endangered species, the environment, archeological or cultural or natural features, historic preservation. Are there trade-offs with other engineering standards, best practices or other conflicting interests which are impacted due to achieving a requirement? Describe any feature that would be affected because of compliance with the requirement.

17 **Mitigation:** Include the items that are included in the project to mitigate the specific design exception. There are suggested items to use in the HDM in Part 200.

18 **Supporting Documentation:** The Design Exception submittal must include appropriate plan section, cross section, alignment sheet and plan details. Digital pictures may also be included.

Note: On all projects, exceptions are required when the below geometric design elements do not meet or exceed the minimums given in the ODOT Highway Design Manual for the type of project.

1 Figure 1000-4: General Design Exception Form (Page 3 of 3)

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

Signatures

Prepared By: ______________________ **Date:** __________
(Engineer of Record)

Print Name:		**Phone:**			
Company Name:					
Company Address:					
City:		**ST:**		**Zip:**	
Email Address:					

Concurred By: ______________________ **Date:** __________
(ODOT Program Manager: Area Manager, District Manager, BDU, Private Public Partnerships, Local Government)

____
(Print Name)

Concurred By: ______________________ **Date:** __________
(ODOT Region Tech Center Manager or Region Roadway Manager)

____
(Print Name)

Approved By: ______________________ **Date:** __________
(State Traffic-Roadway Engineer)

____
(Print Name)

PREPARED BY:	**APPROVED BY:**
Engineer of Record Professional Engineer Stamp	State Traffic-Roadway Engineer Professional Engineer Stamp

Table 1000-3: Design Exception List

Design Elements / Features	Requires FHWA approval for all NHS facilities	Requires FHWA approval "High-Speed" NHS roadways[1]	Requires ODOT approval for all projects
Design Speed	√	√	√
Structural Capacity	√	√	√
Lane Width		√	√
Shoulder Width/Shy Distance		√	√
Horizontal Alignment		√	√
Grade		√	√
Stopping Sight Distance		√	√
Pavement Cross Slope		√	√
Superelevation		√	√
Vertical Clearance		√	√
Clear Zone[2]			√
ADA Standards			√
Bridge Width			√
Spiral Length (curves 1 degree or sharper)			√
Superelevation Runoff (match spiral length)			√
Pavement Design Life			√
Design Life and V/C Ratio			√
Bike Lane/Multi-Use Path Width			√
Sidewalk Width			√
Median Width			√
Parking Width			√
Diagonal Parking (Jointly with State Traffic Engineer)			√
Bridge Rail			√
Interchange Spacing			√
Other[3]			√

[1] "High-Speed" NHS roadway defined as Interstate highways, other freeways, and roadways with a design speed greater than or equal to 50 mph.

[2] Design exceptions are required for 4R projects. For 3R projects clear zone design will be the responsibility of the Region Technical Center. Contact the Region Roadway Manager for exact procedures to be followed. FHWA approval of clear zone design on 3R projects not required.

[3] Items that are in the Highway Design Manual that require approval of the State Roadway Engineer but not specifically listed above. These include existing guard rail upgrade, livestock under passes, barrier placement, acceleration lanes from at-grade intersections, right turn lanes, and interchange design.

♦ Examples of Design Exceptions

The following examples of design exceptions are include giving the designer an idea of the level of detail required for a typical design exception.

Figure 1000-5: Example 1 - General Design Exception Request

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

For Roadway Section Office use only	
Control No:	15555-01

Section Name:	OR212/224: SUNRISE CORRIDOR (I-205 – SE 122ND AVE)					**Route No.:**	OR 224
Highway Name:	Sunrise					**Highway No.:**	171
County Name:	Clackamas	**Region:**	1	**Key No.:**	15555	**EA No.:**	PE001727/020

PROJECT DATA

Functional Classification:	Urban Principal Arterial-Other (OR 213 – 82nd Avenue)				
Current ADT (Year):	8,000 for on-ramp from 82nd Ave to I-205 SB (2010)		**Design ADT (Year):**	6,000 for on-ramp from 82nd Ave to I-205 SB (2020)	
% Trucks:	4-6	**Freight Route:**	☒ Yes ☐ No		
Posted Speed:	55 mph	**Design Speed:**	55 mph	**Bid Date:**	March 2013
Funding:	Modernization (JTA)				
Current Estimate:	$100 million	**Additional Cost to Meet Standard:**	$5 million		
Cost over $5 M: Yes ☒ / **Cost over $1 M:** Yes ☐	**Design Standard** 3R ☐ 4R ☒	**SIP Category:** (1-5) 5	**Top 10% SPIS Site:**	Yes ☐ No ☒	
NHS: ☒ / **Non NHS:** ☐	**Federal Highway Approval Required:**	Yes ☐ No ☒			

Design Exceptions		
☐ Design Speed	☐ Pavement Cross Slope	☐ Design Life and V/C Ratio
☒ Lane Width (Ramp Meter)	☐ Superelevation	☐ Bike Lane/Multi-Use Path Width
☒ Shoulder Width/Shy Distance	☐ Clear Zone	☐ Sidewalk Width
☐ Bridge Width	☐ Structural Capacity	☐ Median Width
☐ Horizontal Alignment	☐ ADA Standards	☐ Parking Width
☐ Vertical Alignment	☐ Spiral Length	☐ Diagonal Parking
☐ Grade	☐ Superelevation Runoff	☐ Bridge Rail
☐ Stopping Sight Distance	☐ Pavement Design Life	☐ Vertical Clearance
☐ Interchange Spacing		☐ (Other)

Description of Exception:
The Highway Design Manual (page 9-57) requires two-lane ramp meters to be built to full two-lane ramp standards. An exception is requested for the I-205 southbound on-ramp from 82nd Avenue. The I-205 southbound on-ramp from 82nd Avenue to I-205 is part of the I-205/Milwaukie Expressway/82nd Avenue interchange south of Clackamas Town Center. Today there are two southbound lanes from 82nd Avenue controlled by a ramp meter located about 1,200 feet south of the gore of the 82nd Avenue off-ramp to Milwaukie Expressway. The project will split those two lanes, sending one to southbound 82nd Drive and keeping one as the southbound I-205 on-ramp. The existing ramp meter will be removed and the proposed ramp meter will be installed on the ramp to I-205 about 275 feet to the south of the current ramp meter location. A single 16-foot ramp will be striped with two-lane ramp meter markings per the ODOT Standard Drawings (see attached Draft DAP plans ST-5, 00020, and 00021).

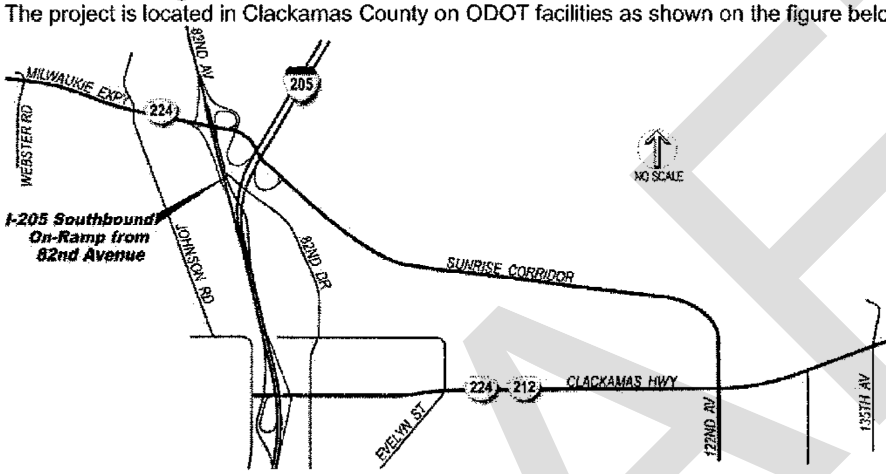
Standard = 2 – 12' lanes, 10' right shoulder, 6' left shoulder
Proposed = 1 – 16' lane striped for a two lane ramp meter, 6' right shoulder, 4' left shoulder

Figure 1000-6: Example 1 - General Design Exception Request (Continued)

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

Description of Project (From Prospectus):
The Sunrise JTA project is a 2-mile mainline extension of the Milwaukie Expressway (OR 224) from I-205 to 122nd Avenue. It also includes widening 122nd Avenue near OR 212/224, local access modifications, and a reconfiguration of the 82nd Ave/82nd Drive connection.

Location of Design Feature:
The project is located in Clackamas County on ODOT facilities as shown on the figure below.



Crash History & Potential: (Specifically as it applies to requested exception)
Available collision data for the I-205 southbound on-ramp from 82nd Avenue was reviewed for the recent five-year period of January 1, 2006 to December 31, 2010. The data included collisions from about 1,000 feet north of the existing ramp meter to the gore point of ramp about 750 feet south of the existing ramp meter. During that period of five years, there were nine crashes, none of which resulted in fatalities. Eight out of the nine crashes resulted in injuries. All were rear-end collisions upstream of the existing ramp meter.

Reasons For Not Attaining Standard: (Such As Cost/ Benefit, Crash History, Environmental, Etc.)
The proposed lane configuration for the Sunrise JTA project will split the existing 2 lane section of 82nd Ave SB into two single lanes (one to 82nd Dr and one to I-205 SB). Widening to two full lanes on the I-205 southbound on-ramp from 82nd Avenue would require replacement of the existing bridge over 82nd Avenue to gain proper width for three lanes (existing bridge wide enough for two lanes). Widening of the ramp would also require reconfiguration of the Milwaukie Expressway to I-205 SB ramp due to the limited space available between 82nd Ave northbound and the Milwaukie Expressway to I-205 SB ramp.

In total these modifications would cost about $5 million. This ramp meter is an interim condition (does not exist as part of the Sunrise FEIS preferred alternative) and would be consistent with a typical two-lane retrofit layout. When the ramp meter is not operating, the roadway will function as a single lane ramp to I-205.

Effect on Other Standards:
None.

Compatibility with Adjacent Sections:
Although the standard requires two full ramp lanes at ramp meters, most of the existing ramp meters in the Metro area are not built to that standard. Drivers in the region are very familiar with the configuration of forming two lines at a ramp meter on a one-lane on-ramp.

Probable Time before Reconstruction of Section:
Funding has not been determined for the future phase of the Sunrise Corridor, so the construction schedule is unknown.

Figure 1000-7: Example 1 - General Design Exception Request (Continued)

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

Mitigation For Exception Included In Design:
The overall project includes significant capacity improvements, new/modified traffic signals and ramp meters, improved roadway illumination, updated ITS/communication elements, and updated signing/striping.

Supporting Documentation (Include the appropriate Plan Section, Cross Section, Alignments Sheets & Plan Details):
Draft DAP ramp meter and striping plans

Figure 1000-8: Example 2 - General Design Exception Request

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

For Roadway Section Office use only	
Control No:	17806-61

Section Name:	US101: Pistol River Bridge					**Route No.:**	
Highway Name:	US101 OREGON COAST					**Highway No.:**	9
County Name:	CURRY	**Region:**	3	**Key No.:**	17800	**EA No.:**	PE001907

PROJECT DATA

Functional Classification:	RURAL PRINCIPAL ARERIAL				
Current ADT (Year):	3200			**Design ADT (Year):**	3420
% Trucks:	15	**Freight Route:**	☐ Yes ☒ No		
Posted Speed:	55	**Design Speed:**	60	**Bid Date:**	October 1, 2012
Funding:	STIP $6.134 million				
Current Estimate:	$5.0 million	**Additional Cost to Meet Standard:**	$17.0 million		
Cost over $5 M : Yes ☒ / **Cost over $1 M :** Yes ☐	**Design Standard** 3R ☒ 4R ☐	**SIP Category:**	**(1-5)** NA	**Top 10% SPIS Site:**	Yes ☐ No ☒
NHS: ☒ / **Non NHS:** ☐	**Federal Highway Approval Required:**		Yes ☒ No ☐		

Design Exceptions		
☐ Design Speed	☐ Pavement Cross Slope	☐ Design Life and V/C Ratio
☐ Lane Width	☐ Superelevation	☐ Bike Lane/Multi-Use Path Width
☒ Shoulder Width/Shy Distance	☐ Clear Zone	☐ Sidewalk Width
☒ Bridge Width	☐ Structural Capacity	☐ Median Width
☐ Horizontal Alignment	☐ ADA Standards	☐ Parking Width
☐ Vertical Alignment	☐ Spiral Length	☐ Diagonal Parking
☐ Grade	☐ Superelevation Runoff	☐ Bridge Rail
☐ Stopping Sight Distance	☐ Pavement Design Life	☐ Vertical Clearance
☐ Interchange Spacing		☐ (Other)

Description of Exception:
4 foot shoulder width on bridge (zero shy) and 4 to 6 foot shoulder widths in guardrail transition areas at the bridge approaches.

Description of Project (From Prospectus):
The existing structure is showing corrosion, deck wear and the bridge has structural deficiencies throughout. The Pistol River bridge is a good candidate for repair versus a full replacement. Proposed repairs include cathodic protection for all elements above the Ordinary High Water Line, removing and replacing the existing bridge rail, cross beam strengthening, seismic restraints, poly deck overlay, and asphaltic plug joints. The proposed repair will extend the life and functional use of the bridge for the traveling public. The costs of repairs present the best value to correct the structural deficiencies currently found.

Location of Design Feature:
US101 MP338.72 to MP339.50. The reduced shoulder width varies from 4 foot on the north side of the bridge, 4 foot on the bridge, and 4 to 6 foot south of the bridge. The existing bridge deck width is 30' wide and as part of this project new bridge rail will be installed on the structure and will widen the deck width to 32'. The guardrail runs on the north end of the structure will be completely replaced with the same 4 foot offset from fog line as they are today.

Figure 1000-7: Example 2 - General Design Exception Request (Continued)

OREGON DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION REQUEST

Crash History & Potential: (Specifically as it applies to requested exception)
In the last three years there has been one collision reported. The collision was a head on at MP339.35 with one occupant a fatal and another injury A. Shoulder widths off the structure will remain 4 foot, the same as they are currently and the shoulders on the structure will be increased from 3 to 4 foot wide with this project. As this section of rural highway is not a freight route or truck route, given the low accident history on this tangent section of highway, the available sight distances above standard, it would be unreasonable to meet standard.

Reasons For Not Attaining Standard: (Such As Cost/ Benefit, Crash History, Environmental, Etc.)
According to the bridge engineer for this project the entire structure would need to be replaced to attain a standard deck width of 44 feet. In addition, given the topography, steep cut and fill slopes to the north and south of structure, it would not be practical to widen shoulders to meet standard.

Effect on Other Standards:
None.

Compatibility with Adjacent Sections:
The lane and shoulder widths of this section of rural coast highway is consistant with both north and south directions from this project.

Probable Time before Reconstruction of Section:
20 years

Mitigation For Exception Included In Design:
The brigde deck will have new microsilica surfacing and the highway will be paved for 200 feet off both approaches. There will be new guarail with energy absorbing, non-flared, terminals, new bridge rails that will allow 1 foot wider shoulders on structure and new striping installed with this project.

Supporting Documentation (Include the appropriate Plan Section, Cross Section, Alignments Sheets & Plan Details): Sheets 2, 3 thu 5, and bridge drawing showing the deck sections.

Section 1006 ADA Curb Ramp Design Exception Requests

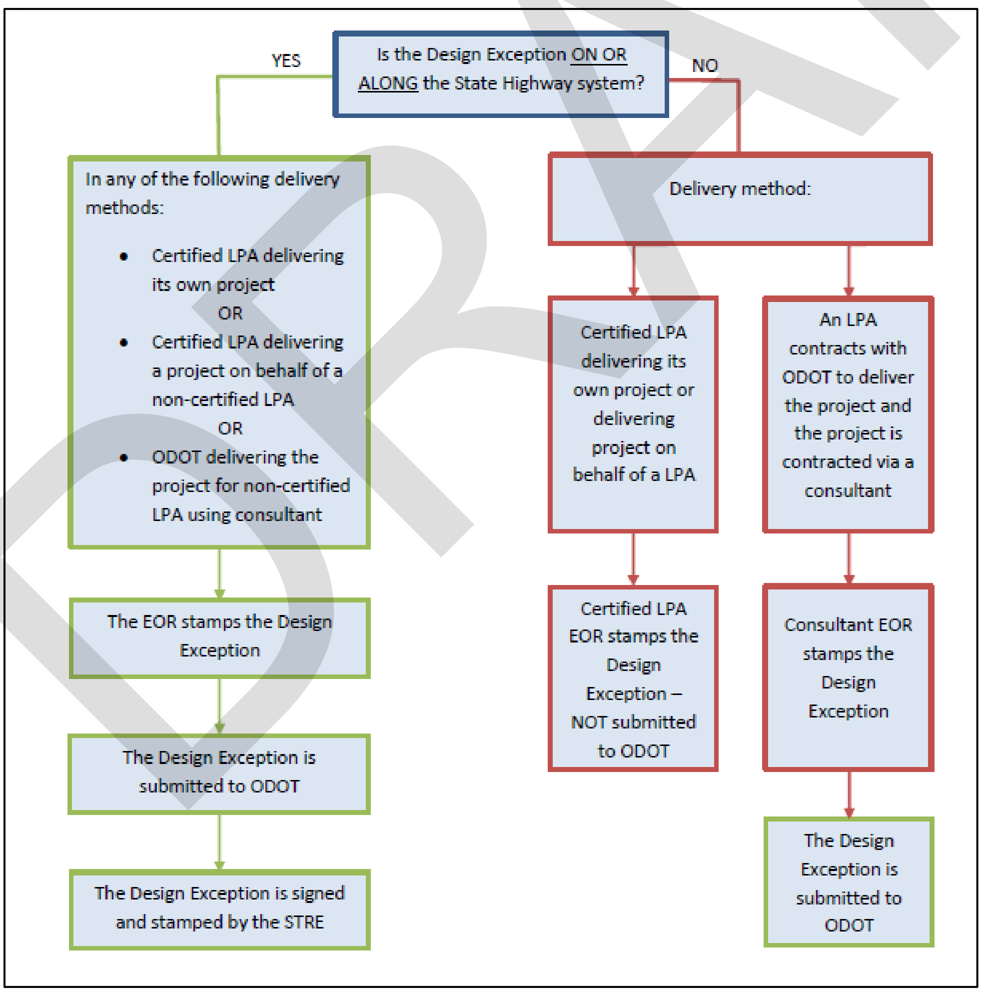
The design exception process is intended to ensure that sound engineering decisions are made when design options are limited. Exceptions to design standards should be discussed early in the design process when project limits are first determined. All design exception requests must show justification. Refer to Section 1003 and Section 1004. Applying for an exception does not guarantee approval. The design exception webpage outlines the basic steps and has the latest forms posted for download.

Although the current ODOT design exception form lists ADA Standards as one of design elements that requires a design exception for not meeting current guidance, that current form does not have the detail that is needed in the justification of design exceptions for non-compliant curb ramps. The ADA Curb Ramp Design Exception Request and additional curb ramp guidance documents will allow the Department to document, justify, and identify the location of those curb ramps that have been determined not to be able to comply with current ODOT standards.

♦ Local Agency Projects

This process applies to all work on or along the State Highway System. In addition, all local agencies (certified and non-certified) receiving project funds through ODOT (except fund-exchange state funds) shall use the ODOT ADA Curb Ramp Design Exception Request form and submit curb ramp design exceptions to ODOT for approval through their ODOT Local Agency Liaison. Certified agencies are to use this form and process until ODOT/FHWA have reviewed and approved the certified agency's written curb ramp design exception and inspection processes.

Figure 1000-9: LPA Project ADA Design Exception Approval Process



1006.2 Informational Needs

A sufficient amount of information gathering and design work is required to justify the design exception prior to submitting a request for a design exception. ADA design requirements are codified into federal law and the justification to not provide the standard is limited. Unlike general roadway design exceptions, ADA exceptions are limited to technical infeasibility in most cases as ODOT's overall operating budget is rather large (see Section 1004.4). The ODOT design standard includes a margin for error in construction and reducing that margin (slope or dimensions) can result in a curb ramp system that does not meet the federal regulation requirements.

The purpose of a design exception for curb ramps is to document when standards are technically infeasible based on the scale of the project improvements. Projects are required to be scoped such that standards for curb ramp design can be met to maximum extent feasible [TSB 18-03(B)]. The professional engineering decision and analysis, and documentation is reviewed for engineering standards and practices in constrained locations. Design exceptions for curb ramps are rare when the highway is newly constructed or on a new horizontal alignment.

The information required in the request includes the following items:

- Location of the curb ramp based on ODOT's Linear Reference Method and mile point.
- Project construction information and funding.
- A diagram of the intersection with curb ramp corner number information.
- Description of the curb ramp criteria with the specified values planned for design.
- Description of the project purpose and need from the project business case, and triggering construction work for the curb ramp.
- Reason for not attaining the standard for each criteria that cannot met and a description of alternatives explored.
- Effects on other standards related to roadway design or relevant laws.
- Mitigation incorporated in the design to offset the impact of not obtaining the standard.
- Supporting documents and exhibits to show the design analysis and design details.

NOTE: Any data omitted from the submittal package can cause a time delay in processing the request for consideration of approval. A draft review and consultation with the Technical Services Roadway Engineering staff is recommended as described in Section 1004.1 prior to submission of the request.

Many of the data fields in the ADA Curb Ramp Design Exception Request form correspond to information that is defined in Section 1004, and will aid the designer when preparing the form.

♦ Location Information

ODOT's has an extensive inventory database of every curb ramp on or along the state highway, with a methodology that is unique to ODOT. Every curb ramp has unique ID associated with it that is permanent throughout the curb ramp life cycle. The location information is based on the Linear Reference Method and mile point. Individual curb ramp assets are described using corner position and ramp number. The ADA Curb Ramp Design Exception Request form populates the overall ODOT database field and attributes, therefore the information must be accurate.

Refer to the FACS-STIP user guide for instructions on how to access the detailed information on a given curb ramp and corner. Consult the Statewide Asset Specialist for any clarification on curb ramp location information and methodology. Refer to the RD900 series of the standard drawings and Exhibit "A" for the linear reference syntax, corner number, and ramp number conventions diagram. The ODOT Inspector Guide for Curb Ramp and Push Buttons is an additional reference document, and referring to ODOT Exhibit A will be helpful in filling out this information.

Exhibit"A" Curb Ramp Location and Numbering, and Exhibit "B" Curb Ramp Types are located on the web at:

https://www.oregon.gov/odot/Engineering/Pages/Design-Exceptions.aspx

State Highway Number: The ODOT, 3-digit number given to each state highway for identification purposes. Generally, this is not the same as the route number. If the project is off the State Highway System, use the street name of the mainline.

Suffix Code: In ODOT's GIS, the suffix code is a two digit highway suffix that differentiates mainline roads from connections and frontage roads with the same highway number. The mainline suffix is the numerical value 00. Connections and frontage roads each have a unique combination of two letters (AA to ZZ).

Roadway ID: In ODOT's GIS, the roadway identifier code determines the alignment when there is a separated highway alignment such as a freeway. Code I (Increasing) is for the primary alignment that increases with the mile point. Code D (Decreasing) is for the alignment with the decreasing milepoints.

Mileage Type: In ODOT's GIS, the mileage type code is for when there are unique milepoints along a highway. The O Code indicated regular mileage. The Z code indicates an overlap i11 the milepoints. During realignment that lengthens the highway, an overlap in the mile poi11ts will result. The Z code indicates the repeated milepoints.

Mileage Overlap Code: In ODOT's GIS, the mileage overlap code is used when the "Z" code is used to i11dicate each unique occurrence of duplicate mile points. A code of 1 is use for the first occurrence, a code of 2 for the second occurrence, etc.

Intersection MP: If a state highway, list the appropriate milepoint of the intersection. If the project is off the State Highway System use the local agency milepoint if available, cross streeeet name, or general location (i.e. midblock crossing between 25th and 26th). A new design exception request form is required for each individual intersection, entrance, midblock crossing, etc.. Multiple curb ramp design exceptions for each milepoint location can be included in the Design Exception Request form if identified appropriately

Corner Position(s) and Ramp Position Number(s): In addition to the intersection milepoint, list the appropriate corner and ramp position number (i.e. 1-1., 2-1, 2A- 1, 2A-2, 4-2, etc.) as demonstrated in Exhibit "A" attached. Every curb ramp design exception must have a corner position and ramp position number assigned for documentation purposes. Multiple corner positions and ramp position numbers (one milepost location) should be shown on a single design exception request form.

♦ Project Information

This section provides information about the project, including when it is planned for construction, what type of funding will be used to construct the project, if FHWA approval is required, and if there is an associated crosswalk closure at the intersection. This helps the agency retrieve information about the contract at a later date and what the applicable standards are at the time of construction.

A concise yet descriptive narrative of the proposed project improvements is required to determine the scale of the overall project improvements. For example, is the project new construction (4R), restoration (3R), preservation (1R), or triggered by something else. A lack of information will cause a delay as the reader is not as familiar with the details of the project as the designer engineer. Include information if the project is addressing formal ADA complaints or CQCR corridor with numerous complaints.

Key Number: The ODOT unique 5-digit number given to each project.

EA Number and Sub-Job: The ODOT internal account number for the project including the sub-job number.

Description of Project: The scope of work indicates which ADA requirements are triggered by the project. Describe the project's scope of work with special detail to the following features:

- whether pavement surfacing is included;
- what surface treatment is used;
- what is the length of pavement surfacing work;
- whether sidewalk is constructed and where;
- whether traffic signals will replace pushbuttons, walk signals or controllers

♦ Intersection Diagrams

Intersection diagrams help the reader orient themselves to the intersection configuration with graphics that can be produced by a variety of methods. This might be a clipping from your CADD design plan or aerial image that is clear and legible. The important information is the street names, mile point, corner number and ramp number; labeling the curb ramp(s) you are requesting a deviation from standard.

Sketch or insert graphic file for entire intersection. Indicate which ramps are addressed or not addressed in the project scope. Corner number is based on increasing milepoints (generally southbound or eastbound) beginning with the first encountered corner on the right and proceeding counter-clockwise as demonstrated in Exhibit"A". An 'A' is added to the number for an island.

♦ Description of the Exception and Reason for Not Attaining Standard

Description of Exception: For each location identified in the table, 'describe the difference between the requirement and the level of accessibility achieved by the design (e.g. what slope is attained?)

Reasons for Not Attaining Standard: ADA requirements allow deviation from a requirement only when meeting that requirement is technically infeasible or infeasible within the scope of work. Explain in detail why the geometric requirement cannot be achieved. Describe the site specific constraints for each curb ramp where an exception is sought. Physical constraints may include underlying terrain, underground structures adjacent developed facilities, right-of-way availability, drainage, or the presence of notable natural or historic feature. Explain why the constraint precludes achieving the ADA requirement. If achieving a compliant solution is possible, but outside the scope of work, describe why it would not be possible to add this to the scope of work. Explain the decision process to work around the loss in accessibility and describe alternatives explored during design.

Effect on Other Standards: Does compliance with a requirement conflict with federal state, or local laws? Regulatory conflicts may include preserving threatened or endangered species, the environment, archeological or cultural or natural features, historic preservation. Are there trade-offs with other engineering standards, best practices or other conflicting interests which are impacted due to achieving an ADA requirement? Describe any feature that would be affected because of compliance with the ADA requirement.

♦ Mitigation Incorporated

Curb ramp design is required to be accessible and useable by people with disabilities to the maximum extent feasible or practicable. Since at least one standard is not being met in the request, explain what site-specific mitigations are employed to ensure that people with disabilities can access and use the curb ramp. Clearly link the mitigation to the design criteria that is substandard and how accessibility is improved at the location with the given design to the maximum extent feasible.

♦ Supporting Documents

Supporting Documentation: Include the appropriate Plan Section, Cross Section, Alignments Sheets & Plan Details. Include a detail sheet showing elevations and slopes for each curb ramp where an exception is sought. See template in ODOT Standard Detail DET1720 & DET1721. Indicate the signal pole, pedestrian pole & pushbutton location if applicable. Include curb line alignment profile if design exception pertains to the gutter flow slope. Include proposed curb ramp details, general construction plans, existing condition site photos, alternative designs considered, and crosswalk closure approvals or determination letters.

When the Crosswalk Closure box is checked for the intersection, include the approval letter with the submittal in the supporting documents. When a crosswalk is officially closed, an engineering study has been conducted and an approval letter is signed by the State Traffic Roadway Engineer. The approval letter has a unique filing code that resides in the Traffic Section and serves as the decision document in lieu of a ADA Curb Ramp Design Exception Request Form for a single ramp construction.

1006.3 Design Exception Checklist

The ODOT's ADA Curb Ramp Design Checklist is a design aid for determining when design exceptions are required for the curb ramp design. The design exception checklist will aid you in design of the curb ramp system to ensure you do not miss a key requirement for ODOT standards. Download ODOT's ADA Curb Ramp Design Checklist (form number 734-5184) during your project scoping or design. Discussion on each of the design criteria is included in Part 800. Retain the checklist in the project documentation folder once completed utilizing the most current version. Exhibit "A"- Curb Ramp Location and Numbering guidance; and the Exhibit "B"- Curb Ramp Types are available to assist designers when submitting a request and linked within the checklist for reference.

ADA Curb Ramp Design Check List is located on the web at: https://www.oregon.gov/odot/Forms/Pages/default.aspx

1006.4 ADA Curb Ramp Design Exception Form and User Guide Procedure

The ADA Curb Ramp Design Exception Form is a smart pdf file that has automated features used in processing the exception request and transferring information into ODOT's asset database and inventory for curb ramps. Review the ADA Curb Ramp Design Exception Request Form 734-5112 User Guide to complete the request. Adobe Reader is a free software and is used when filling out and submitting the form. Use of software other than Adobe Reader may result in corruption of the ADA Curb Ramp Design Exception Request Form. This document provides step-by-step instructions for all user roles, for filling in, signing, submitting, reviewing and processing ODOT form 734-5112; the ADA CURB RAMP DESIGN EXCEPTION REQUEST form.

The fillable ADA Curb Ramp Design Exception Request form and the ADA Curb Ramp Design Exception Request Form 734-5112 User Guide are located on the web at: https://www.oregon.gov/odot/Forms/Pages/default.aspx

Signatures are obtained by forwarding the document via an automated email and naming convention of the file. Carbon copy appropriate members of your region or design team so they can track the progress of the submission.

Similar to the roadway general design exception form, the basics steps for ADA Curb Ramp Design Exception Request approvals is outlined below:

Step 1 Project Teams determine justification for design exception(s) at scoping, design phases, or planning process.

Step 2 Roadway Designer prepares design exception with supporting justification with review from Region Roadway Manager. The Engineer of Record digitally seals and signs the exception request. Consultation with Technical Service's Roadway Engineering staff is encouraged during the preparation of the request and prior to signing by the Engineer of Record (see Section 1003).

Step 3 The program manager is the ODOT Area Manager, District Manager, or Urban Mobility Office (UMO) Manager. The program manager reviews request and consults with Engineer of Record to assure that the request accurately describes the conditions that warrant a design exception. The Program Manager then digitally signs the design exception request on the "Concurred by" line and forwards to the ODOT Region Technical Center Manager or the Region Roadway Manager.

Step 4 The ODOT Region Technical Center Manager or the Region Roadway Manager reviews the request and consults with the engineer of record and other applicable groups in Region, such as Traffic or Safety. The Region Technical Center Manager or the Region Roadway Manager digitally signs the design exception if they concur with the request.

Step 5 The design exception, or ProjectWise link to the design exception is submitted by email to the **ODOT Design Exception inbox** at ODOTDesignExceptions@odot.oregon.gov. The Design Exception is assigned to a member of the Design Exception Review team for review and a formal recommendation is prepared by the member. This team meets **weekly** to review exceptions and discuss the merits of all ADA Design Exceptions. Informal reviews are completed as required based upon the complexity of the project.

Step 6 The State Roadway Engineer reviews the design exception request and recommendation from the Design Exception Review team.

Step 7 The State Traffic-Roadway Engineer digitally seals and signs the request if sufficiently justified.

Step 8 The State Traffic-Roadway Engineer receives FHWA approval (if necessary) for design exceptions and forwards copy to the signers of the Design Exception. The State Traffic-Roadway Engineer maintains the original request in approved design exception file.

Step 9 Where agreement between the Region Technical Center Manager and the State Traffic-Roadway Engineer cannot be reached, the State Traffic-Roadway Engineer forwards the request to the Chief Engineer. The Chief Engineer makes the final decision on approval or denial of the design exception request.

1006.5 ADA Curb Ramp Design Exception Database

Each design exception is assigned a control number that is used for permanent storage and filing. The control number is assigned once the design exception request has been formalized with signatures for the ADA Curb Ramp Design Exception Request and received by the Design Exception Administer for the roadway unit. The ADA Curb Ramp Design Exception Request Form auto populates information into the asset database and inventory systems and therefore paper submissions are not permitted. Approved requests can be looked up with the database which is publicly available at https://ecmnetintra.odot.state.or.us/DesignExceptions**.**

♦ FACS-STIP Layer

The ADA Curb Ramp Design Exception Request Form auto populates information into the asset database and inventory systems, and information is available on the curb ramp layer. Refer to the FACS-STIP User Guide.

Section 1007 Digital Seal Requirements

General and ADA Design Exception Request Forms require digital professional engineering seals and signature from the professional of record and the State Traffic-Roadway Engineer. Digital seals and signatures must meet the ODOT requirements and the requirements of the Oregon State Board of Examiners for Engineering and Land Surveyors. Engineering. Digital seal and signature requirements are provided in Part 100 of the HDM and in ODOT Engineering and Technical Services Branch Directive TSB21-01(D).

Section 1008 References

1008.1 Code of Federal Regulations

♦ 28 CFR Part 35

For all states in the US, ADA features constructed after 1992 are required to be readily accessible by individuals with disabilities if the construction commenced after January 26, 1992. The burden of proving technical infeasibility lies with the state or local government that constructs the ADA feature. Conditions for exceptions to the regulation requirements for ADA stipulated in the code of federal regulation as it pertains to Title II entities. Title II entities include all local and state government agencies.

Part 1100 3D Design

Section 1101 Introduction

The final quality review for any project occurs in the field. Mistakes and unresolved issues must be worked out under the time and cost constraints imposed by the construction contract. Hurried efforts to resolve issues frequently result in delays, added cost, and less than optimal solutions. Discovery and resolution of these issues during design helps to keep a project on time and within budget. By modeling a project in 3D, the designer "builds" a virtual project before it is constructed physically. The 3D design process and the resultant 3D engineered model reveal many of the design issues prior to construction when they can be managed more effectively.

A 3D engineered model, created by the designer, is a virtual representation of a real world project. In its simplest form it consists of the geometry of the roadway: the points, lines and shapes that define the alignments and surfaces. The ultimate model includes not only the geometry of the roadway but also the associated features (drainage, structures, signing, signals, illumination, etc.) and related metadata.

In order to realize the greatest value from the model it must be designed to a higher level of detail than is required for 2D drawings and plans. The model should incorporate all of the grading details such as widening for guardrail or mailboxes and transitions between different cut and fill slope designs. Abutting surfaces need to match – not just the top surface but subgrade as well. These details allow for the use of automated machine guidance. Drainage facilities and foundations should be placed to identify conflicts between the various assets.

Because the 3D model captures the physical relationships between the various construction elements, the model conveys the intent of the project more effectively than 2D drawings and plans. The 3D model offers many advantages over 2D drawings:

- Visualizations and simulations help stakeholders more easily understand the scope and impacts of a project.
- Design analysis can be done graphically.
- Design gaps and clashes are more easily detected.
- Quantities can be measured directly from the model.
- Constructibility issues can be identified and resolved early.
- Design of construction sequencing and staging is simplified.
- Grading is done directly from the design when using AMG.

3D model creation may require a considerable amount of time and resources. While this could increase design costs, it rarely increases the overall cost of a project. The engineering issues that have typically surfaced during construction are, in the 3D design workflow, resolved prior to the start of work.

Section 1102 3D Engineered Models for Construction

The use of automated machine guidance (AMG) by ODOT's contractors has been steadily increasing since it first appeared in the late 1980s. A prerequisite for the use of AMG is a 3D model of the work. Historically, these models have been created by the contractors, or third-party consultants, based on the contract plans and cross sections or grades provided by ODOT. Recognizing the value of AMG to ODOT, in 2013, the agency started to require that its 3D design models be made available to contractors for use in bid preparation and, separately, for construction. ODOT's intent is to encourage and support the use of AMG. There is currently no plan, however, to prohibit the use of traditional survey and construction practices. The required contents of the data handoff packages have been selected to provide support for contractors using all types of survey and construction methods.

1102.1 Digital Design Handoff Packages

Digital design data is compiled into two separate digital design packages:

- The Bid Reference Handoff package:

  The contents of this data package is standardized in order to provide a "level playing field" for all bidders. Note that this handoff package is an estimating aid only; it is meant to convey design intent, not necessarily construction details. Do not leave information out of the contract plans expecting bidders to find the information in the handoff package. The data included in the Bid Reference Handoff package is not intended for use in project construction.
  The Bid Reference Handoff data is submitted to the ODOT Resident Engineer-Consultant Projects (RE-CP) or ODOT Transportation Project Manager (TPM) no later than 1 week prior to the Project Advertisement milestone. The ODOT RE-CP or TMP uploads this data to eBIDS as a reference document at the time of Project Advertisement to assist contractors in the bidding process.

- The Construction Survey Handoff package:

  The provided data communicates the design information needed for the administration of the construction contract. This handoff package is tailored to the needs of both the Resident Engineer and the contractor. The designer must coordinate with the Resident Engineer to establish its content. The Construction Survey Handoff package supersedes the data in the Bid Reference Handoff package.
  The Construction Survey Handoff data is due to the Resident Engineer 30 days after Bid Opening, which generally coincides with Notice to Proceed for the contractor.

The delay between the Bid Reference Handoff package and the Construction Survey Handoff package serves two purposes. It allows the designer time to refine and complete all details of the 3D model and it provides time for the designer to assemble the Construction Survey Handoff package requested by the Resident Engineer.

1102.2 Projects Requiring 3D Digital Design Packages

The Bid Reference Handoff package and Construction Survey Handoff package are required on all state and federal aid STIP roadway projects designed to 3R or 4R standards, but should also be included in any other project that includes designed grading. The handoff packages are only required for projects that are accepted by the Project Controls Office (PCO), These requirements apply to projects located on the state system, whether delivery is by ODOT, local agency or consultant forces.

Preparation of the digital design data package may not be appropriate for some projects due to various constraints such as schedule, scope, and/or budget. The responsible Region Roadway Manager (RRM) may approve an exception to the requirement for the Bid Reference Handoff package upon written request prior to the Advance Plans milestone.

1102.3 Required Content for Handoff Packages

♦ General

The contents of a digital design package will vary with the complexity of the project. Shoulder widening projects usually require some horizontal and cross section control and would merit a minimal package. An interchange or urban modernization project requires an extensive package that includes many alignments and surfaces defining the project. Regardless of project complexity, some guidelines must be followed in order to reduce the possibility of errors (and claims) during construction:

- Include only the information incorporated in the final design. Multiple versions or design iterations will create confusion during construction.
- Follow a consistent naming convention. Using ODOT's ProjectWise file naming standards will help to achieve that consistency.
- Organize the package logically and consistently. Construction office staff are usually under tight time constraints; they need to find the desired files quickly.

♦ Index

The index is mandatory for all handoff packages. Include the project data (name, highway, key number, etc.), directory structure, file names and file descriptions. Index the multiple models within design files as though they are files. An index template file is available at https://www.oregon.gov/odot/ETA/Docs_3DDesign/AppM-eBIDS_Index.xls. See Figure 1100-1 for a sample computer file index for the eBIDS handoff.

Figure 1100-1: Sample Computer File Index for eBIDS Handoff

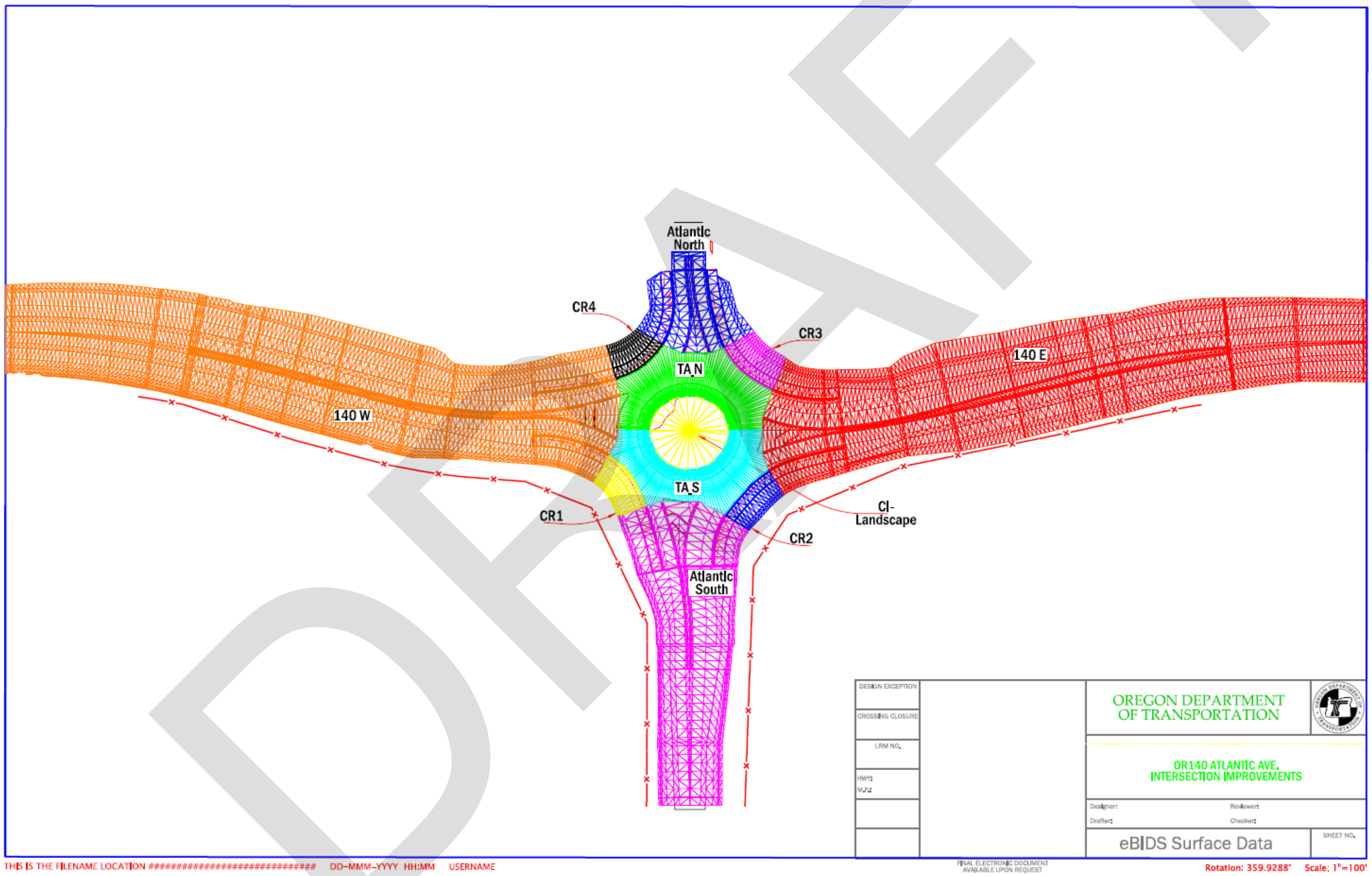
COMPUTER FILE INDEX - eBIDS Handoff

PROJECT	Old Hwy 99N: Oakland Bridge and Melrose Rd: Conn Ford Bridge	**KEY #**	21591
HIGHWAY	Oakland Shady Highway & Melrose Road	**MILEPOINTS**	0.55-0.84 (Oakland); 0.70-0.92 (Melrose)
COUNTY	Douglas County	**DESIGNER**	Jakki R. Carter, P.E.
CONTRACT # (Optional)	C15318	**DATE**	September 18, 2021
COORDINATE SYSTEM	OCRS Cottage Grove - Canonville Zone	**VERTICAL DATUM**	NAVD88, GPS DERIVED (GEOID 12A)

FOLDER NAME	FILENAME	DESCRIPTION
	Alignment Data in XML format	
Melrose XML	*L-ALG.xml*	Melrose Road mainline centerline alignment with existing right of way stationing.
Oakland XML	*AP2-ALG.xml*	AP2 centerline alignment.
	AP3-ALG.xml	AP3 centerline alignment.
	G-ALG.xml	Green Valley Road re-alignment construction centerline alignment.
	MA-ALG.xml	Maintenance Access centerline alignment.
	O-ALG.xml	Oakland Bridge re-alignment construction centerline alignment.
	Surface Data in XML format	
Melrose XML	*L-FG.xml*	Melrose Road finish grade surface.
	Melrose_Extg.xml	Melrose Road existing ground surface.
Oakland XML	*AP2-FG.xml*	AP2 finish grade surface.
	AP3-FG.xml	AP3 finish grade surface.
	Bent1-FG.xml	Bent 1 abutment fill finish grade surface.
	Bent4-FG.xml	Bent 4 excavation finish grade surface.
	G-FG.xml	Green Valley Road finish grade surface.
	MA-FG.xml	Maintenance access finish grade surface.
	Maintenance_Pad-FG.xml	Maintenance pad finish grade surface.
	Oakland_East_Merged.xml	Oakland Bridge merged surface 1/2; East end (includes G-FG, O-FG east of proposed bridge, Bent1-FG)
	Oakland_West_Merged.xml	Oakland Bridge merged surface 2/2; West end (includes O-FG west of Bent 1.)
	Oakland_EG.xml	Oakland Bridge existing ground surface.
	O-FG.xml	Oakland Bridge finish grade surface.
	Cross Sections in pdf format	
Cross-Sections	*G-Line.pdf*	Contains cross sections of G-FG surface along G-ALG at 10' intervals.
	L-Line.pdf	Contains cross sections of L-FG surface along L-ALG at 25' intervals.
	O-Line.pdf	Contains cross sections of O-FG surface along O-ALG at 25' intervals and at points of interest (i.e. guardrail flares, taper points, etc.)
	Computer File Index - Excel	
	R_K21591_eBidCFI.xls	Excel version of computer file index.

On large projects a graphical index helps to locate the various alignments within the project limits.

Figure 1100-2: Sample Graphical Index for eBIDS Handoff



♦ Project Identification

Include the project name and the names of any alignments included in reports or on sheets. Do not include the “V-number” shown on the plans; this number is to be used only on the contract plans.

♦ Original Ground Survey

Provide the original ground survey from the project surveyor that is the basis for design and quantity calculations with both the Bid Reference Handoff package and the Construction Survey Handoff package. The surface shall be in LandXML format and shall include all features and triangle definitions.

1102.4 Bid Reference Handoff Package

All files in the Bid Reference Handoff package must be in non-proprietary format: standard Microsoft Office file types (.docx, .xlsx), pdf, text, LandXML or html. Do not include CADD graphics files in the Bid Reference Handoff package. Provide any necessary graphic information – e.g., cross sections – in the pdf file format. Identify the information within the Bid Reference package as informational only and not to be used for construction. Include a completed copy of the handoff checklist (ODOT Form No. 734-5019) with the data package.

Figure 1100-3: eBIDS Handoff Checklist

QUALITY CONTROL OF ROADWAY DIGITAL DESIGN
eBIDS Handoff Checklist*

Oregon Department of Transportation

PROJECT NAME	DESIGNER		MILE POINTS (FROM / TO)	COUNTY
HIGHWAY		REGION	KEY NUMBER	DATE OF PROJECT ADVERTISEMENT

Item	Description**	Required?	Provided?
Notice of eBIDS Roadway Digital Design Data Letter	Include Notice of eBIDS Roadway Digital Design Data Letter using template provided	Yes	☐
Computer File Index* **	List of computer file names with a brief description for all provided files	Yes	☐
Alignment Data	Primary alignments in LandXML Format	Yes	☐
	Secondary Alignments in LandXML Format	Not currently required	☐
	Design Finish Surface in LandXML Format	Yes	☐
		Not currently	

♦ Notification Letter

Submit a notification letter (ODOT Form No. 734-5037), separate from the data package, with the Bid Reference Handoff package. The letter notifies contractors that 3D design information is available and updated information will be provided for construction. Print the filled form; do not just save. The document remains fillable if only saved. Attach copies of the handoff package checklist and file index to the letter.

Figure 1100-4: Sample Notice of eBIDS Roadway Digital Design Data

Oregon

Kate Brown, Governor

Department of Transportation
Technical Services
Office of Project Letting
4040 Fairview Industrial Drive SE
Salem, Oregon 97302
(503) 986-4040

Date: September 23, 2021

To: **PLAN HOLDERS**

Notice of eBIDS Roadway Digital Design Data

Subject: Key Number: 21591
Project Name: Old Hwy 99N: Oakland Bridge and Melrose Rd: Conn Ford Bridge
Highway Name: Oakland Shady Hwy & Melrose Road
County: Douglas County
Type of Project (grading, paving, etc.): Grading, Drainage, Structure, Paving, Signing, & Roadside
Bids to be opened and read October 28, 2021

ODOT design staff and/or Consultant partners have prepared an "eBIDS Handoff Package" that contains roadway digital design data. The digital data includes alignment data and three-dimensional surfaces provided in LandXML format, as described in the attached eBIDS Handoff Checklist and Computer File Index.

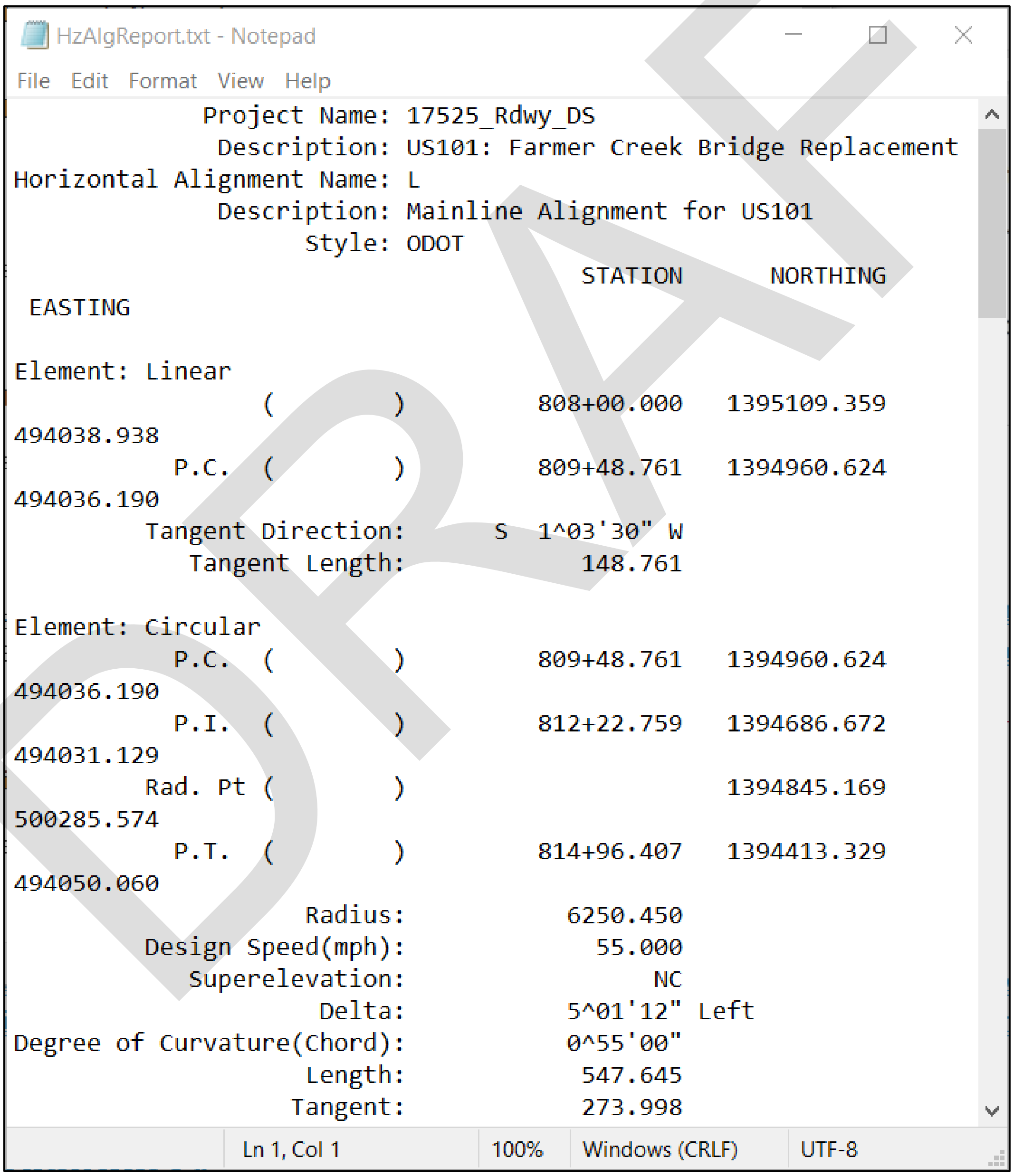
The "eBIDS Handoff Package" roadway digital design data provided on the eBIDS reference documents site is for bidding purposes only. As with all documents on the eBIDS reference documents site, use of this data for any other purpose is at the Bidder's own risk.

In addition to the "eBIDS Handoff Package", a "Construction Survey Handoff Package" may be provided to the awarded Contractor at the pre-survey meeting. Additional information regarding the content of the Construction Survey Handoff Package is provided in Appendix M of ODOT's Highway Design Manual. The roadway digital design data provided to the awarded Contractor may be used to aid in the use of automated machine control equipment, such as GPS grade control, for earthwork construction. Three dimensional representations of physical project component "solids" (pipes, footings, structures, poles, etc.) will not be provided.

♦ Geometry

Include alignment data for all alignments shown on the general construction plan sheets. Alignment names are to match the names shown on the plans. Where applicable, include the corresponding vertical alignments and superelevation definition. Provide the alignments in both the LandXML format and a text report. See Figure 1100-5 through Figure 1100-7 for examples of alignment reports in text format.

Figure 1100-5: Sample Horizontal Alignment Report



HzAlgReport.txt - Notepad

File Edit Format View Help

```
             Project Name: 17525_Rdwy_DS
              Description: US101: Farmer Creek Bridge Replacement
Horizontal Alignment Name: L
              Description: Mainline Alignment for US101
                    Style: ODOT
                                         STATION       NORTHING
 EASTING

Element: Linear
                  (        )          808+00.000   1395109.359
494038.938
           P.C.   (        )          809+48.761   1394960.624
494036.190
         Tangent Direction:       S   1^03'30" W
            Tangent Length:              148.761

Element: Circular
           P.C.   (        )          809+48.761   1394960.624
494036.190
           P.I.   (        )          812+22.759   1394686.672
494031.129
         Rad. Pt (        )                       1394845.169
500285.574
           P.T.   (        )          814+96.407   1394413.329
494050.060
                    Radius:             6250.450
         Design Speed(mph):               55.000
            Superelevation:                   NC
                     Delta:             5^01'12" Left
Degree of Curvature(Chord):             0^55'00"
                    Length:              547.645
                   Tangent:              273.998
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

Figure 1100-6: Sample Vertical Alignment Report

VAlgReport.txt - Notepad

File Edit Format View Help

```
              Project Name: 17525_Rdwy_DS
               Description: US101: Farmer Creek Bridge Replacement
Horizontal Alignment Name: L
               Description: Mainline Alignment for US101
                     Style: ODOT
  Vertical Alignment Name: Lv
               Description: Vertical Alignment for mainline US101
                     Style: Default
                                       STATION          ELEVATION

Element: Linear
                                    808+53.000             69.911
                         PVC        810+55.000             63.996
              Tangent Grade:          -2.92809
             Tangent Length:           202.000

Element: Parabola
                         PVC        810+55.000             63.996
                         PVI        811+75.000             60.482
                         PVT        812+95.000             59.428
                     Length:           240.000
  Headlight Sight Distance:           1486.767
             Entrance Grade:          -2.92809
                 Exit Grade:          -0.87811
        r = ( g2 - g1 ) / L:           0.85416
        K = l / ( g2 - g1 ):         117.07443
            Middle Ordinate:             0.615

Element: Linear
                         PVT        812+95.000             59.428
                         PVC        815+00.000             57.628
              Tangent Grade:           0.87811
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

Figure 1100-7: Sample Superelevation Report

```
* Alignment: NX
* Superelevation Section: NX-1

            Left,151+34.0822370,-0.02719000,RS,U,PC,0.0000000
            Left,151+61.0000000,-0.02850000,RS,U,PC,0.0000000
            Left,153+82.7556960,0.05000000,RS,U,PC,50.0000000
            Left,154+35.2659750,0.05000000,RS,U,PC,50.0000000
            Left,157+83.7215540,-0.05800000,RS,U,PC,100.0000000
            Left,159+40.1379560,-0.05800000,RS,U,PC,100.0000000
            Left,161+00.0000000,-0.01420000,RS,U,PC,100.0000000
            Left,165+02.7300000,0.03500000,RS,U,PC,0.0000000

            zero,151+34.0822370,0.00000000,LS,U,L,0.0000000
            zero,153+32.7556960,0.00000000,LS,U,L,0.0000000
            zero,154+35.2659750,0.00000000,LS,U,L,0.0000000
            zero,155+35.2659750,0.00000000,LS,U,L,0.0000000
            zero,155+88.7215540,0.00000000,LS,U,L,0.0000000
            zero,157+83.7215540,0.00000000,LS,U,L,0.0000000
            zero,159+40.1379560,0.00000000,LS,U,L,0.0000000
            zero,161+35.1379560,0.00000000,LS,U,L,0.0000000
            zero,162+23.4300000,0.00000000,LS,U,L,0.0000000
            zero,165+02.7300000,0.00000000,LS,U,L,0.0000000

            Right,151+34.0822370,0.02718000,LS,U,PC,0.0000000
            Right,151+64.7300000,0.02718000,LS,U,PC,0.0000000
            Right,153+82.7556960,-0.05000000,LS,U,PC,50.0000000
            Right,154+35.2659750,-0.05000000,LS,U,PC,50.0000000
            Right,157+83.7215540,0.05800000,LS,U,PC,100.0000000
            Right,159+40.1379560,0.05800000,LS,U,PC,100.0000000
            Right,161+00.0000000,0.01420000,LS,U,PC,100.0000000
            Right,165+02.7300000,-0.03500000,LS,U,PC,0.0000000
```

Provide LandXML files for all top surfaces. Include both the features (breaklines, random points, and boundaries) and the triangle definitions. Separate files (one for features and one for triangle definitions) are recommended for large surfaces. No file should have more than one surface.

♦ Cross Sections

Include pdf sheets of cross sections for all modeled alignments. Space the cross sections no more than 25′ apart. Include cross sections at the following key points along alignments:

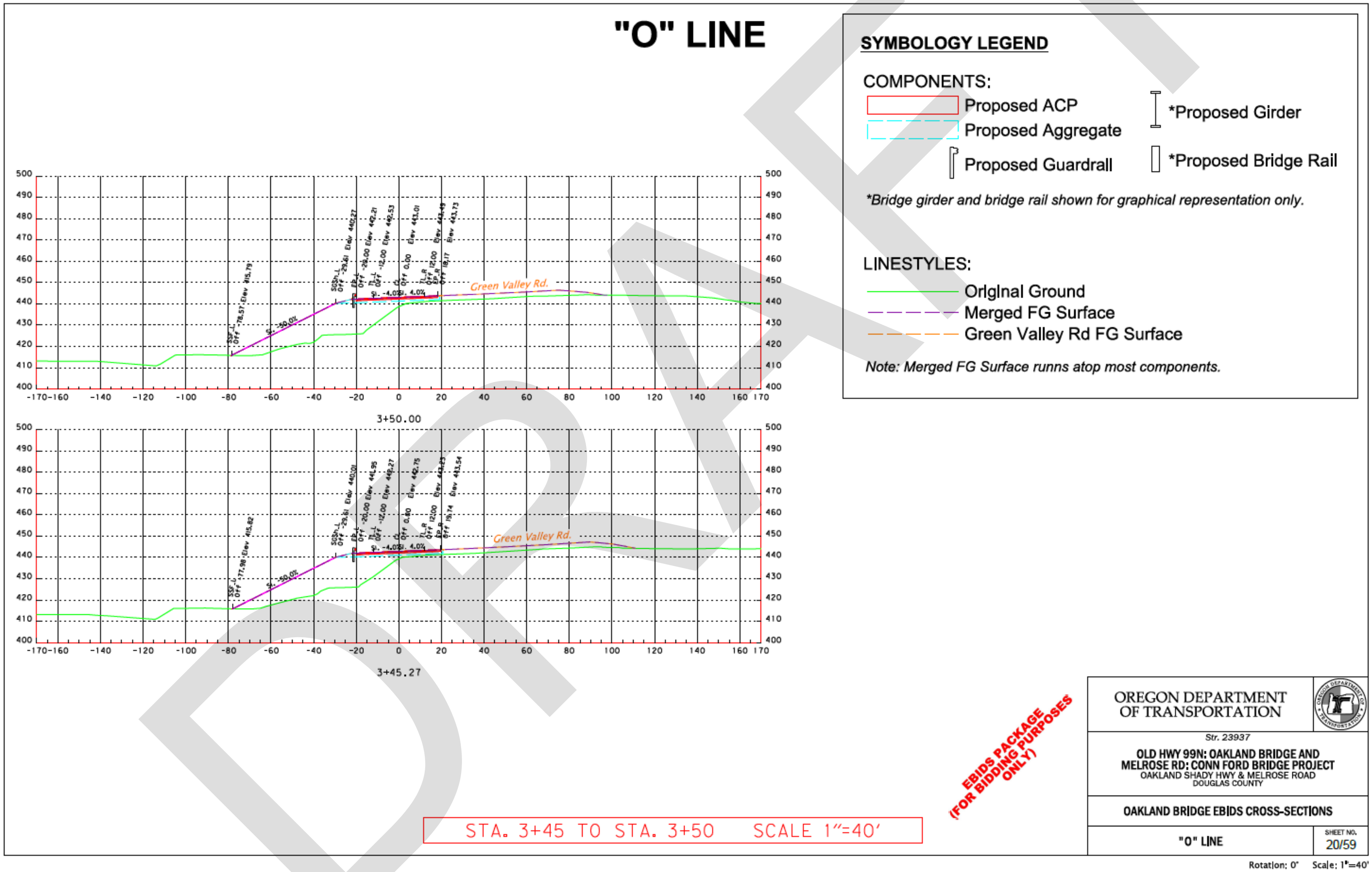
- Typical section changes
- Alignment cardinal points
- Drainage facilities
- Taper start and stop locations
- Guardrail and barrier limits
- Centerline of approaches
- Curb or pavement return points
- Luminaire and signal pole locations

There may be other features unique to a project that will require special sections.

Include all surfaces and components that fall within the range of the cross section set. Annotate the features in the cross sections with name, offset and elevation. Identify all surfaces and components by either labeling directly or with a legend at least once on each sheet. Be sure to print to pdf in a vector (not rasterized) format with lightweight lines.

On each sheet, include the disclaimer that the cross sections are informational only and are not to be used for construction.

1 Figure 1100-8: Sample eBIDS Cross-Section



2

1102.5 Construction Survey Handoff Package

The Construction Survey Handoff package includes the data to be used for construction. The contents are tailored to meet the needs of the Resident Engineer to administer the contract and the needs of the contractor to construct the project. Typically, the model is not complete at the time of bidding – there may be several, usually small, details requiring attention before it can be used for construction. After a project is advertised, the designer has six to seven weeks to finalize the model and assemble this handoff package. The contents of the package is dictated by the needs of the project participants: the Resident Engineer and the contractor. The designer must collaborate with the Resident Engineer to define what information is needed and in what format it should be provided.

These are some general expectations and some of the common file types:

- **Geometry** - Include all alignment data for the project, the horizontal and vertical alignments used to control the model as well as alignments identified in the plans. These might be in CADD files, LandXML files, text reports, or other formats.
- **Surfaces** - All surfaces that define construction materials or pay quantities. LandXML and 3D CADD files of the model will probably be the most useful.
- **Cross Sections** - Updated surfaces and components will necessitate new cross sections. Different or additional cross sections may be required at this handoff. CADD and pdf are common file formats.
- **Reports** - Grade and staking reports will probably be required. These are usually spreadsheets or text files.
- **Additional Information:**
    - Drainage facility information can frequently be delivered as 3D alignments and COGO points, surface features or in 3D CADD files.
    - Sign and other traffic-related locations.
    - Earthwork around structures.
    - Files describing many of the boundaries – R/W, no-work areas, clearing limits, etc. – may be required.

The Resident Engineer is the agency's contact with the contractor. Route all communication with the contractor through the Resident Engineer's office.

Section 1103 Digital Design Elements

1103.1 Software

ODOT roadway designers use Bentley InRoads or Bentley OpenRoads Designer to provide digital design packages for construction projects. Subject to their respective contracts, ODOT's consultant partners may use other software to execute their design, but the deliverables shall be in file formats compatible with ODOT's design software.

1103.2 Possible Digital File Formats

These are the various file types and formats that may be used in the digital handoff packages:

- **CADD (graphics)** – MicroStation design file (.dgn). Do not include CADD files in the Bid Reference Handoff package.
- **Horizontal control coordinates** – ASCII/text (.txt).
- **Elevations** – ASCII/text (.txt).
- **Horizontal and vertical alignments** – Text file (.txt); Geometry report (.xml or .html); LandXML (.xml) alignment; MicroStation design file (.dgn).
- **Superelevation** – superelevation diagram in MicroStation design file (.dgn); HTML (.html) report; text (.txt).
- **Existing ground surface** – LandXML surface (.xml); MicroStation design file (.dgn).
- **Proposed surfaces** – LandXML surface (.xml); MicroStation design file (.dgn).
- **Cross section data** – MicroStation design file (.dgn); Adobe PDF; cross section report (.xml, .html and .txt); spreadsheet (.xlsx).
- **Quantities**:
    - **Volume** – volume report (.xml or .html); MicroStation design file (.dgn); text (.txt); spreadsheet (.xlsx).
    - **Area** –surface area report (.txt); MicroStation design file (.dgn); text (.txt); spreadsheet (.xlsx).
    - **Linear** – MicroStation design file (.dgn); text (.txt); spreadsheet (.xlsx).

Section 1104 3D Design Quality Control

Review of the 3D model is a part of the region quality control process. While the 3D model may be used for design analysis or as an aid to design review, the 3D model review should not be considered a design or a plan review. The purpose of the 3D model review is to ensure the integrity of the model and to verify that it agrees with other project documents. Review digital design data handoff packages prior to submission. Review at other design milestones may also be beneficial. Ideally, reviewers of the handoff packages have direct knowledge of construction methods and contract administration practices.

Provide the following information to the reviewer:

- Engineering files defining the 3D model:
    - Alignments.
    - Original ground surface.
    - Design surfaces.
    - Cross sections.
    - 3D models from other disciplines if available,
    - Pertinent information from other disciplines.
- Latest set of plan sheets (DAP, Preliminary, Advance, Final, Mylar).
- Quantity summary.

Reviews at design milestones have a different objective from reviews of the handoff packages. Milestone reviews focus on how well the model represents the designer’s intent. The degree to which the model matches the designer’s intent depends on the design stage and increases as the project progresses.

Handoff package reviews focus on the suitability of the digital data package for estimating or construction, respectively. Since an accurate representation of the design is essential to estimating and construction, he review focuses on the finer details of the model and composition of the digital design data package itself. There should be very few discrepancies or errors in the model when the Bid Reference Handoff package is due, which is at the time of contract advertisement.

Handoff package reviewers must check the following items:

- Geometry
    - Alignments match plans
    - Stationing matches plans

  - Alignment integrity is suitable
- Surfaces
  - Accurate triangulation
  - Abutting finish grade surfaces match
  - Abutting subgrade surfaces match
  - Design model surfaces and features tie into original ground
  - Features match plan
  - Component depths match typical section thicknesses
  - Constructability
- Quantities measured from model match quantity summary
- Package Documentation
  - Notification letter (printed to pdf so fields are no longer fillable) with checklist and index attached
  - Handoff checklist
  - Computer file index
    - All project data is provided, including project geographic coordinate system
    - All files listed are included in package
    - All files included are listed in index
    - Files are sorted by data type
    - All files have descriptions
  - Corridor map index for complicated projects
- Alignments
  - Alignment names match the names on plans
  - Only alignments used for final model included; no alternative or early versions
- Surfaces
  - Separate file for each surface
  - No gaps or overlaps
  - Constructible transitions at typical section changes and surface connections
  - Feature and component names consistent with naming convention

    - Components match typical sections
- Cross Section Data
    - Project identified on all sheets
    - Alignment identified on all sheets
    - All components shown on each sheet and identified by legend or annotation
    - Key point labeled with name, offset and elevation
    - All surfaces falling within the cross section extent are shown
    - Cross sections spaced no more than 25 feet apart
    - Cross sections included at key stations (typical section changes, alignment cardinal points, drainage facilities, taper start and stop locations, guardrail or barrier ends, centerline of approaches, curb/pavement return points, and luminaire and signal pole locations)
    - Disclaimer on bid reference cross sections
- Drainage
    - Locations and inverts of drainage pipes and structures are shown
    - Earthwork adapted to accommodate drainage features – e.g., ditch deepened to match pipe invert

Part 1200 Other Technical Disciplines

Section 1201 Bridge

1201.1 General

It is important to contact the Bridge Engineering Section when a project involves some type of structural element, whether it is a retaining wall, culvert, bridge, cantilever sign support, etc. The designer should stay in contact with the bridge designer as a project develops to ensure that the roadway and bridge elements of a project fit together.

1201.2 Bridge Definition

A bridge is defined as a structure spanning and providing passage over a river, chasm, road, or the like, having a length of 20 feet or more from face to face of abutments or end bents, measured along the roadway centerline.

1201.3 Structure Types

Structure types include various culverts, slabs, box beams, and various types of deck girders, box girders, arches, and trusses. The selection of structure type is determined by the site, economic, environmental (in-water work windows, etc.) and esthetic considerations.

For small streams, a culvert might be used instead of a bridge. However, for locations with low deck-to-streambed clearances, a culvert may not be proposed because it could not provide enough waterway area. Fish passage issues may also influence the type of structure selected.

Concrete structures may either be pre-cast or cast-in-place. Pre-cast members offer the advantage of off-site fabrication (especially important in remote locations), speed of construction and minimal falsework. Pre-cast members can play a key role in Accelerated Bridge Construction, where it is important to minimize the impact of a construction zone on stakeholders. However, it may be difficult to accommodate horizontal curves, and change in gradelines or superelevations. Cast-in-place structures can more easily accommodate the geometrics. However, cast-in-place concrete requires falsework, which can create a traffic hazard at grade crossings and potentially cause problems at stream crossings.

The roadway designer needs to be aware that there are many types of structures with features that can compliment the specific site conditions. It is very important that the roadway designer and the structure designer communicate all of the site conditions to facilitate appropriate structure type selection.

1201.4 Structure Lengths

♦ Roadway Crossings

Provide the required roadway horizontal clearances plus 1:2 end slopes for all bridges except for county roads or less-traveled highways. Use 1:1.5 end slopes for county roads and less-traveled highways per the Highway Design Manual. When using end slopes steeper than 1:2 a geotechnical review shall be completed to ensure stability.

♦ Stream Crossings

1. Provide the required waterway opening to pass the specified design flood. The Hydraulics Report will provide a required waterway area, the stream bed elevation and the design flood high water elevation. Normally, a minimum bottom-of-beam clearance of 12 inches is provided above the design flood high water elevation. If drift or debris is a concern, the bottom of beam clearance will be increased.
2. Normally, overtopping is not desirable, but may be required to accommodate regulated hydraulic considerations.
3. Provide the required waterway opening to meet fish passage requirements.

1201.5 Structure Clearances

See Part 300 for additional information on all clearances.

♦ Vertical Clearance for Highway Traffic

Proposed new construction that reduces vertical clearance shall require consultation with MCTD to ensure understanding of the impact of the proposed decrease to the user. All other projects, which result in final vertical clearances at or above the minimum vertical clearance, require notification of MCTD to ensure all vertical clearance inventories are current and updated for the appropriate routing of permit vehicles.

For projects other than new construction, no reduction of the existing vertical clearance below the minimum vertical clearance is allowed. No reduction in vertical clearance is allowed if the existing vertical height is currently below the minimum vertical clearance.

1. All High Routes the Vertical Clearance Standard is 17 feet-4 inches.

2. All non-High Routes on the NHS the Vertical Clearance " Standard is 17 feet.
3. All non-High Routes and non-NHS the Vertical Clearance Standard is 16 feet
4. Vertical clearances during construction below the minimums requires consultation with MCTD.

More information, standards, and guidance on vertical clearance are available in Highway Directive TRA 07-15 and Tech Bulletin RD17-02(B).

♦ Horizontal Clearances for Highway Traffic

Normally the bridge roadway width will equal the approach roadway width plus 4 feet for bridge rail shy distance.

♦ Vertical Clearances for Railroad Traffic

Coordinate with the Railroad Liaison to determine required vertical clearances for railroad traffic. In general, the following minimum vertical clearances apply, however, the Railroad Liaison may determine that project-specific clearances are required.

1. All new structures are to be designed with a minimum of 23 feet 6 inches vertical clearance.
2. A minimum vertical clearance of 21 feet (UPRR) or 21 feet-6 inches (BNSF) is required during construction.

♦ Horizontal Clearances for Railroad Traffic

Coordinate with the Railroad Liaison to determine required horizontal clearances for railroad traffic. In general, the following minimum horizontal clearances apply, however, the Railroad Liaison may determine that project-specific clearances are required.

1. The minimum clear distance from the center line of the track to a column face is 25 feet. This distance can be reduced to 18 feet if crashwalls are installed.
2. A minimum horizontal clearance of 12 feet (UPRR) or 15 feet (BNSF) is required during construction.

♦ Horizontal Clearance during Construction

Coordinate with the Mobility Services Team to determine required horizontal clearances during construction. In general, the following minimum horizontal clearances apply, however, the Mobility Services Team may determine that project-specific clearances are required.

1. On Interstate Freeways the minimum width of 19 feet between face of rail for one-way/one lane traffic, plus additional clearance to falsework behind rails. Above 8 feet vertical on each side an additional 2 feet horizontal is required.
2. On non-Interstate highways the minimum width of 16 feet between face of rail for one-way traffic, plus additional clearance to falsework behind rails.
3. Minimum width of 28 feet between face of rail for two-way traffic, plus additional clearance to falsework behind rails.

1201.6 Curbs and Sidewalks

For a particular crash tested bridge rail, the curb or sidewalk height should be used as shown on the appropriate standard drawing.

1201.7 Deck Drains

Some form of drainage system is normally needed on or off structures that have curb or concrete parapet rails. The Roadway Plans drainage details should be carefully reviewed. If drains are required, the project hydraulics engineer will do the design and determine the size and spacing. Bridge length, deck grades, cross slope, typical section, and deck surface type will be needed to determine the deck drain layout.

1201.8 Structure Superelevations

The structure superelevation should match the roadway superelevation criteria. Structures are more susceptible to surface icing therefore superelevation rates may need to be limited to 8% or less in areas beyond the traditional snow/ice limits of the roadway superelevation criteria.

1201.9 Traffic Control during Construction

There are four basic methods of handling traffic for replacing a bridge:

1. Close the highway while removing and rebuilding the bridge.
2. Use the existing roadway and bridge while constructing a parallel bridge on new alignment.
3. Construct a temporary detour bridge around the existing bridge and replace the bridge on the existing alignment.
4. Use stage construction with existing or new lanes carrying traffic while other portions of the existing bridge are being removed and rebuilt.

Another traffic handling consideration that should not be overlooked is accommodating pedestrians (including the disabled) and bicycles passing through the work site, especially in urban areas.

1201.10 Bridge Rail End and Barrier Treatments

The proper type of bridge rail end and barrier treatment is dependent upon the location of treatment. Below is a listing of ways of treating bridge ends and barriers. Engineering judgement is still required when areas of treatment are other than normal

1. Rural conditions, bridge rail end treatment: Use standard approach guardrail to bridge rail transitions. Apply at all rail ends inside the clear zone.
2. Urban conditions, bridge rail end treatment: Normally no approach rail is used when the design speed is 40 mph and below. In these cases, the end of the bridge rail will be protected by a tapered down concrete transition, even if the rail is at the back of a raised sidewalk and is outside the clear zone.
3. Ditch rider roads, bridge rail end treatments: When ditch rider roads are closer to the end of the bridge than standard transitions will allow, a crash-tested treatment shall be used. There is a minimum distance from transition to ditch rider road that allows this system to work, so judgement shall be used in those situations.

Section 1202 Geotechnical Design

1202.1 General

Two of the many questions faced by the highway designer include:

1. What are geotechnical project elements; and
2. How should they be dealt with?

Geotechnical project elements include all issues of design and construction involving soil and rock. How to deal with geotechnical project elements is a more complicated question. Since almost every highway project uses either earth or rock as a construction material and relies on earth support, subsurface information and geotechnical data is essential for project planning, design, and construction. Any geologic feature or material that affects the design and construction phase of a project, or has a bearing on site or corridor selection in terms of hazards or economics must be investigated and analyzed. Of equal importance is the clear and accurate portrayal of these conditions in a format that is accessible and understandable by all users.

The purpose of this section is to make the highway designer aware of the broad range of geotechnical issues that may need to be addressed, and their potential effects on any project regardless of size or apparent complexity. There are common project elements that typically require site-specific geotechnical investigation and design such as bridge foundations and landslide mitigations, and there are project elements that, depending on the site history and underlying geology, may or may not need a site-specific geotechnical investigation and design, or may require different levels of effort. The geotechnical designers will be able to determine the level of effort based on their own or other's knowledge and experience of the site to make these judgments. Because of the underlying site conditions, elements that generally don't warrant geotechnical design for most sites may require it at others. Conversely, investigation and design efforts may be scaled back or eliminated at other sites due to known favorable conditions, ant the significance of the project feature. It is the geotechnical designer's responsibility to make these decisions.

The guidance provided in this section is not exhaustive as every project is unique. The ODOT Geotechnical Design Manual (GDM) must be consulted for all geotechnical design elements.

1202.2 Common Geotechnical Design Issues

The following is a list of the geotechnical issues common to highway projects of almost any size:

♦ Selecting and Designing Stable Slopes for Cuts and Embankments

This far ranging issue must consider the materials available or required for construction, the space available to make the slopes, erosion from the slope, picking slopes to minimize maintenance, how the slopes will be constructed, surface drainage over the slope, and quality control to insure good performance. The subject also includes designing steeper than usual slopes to accommodate right of way limitations, avoid environmental features, or simply save money. Many options can be used to build steep slopes ranging from specially placed select materials to geosynthetic reinforcement.

♦ Avoiding or Dealing with Unstable or Potentially Unstable Slopes

This deals with the broad subject of building on or around landslides or not creating landslides with earthwork construction. Both cuts and fills may be involved. The subject also includes the possibility of destabilizing an existing fill by making changes to it including widening or slope steepening. Special design is usually necessary to recognize and deal with this issue.

♦ Embankments over Soft Foundations

An embankment on soft ground often settles dramatically and may slide, slump, or sink during construction if not designed properly. It is important to know how much settlement will occur and how long it will take to finish. Often, measures must be taken to accelerate settlement or improve foundation strength. Options include flat slopes, berms, stage construction, surcharging, wick drainage, foundation reinforcement, ground improvement and lightweight embankment materials.

♦ Materials for Construction

On-site soils must generally be used for economy but they may be poorly suited for embankment construction. Soil type and excess moisture are often problems. Wet soils and strategies for dealing with them must be recognized. Finding suitable sources for borrow can be important. Also under this heading are design strategies for getting embankment built over wet, soft subgrade, or building embankment in wet weather. Other issues may include the presence of boulders, rock, or other obstructions in excavation and the proper placement and compaction of soil, soil rock mixtures, and rock fills. Special density testing and compaction requirements will often be required for special cases including embankments with steep slopes, high embankments, or fills in critical locations.

♦ Widening Cuts and Fills

Projects involving widening must be carefully considered to assure that cuts and fills will perform well and can actually be constructed. Sliver cuts and fills can be and often are severe construction problems. There are also issues around the type of fill used in a widening and whether certain material may actually destabilize an existing embankment by causing water to backup in the old fill.

♦ Earthwork Balance Analysis

On moderate to large projects, estimating the volume shrinkage or swell of earth and rock material from borrow to embankment can be a major source of error in balancing the earthwork. A careful consideration of the volumes of material along with evaluation of the earth density can be used to refine shrink/swell estimates.

♦ Surface and Groundwater Control

Water control is necessary for stable slopes.

♦ Seismic Site Response and Mitigation Design

Consideration will be increasingly given to the seismic stability of embankments and slopes. A key issue is the liquefaction of embankment foundations.

♦ Rock Slopes

In designing new alignments or widening in rock, the issue is the appropriate slope and its configuration to minimize rockfall. Some projects may require improvements in existing rock slopes to minimize the impacts of rockfall. Design guidance is provided later in this document.

♦ Pavement Subgrade

The Pavement Unit deals with this issue to determine if wet soils will make pavement construction difficult.

The above list is not exhaustive as every project is unique. The GDM must be consulted for all geotechnical design elements.

Section 1203 Environmental Studies

1203.1 Project Classification

Per FHWA, ODOT is required to document National Environmental Policy Act (NEPA) compliance for federal proposed actions. The NEPA document serves a federal purpose and therefore focuses primarily on compliance with federal statutes, regulations, and policies. ODOT is also responsible for adhering to state and local environmental and land use requirements, which are typically documented in the Environmental Prospectus and Environmental Baseline Report if required. These requirements exist for both state and federally-funded projects as relevant.

When a project is identified in the Statewide Transportation Improvement Program (STIP), the responsible Region initiates scoping and project development. For NEPA classification and approval documentation, the Region Environmental Coordinator (REC) prepares an Environmental Prospectus in order to document scoping and to recommend a preliminary NEPA classification to cover the project's proposed actions.

The Environmental Prospectus is required as an attachment for further required NEPA documentation as follows depending on the applicable NEPA classification. For PS&E submittal, only the final NEPA document is required (not the Environmental Prospectus or any other environmental attachment). For NEPA Class 2: Programmatic Categorical Exclusions (PCE) - the PCE Approval (signed by ODOT); for NEPA Class 2: CEs - the CE[1] Closeout (signed by FHWA); for NEPA Class 3: EAs - the Finding of No Significant Impact (FONSI)[2] (signed by FHWA); and for NEPA Class 1: EISs - the Record of Decision (ROD)[3] (signed by FHWA).

Most projects are Class 2 projects, which do not require an Environmental Assessment or Environmental Impact Statement, but may require specific environmental reports and/or mitigation and do require specific permits, approval and/or clearance documents which are attached to the PCE Approval (signed by ODOT) or CE Closeout (signed by FHWA). Class 1 projects will have a significant impact on the natural or human environment and require a draft

[1] Categorical Exclusion (CE) for Class 2 projects.

[2] Finding of No Significant Impact (FONSI) for Class 3 projects. A FONSI is attached to the Environmental Assessment or the Revised Environmental Assessment if revisions are called for.

[3] Record of Decision (ROD) for Class 1 projects. The ROD is the final NEPA approval document for a project that has significant impacts and is therefore required to be analyzed in an Environmental Impact Statement (EIS)—consisting of a Draft EIS (DEIS), a Final EIS (FEIS), and a ROD which captures the decision made and the rationale for making the decision. FHWA is the decision-maker for all NEPA documents.

and final Environmental Impact Statement (DEIS/FEIS) and the issuance of a Record of Decision (ROD). Class 3 projects that may have significant impacts to the natural or human environment require an Environmental Assessment/Revised Environmental Assessment (EA/REA) and a Finding of No Significant Impact (FONSI).

Approving the PCE Approval, CE Closeout, FONSI, or ROD by FHWA prior to PS&E allows the project to advance to the final design phase and to undertake right of way acquisition.

1203.2 Environmental Studies

PCE and CE (NEPA Class 2) projects must be evaluated for several of the same elements as NEPA Class 1 and 2 projects are, depending on the type and severity of impact. All impacts, including if there are no or minor impacts, are summarized in the specified locations of the PCE Approval and CE Closeout. Public involvement and community/EJ/equity engagement, environmental commitments, and Tribal consultation summaries are also included in all PCEs and CEs. Projects that are classified as Categorical Exclusions are evaluated to determine that there are minimal impacts, if any, and documented in the Part 3 of the Prospectus. The level of detail required is driven by the nature of the impacts, not necessarily the class of the project.

The purpose of the environmental evaluation is to give information to the project team, the public, and the regulating agencies so that project decisions can be made by decision makers who are informed of all the consequences of the decisions they are making. It is hoped that this will lead to the solution that best balances transportation needs, safety, economics, and protects to the greatest extent feasible, the natural habitat and human environment.

Environmental Policy requires avoidance, minimization, and compensatory mitigation, in that order. All ODOT and LPA sponsored transportation projects require a standard list of regulatory approvals, clearances, and/or permits as applicable to the project's environmental impacts. The ODOT NEPA Program website contains all the FHWA-approved NEPA forms, templates, and procedures for complying with CEs, EAs, and EISs. Individual ODOT environmental discipline program websites contain forms, templates, and procedures for those disciplines – including any specific qualifications required for the preparation and/or completion of any environmental documents that support the NEPA decisions for CEs, EAs, and EISs. Further, ODOT's NEPA Manual can be found at the external website:

https://www.oregon.gov/odot/GeoEnvironmental/Pages/NEPA-Manual.aspx

If federally-protected Parks or Recreation Areas are impacted, those clearances and/or approvals would be required as well, and there can be several other environmental clearances, approvals, and/or permits that are also required either before NEPA is approved or after—during final design and prior to bid let.

Designers should work very closely and as early in the project as possible with the Region Environmental Coordinator (REC) or EPM (Environmental Project Manager) for any questions or issues they may have with a particular design especially if the project is a Federal-aid Highway Program (FHWA-funded) or other federalized modernization, bridge, culvert, or safety project. These types of projects can be much more complex in addressing all the various aspects of environmental constraints and requirements if impacts cannot be entirely avoided. The REC or EPM coordinates with the Region or TLC[4] environmental technical specialists working on the project, and is responsible to carry any messages related to design scope, schedule, or budget changes from environmental requirements to the Project Leader and PDT[5] for further discussion if needed.

There are certain time-saving programmatic permits and agreements with various state and federal regulatory agencies available that are intended to cover certain projects without needing an individual permit or approval. It is crucial to coordinate with the Region REC or EPM along with the other environmental specialists on the PDT to ensure the correct 'environmental performance standard' or 'best management practice' is being applied to the design in order to meet the relevant environmental standards as well as all the terms and conditions contained within individual permits if those are required. Environmental performance standards include specific design guidance that should be applied to projects that fit a certain category.

ODOT environmental staff capture environmental commitments made before, during, and after the NEPA process. Some commitments are captured in the various NEPA documents (i.e., CEs, EAs, and EISs) and some are captured in environmental permit terms and conditions. Remaining environmental commitments are captured via the use of ODOT standard environmental specifications and "specials" as well as other relevant project documentation.

1203.3 Specific Impacts

Project impacts that affect the environment can be either direct or indirect as well as cumulative; occurring over time in addition to other similar impacts within a certain established area such as a watershed or ecosystem region. An example of a direct impact would be the removal of habitat by realigning the roadway prism. Indirect impacts often occur from changes in access. For example, providing an interchange where only an overcrossing existed may induce land use changes which, in turn, impact habitat. Other indirect impacts can occur from increasing development that can result from improvements made (i.e., the projects) to the transportation system. These are more difficult to predict with certainty, but are often the more profound impacts. Either type of impact can influence the facility design as the project team attempts to avoid, minimize or offset/mitigate the impacts. Typical of some of the impact areas are:

[4] Technical Leadership Center—where Environmental Technical Specialists and Program Coordinators reside (within the Environmental Section).

[5] Project Development Team.

♦ Noise

Noise barriers may be used to mitigate traffic noise on a project. The preliminary design (location, height, length) for these barriers is done by the noise analyst (consultant) conducting the technical work for the noise study. After the barrier has been determined to be feasible and reasonable, the affected residents and property owners must vote their approval before the wall can be built. The public involvement process may also be used to help determine the type and the surface features (if any) of the wall and desirability of a noise barrier.

The final decision as to the type of noise barrier to be constructed will be made during the final design process. The project structural designer will do the final design of the structural element of a noise wall often times working with the noise analyst who did the preliminary design to ensure effectiveness of the final wall location and dimensions. The project roadway designer will do the final design of an earth berm.

It is essential to realize that additional right of way may be necessary to construct the footings for a wall. In addition, conflicts can arise between a noise barrier's location and utilities, signing or drainage facilities. Coordination during the final design process involving all of the affected groups will help in avoiding conflicts with wall placement.

♦ Historic

Environmental laws that require that all buildings, objects, sites, structures (i.e. bridges/tunnels) or districts (i.e. historic roads, railroads) listed in or eligible for listing in the National Register of Historic Places, and publicly owned parks, recreation areas, and wildlife or waterfowl refuges, be avoided, or if part of the transportation system, are minimally affected.

♦ Archaeology

Archaeological sites are frequently identified on our projects and can influence engineering/design. The archaeological site type, depth, and location may require special protections and sometimes even warrant preservation in place. For example, archaeological sites are frequently found at stream crossings and confluences; they can be deeply buried or relatively shallow. Such sites may require special re-designs to avoid the locations. In addition, some Tribes continue to use certain site locations for ceremonial practices; in those cases a project may require special engineering/design for access points. Designating no-work zone areas is also typical. Successful design alternatives can be reached by working closely with the Project RECs and ODOT Archaeologists and through consultation with the Native American Tribes.

♦ Wetlands

All classes of projects frequently impact wetlands. It is critical to determine if there are alternatives that avoid the impact, and if not, how the impact can be minimized or mitigated, in that order, for all wetland areas. Different alignments, steeper slopes, retaining walls, and other techniques must be used to avoid or reduce impacts, if these techniques are feasible in the impact area.

♦ Water Quality

Designs that can avoid disturbance of water quality, including changes to an area's hydrology, are important to consider. Stormwater management for water quality is required for projects that:

1. Increase impervious surface area,
2. Change highway alignment and/or modify the storm drainage system including adding curbing to current uncurbed sections of roadway,
3. Replace or widen stream crossing structures (bridges, culverts, etc.), or
4. Do extensive reconstruction of the roadway by removing and replacing the pavement.

Water quality treatment is to be designed to treat all of the runoff from the project's Contributing Impervious Area (CIA) resulting from the Water Quality Design Storm[6]. Treatment techniques that incorporate infiltration, media filtration and filtration through vegetation are considered to be highly effective at removing highway pollutants thereby maintaining and/or improving water quality. Further information on what triggers the requirement for treatment of stormwater is found in Geo/Environmental Technical Bulletin 09-02(b). Information on the Water Quality Design Storm and treatment techniques is available in the ODOT Hydraulics Manual.

Flow control is required for projects that increase discharges to a surface water by more than 0.5 cfs from the 10-year 24-hour storm, and which do not discharge into a large water body (river, lake, reservoir, estuary, ocean). The intent is to prevent adverse changes to stream stability and form by matching the post-project to the pre-project hydrology for the range of flows most responsible for stream channel processes and erosion. Detailed information on the

[6] The Water Quality Design Storm is 50% of the 2 year 24 hour storm for climate zones 1, 2, 3, 6, 7 and 8, 67% of the 2 year 24 hour storm for climate zones 4 and 9, and 75% of the 2 year 24 hour storm for climate zone 5.

range of flows is found in Geo/Environmental Technical Bulletin 09-02(b) and in the ODOT Hydraulics Manual.

♦ Threatened and Endangered (T&E) Species

Many projects have the potential to impact wildlife in general and T&E plant and animal species more specifically. In this case, design changes to avoid impacts are required. Conservation measures are often required as part of the construction contract to avoid impacts to protected species. Since these vary widely with the various species, it is important to work closely with the Region biologist and/or Local Agency consultant biologist when designing the facility and work conditions near endangered and threatened species, particularly near fish bearing streams and wildlife groups.

Seasonal in-water work periods are designated for most Oregon waterways; stream classification and fisheries activity can also influence the design of most bridge and culvert replacement and larger transportation improvement projects. Due to the presence and/or likelihood of T&E species and/or critical habitat in many areas of the state, water quality requirements to protect species and in-water work timing prompt critical project discussions between designers and environmental specialists. Designs that can avoid in-water work or disturbance of water quality, including changes to an area's hydrology, are important to consider.

♦ Migratory Bird Treaty Act

Many projects have potential to violate the Migratory Bird Treaty Act and should be reviewed by regional environmental coordinators. Activities which are most likely to impact and result in take of migratory birds on highway projects include, but are not limited to; clearing or grubbing of migratory bird nesting habitat during the nesting season when eggs or young are likely to be present, bridge cleaning, painting, demolition, or reconstruction where bird nests are present. Proper coordination with regional environmental coordinators will help prevent projects from being halted or delayed due to bird issues.

♦ Air Quality

Transportation plans, programs and projects within Oregon's air quality non-attainment and maintenance areas must conform with the intent of the State Implementation Plan (SIP) for air quality. Major projects in these areas requiring DEIS/FEIS or EA/REA environmental documentation must demonstrate conformity before FHWA can issue a ROD or FONSI. Smaller projects involving signalization, channelization, changes in vertical or horizontal alignment or bus terminals may also require a conformity determination. Coordinate with the Region Environmental Coordinator (REC) or an air quality specialist when questions arise regarding specific conformity requirements.

♦ Hazardous Materials

All projects need to be reviewed for potential impacts to hazardous material sites. There are many risks that can be created or aggravated even when working completely on ODOT right of way. When excavating or working along ditches the designer must be careful of disturbing contamination or causing lateral transport of that contamination, and the design must manage contaminated material, transport, and surface drainage.

All projects require a Pollution Control Plan. The plan will address the contractor's response in the event of an unforeseen spill, leak, or discovery.

New federal policies stress that the State needs to consider future land uses when deciding the location of facilities. It is not necessary to try to avoid all contamination. The contaminated site could be used for transportation, which could to bring the site into greater productivity.

♦ Public Parks and Recreation Areas

Certain public parks, recreation areas, trails, scenic corridors, and other recreation resources could have received funding from state and/or federal grant programs that require that land to stay in recreation use "in perpetuity". If a transportation project needs to acquire any amount of property (including temporary and permanent easements or rights-of-entry) from those protected recreational properties, formal consultation with and approvals from certain state and federal parks agencies, FHWA, and the local park or recreation area "official with jurisdiction" may be needed to allow a use other than recreation to occur. Region RECs and EPMs will assist designers and project teams in determining those needs and will also lead the consultation and approval process along with the region ROW agents. In the worst cases, project re-design may be needed to avoid impacts to these recreation properties.

♦ Other Areas

Project impacts to floodplains, scenic resources, emergency services, neighborhoods, social and cultural interactions, businesses and other environmental subject areas can be of sufficient importance to influence the design. Land use and planning, particularly compatibility with comprehensive plans, Department of Land Conservation and Development Statewide Planning

Goals, and requirements of the Transportation Planning Rule, are critical elements in determining the design of the facility.

♦ Permits

Many of the above areas will require individual environmental permits (see Section 1213), if the project cannot meet the available programmatic permit requirements that ODOT currently has in place with several regulatory agencies. The Region REC or EPM is the best source for designers to determine if and when individual environmental permits and other individual approvals are needed.

1203.4 Design Specifications

A summary of mitigation and conservation measures, known as 'environmental commitments', is included in the CE Closeout, REA, or FEIS for the specific project. These environmental commitments are incorporated into the plans and specifications for the project. Although there are some standard conservation measures listed in the *"Oregon Standard Specifications For Construction"*, project specific items are identified in the CE Closeout, REA, or FEIS.

As stated previously, the Region REC or EPM for a specific project should be consulted early in the project's design on questions regarding all environmental commitments.

1203.5 Plans, Specifications and Estimate (PS&E)

Approximately 7 weeks prior to bid letting, the PS&E package - which includes the required NEPA approval document and all environmental clearances, approvals, and permits - is delivered to the Project Controls Office (PCO)for final processing. All NEPA approvals and other environmental permitting work must be completed at this point.

Section 1204 Rail

1204.1 General

As with airports, rail crossings in the vicinity of projects cause the influence areas of the respective modes to overlap. Projects near railroads, light rail, and other rail system crossings need to be reviewed for potential impacts. Rail crossings may be at-grade or grade separated depending on elements such as type of facilities, conflict points, and safety requirements. It is desirable to avoid or reduce at-grade rail crossings. Discussions between the Project Team and ODOT Commerce and Compliance Division should be held to determine the need to grade separate the crossing or leave it as an at-grade crossing.

Roadway projects in the vicinity of railroads need to accommodate the type of cargo and goods that are exchanged between rail and other transportation modes such as truck freight. Turning radii, travel lanes, or additional dedicated turn lanes need to be considered in the accommodation of vehicles moving such cargo and goods between roadway freight and rail lines. Review the existing Transportation System Plans to determine any related rail transportation needs.

ODOT Commerce and Compliance Division’s jurisdiction for the regulation of the railroad-highway at grade crossings extends a distance equal to the stopping sight distance (SSD), for the posted or statutory speed, measured back from the location of the stop clearance line at the railroad crossing (OAR 741-100-0005).

Because ODOT Commerce and Compliance Division has jurisdiction within the SSD from the stop clearance line, it is important to include them in the scoping phase of project development so that there is enough time to obtain a Rail Crossing Order if needed. It is also important to include the State Railroad Liaison in the scoping as they will be developing an agreement with the Railroad Company. (See Right of Way Manual, Chapter 10)

Failure to coordinate with ODOT Commerce and Compliance Division and the State Railroad Liaison will result in excessive delays to your project schedule.

1204.2 Field Diagnostic Review

The field Diagnostic Review is part of the requirements found in 23 CFR Part 646 – Railroads, Part 646.214 – Design. This will occur early in the design process, at project scoping or prior to DAP plans, and is coordinated by the State Railroad Liaison and the ODOT Commerce and Compliance Division. The review typically includes the following members:

- The State Railroad Liaison
- Road Authority
- Project Team Leader
- Rail Division representative
- Railroad Company representative
- Construction representative
- Designers (Signal, Roadway, and others as needed)

The field diagnostic review team will meet on-site to determine the required safety upgrades to the railroad crossing. The findings from the field diagnostic review will be the starting point for:

- Identifying design constraints and work to be completed;
- Completing the Railroad-Highway Public Safety Application (which is required to obtain the Rail Crossing Order for ODOT Commerce and Compliance Division; and
- Obtaining any necessary design exceptions.

1204.3 Rail Crossing Orders

Each public railroad crossing is required to have a Rail Crossing Order. Rail Crossing Orders are issued by the ODOT Commerce and Compliance Division and authorize the alterations to crossings, both at-grade and grade separated crossing types. Private crossings are not regulated by the ODOT Commerce and Compliance Division and therefore do not require a Rail Crossing Order. The majority of projects involving railroad crossings will require an Order to alter the subject crossing. New at-grade crossings are rarely approved by ODOT Commerce and Compliance Division because state law directs ODOT to eliminate railroad crossings at-grade, wherever possible.

Rail Crossing Orders contain specific requirements related to the roadway geometry and roadway features. In order to obtain a Rail Crossing Order, a Railroad-Highway Public Crossing Safety Application must be completed and submitted to ODOT Commerce and Compliance Division early in the design phase. (add web link) This application is typically done by the project team leader or designer, with assistance from the State Railroad Liaison.

1204.4 Railroad Roadway Plan Sheet

ODOT Commerce and Compliance Division requires a separate, sealed railroad roadway plan sheet to be included with the Railroad-Highway Public Crossing Safety Application. This plan sheet will be completed early on in the project, DAP or preliminary plans, prior to completion of the other roadway plan sheets for the project. This is due to the design phase and the Rail Crossing Order process running concurrently, with the requirement that the Rail Crossing Order is complete prior to bid letting.

This plan sheet should contain the roadway design features that will be shown in the final roadway contract plans, including:

- A plan view of the railroad crossing
- Vertical grade
- Length of roadway surface, gates and lights, gate arms type

- Location of guardrail, gates by station and offset
- Curb exposure

The final signed and stamped railroad roadway plan sheet(s) should be sent to the Traffic-Roadway Section, who will then submit a copy to the ODOT Commerce and Compliance Division and the State Railroad Liaison and file the plan sheet(s) with the project plans in ProjectWise.

While the railroad plan sheet(s) is not part of the contract plan set, it is an important and required part of the Railroad-Highway Public Crossing Safety Application.

1204.5 Design Elements

If at all possible, the intersection angle between the roadway and railroad should be as close to 90 degrees as possible. Right angle crossings maximize the driver's view of the rail crossing, location of tracks, and view of on-coming trains. A right angle crossing is also preferred for bicyclists and pedestrians. Besides the same visual problems of such a crossing, angled crossings coupled with flange openings create problems for the thin tires of a bicycle. The flange opening width should be kept to a minimum through the entire rail crossing section.

Sight distance is a critical consideration at railroad crossings. Sufficient sight distance must be available to the driver to recognize the crossing, see and perceive the crossing device and the trains themselves, and come to a stop condition if necessary.

Horizontal and vertical alignments are very important at rail crossings. The vertical profile between the roadway and the rail crossing should be as level and consistent as possible for smooth transition between surface types, sight distance and visibility of the crossing, and ability to react to the specific situation. Rail crossings along horizontal curves are not preferred as they impact the visibility of the crossing and cause the driver to focus on the curvature of the roadway instead looking for a train.

Some additional design elements involved with rail crossings include location of driveways, other accesses, and signals located at rail crossings. Vehicular storage queues in the vicinity of rail crossing intersections must be carefully reviewed and measures taken to prevent trapping of vehicles on the rail crossing. Sign locations need to be thought out in order to maintain proper clearance between the roadway and the railroad tracks.

The minimum horizontal and vertical railroad clearance to be provided on crossings shall conform to ODOT regulations shown in Figure 300-25 Railroad Clearances. Additional clearance may be required and should be determined individually for each crossing. Information regarding these clearances shall be obtained from the State Utility and Railroad Liaison. Contact the ODOT Commerce and Compliance Division when rail crossings are involved in a project.

1204.6 Crossing Types

The crossing type (signals, signals and gates, stop sign) is generally determined on a case by case situation, but typically the crossing will have both crossing gates and signal lights. The designer needs to take into account the lead time needed for interaction with other divisions such as Rail when a crossing is involved. Contact the ODOT Commerce and Compliance Division to determine the appropriate crossing type and other rail requirements.

1204.7 Stopping Lanes At Railroad Crossings

Additional stopping lanes at railroad at-grade crossings were formerly added routinely. In some cases stopping lanes are not justified. The ODOT Traffic Manual outlines the procedure for determining the need for additional stopping lanes at railroad at-grade crossings. Additional design guidance for railroad grade crossings can be found on Oregon Standard Drawings RD400 series, for use when stopping lanes have been justified.

1204.8 Curb Exposure

Curb exposure at railroad crossings is very important. Standard curb (barrier) is to be used. The roadway curb exposure at railroad protective devices shall be a minimum 7 inches for new construction and 6 inches for existing installations and for maintenance after initial installation. In overlay situations, the construction of a new curb should not be ruled out. Each situation should be looked at individually to determine the correct solution.

Section 1205 Utilities and Utility Relocation

[Placeholder for future section]

Section 1206 Transportation Analysis

1206.1 General

The Transportation Planning Analysis Unit (TPAU) and Region Traffic Sections, with assistance from region staff, cities, counties, and other state agencies, are responsible for providing highway design hour volumes, traffic analysis and performance measures such as volume/capacity ratios for projects and studies.

TPAU typically performs this work for large or complex systems and/or the Environmental Assessments (EA) and Environmental Impact Studies (EIS). Region Traffic staff typically does the analysis for operational, preservation, bridge and other small improvement projects as well as scoping and review of developer-submitted Traffic Impact Analysis (TIA). Criteria for TIA's are discussed in the Development Review Guidelines available at

https://www.oregon.gov/ODOT/Planning/Documents/Development-Review-Guidelines.pdf

ODOT traffic analysts scope and review consultant analysis work. The analyst should work iteratively with design staff in the development of alternatives. The ODOT Analysis Procedures Manual (APM) available at https://www.oregon.gov/odot/Planning/Pages/APM.aspx guides the analysis process from scoping through the analysis and documentation for projects and studies. Any traffic analysis performed involving state highways must conform to the APM or be explicitly agreed to by the Department.

1206.2 Projects

In project development, the traffic analyst should be involved beginning in the scoping phase and continuing throughout the entire process. The transportation analysis for modernization projects includes developing air, noise, and energy traffic data for environmental studies. The analyst may also furnish volumes and vehicles classifications for pavement design.

The analysis process is detailed in the APM for the analyst to furnish traffic information for base and (appropriate) future year(s), such as hourly and daily volumes along with truck percentages. The analysis should report performance information including lane configurations, volume/capacity ratio (v/c) and any other operational performance measures, 95th percentile queues/storage lengths, signal progression, and preliminary signal warrants. The analysis process and results must be documented in either technical memoranda or a narrative report.

1206.3 Design Guidelines

Table 1200-1 shows the acceptable v/c ratios for project development/design. Table 1200-1 applies to all modernization projects and should be applied within other project categories except for development review. A design exception should be processed if the volume/capacity ratios in Table 1200-1 cannot be met. If it is known early in the planning or project development process, that the v/c measures cannot be met, the design exception should be sought at that time instead of later in the project design phase.

The volume/capacity ratios shown in Table 1200-1 are generally different than those shown in the Oregon Highway Plan (OHP). The v/c ratio values in the OHP are used to assist in the planning phase identifying future system deficiencies. The OHP v/c ratio values also allow flexibility for land use applications and Transportation System Plans by having at-capacity v/c ratios in urban areas. The HDM v/c ratio values are different as the expectation is to provide a mobility solution that corrects those previously identified deficiencies and provides the best investment for the State in establishing 20 year design life solution. The Table 1200-1 values, although v/c oriented, are based upon the *AASHTO's "A Policy on Geometric Design of Highways and Streets"*.

Issues may arise when a large difference occurs between the design and planning v/c ratios particularly when alternative mobility standards have been adopted. The issues occur due to different interpretations of which measure applies. Technical Services should be contacted if agreement between Region Planning and Design staff cannot be reached on the use of the design-life requirement.

Although traffic data is needed in the design of all highway improvements, preservation type projects are primarily focused on extending the service life of the pavement while looking at cost-effective safety enhancements. Traffic forecasts can assist in making decisions regarding needed safety improvements as part of the 3R project (adding turn lanes, signals) or as a future standalone project. Table 1200-1 v/c ratios should be used as guidance in making cost effective safety improvement decisions for 3R preservation projects.

Region Traffic Unit and Region Roadway Design Unit need to determine when a design-life design exception request is required for a new or modified traffic signal. Consensus on the proposed improvements needs to be reached prior to submitting design exception requests for design life to Technical Services.

Design Life exceptions are not required on the following project types:

1. Private approaches
2. Unsignalized public approaches that do not modify their capacity
3. Development review projects
4. Operation STIP projects
5. Maintenance projects not in the STIP
6. Transportation System Plans
7. Traffic Growth Management (TGM) projects that do not have design details and would not be considered a 4R project in the design phase, however, any future build scenario for TGM projects are to use the v/c ratios in Table 1200-1.

Table 1200-1: 20 Year Design-Mobility Standards (Volume/Capacity [V/C]) Ratio

Highway Category	**Land Use Type/Speed Limits**					
	Inside Urban Growth Boundary				**Outside Urban Growth Boundary**	
	STAs	**MPO**	**Non-MPO outside of STAs where non-freeway speed limit <45 mph**	**Non-MPO where non-freeway speed limit >= 45 mph**	**Unincorporated Communities**	**Rural Lands**
Interstate Highways and Statewide (NHS) Expressways	N/A	0.75	0.70	0.65	0.60	0.60
Statewide (NHS) Freight Routes	0.85	0.75	0.70	0.70	0.60	0.60
Statewide (NHS) Non-Freight Routes and Regional or District Expressways	0.90	0.80	0.75	0.70	0.60	0.60
Regional Highways	0.95	0.85	0.75	0.75	0.70	0.65
District/Local Interest Roads	0.95	0.85	0.80	0.75	0.75	0.70

Notes:

- Interstates and Expressways shall not be identified as Special Transportation Areas (STAs).
- The peak hour is the 30th highest annual hour. This approximates weekday peak hour traffic in larger urban areas.
- MPO category includes areas within the planning boundaries of the Bend, Corvallis, Eugene/Springfield, Medford, Portland (METRO) and Salem/Keizer Metropolitan Planning Organizations, and any other MPO areas that are designated after the completion of this manual.

♦ Estimating Capacity for Highways

Since there are many variables that could affect the capacity of a highway, use the following process as a general guideline only. This process enables designers to estimate allowable daily traffic volumes. These volumes can be used to determine the correct number of lanes on a state highway has been identified in a prospectus. The allowable daily traffic volumes are not intended for detailed design purposes. The assigned traffic analyst will provide design level traffic data. If there is a discrepancy between the prospectus and the results from this analysis, a designer should contact the TPAU for a more detailed evaluation.

♦ Capacity Estimation Process Outline

1. Determine the "Highway Category" and "Land Use Type/Speed" for the facility that you are working with.
2. Determine the acceptable Volume/Capacity Ratio
3. Determine the average daily capacity
4. Determine the allowable average daily traffic volume (ADT)
5. Compare the allowable ADT to the 20-year future ADT projected for the facility.

Note: This estimation process uses two of the most critical adjustments when determining the capacity of a roadway (signals and truck traffic impacts). There are several other factors used by a traffic analyst when determining the actual capacity of a facility.

1. **Determine Highway Category and Land Use Area Type:** Refer to Appendix D of the Oregon Highway Plan.
2. **Determine Highway acceptable Volume/Capacity Ratio:** The maximum allowable volume/capacity ratios for state highways can be found in Table 1200-6.
3. **Determine the Average Daily Capacity:** This process will allow you to estimate the average daily capacity for the highway under study/investigation. Note that this is only an estimation of the capacity, the Transportation Planning Analysis Unit should be contacted to determine the capacity of a roadway for design purposes.

Average Daily Capacity = Ideal Daily Capacity x FS x FT

- **Ideal Daily Capacity** – unadjusted capacity of a roadway (Table 1200-2).
- **FS** – a factor to account for the presence of signals (Table 1200-3).
- **FT** – a factor to account for the presence of truck traffic and the type of terrain (Table 1200-4).

Table 1200-2: Ideal Daily Capacity

Highway Category	Land Use Type/Speed Limits				
	Inside Urban Growth Boundary			Outside Urban Growth Boundary	
	MPO	Non-MPO outside of STAs where non-freeway speed limit <45 mph	Non-MPO where non-freeway speed limit >= 45 mph	Unincorporated Communities	Rural Lands
Interstate/ Expressways					
4 lane*	74,500	NA	68,000	63,000	63,000
6 lane	117,500	NA	107,500	94,500	99,500
Statewide					
2 Lane Undivided**	31,500	30,000	30,000	26,000	21,000
2 Lane Divided	39,000	37,500	37,500	32,500	26,000
4 Lane Undivided	51,000	48,000	48,000	45,000	42,000
4 Lane Divided	68,000	64,000	64,000	60,000	56,000
6 Lane Divided	102,000	96,000	96,000	90,000	84,000
Regional Highways					
2 Lane Undivided	30,500	29,500	29,500	25,500	20,500
2 Lane Divided	38,000	37,000	37,000	31,500	25,500
4 Lane Undivided	49,500	47,000	47,000	45,000	41,500
4 Lane Divided	66,000	63,000	63,000	59,500	55,500
6 Lane Divided	99,500	94,500	94,500	89,500	83,500
District/Local Interest Roads					
2 Lane Undivided	28,000	28,500	28,500	25,000	20,000
2 Lane Divided	35,000	35,500	35,500	31,000	25,000
4 Lane Undivided	48,500	46,000	46,000	44,500	41,000
4 Lane Divided	64,500	61,500	61,500	59,000	55,000
6 Lane Divided	96,500	92,000	92,000	88,500	82,500

* The number of lanes refers to the total number of through lanes on the facility.

** For the purpose of this computation, a divided roadway has a raised median to prevent mid-block left turns or it allows mid-block left turning vehicles to exit from the through traffic lanes.

If the facility is in an urban area that has signalized intersections, the signalized intersection adjustment factor (FS) needs to be applied to the ideal capacity. FS is the same for all of the land use types/speed limits.

Table 1200-3: Signalized Intersection Adjustment Factor (FS)
(applied to ideal daily capacity if there are signalized intersections)

Highway Category	FS
Interstate	NA
Statewide	0.51
Regional	0.46
District	0.45

If the facility has truck traffic, the slower moving trucks will take up more capacity than a passenger vehicle, especially if they are traveling on grades. Table 1200-3 shows the adjustment factors (FT) for truck traffic on Level (1-2%), Rolling (3-4%), and Mountainous (5% or greater) terrain that are one-quarter mile or longer.

Table 1200-4: FT (Reduction factor for presence of trucks)

Number of Lanes	Percent Trucks											
	0-5%			6-10%			11-15%			>15%		
	L*	R**	M***	L	R	M	L	R	M	L	R	M
2	.97	.91	.80	.95	.83	.67	.93	.77	.60	.91	.71	.50
4-6	.95	.85	.69	.90	.73	.53	.86	.65	.43	.82	.58	.36

* L - level terrain, which has a grade of 1-2%

** R - rolling Terrain, which has a grade of 3-4%

*** M – mountainous terrain, which has a grade of 5% or more

4. **Determine the Approximate Allowable Average Daily Traffic:** To determine the allowable average daily capacity for a facility, carry out the following computation:

Allowable Average Daily Traffic = Average Daily Capacity x (v/c from Table 1200-1)

5. **Compare the Approximate Allowable ADT to the 20-year future ADT projected for the facility:** If the forecasted ADT, found on the prospectus, is greater than the calculated allowable ADT, contact the Transportation Planning Analysis Unit for clarification.

Section 1207 Traffic Engineering

1207.1 General

The design of a project will include traffic management elements such as the location and function of traffic control devices (signals, signing, pavement marking, etc). The Traffic-Roadway Section (TRS) provides traffic support during all phases of project development and construction. TRS provides standards for preparing project plans, specifications and estimates for traffic signals, ramp meters, variable message signs, permanent signing, and illumination. In addition, the Traffic-Roadway Section provides statewide policies and guidelines for all traffic control devices, administers ODOT's Project Safety Management System and provides technical assistance for traffic operation improvements on state highways. TRS also manages traffic signal approvals, manages speed zone designations for all public roads, monitors traffic speeds, tests electrical equipment, and coordinates development of design standards. The designer should be aware of these traffic functions and the support which is available from TRS during the design phase of projects. The designer should provide adequate notification to TRS staff through the assigned traffic designer or designated representative to ensure timely input consistent with the project schedule. In addition to the traffic design aspects of projects, the designer should consider future maintenance access and right of way need for electronic traffic equipment.

For further discussion of the roles and responsibilities of TRS, as well as information regarding the use of traffic control devices, see the ODOT Traffic Manual. This manual contains information regarding policies, procedures, warrants, and design considerations for traffic related items.

1207.2 Authorities of the State Traffic-Roadway Engineer

The designer should be aware that State Traffic-Roadway Engineer approval is required for the installation or modification of traffic signals as well as other traffic control devices and applications. Other examples of applications requiring the approval of the State Traffic-Roadway Engineer include: provision of multiple turn lanes, emergency vehicle preemption capability, U-turns at signalized intersections, turn prohibitions, flashing beacons, marked crosswalks at uncontrolled intersections or mid-block locations, crosswalk closures, designation of one-way operation, speed zones, parking prohibitions, restriction of lane use by type of vehicle, variable message signs (and other ITS devices), and the approval of roundabout locations. (See the ODOT Traffic Manual for more detail.) Many of these authorities are designated by Oregon Administrative Rule or come through a letter of authority from the Technical Services Manager.

Typically all requests for approval of traffic control changes or applications come from Region Traffic. Region Traffic staff are familiar with the requirements for documentation and investigation of traffic control applications. The Region Traffic Manager or Engineer should concur with all requests before forwarding them to the State Traffic-Roadway Engineer.

Early participation of traffic representatives in project scoping and identification can identify items requiring approval of the State Traffic-Roadway Engineer as well as related traffic concerns with safety, operation, and application of traffic control devices.

1207.3 Signals

When a project involves signals the roadway designer should contact the Region Technical Center Signal Designer. Information that the signal design will require includes: roadway features such as elevation profiles; guardrail requirements; truck turning radius requirements; pedestrian ramp designs; utility locations (particularly poles, above ground wires and possible underground conflicts with infrastructure such as fiber optic lines); storm drain locations; lane use width; pedestrian ramp locations; proposed curb and corner radii alignments; or other features that will have a bearing on the placement of traffic signal equipment. It is very important that items such as signal cabinets, power service cabinets and signal poles be located where they are not obstructions to pedestrians, bicyclists, or vehicles. Overhead utility lines such as power and communications should be reviewed to determine any conflicts with signal poles and signal heads. Typically this field information is in electronic file format.

The signal designer will provide projected layout of signal equipment (poles and controller cabinet) and cost estimates. The signal designer will also provide technical expertise regarding the signal equipment such as signal pole foundation size, ramp metering, lane usage, and vehicle detection type and locations. In the case of retrofit projects, the signal designer can provide information on existing signal equipment locations, lane configuration, vehicle detection replacement, and signal phasing. Crosswalk locations are normally determined through communication between the roadway and signal designers.

One of the most essential items the signal designer can provide the roadway designer is locations where the purchase of right of way or easements is needed. This item is sometimes overlooked but is critical in keeping the right of way purchase process on track. It is essential that the roadway designer notify the signal designer in advance so that proper right of way needs are determined and submitted, enabling the purchase of all right of way needs to occur in one phase of the project.

In some projects, multiple signals are involved and are part of an interconnected traffic signal system. Safe and efficient traffic signal timing along state highways depends on optimal intersection spacing. It is difficult to predetermine where such locations should exist, although one-half mile intersection spacing for Statewide and Regional highways is often desirable. Items that are involved in interconnect systems include highway capacity, lane balance, cycle lengths, vehicle storage and progression speed. When a project involves multiple signals, the roadway designer should contact Traffic Operations to determine the need for a signal interconnect system.

Temporary signals may be needed for traffic staging or in temporary locations during project construction. As with permanent signals, the designer should contact and communicate with the Region Technical Center Signal Designer in the early project stages to ensure that adequate time is allowed for temporary signal design.

1207.4 Signs

The designer should contact the Region Technical Center Sign Designer when a project involves signing. Typical information that the sign design will require includes a detailed sign inventory with dated photographs and accompanying highway milepost or station. Typically, a roadside inventory or detail map (electronic version) is provided that identifies sign locations. The sign designer should be provided with project limits and the scope of work. Projects that involve sign bridges or cantilevered signs will require communication between the sign designer, roadway designer and structure designer.

As with traffic signals, right of way or easement needs are critical for sign designs. Accurate right of way or easement acquisitions will lead to proper location of signs. The road designer should contact the Region Technical Center Sign Designer early on in project development to determine if signing will or should be included in the project. When notified early in the process the sign designer will be able to provide signing plans, special provisions, and right of way needs in an efficient manner.

1207.5 Signal and Sign Supports in Islands

Designers need to carefully weigh the benefits of constructing islands for the accommodation of sign and signal support. It may be preferred to look at other alternatives such as location of the supports on the other side of the roadway. If installation cannot be avoided and a raised island is considered necessary, consider the following priorities:

1. Clear islands with mountable curb are most desirable.
2. Where pedestrian or other small devices are necessary, they will be on breakaway supports.
3. Where a fixed object cannot be avoided, a brief, written justification should be attached to the preliminary plan review transmittal letter.

Standard barrier curb on islands will be considered inappropriate for use on any arterial or rural facility unless supported in the justification document noted in 1207.3 above.

1207.6 Illumination

Prior to illumination design for a project, it must first be determined if illumination is warranted for the project. Region Traffic identifies locations for illumination and forwards the information to the Traffic-Roadway Section for determination of policy agreements and statewide consistency before proceeding with project illumination design. If there are agreements between ODOT and local governments, the designer or project leader should forward them to the illumination designer.

When it has been determined that illumination will be part of the project, the roadway designer will need to provide the illumination designer with final roadway alignment, detailed project information relating to illumination needs. Typically 30% roadway plans that include centerline profiles, cross sections, existing roadside features, roadway alignment, and right of way line information will be sufficient for the illumination designer. Communication between roadway designer, the illumination designer, bridge designer, and traffic signal designer is critical in providing proper illumination designs for a project.

1207.7 Striping

Traffic-Roadway Section is responsible for the policies and guidelines regarding striping and pavement marking. The striping guidelines provide statewide consistency. The responsibility for completion of the striping plans on state highway designs rests with the Roadway Designer. Striping should conform to the Traffic Line Manual, Pavement Marking Design Guidelines, and the MUTCD.

1207.8 Intelligent Transportation Systems (ITS)

Intelligent transportation systems goal is to improve safety and reduce congestion on the roadway infrastructure through the use of technology. Some of the ITS applications include ice sensors (road and weather information systems); speed monitoring sites, variable message signs, traffic cameras, communication lines, and ramp meters. ITS projects can be stand-alone but it is important for the designer to consider ITS improvements as part of highway modernization/reconstruction project work.

As with other types of traffic projects, early identification of right of way needs is important. Items such as variable message signs, speed monitoring cabinets, and traffic cameras may require additional right of way or need to be protected by guardrail or barrier. Traffic cameras may require special right of way locations to allow proper orientation and field of view.

1207.9 Crash Analysis

There are several tools available to the designer to assist with the crash analyses. The Motor Vehicle Traffic Crash Database, compiled and maintained by the Crash Data Unit, covers state, county, and city road systems. The SPIS (Safety Priority Index System) Reports and the Crash Summary Database is compiled and maintained by Traffic-Roadway Section. Other tools such as the crash graphing tools help identify patterns of crashes and are available via the intranet, contact the region Traffic investigator for more information.

These reports and others allow the designer to summarize data by different characteristics, such as weather conditions, types of crashes and types of vehicles. Preparing collision diagrams to identify patterns is helpful. Familiarization with the volumes, speeds, physical features and geometry also assists in the process. Crash and fatality rates should be compared to the statewide average for similar facilities. After analyzing the specific site or segment the designer can better determine the appropriate actions for correction. Region Traffic personnel routinely perform crash analyses and can help with specific sites or trends and have the latest investigation on SPIS top 10% sites. Contact Region Traffic for assistance.

1207.10 Project Safety Management System

Traffic-Roadway Section, in cooperation with other ODOT sections, has developed and is maintaining ODOT's Project Safety Management System (PSMS). The PSMS consists of the Highway Safety Program and the Safety Priority Index System (SPIS). In addition the Traffic Section has developed plans around specific Safety Emphasis Areas (i.e., Roadway Departure and Intersections). See Traffic-Roadway Section's Highway Safety Website for more information.

These elements consist of evaluation tools, plans and funding options. These tools will assist project leaders and designers to evaluate and improve safety on Oregon highways.

♦ Highway Safety Program

The Traffic-Roadway Section administers the Highway Safety Program to encourage engineering improvements that address identified safety needs (i.e., SPIS locations). The funds are primarily federal funds from the Highway Safety Improvement Program (HSIP). The mission of the Safety Program at ODOT is to carry out safety improvement projects to achieve a significant reduction in traffic fatalities and serious injuries.

In addition the department receives 164 penalty funds from Transportation Safety Division Grants. These funds are allocated towards Safety Emphasis Areas (i.e., Roadway Departure).

For up to date information on the Highway Safety Program see the Traffic-Roadway Section Highway Safety web site. Also contact region traffic staff for more information.

♦ Safety Priority Index System (SPIS)

SPIS is a methodology developed by ODOT to identify potential safety problems on state highways. Essentially, SPIS is a tool for comparing and prioritizing crash histories of state highway locations. Each year regional reports of the top ten percent ranked SPIS sites are generated for review by Region Traffic. Region Traffic evaluates these sites for correctable safety problems and possible solutions. If a correctable problem is identified, a cost/benefit analysis may be performed. If viable options are identified, funding may be pursued.

♦ Safety Emphasis Areas

Data analysis of crash data is combined with cost effective strategies to identify locations for the most effective uses of funds in order to achieve a 20% reduction in targeted fatal and serious injuries. This approach involves deploying large numbers of low cost, cost effective countermeasures on targeted segments of roadways with a history of specific crashes.

1207.11 Work Zone Analysis and Constructability

Work Zone Traffic Analysis is used to determine lane closure restrictions and delay estimates for highway construction projects. Lane closure restrictions are used to determine times when road work is less likely to adversely impact traffic. Lane closures restrictions are determined by comparing actual or forecasted traffic volumes to a Free Flow Threshold. Delay estimates are used to manage mobility throughout the highway system. An estimate of delay is the average additional travel time a construction project will add to a segment of highway.

The Region work zone traffic analysts determine both the lane closure restrictions and delay estimates for projects. The work zone traffic analyst should coordinate with the Region traffic control plan designer when developing the lane closure restrictions and delay estimates. The traffic analyst should send a formalized report recommending lane closure restrictions and delay estimates to the project leader and Region mobility liaison.

Several tools are available to determine lane closure restrictions and delay estimates. For segment analysis, the ODOT work zone traffic analysis methodology should be used. For work zones that are near convenient alternate routes or contain various types of traffic control (i.e. signals), the Highway Capacity Manual and recognized traffic simulation software should be used. For these more complicated analyses, the Transportation Planning Analysis Unit (TPAU) is available to help determine both lane closure restrictions and delay estimates.

The Traffic Control Plan can change based upon the lane closure restrictions and delay estimates. Determine both the lane closure restrictions and delay estimates early in the project development process and refine as the project progresses to PS&E. Document the lane closure restrictions and delay estimates and any supporting information in the project Transportation Management Plan (TMP).

For further information regarding ODOT's Work Zone Traffic Analysis, refer to the ODOT Work Zone Traffic Analysis Manual and the ODOT Traffic Control Plan Design Manual.

Section 1208 General Survey Procedures

Location surveys are performed to provide the designer with information about the project site. The products generated by the location survey depend upon the type and scope of the project. These products may include: Geodetic Control Monuments, Horizontal Control Network, Vertical Control Network, Planimetric Map, Digital Terrain Model (DTM), Property Monument Recovery Map, existing right of way Centerline and Boundary Resolution Map, and a variety of other specific purpose maps, such as Utility, Airport Permit, Railroad Encroachment, etc.

For detailed ODOT survey procedures contact the ODOT Geometronics Unit.

1208.1 Land Survey Law

It is ODOT policy that licensed land surveyors, in appropriate positions, are responsible for land surveying practiced under their supervision including conformance to all state statutes pertaining to survey and land laws. This includes but is not limited to the following statutes:

- ORS 92 Subdivisions and Partitions
- ORS 93 Conveyancing and Recording

- ORS 209 County Surveyors
- ORS 672 Professional Engineers, Land Surveyors, Geologists

In addition to the requirements of state law, the Chief Engineer has directed that:

1. The Project Manager, Region Survey Manager, or Region Technical Center Manager shall contact the appropriate County Surveyor upon commencement of any field location surveys. This will keep the County Surveyor informed of work within their jurisdiction. For government monuments in danger of being destroyed by construction activities, arrangements should be made with the appropriate County Surveyor for monument referencing or replacement. (Use "*Project Notification to County Surveyors*" form # 734-2298)
2. Copies of field notes with references to found and/or set monuments will be furnished to County Surveyors upon request.

1208.2 Survey Types

♦ Geodetic Control Survey

Geodetic Control Surveys cover a large area and take into account the curvature of the earth. They are executed to specified accuracies and standards and may be used to provide primary control for projects. These surveys provide monuments that are connected to the Oregon High Accuracy Network (HARN). Project Horizontal and Vertical Control Networks may be based on Geodetic control in the vicinity.

Information concerning the HARN is available from the ODOT Geometronics Unit. The Geometronics field crew will, upon request, establish geodetic control points where none exist in the vicinity of the job.

♦ Cadastral Survey

Acquisition of land for highway right of way requires a Cadastral Survey to establish existing property lines and to establish and monument new boundaries. This work must be done in compliance with the laws of the State of Oregon and within the "*Rules of Professional Conduct*" for practicing land surveyors as defined by the State Board of Examiners for Engineers and Land Surveyors. (See OAR 820-020-0005.)

♦ Topographic Survey

Topographic Surveys are made to determine the relative position of points on or near the surface of the earth so that maps showing a plan view of an area can be made. Topographic maps show natural and synthetic features and are used in the planning and design of highways, subdivisions, parks, etc. It is common practice to collect topographic data with an electronic theodolite and data collector. The survey crew records code information along with the measurements to instruct the computer in processing the data. The data is downloaded and processed into a 3D digital map. This digital map is stored in real world coordinates (1:1 scale) and can be plotted at any scale required.

The topographic map should generally include the following:

1. Fences: measurements to the fences should be taken at frequent intervals. All intersecting fences should be tied.
2. Approach Roads: Note the grade, type of surfacing, width, name, private approach or public, controlling agency, direction and distance to nearby towns.
3. Utilities: Locate all utility lines both above ground and underground, even though it may not be necessary to move them. Note the name of the owners, pole numbers, number of wires, pipe sizes, depths, and flow lines. Frequently the local utility company will assist in the location of their facilities. The right of way Liaison Agent may be of help in determining a property owner's independent source of water, underground pipes, septic tank, drain field and other important features which must also be shown on the map.
4. Improvements: Locate buildings, orchards, improved lands, etc., adjacent to the project. Field tie all buildings on properties that may have a R/W taking or potential for flooding.
5. Irrigation Facilities: Note irrigation ditches and show the direction of flow, the grade, typical section, size of structure, centerline station and angle of the crossing.
6. Bridges: Show stationing at both ends, width of roadway, type of bridge, type of rail, dimensions of walks, etc.
7. Railroads: Show centerline stationing of both highway and the railroad at their intersection and the angle of crossing. Tie in head blocks, switches, culverts, bridges, etc. Where the highway runs adjacent to a railroad, frequent ties should be made to the facility.
8. Terrain: Designate whether the area is cultivated, forested (note if recently logged), marsh, or rangeland. Also note the character of the ground such as clay, rocky, etc. Locate any significant grade breaks or changes in vegetation.

9. Hydraulics: Show the names and location of all streams in the area. Determine the high and low water stages. Note if the land is ever flooded by backwater. If there are other bridges in the vicinity, make a note of the location of the structure and the size of its opening.

10. Permanent Monuments: A diligent search should be made for all recorded survey monuments. All found evidence, both recorded and unrecorded, will be shown on the map

11. DTM: A DTM is a representation of the surface of the earth utilizing a triangulated network of points. The DTM models the surface with a series of triangular planes. Each of the vertices of an individual triangle is a field-measured 3D coordinate point. DTMs are created by measuring data points that define breaklines and random spot elevations. Cross sections, profiles, contours, and slope vectors can be developed from a DTM.

1208.3 Stationing

Stationing will run from north to south and from west to east, corresponding with the highway route number (odd is north-south and even is west-east). If the existing stationing does not follow this rule, the existing stationing direction will be followed.

Stationing will be in 100 foot increments with control points measured to 0.01 foot accuracy, i.e. 10+00.00.

When the existing alignment is in SI units (Metric), the beginning of that Metric alignment will be equated to an earlier alignment that used US customary units (English). Stationing will be recalculated from that point using English units. The radius of the Metric curve will be converted to English units to the nearest 0.01 foot and the radius will be used to define the curve.

There are different types of projects that affect how the features will be located on the construction plans. These can be shown on the construction plans as either stations or mile points as outlined below. In all cases, the construction plans will identify the right of way map number(s) used in establishing a link to the record data.

For projects that require a change in the right of way and a retracement survey has been completed, the construction alignment and stationing will be based on the retracement survey information. Further the retracement survey will be based on the alignment and stationing of the latest published right of way map in the Map Center in FileNet. It is a best practice for the construction alignment and the right of way alignment to be the same.

For projects where the construction alignment deviates from the right of way alignment, the construction alignment will begin and end the deviation on the same tangent bearing as the right of way alignment. An offset to the right of way alignment must be 2 foot or greater to avoid confusion of the two alignments. If the deviation occurs on an arc section of a curve, the local tangent of the two alignments will be the same bearing at that point. No deviation will occur on the spiral portion of the curve. The deviation will be shown on the construction plans as an equation at both ends of the construction alignment. The stationing used on the construction alignment will be significantly different from the right of way alignment stationing. In no case will the construction alignment create an angle point with the right of way alignment without prior approval from the State Traffic-Roadway Engineer.

For projects that do not require a right of way centerline retracement survey, the stations will be derived from the current published right of way center line. A disclaimer will be placed on the project plans stating that the center line is for construction purposes only and should not be used for determining existing right of way.

For very simple projects, such as resurfacing projects, mile points can be used in lieu of engineer stations to define the construction limits. The mile point must be taken from an existing data source. An appropriate source is Transviewer 'Inventory Summary' reports for current mile point data. The photo log mile points are not recognized as existing data sources for determining accurate mile points for a project. The point that is used to determine an accurate project mile point will be equated to the engineer station from the current right of way map and shown on the construction plans. Typical locations used to equate stations and mile points are bridges, intersections, box culverts, and in very rural areas a mile point marker. Two equation points need to be shown on the plans. If the construction sheets are a part of the project special provisions, the mile point and right of way station equation will be shown with the typical sections.

Projects that use mile points in lieu of engineer stations are less accurate than a surveyed retracement of the alignment for calculating a station for any given feature but are generally close enough to cross check with existing data. In these cases, the record station would be considered the accurate station and not a calculated station from a mile point.

Stationing should be continuous. Station equations are required at intersections of lines, bearing equations, and where new lines tie into previously established lines. Secondary alignments will be differentiated from the main centerline through labeling or naming the line (i.e. "SW" 10+00.00). Stationing will not begin below 10+00.00 for any alignment.

1208.4 Project Survey

♦ General

This section provides general guidance in determining the appropriate level of survey data required for project development projects. The guidelines are broken down by the following project types: maintenance projects, 1R projects, preservation projects (3R), and modernization projects (4R Reconstruction, New Construction). The project scoping team will determine the amount of survey work that will be required for individual projects.

♦ Maintenance And 1R Projects

The amount of survey work for maintenance and 1R projects can vary depending on the project. Generally maintenance projects are small and typically require only roadside inventory type of field data collection. Roadside safety hardware requirements for 1R Projects is discussed in Part 100.

♦ Preservation Projects

Preservation projects that don't include work outside the existing typical section generally only need roadside inventory information collected prior to project design. During the design work phase, it may be necessary to obtain additional data such as superelevation information on curves in need of correction, or additional widening required for new guardrail flares. The amount of additional survey data will vary and is project dependent.

Preservation projects that include major shoulder widening, curve correction, intersection channelization, or other reconstruction type work, will require more initial survey work. This work will most likely include a DTM of the area.

♦ Modernization Projects

Modernization projects will almost always require a DTM, which could require a combination of extensive survey work and/or alternative mapping methodologies such as photogrammetry, LiDAR, and laser scanning. Survey work would include gathering topographic information on breaklines (edge of pavement, ditches, shoulders) and features (guardrail, barrier, poles, signs, utilities, etc.). One of the best ways to determine the limits of the survey work is for the designer to conduct a site visit with the survey crew chief.

Section 1209 Right of Way

1209.1 General

The Right of Way Section of the Technical Services Branch is responsible for the following project development functions:

1. Estimates of right of way costs and impacts for development of the project prospectus.
2. Estimates of right of way costs and impacts for different alternatives because of environmental assessments.
3. Collaboration with the Regions in developing project access lists.
4. Cost estimates for justification of proposed land service design features.
5. Acquisition of additional real property and real property rights needed to support the project design. This includes the relocation of all people and personal property displaced by the project.

1209.2 Acquisition Process

Of particular importance for project location and design staff is an awareness of the time requirements necessary for the acquisition of real property and real property rights. The right of way phase in project development begins after applicable environmental document clearance with the preparation of the right of way drawings and legal descriptions of the proposed right of way takings by the Region Survey Group. When the Region Right of Way office receives the completed right of way drawings and legal descriptions, the right of way acquisition process can begin. This process includes the appraisal of property values, offers to property owners, relocation of tenants, and demolition of property improvements. The right of way acquisition phase ends when the Region Right of Way office has acquired all of the right of way and it is certified for the project bid letting.

Design decisions that are delayed until after the start of the right of way acquisition process result in revisions to legal descriptions and right of way drawings. This may result in negotiations with property owners being restarted; appraisals being redone; and/or relocation work being significantly changed. This also occurs when design parameters change after starting the right of way acquisition process.

1209.3 Time Allowances

The time required for the Region Survey Group to complete the right of way drawings and legal descriptions varies due to the complexity and number of properties involved. It can be as little as one week for a simple, one-file project with an exhibit map showing a temporary easement to several months for large, urban projects with dozens of multi-parcel files. The acquisition of the right of way and the relocation of displaced people and property are governed by state and federal laws. These laws guarantee all property owners certain time periods during the acquisition phase. Property owners have a minimum of about four months, from the start of the right of way acquisition process for their own property, before the State can demand possession of the right of way. Additional time is normally required for completing property appraisals and doing any required relocation studies. Because of the statutory allowances for time, as well as the complexities surrounding many properties, typical right of way acquisition projects require eight months to several years for completion. Projects cannot be constructed until the State has legal possession of the right of way and the right of way has been certified.

Design changes with minor right of way impacts will delay completion of an ongoing right of way acquisition process from one to four months. Design changes with major right of way impacts will delay the right of way acquisition process from four to seven months (or more). Contract letting dates can and do slip because of these delays. All project design decisions and work in areas having potential right of way impacts must be addressed as early as possible. Design changes after the start of the right of way acquisition process must consider the impact to the scheduled contract letting date.

1209.4 Property Rights

The State secures the property right to enter upon land to construct and maintain facilities by acquiring either fee title or various types of easements. The following describes these different property rights.

1209.5 Fee Title

This covers all property rights with full title being conveyed to the State. The property owner retains no rights to the property being acquired. The State can acquire the entire property or just a portion of the property. The minimum widths for freeways, expressways, and major streets in urban areas are based on sound engineering judgment and local government policies. The standard margin for rural locations is 10 feet to 15 feet outside the average cut (including slope rounding, see Part 300, Section 322) or fill slope to provide an adequate area to construct the project, maintain drainage facilities, locate utilities, etc. Fee title for city streets or urban highways is normally 1 foot outside the sidewalk, but may be at the outside edge of the sidewalk if it greatly reduces property expenses or impacts to buildings. The Project Team makes these decisions.

1209.6 Easements

An easement is the right to use an exact piece of property for a specified need for a certain period of time. It may be necessary to acquire easements for slopes, drainage facilities, utilities, detours, irrigation facilities, riprap, road approaches, illumination facilities, signs, wetland mitigation, work areas, etc. All of the different uses must be specified and cited in the conveyance document. The State's future use of the easement area will be limited to only those uses declared in the deed. The underlying fee title to the easement area remains with the property owner. The property owner's use of the easement area is limited to only those activities that do not interfere with or affect any of the State's easement rights. Easements are never within a fee title acquisition. Easements usually adjoin property acquired as fee title. Easements not adjoining the right of way need to include a designated path for ingress and egress.

By state and federal law, fee title and easements must be valued and negotiated in exactly the same manner. The time allowances for the property owner are the same. Project Leaders and all staff working on the project should not be misled into thinking that projects requiring mostly easements rather than fee title are simpler or can be done more quickly. The exact same considerations must be observed so that sufficient time is provided for any property acquisition. The necessary location data and technical design information needs to be delivered to the Region Survey Group in a timely manner.

The following outline provides information about two categories of easements that may be needed:

♦ Permanent Easements

This provides the permanent right to use a certain piece of property for a specified need. The deed or conveyance document will be recorded in the public records of the County and thus the easement will show as an encumbrance on a title report for the property. There are two categories of permanent easements:

1. To accommodate the transportation facility. Examples would include permanent easements for slopes, drainage facilities, riprap, illumination facilities, signs, wetland mitigation, etc.

2. To accommodate utility companies, irrigation districts, government agencies, and other commercial or private facilities. Occasionally, utility easements are purchased in the name of the appropriate utility company. The Region Utility Specialist provides information about what, when, and where utility easements are necessary.

♦ Temporary Easements

This provides the right to use an exact piece of property for a specified need for a limited period of time. For the State, this is almost always for an activity that is necessary only during the time of project construction. The time period for a temporary easement is either the estimated time for project construction or the actual duration of project construction, whichever is sooner. If the project is completed ahead of the estimated schedule then the temporary easement expires at that time. If project construction exceeds the estimated schedule, then the State will need to re-negotiate with the property owner for a new temporary easement. Examples would include temporary easements for detours, work areas, road approaches, etc. If the State is acquiring only a temporary easement from a property owner, then the deed or conveyance document will not be recorded in the public records of the County.

1209.7 Conditional Entry onto Private Property

♦ Right of Entry

A Right of Entry gives the State temporary permission to enter certain private property to perform a specific task. During project development, a Right of Entry can be used to evaluate properties for potential transportation needs by performing geological tests, archeological studies, environmental studies, land surveys, etc. During project construction, a Right of Entry can be used to perform a presumed benefit to the property such as rebuilding road approaches, slopes, drainage operations, etc. It is not intended or expected that a Right of Entry will be followed by a formal right of way acquisition.

A Right of Entry is not a deed. The format may be as simple as a hand-written document with a sketch map attached. A written property description is not required; the map alone defines the area where permission is being granted. The map need not be an official survey; it can be very simple and basic. The Right of Entry only needs to clearly explain when and exactly where the State will be performing a certain task. The property owner usually receives no compensation and can revoke a Right of Entry at any time.

♦ Permit of Entry

A Permit of Entry gives the State temporary permission to enter certain private property to perform a specific task. During project construction, a Permit of Entry is used in emergency situations where access to private property is necessary. Such a permit is to be used sparingly; it is not to be used to circumvent the standard right of way acquisition process. The Permit of Entry should clearly explain when and exactly where the State will be performing a certain task. The permit should also declare the State’s intention to soon enter into negotiations with the property owner. It is expected that a Permit of Entry will be followed by a formal right of way acquisition. The property owner can revoke a Permit of Entry at any time.

1209.8 Property Conveyance Documents

The Region Survey Group develops the legal descriptions for right of way acquisition which are forwarded to the Right of Way Section in Salem to be used in the conveyance documents. The preparation of legal descriptions by the Region Survey Group and conveyance documents by the Right of Way Section ensures the proper transfer of real property and property rights. Property needed for right of way cannot be appraised and purchased until the legal descriptions are written and the right of way drawings are completed. The proposed right of way design relies on the project design and delays in receiving this information or subsequent changes to this information result in delaying the right of way acquisition process. Project Leaders must ensure that the Region Survey Group receive the necessary design information in a timely manner, as agreed to in the project schedule.

♦ Special Rights of Way

Separate legal descriptions and right of way drawings must be developed for parcels of land that are not part of the regular right of way, such as: stockpile sites, quarry sites, scale sites, etc. The data required for acquisition of such parcels is the same as that needed for regular right of way. All stockpile sites are to be purchased, not leased.

♦ Railroad Encroachments

A specific drawing is developed and submitted with the legal description when the State's construction needs encroach upon a railroad right of way. The explicit relationship between the centerline of the railroad track (not the centerline of railroad right of way) and the highway centerline must be shown. Due to the additional time required to develop railroad encroachment drawings, the Project Leader should work closely with the Region Survey Group to assure that the project is kept on schedule.

1209.9 Access Rights

Access is a complex issue that requires careful deliberation and decisions by the Project Team. OAR 734 Division 51 form the basis for access decisions during project development. Information to be considered includes the designation of the highway, ODOT policies and rules regarding access, design standards, safety of the travelling public, and a list of the existing road approach permits and/or access control measures. There are very specific policies and regulations regarding access, which include state and federal laws, Oregon Highway Plan, and agency access management manuals. The Project Team will use this information to determine the access control measures needed on a project. The Project Leader may decide to form a sub-team to consider access management issues to be addressed as part of the project. (See Project Delivery Leadership Team Operational Notice PD-03 for more information about these sub-teams). Detailed guidance and structure for those required to make and carry out appropriate access management decisions in the development of highway projects can be found in the Access Management Manual.

The status of highway access rights for a certain property can be as follows:

1. Access completely restricted. The State has acquired all rights of access between the highway and an abutting property. No highway access is allowed. This can cover the property's entire frontage or just a portion of the frontage. The deed or conveyance document is recorded in the public records of the County and thus the access restrictions show as an encumbrance on a title report for the property.

2. Access controlled to reserved locations. The State has acquired all rights of access between the highway and an abutting property, but provided the property owner a "reservation" of access rights at a specified location. Highway access is allowed only at the specified location. This can cover the property's entire frontage or just a portion of the frontage. The deed or conveyance document identifies the access location (reservation) by Engineer's Station and is recorded in the public records of the County. The access restrictions show as an encumbrance on a title report for the property. Prior to construction of an approach, the property owner must obtain from the State both a Permit to Construct a State Highway Approach and then a Permit to Operate, Maintain and Use a State Highway Approach.

3. Access not controlled. The State has acquired no rights of access between the highway and an abutting property. Only the State's permitting process controls the location of a highway approach. Prior to construction of an approach, the property owner must obtain from the State both a Permit to Construct a State Highway Approach and then a Permit to Operate, Maintain and Use a State Highway Approach. If an approach connects to a local street system then the property owner must also obtain a permit from the County or City.

Access rights are property rights. Where access rights are to be restricted or controlled, the Right of Way Section will use the standard acquisition process. Whether access control is acquired or not, the District Maintenance office is responsible for all approach permits. If the State is acquiring property for the project, the Region Right of Way office can obtain needed signatures from the property owners for the permits.

A Grant of Access is required to provide new or additional access rights for property that has its access rights controlled with reservations or for property that has no access rights to the highway. A grant is also required to remove a use restriction for a farm crossing or farm access on an access reservation. A Grant of Access is very difficult to justify. But if it is approved, the property owner must pay the market value for the access right, based upon a comparison of the property value with the access right versus. The Right of Way Section will order a property appraisal, prepare the conveyance document, and record the fully executed document in the public records of the County.

An Indenture of Access is required to change the location, width, or use of an existing access reservation. (Except the removal of a farm crossing or farm access restriction, which requires a grant). Any changes must comply with current laws and policies regarding access management. The Right of Way Section will prepare the conveyance document and record the fully executed document in the public records of the County.

Some projects require the acquisition of additional access rights or changes to the existing access rights. This is usually done to eliminate or modify existing reservations of access. This can be accomplished through the standard right of way acquisition process.

Oregon law automatically restricts access rights in certain circumstances. ORS 374.405 prescribes that there is no abutter's right of access along a completely new highway alignment constructed after May 12, 1951, unless the State identifies such access rights at the time of right of way acquisition. If highway approaches are to be allowed to a new alignment, it is important to coordinate this with the Right of Way Section. The right of access will need to be declared in the conveyance document. Providing new or additional access rights to a highway alignment established after 1951 may require a Grant of Access. Consult with the Right of Way Section in such circumstances.

♦ Location of Highway Approaches

On projects where highway approaches will be provided, the Access Management Subteam will establish the Official Access List. This list identifies existing approaches that will remain unchanged, existing approaches that will be rebuilt, new approaches that will be constructed as a part of the project, and existing approaches that will be removed. The list will identify the location (by Engineer's Station) and width of all highway approaches that will be allowed after completion of the project. This information may be declared in the conveyance documents for right of way acquisition. The Official Access List must be approved by the Area Manager. Any changes to the list must be approved by the Access Management Subteam Core members and the Area Manager.

Access reservations are identified in the deed or conveyance document from the property owner. All decisions must be finalized regarding the allowable location of access reservations prior to the start of the right of way acquisition process. These decisions should be based upon the State's current Access Management policies as well as any unique project conditions or needs.

If any existing legally-permitted driveways are to be closed as part of the project, the Access Management Subteam, and subsequently the Area Manager, will make that decision based on the access management strategy for the project. Oregon Administrative Rules provide for certain remedies that may be administered by the Right of Way Section. Such remedies may consider the financial cost associated with restoring access to the property, if necessary. If the closure of an approach is at an access reservation or grant of access location, it is elevated to the taking of a property right. In both situations, the Right of Way Section will set up a file and work with the property owner accordingly.

Often the right to enter upon private land to construct or reconnect a highway approach is handled during negotiations with the property owner and generally becomes part of the State's obligations. In such cases, a temporary easement for constructing an approach is not needed. However, if the approach involves major construction such as a fill section, a temporary easement may be needed. The Right of Way Section should be consulted to determine what is necessary.

1209.10 Miscellaneous Right Of Way Issues

♦ Right of Way Estimates

An accurate right of way estimate is needed to establish a workable right of way budget and to apply for Federal Highway approval to use allocated funds. The right of way estimate is based upon the market value of the real property that is needed. This involves researching the highest and best use of each property, zoning, existing use of the property, available utilities, etc.

♦ Encumbrances and Liens

All encumbrances on real property that is needed for right of way need to be discovered. Encumbrances can be easements or permits to others for roadways, waterlines, power lines, etc.

Liens, such as mortgages, trust deeds and contracts, which encumber the necessary right of way must also be discovered. Such liens may need to be cleared which could delay the State's taking possession of the property.

♦ Utilities

The Project Leader, with the aid of the Region Utility Specialist, shall determine the location and ownership of all existing utilities. Careful attention needs to be paid to the difference between

"Utility facilities" and "Private lines." The Region Utility Specialist handles utility facility relocations while private line relocations are generally handled as a part of the right of way negotiations. Utility relocation often affects the amount of right of way needed. It is critical to identify utility needs early in the project development.

♦ Railroads

The Right of Way Section's Project Administration Unit should be contacted. Whether or not the State is obligated to reimburse for railroad moves needs to be established. The Right of Way Section's Railroad Coordinator works directly with the railroad companies regarding their concerns and completes the needed paperwork.

♦ Land Services Justifications

The Right of Way Section may be asked to provide cost estimates to justify land service design options such as frontage roads, cattle or equipment passes, major installations for irrigation or for restoration of water supplies, etc. The estimated costs are a necessary component of the design option decision process when:

1. The amount of right of way plus potential damages varies greatly between design options. The cost of building a facility plus the required right of way impact for that facility should be compared to the cost of the right of way impact if the facility were not part of the design. The latter may result in larger takings and increased damages to the adjacent properties.
2. When the facility is at least partially for the public's benefit. Examples include situations when the facility would provide highway safety, access to recreation areas, fire protection, preservation or enhancement of the area economy or equitable treatment of property owners.

♦ Livestock and Equipment Underpasses

Livestock and equipment underpasses may be provided when:

1. The full cost of the underpass structure is less than the additional right of way costs for eliminating such access.
2. The underpass structure is partially for the State's benefit by eliminating any at-grade crossings. Investigation must show a continuing benefit. This must have the approval of the State Traffic-Roadway Engineer.

♦ Sound Walls

Sound walls usually prevent direct physical access to the highway right of way. Normally the right of way is delineated so that the entire sound wall (including its footing) is within the State's fee title right of way. However, the fee title line may be at the back face of the wall with a permanent easement covering any portion of the footing lying beyond that.

Section 1210 Aeronautics

1210.1 General

Transportation modes often link to each other enabling goods and services to be transferred from one mode to another. The influence areas of the individual modes often overlap each other. Airports that are near a project must be reviewed for impacts to the project and the airport.

1210.2 Design Elements

Projects within the vicinity of an airport must be carefully examined to determine any potential conflict between the two transportation modes. Airport master plans should be reviewed to determine potential impacts to projects. Federal Aviation Regulations – Part 77, *"Objects Affecting Navigable Airspace,"* and Oregon Administrative Rules, Chapter 738, Division 70, are the documents to be complied with involving airport clearance study projects involving structures and other potential obstructions to air navigation. The Regional Technical Centers are responsible for completing airport clearance studies when required.

Projects that are near airports should be reviewed for obstructions or elements that may impact the air space. Roadway elements such as bridges, signals, illumination poles, or equipment that is used on these types of roadway projects may have an impact on air space. Even a proposed roadway with only the height of the vehicles as the only vertical impact may penetrate the imaginary flight surfaces. Location of drainage ditches and retention ponds can have an impact on airports by potentially attracting waterfowl to the area. The type of and pattern of illumination located near an airport should be reviewed for lighting conflict between the project and the airport. Glare shields may be needed to prevent signal light glare to the pilot.

Roadway projects in the vicinity of airports need to accommodate the type of cargo and goods that travel through airports. Turning radii, travel lanes, or additional dedicated turn lanes need to be considered in the accommodation of vehicles moving such cargo and goods. Appropriate signing for airports must be addressed in project design. Projects that add lanes should consider adding the lane away from the airport for clearance purposes. Potential for rail, light rail, bicycle and pedestrian, and transit needs should be examined for projects near airports, providing the necessary links between the different transportation modes. Coordinate with the Regional Transit Coordinator and review the existing Transportation System Plans to determine any related airport transportation needs.

1210.3 Contacts

The Oregon Department of Aviation should be contacted for assistance when any proposed project is within 20,000 feet horizontally of an airport; to assist in determining compliance needs with federal regulations; and to ensure proper coordination between the two divisions.

Section 1211 Hydraulics

1211.1 General

The ODOT Hydraulics Manual must be used to design highway drainage features to convey both subsurface and surface water under, along, or away from the highway. These facilities must be economical and efficient, and they must convey the discharge without damaging the highway or endangering the public. Also, all designs must comply with the Oregon Drainage Law, Federal Clean Water Act, applicable local jurisdiction regulations, and other applicable environmental regulations. A hydraulic engineer in the Region Technical Center or the ETSB Senior Stormwater Hydraulics Engineer should be contacted for assistance about project specific drainage issues.

A drainage plan with design calculations is part of the design data that must be prepared on all projects. A designer qualified in hydraulics design will prepare the drainage plan. In some cases one designer is performing both roadway and hydraulics design for the project. The drainage plan must address the location, size, and alignment of inlets, storm drains, small culverts, pipe materials, outlet protection for small pipes, roadside ditches, and cutoff ditches. The drainage plan must be reviewed by another roadway designer or the project hydraulics engineer prior to finalizing the drainage plan.

ODOT Hydraulics Manual Chapter 13 provides guidance for standard stormwater designs. Standard stormwater designs include roadway inlets, small storm drains and small channels or ditches. This information is part of the drainage design provided to the roadway designer who incorporates the drainage features into the roadway design. It also may be part of the work done by the roadway designer if the drainage and roadway designs are done concurrently.

A hydraulic and/or a stormwater report will be required to document significant bridge, culvert, storm drain, and water quality and storage facilities. These reports are prepared by the project hydraulic engineer. See ODOT Hydraulics Manual Chapter 4 for documentation guidelines.

1211.2 Design Considerations of Drainage Structures

1. Determine the natural points of concentration, discharge and other hydraulic controls.
2. Provide for the safe and efficient removal of surface water.
3. Determine either the total contributing impervious area or the area of net new impervious surface added by the project. Area used is dependent on the drainage structure type.
4. Provide the most efficient drainage, water quality, and/or detention facilities consistent with cost, maintenance, economy and legal obligations.
5. Determine environmental and biological constraints.
6. Provide cost effective design of bank and embankment protection features.

1211.3 Economic and Legal Aspects That Must Be Considered During Drainage Design

1. Cost of construction and right of way costs.
2. Effects on adjacent property, particularly with respect to State liability.
3. Interference with traffic including road closures or detours.
4. Water in natural channels diverted from its usual course.
5. Water diverted or discharged over land or through a drainage course that would not normally receive such waters.
6. Peak surface runoff increased and discharged to water bodies that would not normally receive such peak flows.
7. Percolating waters intercepted and diverted for the protection of the highway.
8. The use of infiltration for disposing of stormwater runoff into soils and facilities with hydraulic connectivity or direct injection to groundwater. Such facilities require registration with the Oregon Department of Environmental Quality and require monitoring.

9. Maintaining hydraulic conditions within a floodplain and an adopted floodway according to Federal Emergency Management Agency (FEMA) regulations.

1211.4 Oregon Drainage Law

Oregon drainage law, which originates from common law or court-made law, has developed without legislative action, and it is embodied in the decisions of the courts. Therefore, there are no Oregon Revised Statues to cite pertaining to Oregon drainage law.

Oregon has adopted the civil law doctrine of drainage. Under this doctrine, adjoining landowners are entitled to have the normal course of natural drainage maintained. The lower owner must accept water that naturally comes to his land from above, but he is entitled not to have the normal drainage changed or substantially increased. The lower landowner may not obstruct the runoff from the upper land if the upper landowner is properly discharging the water.

For a landowner to drain water onto lands of another in the State of Oregon, one of two conditions must be satisfied initially:

1. The lands must contain a natural drainage course; or
2. The landowner must have acquired the right of drainage supported by consideration (i.e., a purchased drainage easement).

In addition, because Oregon has adopted the civil law doctrine of drainage, the following three basic elements must be followed:

1. A landowner may not divert water onto adjoining land that would not otherwise have flowed there. "Divert water" includes but is not necessarily limited to:
    a. Water diverted from one drainage area to another; and
    b. Water collected and discharged which normally would infiltrate into the ground, pond, and/or evaporate.
2. The upper landowner may not change the place where the water flows onto the lower owner's land. (Most of the diversions not in compliance with this element result from grading and paving work and/or improvements to water collection systems.)
3. The upper landowner may not accumulate a large quantity of water, then release it, greatly accelerating the flow onto the lower owner's land. This does not mean that the upper landowner cannot accelerate the flow of water at all; experience has found the drainage to be improper only when the acceleration and concentration of water were substantially increased.

Subsurface waters which percolate to the surface can be intercepted and diverted for the protection of the highway without regard for the loss of these waters to the adjacent landowners. In those cases where wells and springs are involved, the right of way agent should contact the affected owner(s) to prevent any misunderstanding over damage that could be claimed. Drainage designs should satisfy Oregon drainage law to avoid claims or litigation resulting from improper drainage design. When it is apparent that the drainage design will not satisfy the law, then drainage easements should be obtained from the affected property owners. The legal staff should be consulted in those situations that appear to be unique and could result in litigation.

Where certain drainage patterns have been established over long periods of time (i.e., in excess of at least 10 years), that are not the original natural drainage, there may be legal rights acquired which allow the continuance of the altered drainage pattern. Again, legal staff should be consulted in such situations.

Oregon drainage law is discussed further in the ODOT Hydraulics Manual.

1211.5 Cooperative Projects

Participation in cooperative projects for flood control and/or flood protection mitigation, and/or water quality treatment must be approved by the Regional Technical Center with the extent of participation being restricted to the amount of benefit accruing to the Oregon Department of Transportation. No commitments should be made prior to approval by the Regional Technical Center and the amount of participation shall be documented by formal agreement. Actual work performed by ODOT under such agreements shall be limited to highway right of way unless otherwise approved in advance by the Regional Technical Center. Projects should consider opportunities for regional stormwater management facilities as appropriate in conjunction with city or county projects.

1211.6 Hydraulics Report

The hydraulics report is prepared by the project hydraulics engineer. This is the final report that provides detailed information for many tasks, such as structure design, roadway design, environmental documents, and permit applications. This report would detail the hydraulic recommendations for:

1. Bridges
2. Medium and large culverts 48 inches in diameter or larger
3. Floodplain/Floodway analysis
4. Fish passage
5. Scour protection

6. Streambank stabilization
7. Outlet protection of open channels or closed conduits such as culverts or storm drains.
8. Temporary water management

1211.7 Standard Stormwater Design Documentation or Stormwater Report

Standard stormwater design documentation can be prepared by the project roadway or hydraulics designer. ODOT Hydraulics Manual Chapter 13 provides guidance for standard stormwater designs. Standard stormwater designs include roadway inlets, small storm drains and small channels or ditches. This information is part of the drainage design provided to the roadway designer who incorporates the drainage features into the roadway design. It also may be part of the work done by the roadway designer if the drainage and roadway designs are done concurrently.

A stormwater report will be required to document significant storm drain and water quality and storage facilities. The documentation for these projects is greater than the standard stormwater design documentation. These reports are prepared by the project hydraulic engineer. See ODOT Hydraulics Manual Chapter 4 for documentation guidelines. The facility design(s) incorporated in the final plans should comply with the information in the stormwater report. A stormwater report will detail the design recommendations for:

1. Storm drain systems with pipes larger than 24 inches in diameter
2. Stormwater control facilities including detention, retention, split-flow structures, etc.
3. Stormwater water quality

The types of design information that may be in the stormwater report include the following:

1. Inlet spacing
2. Storm drains
3. Culverts, small, less than 48 inches in diameter
4. Detention
5. Water quality
6. Outlet protection
7. Roadside ditches
8. Cut-off ditches

1211.8 Design Features

♦ Floodways

The National Flood Insurance Program has established floodways on many rivers and streams in Oregon. A floodway is the regulated portion of the stream channel plus portions of the adjacent floodplain where encroachment is prohibited or limited. The remaining portion of the floodplain that is not included within the floodway boundaries, known as the floodway fringe, is often suitable for encroachment. The regulations require the areas within the regulated floodway to be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood stage or elevation. Minimum standards of the Federal Emergency Management Agency (FEMA) limit such increases in flood stage in the floodway to no more than 1 foot, provided hazardous velocities do not result. In some instances, community officials have adopted a floodway that allows less than a 1 foot rise. Highways adjacent to or crossing floodways should be designed to maintain the existing floodway conditions, if practicable. Floodway boundaries can be determined by consulting the appropriate Flood Insurance Study or the project hydraulics engineer. The project hydraulics engineer should be contacted for assistance as soon as it has been determined that a floodway or floodplain exists within the project limits, before any work in the floodway or floodplain is considered.

In some cases it may not be practicable to construct a project without modifying the existing floodway boundary. A floodway boundary revision request or other documentation must then be submitted to and approved by FEMA. This process may require up to 12 months to complete. FEMA approval of requests for floodway revisions are normally obtained by the local jurisdiction; either the City or County. In other cases temporary construction (such as work bridges, cofferdams, etc.) is needed to construct the project within the floodway. The project hydraulics engineer provides the engineering analysis necessary for projects to conform to the local floodplain regulations. Additional information on the National Flood Insurance Program and floodways can be found in the ODOT Hydraulics Manual, Chapter 2.

♦ Bridges

The project hydraulics engineer provides the engineering analysis for bridge replacements over waterways. Information on Bridge Hydraulics can be found in the ODOT Hydraulics Manual, Chapter 10.

♦ Scour and Streambank Protection

Scour can occur around bridges, along river bottoms, and along roadway embankments and can lead to catastrophic failure of structures, embankments, and roadbeds. When this scour becomes critical it is necessary to correct the eroded areas and provide protection from future scour. The project hydraulics engineer prepares and/or reviews all proposed solutions for scour mitigation. Information on scour and bank protection can be found in the ODOT Hydraulics Manual, Chapter 10 and Chapter 15.

♦ Inlet Selection

Storm drain inlets are used to collect surface runoff and discharge it to an underground storm drainage system. Inlets are typically located in gutter sections, paved medians, roadside ditches, and median channels. Inlets used for the drainage of highway surfaces can be divided into five classes:

1. Grate inlets
2. Curb-opening inlets
3. Slotted drain inlets
4. Combination inlets, and
5. Trench drain inlets

Inlets recommended for traffic areas include:

- G1 - Single Grate
- G2 - Double Grate
- CG1 - Single Grate plus curb opening
- CG2 - Double Grate plus curb opening
- CG3 - Curb Opening only

The performance of inlets and cross slope has an impact on hydraulic capacity. In a past study, the performance of the CG-3 curb opening inlet was compared to the standard grated inlets. The study ignored the curb opening portion of the CG1 and CG2 inlets in the calculations; this provides additional safety factor in the analysis for these inlets.

The efforts of the study provided the following results:

Table 1200-5: Inlet Recommendations

Gutter Grade	Inlet Recommendations
< 8%	CG-2 and G2 are acceptable
< 1%	CG-3 more efficient than CG-1 and G1
> 1%	CG-3 not recommended

In summary the study concluded that the CG-3 curb opening inlets are cost effective when the gutter grade is less than 1%.

Slotted drain inlets are cost effective and efficient inlets, but create challenges for maintenance. The slotted drainpipe should be evaluated in the same manner as other pipes (i.e., minimum cleanout velocity = 3 ft./s). This translates to providing a minimum slope of 0.89% for an 18 inch and 1.5% for a 12 inch diameter corrugated pipe. It is not recommended to place slotted drain inlets in sags unless a tapered slot is provided. Due to the tendency of these inlets to plug, assume 50% clogging and provide twice the calculated required length for flow interception.

Trench drain inlets are long and thin like slotted drains but include small removable grates that provide maintenance access and a sloped bottom so they can be installed in pavement on any slope. Trench drain inlets should not be used in areas with high speed traffic.

Information on inlet selection and design is provided in ODOT Hydraulics Manual, Chapter 13.

♦ Storm Drains

Roadway drainage often includes inlets and storm drains to convey runoff collected by the inlets. Each inlet should be checked for efficiency and capacity. Each pipe should be evaluated for structural integrity, capacity and outlet protection. Design of inlets and storm drain pipes included in the Drainage Plan is usually prepared by the project roadway engineer. The drainage plan must be reviewed by another roadway designer or the project hydraulics engineer prior to finalizing the drainage plan. Storm drain design guidance is provided in ODOT Hydraulics Manual Chapter 13. Design analysis documentation guidance is discussed above and in ODOT Hydraulics Manual Chapter 4.

♦ Culverts

All culverts should be evaluated for structural integrity, capacity and outlet protection. An existing culvert should not be extended without first conducting a thorough evaluation of the pipe's structural integrity. Pipe rehabilitation or replacement may be required if the culvert has exceeded its service life. Culverts with diameters 48 inches or larger should be designed by the project hydraulics engineer and are considered “Large” or "Medium" culverts. “Small” culverts have a diameter of less than 48 inches. Refer to Chapter 9 in the ODOT Hydraulics Manual for design policy and procedures. A culvert Design Sheet (a sample is available in the Hydraulics Manual) or equivalent computer hydraulic modeling, should be prepared with the design data.

♦ Fish Passage

It should be assumed that fish passage will be required at all proposed highway-stream crossing projects regardless of stream size unless told otherwise by the ODOT Region Environmental Coordinator. If fish or wildlife passage is necessary, the project hydraulics engineer should be consulted for the replacement or retrofit evaluation and design, if required. Information on design for fish passage is located in the ODOT Hydraulics Manual, Chapter 9.

♦ Pipe Materials

Concrete, metal, and various types of plastic pipes are available for use on projects. The site conditions and design criteria will determine which materials are viable options. Alternate materials that are viable for use at a particular site are required to be allowed. The contractor will supply the most economical product from the allowable alternatives.

The use of metal pipes is an excellent economical choice provided that care is taken regarding the material that used for foundation and backfill. Soil samples must be taken at the site where metal pipes might be used to measure soil and water pH and resistivity.

Lack of care in the determination of gauge size and/or coating of metal pipe can lead to catastrophic failure in relatively short time frames. Figure 1200-1 shows a sink hole developed 2 years after the metal pipe was installed due to corrosion.

Figure 1200-1: Sinkhole in Metal Pipe 2 Years After Installation

During the field survey, soil samples will be taken at each site and of backfill soil that may be used. If there is evidence of corrosion in other metal pipes handling the same stream flow, water samples will be required. If the foundation soil changes significantly throughout the length of the pipe, or if the backfill material shows evidence of variability, adequate samples of foundation material and backfill material will be required.

Samples will be sent to the ODOT Engineering Laboratory in Salem or a qualified testing facility for testing. A sample should weigh 9 to 15 pounds, and may be submitted in either a heavy plastic or canvas bag. The sample data sheet must show the station, anticipated pipe size, whether the material is for foundation or backfill, and any appropriate comments about the condition of metal pipes in the vicinity.

Plastic pipes are an excellent economical alternate material. Particular care must be given to the end treatment used in culvert applications. Sloped ends of corrugated High Density Polyethylene (HDPE) require additional end treatment to prevent the folding up of the inlet end of the pipe in normal storm events. Removing the top section of the pipe to make the sloped end reduces the strength of the material to resist the upward buoyancy force of the pipe as water accumulates at the inlet end of the culvert. Solutions to this problem are to use either a paved end slope or install a metal end piece when plastic pipes are allowed and a sloped end is required.

Figure 1200-2: Untreated Sloped End Lifted After Normal Rain Event

See Chapter 5 of the ODOT Hydraulics Manual for information about alternate materials policy and design instructions for pipe material selection.

♦ Detention

Detention may be necessary to limit peak runoff if existing drainage facilities used for stormwater conveyance are not sized adequately for estimated peak flows, if the project increases peak flows to a quantity-limited waterway, or in accordance with an approved drainage master plan. All detention facilities must be reviewed or designed by the project hydraulics engineer. Refer to Chapter 12 of the ODOT Hydraulics Manual for guidance on project requirements and design guidance.

♦ Water Quality Treatment

Most projects must address water quality. The water quality goal is considered to be met if the following design criterion is met:

1. Treatment is provided for all of the runoff generated by the Water Quality Design Storm from the Contributing Impervious Area using Best Management Practices that utilize infiltration, media filtration or vegetative filtration.

It is not always possible to meet this criterion. The goal can still be met by taking alternative actions, including off-site mitigation, that provide a similar water quality benefit.

Projects that include the following "trigger" elements are required to provide treatment of highway runoff:

1. Producing new impervious surface area. Does not include:
   a. Minor actions such as constructing sign or signal post pads, etc., or
   b. Non-pollutant generating areas such as detached bike paths and detached sidewalks
2. Changing the total Contributing Impervious Area.
3. Re-constructing a roadway from the subgrade. Does not include pavement overlays or inlays, or spot reconstruction.
4. Changing the type, location, direction, length or endpoint of the pre-project stormwater conveyance system.
5. Replacing or widen a stream crossing structure including adding new bridge decks or retrofitting bridge deck drainage.
6. Requiring a Clean Water Act Section 404 permit and actively involving modification of impervious surfaces.

Some projects will require specially designed treatment facilities while other projects will only require implementation of best management practices (BMPs). The Roadway Designer or Hydraulics Designer must provide the project's contributing impervious area to the Water Quality Specialist in the Environmental Section. This information will be used to help determine treatment requirements. Various local jurisdictions have special requirements that must also be addressed. All water quality facilities must be reviewed or designed by the project hydraulics engineer. Refer to PDLT Notice 05 (PD-05) and Chapter 14 of the ODOT Hydraulics Manual for guidance on project requirements and design guidance.

♦ Outlet Protection

Protection should be provided at pipe outlets to minimize local scour caused by concentrated flows and high flow velocities. Typical outlet protection utilizes a rip rap pad sized sufficiently to dissipate the energy from the end of the pipe into sheet flow. Environmentally sensitive locations may require larger transition areas and planting. The outlet protection for pipes 48 inches or larger should be reviewed by the project hydraulics engineer.

♦ Roadside Ditches

Roadside ditches should be provided to convey roadway runoff where storm drain systems are not appropriate. Roadside ditches should also be designed to prevent saturation of the roadway base material. This can be accomplished by requiring the water surface elevation in the ditch to not exceed the elevation of the bottom of the base material. A typical roadside ditch should be sized for capacity and stability in addition to water quality treatment.

The peak discharge, longitudinal slope, and ground cover for each ditch affect the ditch capacity. On steep slopes shear stresses on the ditch bottom should be evaluated to assure the ditch does not erode. The discharge contributing to ditches runs off from areas from within the right of way, but this area is often small compared to runoff from outside the right of way. Evaluate each ditch for significant flows from off-site. The standard 6 inch deep ditch should be used on all projects unless the calculated peak flows indicate insufficient capacity or instability. Water quality mitigation requirements may require a 4 foot wide flat bottom ditch or wider be used to provide BMP level treatment.

Shear stresses will be less in ditches not flowing full. The information on stability for cohesive and non-cohesive soils include a range of values because soil properties such as plasticity and gradation vary considerably and can significantly affect how the soils react to shear stresses in the bottom of the ditch. For more information refer to the ODOT Hydraulics Manual, Chapter 8.

♦ Cut-off Ditches

Cut-off ditches should be provided above high erodible cuts to convey drainage of surface water away from the face of the cut. They should be set back about 10 feet from the point where the slop rounding meets original ground slope (see Section 323 Rounding Cutbanks..

♦ Design Deviations

If a proposed hydraulic design cannot meet requirements as defined in the ODOT Hydraulics Manual - 2011 for the following items listed, then a design deviation shall be required.

1. Design Frequency [Design Flood] (AASHTO *Highway Drainage Guidelines* – 3.2.5 and 7.62; ODOT *Hydraulics Manual* – Chapter 3)
2. Design Spread (AASHTO *Highway Drainage Guidelines* – 13.9; ODOT *Hydraulics Manual* – Chapter 13)
3. Allowable Headwater at Upstream Culvert End (AASHTO *Highway Drainage Guidelines* – 9.3.3; ODOT *Hydraulics Manual* – Chapter 9)

See ODOT Hydraulics Manual, Chapter 3 Appendix A for the deviation form.

Design Frequency: [Design Flood]

The recurrence interval of flood for which the drainage structure is sized; to assure no traffic interruption or significant damage will result. The following issues are of particular concern when evaluating exceptions to the design standard.

1. General
    a. Significant Increase of flood hazard for property
2. Cross Drainage
    a. Overtop Highway, or
    b. Exceed a certain depth on the highway embankment (see allowable headwater)
3. Storm Drains
    a. Encroach on the street or highway so as to cause a significant traffic hazard, or
    b. Limit Traffic, emergency vehicle, or pedestrian movement to an unreasonable extent.

Design Spread:

The width of storm water flow in the gutter measured laterally from the roadway curb.

1. Reflects public expectation for finding water on the pavement surface
2. Is related to design speed and safety concerns with hydroplaning

Allowable Headwater:

The depth of water that can pond at the upstream end of a culvert during the design flood.

1. Stability of roadway embankment. Most roadway embankments are designed and constructed without saturation of embankment materials or lateral forces considered – they are not designed as dams. Geotechnical stability analysis is required to evaluate embankment stability to accommodate headwater.
2. Upstream and downstream impacts relating to erosion and flooding.

Section 1212 Pavement

1212.1 General

The pavement design for each project will be determined by the Pavement Design Group. Because the depth of surfacing is a major factor in the project design and cost, the pavement design is needed early in the project development process. If the Pavement Design Group is to complete their design work on time, keeping them informed of any changes in the project scope and schedule is very important.

The primary function of the Pavement Design Group is to provide the most practical and cost-effective pavement/base/subgrade design for the conditions and criteria for a specific project. Development of the design is accomplished through a combination of field investigation, data analysis, and application of appropriate design procedures. Pavement design procedures and ODOT Policies are outlined in the ODOT Pavement Design Guide. The surfacing type selection, such as PCC versus AC, will be the responsibility of the Pavement Design Group and will not be left to the competitive bidding process.

1212.2 Project Scope

Before the pavement design process can be started, the project scope must be established. Once the project scope is established, the Pavement Designer can begin the field investigation. Because of the limited availability of the Pavement Design Field Crew and other factors, scheduling fieldwork several months prior to the date when a complete design is necessary is important. Any changes in the project scope could require additional field work and should be brought to the attention of the Pavement Designer as soon as possible.

Field work for most projects will involve deflection testing of the existing road surface. This work cannot be performed when the existing pavement or subgrade is frozen. For this reason field work for projects in frost susceptible areas needs to be completed during the summer prior to the time a design is required. This may in some instances (particularly for Regions 4 and 5 and projects at the higher elevations in the Cascades) require the scope and project schedule to be finalized eight to nine months in advance of the time a pavement design is required. Typically, if a pavement design for a project in the above areas is needed prior to July of a given year, a work request needs to be provided by August of the previous year.

1212.3 Design Considerations

Additional information important in the selection of the most appropriate pavement design for a particular project is listed below.

1. The availability of materials
2. Source of embankment materials
3. Traffic staging details*
4. Amount of grade change required or tolerated (curbs, crosslope, R/W, stream or cut encroachment, etc.)*
5. Location and extent of widening
6. Location and extent of alignment changes*
7. Extent of current or future planned projects on the same section of highway
8. Unusual traffic patterns on a project*
9. Areas where soft subgrade may be encountered
10. Age, condition and upgrade plans for utilities under the pavement*
11. Type of drainage facilities in place or to be placed*
12. Actual type of curb present*
13. Change in traffic pattern use on existing pavement*
14. Extent and frequency of chain usage
15. Extent and frequency of snow plow damage
16. Grade constraints at bridges
17. Important for urban area projects

1212.4 Urban Pavement Rehabilitation Projects (in town, curbed sections)

This type of project requires a very detailed review of several of the items listed above before field work should be conducted for development of the pavement design. The items are designated with an asterisk above. Many of these sections have very little curb exposure left or have unacceptable cross-slopes and/or other geometric features. This type of information is very important in determining the options available and the type of fieldwork necessary to develop the design. For more information regarding field work and pavement design for urban projects refer to the ODOT Pavement Design Guide.

1212.5 Pavement Preservation Minimum Design Life

All pavement designs must meet the minimum design life requirements outlined in the ODOT Pavement Design Guide. A design exception may be requested through the process described in Part 1000. Typical acceptable reasons for getting a design exception are as follows:

1. A life cycle cost analysis shows that the proposed maintenance/rehabilitation strategy is more cost effective than what would be required to meet the minimum design life.
2. The proposed short term fix keeps the road passable until a project can be put in the STIP to provide a long term solution. A commitment should be made at the time of the agreement of the exception to get the project into the next STIP.

1212.6 Project Scoping and Design Estimates

The Pavement Design Group is also available to assist in the project scoping process. In most cases the Pavement Design Group can develop a preliminary design estimate that will be fairly close to the requirements of the final design. By using the Pavement Design Groups' expertise in the early stages of a project, the risk of significant cost overruns due to changes in the pavement design may be minimized.

For projects with liquid asphaltic quantities in excess of 150 tons, the designer should include a separate bid item for the liquid asphalt. Any request to not have a separate bid items should obtain the approval of the pavement designer. In addition, the standard liquid asphalt quantity is equal to 6.0% of the mix for 1/2-inch ACP and 6.3% of the mix for 3/8-inch ACP. Any deviation to the standard liquid asphalt quantity requires the approval of the pavement designer.

Section 1213 Roadside Development

1213.1 General

Roadside development is work occurring on a transportation facility right of way that doesn't fall into other categories such as illumination, utilities, or access control. The purpose of roadside development is to help integrate the transportation facility into the surrounding environment, which includes the larger transportation corridor. The purpose may be environmental, cultural, aesthetic, functional, or combination of these. The work may be mitigation (avoidance or minimizing impacts), compensation (replacing functions that are impacted), or enhancement (creating or improving something desirable in the landscape). Roadside land outside the operational right of way can be used to provide a range of environmental services, including providing pollinator habitat, sequestering carbon, providing shade that can reduce urban heat islands, or providing cool aquatic habitats. Also included in this category of work is comment and advice for the modification of the work of other technical specialties that is related to the effect on the natural or cultural landscape of the transportation facility. Roadside development work is most often a part of road projects, but it can be the sole purpose of a contracted project.

Because roadside development usually deals with multiple overlapping large and small systems, it is not easy to precisely describe the term, just as there is no exact definition of the term "landscape." The normal ODOT practice is to have specialists participate in scoping roadside development work on significant projects.

For the reasons cited above, specific roadside development requirements can have a variety of origins. One critical source is the environmental document whose legal purpose is to determine project impacts and state the actions intended to deal with those impacts. Other typical sources of requirements are various kinds of permits, agreements with county or city governments, the operating policies of various authorities such as the U.S. Forest Service, and ODOT's mission concerning the environment or quality of life for residents and visitors to Oregon. Some needs of a project are discovered as the project evolves because they relate to project impacts that come to light or are finalized during later stages of development. Final roadbed slope lines are one example.

It is important to note that the roadside development work done for projects is almost always required, rather than optional. For questions about the sources of requirements that are not referred to in this section, contact the Roadside Development Program Coordinator in the Environmental Section in Engineering and Technical Services Branch. One primary source of actions on federal participation projects is the National Environmental Policy Act (NEPA). For Roadside Development on complex projects, it is often necessary to conduct an inventory and analysis of visual resources along the project, determine the level of impact and identify measures to ameliorate or mitigate those impacts.

1213.2 Project Development Phases

♦ Planning

The ODOT Transportation Development Branch (TDB) usually looks at the “big picture” to develop initiatives like the Corridor Program, and develop policies which integrate local land use policies with statewide transportation systems. Many of these policies condition what actions are to be taken later on in projects and in these cases, TDB or Region planners as well as published documents of the TDB such as the Oregon Transportation Plan or Transportation Corridor Plans can be important resources.

Local government or transportation-related planning also must be considered for a comprehensive project. Some sources of information or requirements include local and regional Transportation System Plans (TSPs), local comprehensive plans, transit plans, and impacts to or from other planned projects in local capital improvement programs. Also included in the planning phase is consideration of other known major factors such as proximity to parks, funding options, access management, or other critical features.

1213.3 Programming and Scoping

Timely anticipation of the need for roadside development work will help establish a realistic design schedule and budget. Any project may have roadside development, but the rule of thumb is that the greater the disturbance to the natural or built landscape, the greater will be the need for work. Key flags are sensitive environments or populated urban areas where extensive work is being proposed. A brief review of the sources of work in the first section may help in scoping, but specific development of needs with the appropriate specialists may be required. In spite of best efforts, there will be times that the total work is not determined until late in the project design phase.

1213.4 Design

Field data collection that enables design work to begin is important to the success of roadside development. Data needs vary for the kind of work anticipated and ideally will be determined during project scoping. Data must be requested as the need becomes clear in the design process. Examples of data are a survey of existing trees, analysis of native plant communities, existing and proposed topography, soil types and depths where planting is proposed, existing wetlands or other water features, available potable water supply information, existing noxious weed populations, or similar data. Also falling into the category of field information are government regulations, policies, or initiatives external to ODOT. Examples of these could be master plans for local improvement districts, zoning or development requirements, scenic waterway or byway requirements, and other similar kinds of information that must be known in order for design to be completed. Primary resources to research this kind of information are the Region Permit Specialist, Local Government Coordinator, or Region Environmental Coordinator. Often, agencies with jurisdiction will have to be surveyed for relevant requirements, and project needs are sometimes determined through such forums as meetings with neighborhood groups or other stakeholders.

Roadside development design in ODOT often focuses on the proposed contract document or design products as one way to scope the design process. The following is a list of the most familiar contract document and design products:

1. Roadside development conceptual mapping
2. Sketches or renderings to illustrate concepts.
3. Planting, Irrigation, and Contour Grading Plans
4. Various environmental mitigation plans - whether specifically identified by name, such as Wetland Mitigation, or not
5. Site Development Plan
6. Typical or unique project details
7. Cost Estimate with Bid Items
8. Specification Special Provisions
9. Special advice for project construction
10. Post-construction Maintenance Plan

♦ Construction

Design work of any type must be “biddable and buildable,” and also anticipate potential construction problems. This is critical for roadside development work because it usually deals with living systems that are subject to natural elements such as weather, and business elements such as supply of plant materials in a timely fashion. A few considerations are waterway high and low periods, planting seasons versus contract periods, problems caused by erodible soils, restrictions on work such as in-stream periods, the ability to water new plants where no irrigation system exists, length of the plant establishment period, and many other such issues. Good communication between the various parties involved in the origination and design of the work is required for successful construction, especially because "adjustment" of all types of project elements as construction progresses is the rule, rather than the exception.

♦ Post-Construction

A critical concept in roadside development is, that in meeting legal and other requirements, ODOT is responsible for establishing permanent functions. Some examples of functions include modifying topography or establishing vegetation for specific purposes such as habitat mitigation, water quality enhancement, creation of new wetlands, neighborhood screening, sound wall mitigation, or existing planting replacement. If state or federal permits are involved then the permit often requires monitoring after completion. For example, regulatory agencies require ODOT to monitor wetlands for five years to correct problems. Some cities require the replanting of newer street trees that fail to thrive after the plant establishment period ends. Federal funding participation brings with it the need to protect the federal investment. In the post-construction period, roadside maintenance is the most critical element in maintaining the designed function. However, there are other activities that affect roadside functions such as utility work, permit activities like plant collection, or other causes of disturbance.

ODOT regions are responsible for post-construction activities, and the system works best if the maintenance needs of new work are understood as the project is being developed. Transportation facilities such as roads are designed and built according to established needs, and then appropriate maintenance is programmed to keep the facility safe and functioning. In the same way, the best practice in planning for roadside maintenance is a clear understanding of the functions to be maintained and then working to ensure the ongoing maintenance capability.

1213.5 Roadside Development Responsibilities

Roadside Development is currently housed within the Environmental Section in each Region, although not every Region has a Landscape Architect on staff. The role of the Region Landscape Architect is to develop projects and provide design and contract document development support to other environmental disciplines as needed. The Statewide Roadside Development Coordinator is based in Salem in the Environmental Section of Engineering and Technical Services Branch. The Statewide Coordinator is responsible for related program and policy development, and also provides project support to Regions as needed and requested. Several other units have major responsibilities including the Environmental Section, Project Design Teams, and Region Environmental Specialists, among others. Private consultant landscape architects and environmental specialists may also have important design roles on projects.

Project teams are now responsible for overseeing the development of projects. Ownership of roadside development work generally follows the same path as other kinds of work; the specialists are responsible for their work but the project team determines how the work is conducted and coordinated on a given project. Whenever there are roadside design contract documents, the individual responsible for the design needs to be identified on the plan sheet. The Professional of Record will be a Registered Landscape Architect.

Roadside development offers a focal point to assess the whole project site at any point in development, and assess, mitigate, and compensate for project impacts. Every design specialty can participate in how their project work affects the quality of the roadside as well as how roadside environments impact the quality of the project. One example of this is how traffic signing designers now routinely call for painting the backs of signs on certain highways to reduce their visual contrast in scenic areas.

Projects are transferred to maintenance after construction, so they assume the ongoing responsibility. It is important for Maintenance to understand and support roadside development designs, which allows the designer's intent to mature as intended. Their participation in project design and construction is critical for long term success. Roadside maintenance is one of the legs to the "three-legged stool" of planning, design/construction, and maintenance. The ability to provide long-term care for constructed designs allows ODOT to be able to continue to practice partnership with regulatory agencies such as FHWA, the Army Corps of Engineers, and many others. The advantage of this regulatory partnering to ODOT's ability to conduct project development cannot be overstated.

1213.6 Roadside Development Tools and References

Some references for roadside development projects have already been mentioned, such as the project environmental document, permits, agreements, relevant policies or regulations of various agencies and governments, and project documents such as the Prospectus and Narrative. Some useful internal references are the Roadside Development Manual, Right of Way Development and Control part of the Oregon Standard Specifications for Construction; and the Integrated Vegetation Management Guidelines. External references include A Guide for Transportation Landscape and Environmental Design by the American Association of State Highway Transportation Officials (AASHTO) and the American Standard for Nursery Stock from the American Association of Nurserymen (AAN).

Roadside Development requires the development of Specifications. It is important that landscape architects are familiar with the Oregon Standard Specifications for Construction, and with the process of editing special provisions. The ODOT Specifications Manual provides guidance on special provisions, the function and organization of the Standard Specifications, and general clarity in written communication.

Another important tool is the terrain modeling capability of Bentley InRoads and OpenRoads Designer software. The use of terrain modeling for contour grading design will become a standard on road projects as it applies to landscape, wetland, and riparian restoration or enhancement. This allows accurate cross sections to be developed for testing alternate design concepts and for use during project construction. Project terrain modeling works best when anticipated in project scoping and scheduling. Other tools in use and expected to see greater use are photo image editing and three-dimensional rendering of site designs using Microstation CAD.

1213.7 Specific Project Considerations

It should be noted that every project which disturbs ground will need at least a minimal roadside development consideration, such as temporary and permanent seeding for site stabilization.

Conservation and protection of existing resources should be considered wherever possible and practical. This includes retention of existing vegetation or other habitat features, and salvaging project topsoil, stockpiling, and re-using on finished slopes wherever practical.

As we meet the basic design and construction needs of roadways and structures, existing native plant communities must be saved and protected wherever practicable. They can never be re-created exactly as they were before disturbance and attempts to re-create native plantings still meet with mixed success. Additionally, existing vegetation provides significant site stabilization, reducing the requirement for erosion control in those areas.

Roadside development requirements need to be identified during the location survey to assure that enough right of way is available for compliance. Sufficient right of way should be included to provide smooth finish grade transitions between existing landforms and the facility. Flattening steep slopes, slope rounding at the top and bottom of cuts and fills, and parabolic ditch sections are methods for developing a more compatible transition.

Additional right of way may be appropriate where issues exist such as endangered species or habitat preservation, wildlife corridors required to be protected, water quality facility locations, or transportation corridor visual quality. Roadside Development coordination with terrestrial biologists or Fish & Wildlife Service can identify locations where grade separated wildlife crossings can be developed to reduce animal/vehicle conflicts and increase safety.

High visibility areas and urban roadside areas almost always require some degree of ongoing maintenance. Slopes 1:3 or steeper cannot be maintained by normal roadside mowing, so reducing slopes to less than 1:3 can reduce future maintenance efforts where mowing is acceptable. Planted shrubs and trees are an alternative to mowing on steep slopes and they have many other kinds of benefits. Even these planted areas, however, are not maintenance free and will receive maintenance, supporting roadside development design, as needed.

Interchanges, except in special circumstances, require roadside development. The degree of treatment is determined by the amount of landform change, urban/rural nature of the site, local interests and participation, local ordinances, and other such factors. A basic level of roadside development, such as permanent seeding for site stabilization, is expected for all projects which disturb the ground surface. Since interchange areas are highly visible to many travelers every day, they often receive a higher level of treatment than other areas.

Sound berm designs should allow sufficient area (10 – 12 feet) between the toe of berm and the Right of Way for maintenance access.

Sound walls should be set back from the edge of curb a minimum of 1.5 times the height of the wall. This achieves a better visual balance between the vertical mass of the wall and the horizontal plane of the roadway. It also helps address clear zone issues. Sound wall ends should be stepped down or wrapped around corners where streets intersect the highway. Sound walls are a large vertical element on the land and treatment of their surface is important, as is the issue of graffiti on walls. The Roadside Development specialist should be involved when considering treatments (color, texture, or vegetative cover) for sound wall designs. Climbing vines can deter graffiti vandalism, and vegetative screening or foundation planting can soften the gray concrete corridor and poor aesthetics created by sound walls.

Areas that require landscape screening, such as residential areas or undesirable views visible from the highway, need sufficient Right of Way for plantings while maintaining clear zone requirements and access to the areas.

Utility pole location signage placements and street tree plantings needs to be coordinated during design. This is often difficult because utility companies may not determine pole locations until very late in the design process.

Any area that is planted in any way must be able to be safely accessed for maintenance.

On federal participation projects, law requires that an amount equal to 1/4 of 1% (.0025) of the roadside development estimated cost must be used to plant native wildflowers. Maintenance treatment of these areas must accommodate the requirements of native wildflowers to support the federal regulation. - 1/4 of 1% of project budgets must go to plant wildflowers. (Erosion control and some other costs are excluded.)

1213.8 Roadside Development Initial Project Checklist

1. **ODOT Information** - Include or check roadside development items in project Prospectus, scoping, environmental documents, schedule, City-State Agreement, key contacts list, special needs such as riparian revegetation, state commitments, Scenic Byways or Scenic Rivers, and other critical policies or programs such as Transportation Corridors or Forest Highways.
2. **External Information** - Relevant city and county permit requirements, external review authorities, key contacts list, critical laws and policies of local, state or federal agencies, working partners, initial project objectives, water supplier, et cetera.

3. **Design and Construction** – Includes performing or coordinating roadside development scoping and preliminary budget, participation on project development team, research, preliminary concepts, designs, contract document preparation, plan sheet drafting, consultant oversight, expert plan review, construction observation, and consultation on change orders. A variety of professionals perform these functions.

4. **Roadside Maintenance** - Name of maintenance authority (ODOT or other), name of responsible contact, inclusion of maintenance in project development review, inspections, maintenance standards, maintenance agreement or contract, maintenance plan for designed areas, approximate resources needed, maintenance ability to meet needs added by project

Section 1214 Temporary and Permanent Erosion and Sediment Control

1214.1 General

The ODOT Erosion Control Manual is the basis for design of Erosion and Sediment Control Plans (ESCP) and is used to assist the practitioner to prepare both temporary and permanent Erosion and Sediment Controls (ESC) on all ODOT projects. The Environmental section should be consulted about problems involving ESC design.

The purpose of erosion control measures is to minimize the disturbance of soil particles, to limit the transport of sediment-laden water from construction sites, and prevent discharge of sediment into receiving waters. The benefits include minimizing turbidity and its impact to water quality and fish habitat.

An Erosion and Sediment and Sediment Control Plan (ESCP) is both a Permit document, submitted to the regultatory agency (DEQ) prior to beginning of construction, and part of the data that must be prepared on all projects that disturb 1 acre or more of soil. It must be noted that the ESCP is a living/dynamic document that needs to be modified during construction when site conditions change, when erosion and sediment control measures change, and to comply with regulatory requirements. The ESCP contains best management practices (BMP) to minimize erosion and control sediment movement on the construction project. The BMP will have to be modified or upgraded (if necessary) to suit the site conditions from project inception to completion.

The Oregon Department of Environmental Quality (DEQ), acting under Section 402 of the EPA's Clean Water Act, requires that all construction activity disturbing 1 acre or more, of soil have an ESCP developed to comply with the National Pollutant Discharge Elimination System (NPDES) permit. Each region has an NPDES 1200-CA permit to cover work done within that region. Contact a Region Environmental Coordinator for a copy of the permit.

The Federal Highway Administration is required by Section 1057 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) to develop erosion and sediment control guidelines for states to follow when constructing highways using federal funds. In order to fulfill this requirement, on July 26, 1994 FHWA adopted the guidelines presented in Volume III of AASHTO Highway Drainage Guidelines.

As part of The Oregon Plan for Salmon and Watersheds, the Oregon Department of Transportation now assures erosion control plans are provided on all projects that disturb soil and use federal funding. Local jurisdictions may also have soil erosion and stormwater quality control requirements, and these should be considered on a location by location basis.

Temporary and permanent ESC measures need to be considered during the project planning. The topography, drainage patterns, hydrology, and developed condition in the vicinity of the project site must be researched and used during the development of ESCP. The ESCPs consist of drawings, details, and specifications that are included in the contract documents and in the designer's narrative. An Environmental Management Plan must be included in the ESCP on projects where pollutants, contamination, or the potential thereof may be used or found during the course of construction. The ESCP must contain all of the necessary elements to accomplish the goals and meet the limitations of permits. Contract documents include specifications in Sections 00280 and Section 170 to address contractors' compliance with this permit.

Section 1215 Permits & Documents

1215.1 Permit Responsibilities

A number of permits and/or documents may be required from various agencies during the advance of a project from design to construction. The following list of permits and the units responsible for obtaining them is as comprehensive as possible at this time:

Table 1200-6: List of Permits and he Units Responsible

Permit	Issuing Agency	Responsible Party
Airport Clearance	Federal Aviation Administration (FAA)	Region Tech Center / Engineering Services / through Aviation Department
Railroad Crossing (New and Alteration)	ODOT	ODOT Commerce and Compliance Division

Permit	Issuing Agency	Responsible Party
Section 401 of Clean Water Act (Water Quality Certification)	Department of Environmental Quality (DEQ)	Environmental Permits Coordinator
Land Use Plan (Conditional Use; Flood Department Plain, etc.)	County/City Planning Department	Region Office
Building Permit	County/City	Region (Project Mgr.)
Other Local Permits	Irrigation/Diking Districts, etc.	Region Office
Right of Entry/Use Permits (through USFS/BLM Lands)	U.S. Forest Service/Bureau of Land Management (BLM)	Region Office / R/W
Material Site	Oregon Department of Geology & Mineral Industries (DOGAMI)	Region Geologist Resources*
* For Commercial and other Contractor Option sites, the permit is obtained by the Contractor, Site Operator, or Landowner.		
Coastal Zone Management	Oregon Dept. of Land Conservation & Development (DLCD)	Environmental Permits Coordinator
Water Use (Water Impoundment)	Water Resources Division	Watermaster
Fill/Removal Permit	Oregon Division of State Lands	Environmental Permits Coordinator
Section 10 of Rivers and Harbors Act	U. S. Army Corps of Engineers	Environmental Permits Coordinator
Scenic Waterway Permit	Oregon State Parks & Recreation and/or Bureau of Land Management	Environmental Permits Coordinator
Waterway Permits	U.S. Coast Guard	Environmental Permits Coordinator
Section 404 of Clean- Water Act Permits	U.S. Army Corps of Engineers	Environmental Permits Coordinator
Water Well	Oregon Water Resources Department	Operations (Buiding Manager)
Construction Permit	Property Owner	Right of Way
Environmental Documents		Environmental Services

Permit	Issuing Agency	Responsible Party
Wetlands Report	See Note	
Cultural Resources Report	See Note	
DEQ Indirect Source Permit	See Note	
Noise Study Report	See Note	
Note: 1200-CA permits are issued to Regions and are effective for 5 years.		

The Project Prospectus (Part 2 and Part 3) will, in most cases, identify those permits and documents required for each project, and who is responsible for obtaining them.

Permits for some local agency and off-system projects are to be obtained by the agency or the consulting engineer as stipulated in the Oregon Department of Transportation/Agency agreement for the project.

An Air Quality report is required for all projects that increase capacity in Portland, Salem, Eugene, Medford, Grants Pass, and Klamath Falls, La Grande, Oakridge, Lakeview.

FHWA also requires a Hazardous Materials report or other documentation.

1215.2 Permit Types

♦ Airports

In compliance with Federal Aviation Regulations (PART 77), "Objects Affecting Navigable Airspace," highway projects within 20,000 feet of an airport will be carefully examined by Project Support and/or Roadway Engineering prior to the public hearing stage to determine if there is a possibility of conflict.

When it is determined that a notice is required, the Engineering Services Unit will complete FAA Form 7460-1 and submit it to the Federal Aviation Administrator as prescribed in FAA Reg. 77.17 via the Oregon Department of Aviation at least two months before construction begins. If during the preliminary design phase an obstruction conflict becomes apparent, immediate contact with FAA should be made.

♦ Diking and Irrigation District

When a proposed highway project is expected to impact an existing development that involved Federal funds in its construction (such as dikes, irrigation projects, revetments, dams, etc.) an investigation shall be made by the Project Manager or a designated representative of the Region Manager, to determine the need for notification, approval or permits of another agency. In most cases, approval will be required from the Federal authority originally involved, as well as the local agency.

The Project Manager should establish communications with these Districts to alert them that some work is proposed that will affect their facility and to ascertain what special considerations are needed in the project plans & specifications.

♦ Use Permits and Agreements

Right of way over government land is acquired through right of entry on Bureau of Land Management property and through an easement from the U.S. Forest Service. Applications for these are made through the Right of Way Section in Salem. The government classification and proposed right of way lines are to be shown on the detail map in the usual manner. The Memorandum of Understanding between the U.S. Forest Service and the Oregon Department of Transportation details the process by which right of way through National Forest land is obtained. The issue of obtaining right of way over government land is a very detailed and time consuming process. There are other permits and authorizations required from the U.S. Forest Service, Bureau of Land Management, and other Federal Agencies.

♦ Department of Geology and Mineral Industries

A permit is required from DOGAMI for all work in all aggregate sources or borrow sources, whether publicly owned, privately owned and commercially operated, or other private sources (e.g., a farmer). These permits control the development and assure the reclamation of the sites as required by state law (ORS 517.750 - 517.955).

After the need for borrow/aggregate has been determined, the Region Geologist will determine whether ODOT will offer its own prospective source or rely on the contractor to obtain his own material source.

When the source is ODOT owned or controlled (ODOT has a lease with the landowner), the Region Geologist will determine the source and prepare the necessary documentation for the permit. The application and supporting documentation and fee is then submitted directly to DOGAMI.

The Region Geologist will forward a copy of the development plan and reclamation specifications directly to the designer for incorporation into the plans and specifications.

When the contractor provides the source, the contractor will obtain the permit. The Construction Project Manager has the ultimate responsibility to verify that the material site has a valid DOGAMI permit.

♦ U. S. Coast Guard Permit

Some of the larger rivers as well as bays and estuaries in Oregon are considered to be navigable. The Coast Guard and the Corps of Engineers operate according to a list of officially designated navigable waters. Commercial navigation may no longer be practical in some of the waterways listed as being navigable and projects over those waters may be exempt from the need for a permit. Since it is easier to define when a permit is not needed that will be the starting point.

For projects involving the construction of bridges or the major reconstruction of bridges over navigable waters a Coast Guard permit may not be required if the bridge is over waters:

1. Which are not being used or are not susceptible to use in their natural condition or by reasonable improvement as a means to transport interstate or foreign commerce; and
2. Which are (a) not tidal, or (b) if tidal, used only by recreational boating, fishing, and other small vessels less than 21 feet in length. (Federal Aid Highway Manual, Vol. 6, Chapter 7, Sec. 1, Par. 1)

The Permit Coordinator requests that the Federal Highway Administration makes the determination that a Coast Guard permit is not required under these criteria.

If the waters in question do not meet Criteria 1 and 2 above, a Coast Guard Permit will be required.

The application for the permit is made by letter to the 13th Coast Guard District (Seattle). This application should be made one year in advance of the project construction date.

The Coast Guard should be contacted and their comments requested about provisions for navigation when a project involves a navigable waterway, whether or not a Coast Guard permit is required. Their stipulations concerning such items as navigation clearances, lighting, etc., will then be included in the project plans and specifications.

♦ U. S. Corps of Engineers/Division of State Lands Permit

The US Army Corps of Engineers (USACE) regulates discharge of dredged or fill material into waters of the United States, including wetlands, pursuant to Section 404 of the Clean Water Act (33. S.C. 1344). A permit will generally be required when filling into waters of the U.S.

The Oregon Division of State Lands, as the state regulating agency, will generally require that a permit be obtained for fill or removal in the beds or banks of streams or wetlands. A joint permit application form is used for both of these agencies. However, two or more permits may be issued.

The joint permit application is reviewed by State and Federal Resource Agencies (ODFW, DEQ, USFWS, EPA, NMFS, etc.) for compliance with statutes, such as the Endangered Species Act (ESA), and good resource management practices. Their comments and conditions will be incorporated into the permits.

It is extremely helpful during the field survey for the Project Manager to contact the local District Fish Biologist of the Oregon Department of Fish & Wildlife to discuss the project and learn in advance the conditions under which work will be allowed in any streams. The Permits Coordinator obtains the permit. Application is made when the following information is available for the impact site:

1. Vicinity map which shows the location of the project.
2. Plan, elevation and typical section drawings which show the existing and proposed structures.
3. Any environmental documents required for the project such as a Wetland Delineation, Impact Assessment and Mitigation Report.
4. The Biological Assessment for the project impacts to the threatened and endangered species can be sent when it is completed.

This information should be submitted as early in the design process as possible. This will insure any conditions or stipulations contained in the permits can be incorporated into the project plans and specifications. These conditions may be as minor as time limits for in-stream work or as major as extensive wetland mitigation plans.

Any special conditions or stipulations regarding work in the stream are then included in the final project plans and specifications. (For Corps of Engineers Permit Rules see Code of Federal Regulations (CFR 33, Ch. 11, part 323)

♦ Construction Permit

The construction permit applies to land service facilities to be built for individuals on their land. It gives the State or its contractor a right to enter upon the property of an individual to perform construction work for the benefit of the owner. This might include road approaches or access roads which cannot be accommodated in their entirety within the highway right of way; irrigation facilities which serve only the individual involved; or any other facility constructed for the sole use and benefit of the owner involved, the later removal of which would not be detrimental to the highway. No time limits are placed on construction permits.

♦ Stormwater Report

The stormwater report can be produced by Roadway or Geo/Hydro, and these two working groups may have shared responsibility for different sections of the calculations and documentation. The report should provide documentation of the design calculations supporting the final plans and specifications. See section 10.5.7 for specific information about the stormwater report.

Part 1300 Deliverables

Section 1301 Introduction

Throughout the Project Development process, the primary milestone used for reference is the project's PS&E submittal date, which other deliverables are measured against. If planned deliverables and milestones are not met, this can cause the project's PS&E submittal date to slip, usually in increments of one month. This can cause serious repercussions to the constructability of the project due to time sensitive windows such as paving seasons, permit dates for in-water-work requirements, budgeting, etc.

For additional information about the project delivery process, consult ODOT's project delivery guidance, operational notices, bulletins, and directives.

Section 1302 Plans, Specifications, and Estimates

1302.1 Plan Procedure

♦ General

Each of the Regional Technical Centers has their own unique process for developing and reviewing their plans, specifications, and estimate. The specific Region process will determine the milestones and type of review required for the project.

For additional information about the project delivery process, consult ODOT's project delivery guidance.

1302.2 Plan Preparation

♦ General

Plan preparation is a team effort and communication between all team members is paramount. This requires direct communication between different disciplines as well as regular communication between the design engineer and the drafter. The design engineer and the drafter need to work well with each other and clearly understand each other's unique role in the plan preparation process. The design engineer is responsible for the content of the design and for the constructability of that design. The drafter is responsible for the presentation of those ideas on the plans in a format that is consistent statewide. Plan consistency is important for contractors bidding work from different geographical locations. There are standardized methods for showing the construction items in the Contract Plans Development Guide (CPDG)). Following the methods shown will assist both drafters and designers in keeping a more consistent look and feel to the ODOT plans. The CPDG is used to manage consistency for ODOT.

All of the final drawings in the plan set that convey technical information are required by Oregon Revised Statutes 671 and 672, that the professional in charge of the data place their professional seal on each specific drawing. No professional seal is required on the title sheet or on the sheet containing the index of drawings, as these sheets convey only general project information and are not technical in nature.

1302.3 Title Sheet & Index Sheets

The title sheet includes several items of information relative to the project and/or plans. It has additional sheets for the index of plan sheets which identifies all plan sheets in a specific order as outlined in the CPDG. It has a title block which lists the major work items, name of the project, highway, county, and letting date. A vicinity map shows the project location, beginning and end of the project, and the Federal-Aid project number.

Other items to be found on the title sheet or on the index sheets are a listing of standard drawings, listing of Right of Way maps used on the project, length of the project, a small scale map with the general project location indicated by an arrow and a block for the Technical Services Manager/Chief Engineer's signature.

1302.4 Typical Sections & Details

Typical sections represent the final cross sections of the roadbed and show the following items: lane, shoulder, and median widths; surfacing materials and thickness; roadbed slopes; profile grade locations; and curbs and walks. The limits of each typical section, including tapers, are indicated by stationing and shown below the typical section. Equations are shown in the typical sections only when the difference between the 'ahead' station and the 'back' station is greater than 50 feet. Differences in stations of an equation that are less than 50 feet do not affect the quantities enough to be considered significant. Typical sections normally begin on Sheet 2.

Special details for design features are prepared when required information is not available in the Oregon Standard Drawing. These details are located immediately after the typical sections.

1302.5 Traffic Control Plans

Specifics to the Traffic Control Plans can be found in the ODOT Traffic Control Manual and the CPDG. The Traffic Control Plans offer a method to direct traffic through the project site during construction. The plans also suggest a method for staging the project to protect work areas and keep traffic moving through the site. Typically the contractor will propose another method for temporary traffic control, but a temporary traffic control method must be provided by either plan sheets and specifications or specifications alone.

For additional information about Traffic Control Plans, consult the ODOT Traffic Control Plans Design Manual.

Section 1303 Erosion and Sediment Control Plans

The roadway designer gives a copy of the design files to the erosion control designer after all roadway profiles, are defined and creation of finished grade surfaces, establishing cut and fill limits, are completed. The information necessary for developing a base map for erosion control should include, but not be limited to, right of way and easements, all drainage features, cut and fill lines and expected slopes, and contour lines of existing ground.

Erosion and Sediment Control Plans are required for each stage of construction. Traffic Control Plans should be submitted to the erosion control designer so erosion control design can be prepared for each stage.

A complete set of plans, details, specifications, bid items, quantities and unit costs must be prepared for inclusion in the construction contract. A complete discussion on plan preparation for erosion and sediment control plans is included in Chapter 6 of the ODOT Erosion Control Manual.

1303.1 Material Source, Stockpile, and Disposal Site Plans

These sheets include a small scale map showing the location and layout of the sites with typical cross sections and other details necessary to delineate placement or removal of materials. Information required for developing these sheets is included with the field data. Site locations are indicated on the title sheet. If the site is mandatory, a letter of public interest must be prepared and approved for the mandatory site prior to submitting the final PS&E package. Lower costs and environmental considerations are generally good reasons to use a mandatory site.

1303.2 Pipe Data Sheet

A Pipe Data Sheet is required when more than a few runs of pipe are included in the project. Care should be taken to ensure information on the Pipe Data Sheet agrees with the Construction Plans. Alternate pipe materials are required by Federal Regulation on federally funded projects. To consider metal pipe as an alternate pipe material, the designer should request soil tests for pH and resistivity at specific locations early in the design process, if this information was not included in the field data. Pipe Data Sheets which include pipes and/or drainage structures that are also detailed on bridge drawings should be reviewed and initialed by the appropriate Bridge Designer.

1303.3 Plans, Construction Notes, and Profiles

♦ Plan Scales

Base plan sheets showing existing roadway, drainage, utilities, and other topography are prepared by the designer and drafter. The scale ratio shall be 1″ = 100′ horizontal and 1″ = 10′ vertical; or 1″ = 50′ horizontal and 1″ = 5′ vertical. On smaller projects in cities, 1″ = 20′ horizontal and 1″ = 2′ vertical scale may be used.

1303.4 Construction Notes

The construction note is listed on the plan sheet and generally includes both a contractor instruction and the quantity of material for that construction item. Using a unique number to identify each specific construction note, the same number is used indicating the location of the work in plan view. Notes are usually shown in the right margin of the corresponding plan sheet or on a separate sheet if space is not available. The construction note numbers are specific to each unique plan sheet.

Quantities of surfacing, earthwork, and watering materials will be rounded using this chart.

Calculated Quantity	Round UP to the nearest
0 - 99 units	Actual
100 – 999 units	10 units
1,000 – 9,999 units	100 units
10,000 – 99,999 units	500 units

100,000 units and over	1,000 units

Earthwork quantities should be rounded in the earthwork bracket distributions such that they meet the above chart and match the quantities in the estimate.

Pipe lengths are to be measured center of structure to center of structure along the slope, for each pipe length. Each length listed in the construction note is to be rounded up to the next whole foot.

Guardrail lengths are to be divisible by 12.5 ft.

Typically called out in the construction notes are removal of guardrail, fences, pipes, and other removal items that are not removed as a part of the work shown in the typical sections. Those items will include the quantity in the construction note. In the special provision under Removal of Structures and Obstructions, these items will be specifically listed noting that the quantities are shown on the plan sheets and are included in the bid item. Usually this is a lump sum bid item for the contractor.

The format of the construction notes is important. The standard format for the notes is listed in the ODOT CAD Manual. The format was developed over a number of years by ODOT staff and by working with the contracting community. As much as possible the standard note format is to be used. The format is tied to the Oregon Standard Specifications for Construction, with the standardization reducing construction disputes. For example fence quantity lengths used to be shown on each plan sheet until it resulted in multiple contractor disputes over the total bid item length and the itemized lengths in each construction note. Standard practice now is to not show the sheet by sheet length for fence but only the total quantity shown in the bid list. It might appear to be a simple change to the construction note format, in this example by adding fence length to the note on the sheet, but a “simple” note format change can result in a contract dispute during the construction phase. It is the drafter’s role to keep the format of the construction notes as close as possible to the standard format shown in the CPDG.

♦ Profiles

Profiles of the proposed alignments, when required by the project, will be shown on the same scale and normally on the bottom of the plan sheet. If no space remains on the plan sheet, profiles are shown on separate sheets.

The Profile Sheet shows existing ground lines, proposed vertical alignments and grades, proposed and pertinent existing sewer profiles with appropriate grades and elevations, earthwork brackets and other special information. Drainage and water quality information may be shown on separate profile sheets.

♦ Striping

The ODOT Traffic Line Manual details permanent striping. Striping plans will be included in the plan set when agreed to by the Project Team. Striping plans are developed by either the roadway designer with input from the Region Traffic Engineer or by the traffic designer.

♦ Wetland Mitigation

Working with the Region Environmental personnel, the designer normally prepares plans for wetland mitigation when required. These plans show locations of wetlands and methods of mitigation by use of sketch maps, typical cross sections, and special details.

♦ Roadside Development

The Environmental Unit in each Regional Technical Center is responsible for the plans, special provisions, and estimate for irrigation and landscaping needs along roadside and parking areas. See Part 1200, Section 1213 for more information about Roadside Development.

♦ Temporary Erosion Control

Erosion and Sediment Control Plans are required for both permanent and temporary soil disturbance (see Part 1200, Section 1214). Plans for erosion control for areas of soil disturbance in ODOT right of way and for required offsite material sources/stockpiles/disposal sites are prepared for the project by working with the Geo/Hydro staff in the Regional Technical Center. Those plans can be prepared by either the roadway design or the geo/hydro designer based on the project complexity and the specific Regional Technical Center. The plans show locations of temporary erosion control best management practices facilities by the use of details and any combination of separate plan sheets, additional information on roadway plan sheets, and/or table of locations.

♦ Standard and Informational Drawings

Oregon Standard Drawings called for within the contract plans and special provisions are listed on the index sheet of the title sheet. The Oregon Standard Drawings called out on the title sheet are inserted during final assembly of the contract plans for printing. Informational drawings are normally plans of existing facilities, usually structures, which are included to assist the contractor in the bidding, staging, and construction. They are stamped "Informational Only" and are listed on the title sheet as such.

♦ Other Plans

Bridge Engineering, Traffic Engineering and Geo/Environmental Engineering provides plans, special provisions, and estimate for structures, sound walls, traffic signals, permanent signing, striping, and illumination for inclusion in the contract. These plans are reviewed by the Roadway Designer for concurrence with the roadway plans. **The Bridge Designer initials all roadway plan sheets that reference structure work.** This is to assist with the coordination of the details between the roadway plans and the structures shown.

1303.5 Specifications

♦ General

Specifications are detailed and exact statements prescribing scope, materials, workmanship, acceptance criteria, and method of measurement and payment for something to be built, installed, or manufactured.

The sequence of events for a specifications writer to produce the Special Provisions and bid booklet for a project is contained in the ODOT Specifications Manual.

♦ Standard Specifications

The Oregon Standard Specifications for Construction is a document that is the base construction contract for public work projects. This document was developed with partners from Oregon APWA members to be used on state, county and city projects. This document encompasses all the standard specifications approved for use on ODOT projects by the ODOT Chief Engineer, FHWA, and the Oregon Department of Justice. Part 100 of the Standard Specifications covers the General Conditions. Part 00200 through Part 03000 contain the Technical Specifications and may require modifications specific to the unique project.

The construction of buildings is an element of work not covered in the “Oregon Standard Specifications for Construction.” Specifications from the Construction Specifications Institute (CSI) are used by the Facilities Management Section for the construction of buildings.

♦ Project Special Provisions

Every project has unique circumstances, so ODOT Specifications Unit provides the boilerplate special provisions (boilerplates), which are template documents for addressing project-specific circumstances. The project edits the applicable boilerplates documents to create the project special provisions. When unique project circumstances require edits not allowed by the instructions in the boilerplates, the project may make the additional edits, but must receive concurrence from the Technical Resource for the specification section and concurrence from the State Specifications Engineer for the entire special provisions document. All specification concurrences are required prior to PS&E.

♦ Guidelines, Procedures, and Required Forms

The procedures followed by each specification writer are delineated in the ODOT Specifications Manual.

Additional information and forms can be found on the Specifications web page at https://www.oregon.gov/odot/Business/Pages/Standard_Specifications.aspx.

1303.6 Final Estimate

♦ General

The programming estimate shows the designated funds set aside for the project. This estimate normally has an Engineering and Contingencies (E&C) value of 40%, and is the amount shown in the prospectus. It is usually the amount shown in the Statewide Transportation Improvement Program. This estimate is subject to refinement in the course of the project's preparation.

Additional estimates are prepared during project development and each one should become more detailed. It is important that each of these detailed estimates include all project items and costs. Items such as shoulder rock on preservation projects or quantities for aggregate sub-base, base, and asphalt at guardrail flares might seem insignificant but can have substantial impact to project estimates.

Estimates prepared during project development are considered confidential, and should be handled accordingly at all times especially if shared electronically.

♦ Anticipated Items

Anticipated Items are used to provide a funding mechanism only for non-biddable elements of work that may be needed to complete a project. Anticipated Items should be identified prior to completion of PS&E. The use of anticipated items is acceptable when there is a high likelihood that non-biddable costs will be incurred. Examples of common anticipated items include statistical asphalt bonus, asphalt smoothness bonus, railroad flagging, asphalt and/or fuel escalation, steel escalation, public information and relations, and migratory bird monitoring.

ODOT has received guidance from FHWA on this matter. FHWA believes that anticipated items should not be created for items of work that can be competitively bid. ODOT's and FHWA's policy discourages the use of Anticipated Items for unfinished, incomplete design work. Using anticipated items in this manner will result in ODOT negotiating with a contractor for the work and most probably, paying a higher price than had it bid competitively.

Requests for anticipated items must be approved in writing by the Area Manager and the OPL Manager for all anticipated items on all projects, including anticipated items added after PS&E and/or bid opening. FHWA must also approve anticipated items on full federal oversight projects.

1303.7 Project Submittal

The Project Controls Office formally receives the projects ready for bid letting. The information about the requirements for submittal can be found in the Phase Gate Delivery Manual. Other important information can be found on the Project Controls Office website https://www.oregon.gov/odot/Business/Pages/Project-Letting.aspx

Appendix A

Functional Classification

2010 OREGON STATE HIGHWAY SYSTEM

ALPHA-NUMERIC LISTING

HWY #	HIGHWAY NAME
453	ADRIAN-ARENA VALLEY
454	ADRIAN-CALDWELL
031	ALBANY-CORVALLIS
058	ALBANY-JUNCTION CITY
211	ALBANY-LYONS
027	ALSEA
201	ALSEA-DEADWOOD
155	AMITY-DAYTON
293	ANTELOPE
334	ATHENA-HOLDMAN
012	BAKER-COPPERFIELD
481	BAKER-COPPERFIELD SPUR
040	BEAVERTON-HILLSDALE
144	BEAVERTON-TIGARD
141	BEAVERTON-TUALATIN
153	BELLEVUE-HOPEWELL
069	BELTLINE
240	CAPE ARAGO
250	CAPE BLANCO
255	CARPENTERVILLE
068	CASCADE HWY NORTH
160	CASCADE HWY SOUTH
301	CELILO-WASCO
487	CELILO-WASCO SPUR
007	CENTRAL OREGON
372	CENTURY DRIVE

HWY #	HIGHWAY NAME
422	CHILOQUIN
488	CHILOQUIN SPUR
171	CLACKAMAS
174	CLACKAMAS-BORING
215	CLEAR LAKE-BELKNAP SPRINGS
002	COLUMBIA RIVER
035	COOS BAY-ROSEBURG
241	COOS RIVER
244	COQUILLE-BANDON
210	CORVALLIS-LEBANON
033	CORVALLIS-NEWPORT
342	COVE
022	CRATER LAKE
429	CRESCENT LAKE
014	CROOKED RIVER
361	CULVER
023	DAIRY-BONANZA
189	DALLAS-RICKREALL
415	DOOLEY MOUNTAIN
172	EAGLE CREEK-SANDY
064	EAST PORTLAND FREEWAY
180	EDDYVILLE-BLODGETT
231	ELKTON-SUTHERLIN
011	ENTERPRISE-LEWISTON
484	ESPLANADE SPUR
227	EUGENE-SPRINGFIELD

HWY #	HIGHWAY NAME
142	FARMINGTON
103	FISHHAWK FALLS
062	FLORENCE-EUGENE
104	FORT STEVENS
485	FORT STEVENS SPUR
339	FREEWATER
019	FREMONT
440	FRENCHGLEN
486	GOLD HILL SPUR
226	GOSHEN-DIVIDE
021	GREEN SPRINGS
413	HALFWAY-CORNUCOPIA
212	HALSEY-SWEET HOME
426	HATFIELD
335	HAVANA-HELIX
052	HEPPNER
321	HEPPNER-SPRAY
333	HERMISTON
140	HILLSBORO-SILVERTON
100	HISTORIC COLUMBIA RIVER
490	HOMEDALE SPUR
281	HOOD RIVER
449	HUNTINGTON
456	I.O.N.
193	INDEPENDENCE
272	JACKSONVILLE
164	JEFFERSON
005	JOHN DAY
048	JOHN DAY-BURNS
351	JOSEPH-WALLOWA LAKE
402	KIMBERLY-LONG CREEK
191	KINGS VALLEY

HWY #	HIGHWAY NAME
020	KLAMATH FALLS-LAKEVIEW
050	KLAMATH FALLS-MALIN
066	LA GRANDE-BAKER
154	LAFAYETTE
270	LAKE OF THE WOODS
049	LAKEVIEW-BURNS
320	LEXINGTON-ECHO
130	LITTLE NESTUCCA
350	LITTLE SHEEP CREEK
092	LOWER COLUMBIA RIVER (2W)
360	MADRAS-PRINEVILLE
229	MAPLETON-JUNCTION CITY
015	MCKENZIE
017	MCKENZIE-BEND
483	MCMINNVILLE SPUR
070	MCNARY
225	MCVAY
340	MEDICAL SPRINGS
420	MIDLAND
110	MIST-CLATSKANIE
194	MONMOUTH
043	MONMOUTH-INDEPENDENCE
292	MOSIER-THE DALLES
026	MT. HOOD
046	NECANICUM
102	NEHALEM
131	NETARTS
162	NORTH SANTIAM
138	NORTH UMPQUA
123	NORTHEAST PORTLAND
370	O NEIL
041	OCHOCO

HWY #	HIGHWAY NAME
282	ODELL
006	OLD OREGON TRAIL
455	OLDS FERRY-ONTARIO
493	ONTARIO SPUR
038	OREGON CAVES
009	OREGON COAST
008	OREGON-WASHINGTON
003	OSWEGO
001	PACIFIC
081	PACIFIC HIGHWAY EAST (1E)
091	PACIFIC HIGHWAY WEST (1W)
489	PARMA SPUR
380	PAULINA
492	PAYETTE SPUR
067	PENDLETON
036	PENDLETON-COLD SPRINGS
028	PENDLETON-JOHN DAY
414	PINE CREEK
251	PORT ORFORD
242	POWERS
480	REDMOND SPUR
025	REDWOOD
482	REDWOOD SPUR
060	ROGUE RIVER
260	ROGUE RIVER LOOP
063	ROGUE VALLEY
072	SALEM
150	SALEM-DAYTON
039	SALMON RIVER
271	SAMS VALLEY
016	SANTIAM
143	SCHOLLS

HWY #	HIGHWAY NAME
390	SERVICE CREEK-MITCHELL
291	SHANIKO-FOSSIL
290	SHERARS BRIDGE
042	SHERMAN
181	SILETZ
163	SILVER CREEK FALLS
273	SISKIYOU
424	SOUTH KLAMATH FALLS
228	SPRINGFIELD
222	SPRINGFIELD-CRESWELL
061	STADIUM FREEWAY
442	STEENS
450	SUCCOR CREEK
410	SUMPTER
332	SUNNYSIDE-UMAPINE
047	SUNSET
120	SWIFT
200	TERRITORIAL
004	THE DALLES-CALIFORNIA
032	THREE RIVERS
230	TILLER-TRAIL
173	TIMBERLINE
029	TUALATIN VALLEY
341	UKIAH-HILGARD
331	UMATILLA MISSION
054	UMATILLA-STANFIELD
045	UMPQUA
451	VALE-WEST
010	WALLOWA LAKE
044	WAPINITIA
053	WARM SPRINGS
431	WARNER

HWY #	HIGHWAY NAME
105	WARRENTON-ASTORIA
300	WASCO-HEPPNER
491	WEISER SPUR
233	WEST DIAMOND LAKE
330	WESTON-ELGIN
071	WHITNEY
018	WILLAMETTE
030	WILLAMINA-SALEM
157	WILLAMINA-SHERIDAN
037	WILSON RIVER
051	WILSONVILLE-HUBBARD
161	WOODBURN-ESTACADA
151	YAMHILL-NEWBERG

1

FUNCTIONAL CLASSIFICATION OF STATE ROUTES

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
1	PACIFIC	0.00	13.12	Yes	01-Rural Principal Arterial-Interstate
1		13.12	35.62	Yes	11-Urban Principal Arterial-Interstate
1		35.62	55.46	Yes	01-Rural Principal Arterial-Interstate
1		55.46	59.35	Yes	11-Urban Principal Arterial-Interstate
1		59.35	117.73	Yes	01-Rural Principal Arterial-Interstate
1		117.73	120.60	Yes	11-Urban Principal Arterial-Interstate
1		120.60	121.16	Yes	01-Rural Principal Arterial-Interstate
1		121.16	131.48	Yes	11-Urban Principal Arterial-Interstate
1		131.48	134.72	Yes	01-Rural Principal Arterial-Interstate
1		134.72	137.15	Yes	11-Urban Principal Arterial-Interstate
1		137.15	172.75	Yes	01-Rural Principal Arterial-Interstate
1		172.75	175.40	Yes	11-Urban Principal Arterial-Interstate
1		175.40	188.01	Yes	01-Rural Principal Arterial-Interstate
1		188.01	200.17	Yes	11-Urban Principal Arterial-Interstate
1		200.17	230.10	Yes	01-Rural Principal Arterial-Interstate
1		230.10	235.08	Yes	11-Urban Principal Arterial-Interstate
1		235.08	248.62	Yes	01-Rural Principal Arterial-Interstate
1		248.62	262.40	Yes	11-Urban Principal Arterial-Interstate
1		262.40	270.79	Yes	01-Rural Principal Arterial-Interstate
1		270.79	273.06	Yes	11-Urban Principal Arterial-Interstate
1		273.06	282.56	Yes	01-Rural Principal Arterial-Interstate
1		282.56	308.38	Yes	11-Urban Principal Arterial-Interstate
2	COLUMBIA RIVER	0.00	17.78	Yes	11-Urban Principal Arterial-Interstate
2		17.78	61.13	Yes	01-Rural Principal Arterial-Interstate

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
2		61.13	64.70	Yes	11-Urban Principal Arterial-Interstate
2		64.70	81.39	Yes	01-Rural Principal Arterial-Interstate
2		81.39	87.79	Yes	11-Urban Principal Arterial-Interstate
2		87.79	167.58	Yes	01-Rural Principal Arterial-Interstate
2		167.58	184.08	No	02-Rural Principal Arterial-Other
2		184.08	184.87	Yes	02-Rural Principal Arterial-Other
2		184.87	203.28	No	06-Rural Minor Arterial
3	OSWEGO	0.00	2.64	No	14-Urban Principal Arterial-Other
3		2.64	6.13	No	16-Urban Minor Arterial
3		6.13	11.29	Yes	14-Urban Principal Arterial-Other
3		11.29	11.66	No	16-Urban Minor Arterial
4	THE DALLES-CALIFORNIA	118.96	119.14	Yes	14-Urban Principal Arterial-Other
4		0.00	0.96	No	14-Urban Principal Arterial-Other
4		0.96	1.27	No	14-Urban Principal Arterial-Other
4		1.27	67.17	No	06-Rural Minor Arterial
4		67.17	91.15	Yes	02-Rural Principal Arterial-Other
4		91.15	96.92	Yes	14-Urban Principal Arterial-Other
4		96.92	119.02	Yes	02-Rural Principal Arterial-Other
4		119.02	124.41	Yes	14-Urban Principal Arterial-Other
4		124.41	132.19	Yes	02-Rural Principal Arterial-Other
4		132.19	134.93	Yes	14-Urban Principal Arterial-Other
4		134.93	140.87	No	14-Urban Principal Arterial-Other
4		140.87	143.47	Yes	14-Urban Principal Arterial-Other
4		143.47	162.67	Yes	02-Rural Principal Arterial-Other
4		162.67	168.50	Yes	14-Urban Principal Arterial-Other
4		168.50	271.27	Yes	02-Rural Principal Arterial-Other
4		271.27	279.32	Yes	14-Urban Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
4		279.32	291.73	Yes	02-Rural Principal Arterial-Other
5	JOHN DAY	0.97	1.13	No	06-Rural Minor Arterial
5		0.00	1.13	No	06-Rural Minor Arterial
5		1.13	124.17	No	06-Rural Minor Arterial
5		124.17	278.21	Yes	02-Rural Principal Arterial-Other
6	OLD OREGON TRAIL	167.58	206.68	Yes	01-Rural Principal Arterial-Interstate
6		206.68	211.57	Yes	11-Urban Principal Arterial-Interstate
6		211.57	259.41	Yes	01-Rural Principal Arterial-Interstate
6		259.41	263.02	Yes	11-Urban Principal Arterial-Interstate
6		263.02	302.71	Yes	01-Rural Principal Arterial-Interstate
6		302.71	306.33	Yes	11-Urban Principal Arterial-Interstate
6		306.33	374.39	Yes	01-Rural Principal Arterial-Interstate
6		374.39	378.01	Yes	11-Urban Principal Arterial-Interstate
7	CENTRAL OREGON	0.51	3.58	Yes	14-Urban Principal Arterial-Other
7		3.58	258.20	Yes	02-Rural Principal Arterial-Other
7		258.20	266.82	No	06-Rural Minor Arterial
8	OREGON-WASHINGTON	-1.77	0.99	Yes	14-Urban Principal Arterial-Other
8		0.99	24.98	Yes	02-Rural Principal Arterial-Other
8		24.98	32.77	Yes	14-Urban Principal Arterial-Other
8		32.77	35.32	Yes	02-Rural Principal Arterial-Other
9	OREGON COAST	45.31	49.51	Yes	02-Rural Principal Arterial-Other
9		0.00	2.93	Yes	02-Rural Principal Arterial-Other
9		2.93	4.99	Yes	14-Urban Principal Arterial-Other
9		4.99	19.31	Yes	02-Rural Principal Arterial-Other
9		19.31	22.76	Yes	14-Urban Principal Arterial-Other
9		22.76	23.16	Yes	02-Rural Principal Arterial-Other
9		23.16	23.34	Yes	14-Urban Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
9		23.34	24.15	Yes	02-Rural Principal Arterial-Other
9		24.15	24.59	Yes	14-Urban Principal Arterial-Other
9		24.59	49.57	Yes	02-Rural Principal Arterial-Other
9		49.57	105.45	Yes	02-Rural Principal Arterial-Other
9		105.45	118.70	Yes	14-Urban Principal Arterial-Other
9		118.70	136.25	Yes	02-Rural Principal Arterial-Other
9		136.25	146.50	Yes	14-Urban Principal Arterial-Other
9		146.50	187.11	Yes	02-Rural Principal Arterial-Other
9		187.11	191.02	Yes	14-Urban Principal Arterial-Other
9		191.02	234.01	Yes	02-Rural Principal Arterial-Other
9		234.01	239.63	Yes	14-Urban Principal Arterial-Other
9		239.63	354.64	Yes	02-Rural Principal Arterial-Other
9		354.64	357.99	Yes	14-Urban Principal Arterial-Other
9		357.99	363.11	Yes	02-Rural Principal Arterial-Other
10	WALLOWA LAKE	0.00	1.61	No	14-Urban Principal Arterial-Other
10		1.61	71.42	No	02-Rural Principal Arterial-Other
11	ENTERPRISE-LEWISTON	0.00	43.19	No	06-Rural Minor Arterial
12	BAKER-COPPERFIELD	2.52	2.77	No	07-Rural Major Collector
12		0.00	1.57	No	14-Urban Principal Arterial-Other
12		2.43	2.77	No	16-Urban Minor Arterial
12		2.77	70.80	No	07-Rural Major Collector
14	CROOKED RIVER	25.04	27.39	No	07-Rural Major Collector
14		1.90	27.39	No	07-Rural Major Collector
14		27.39	42.51	No	07-Rural Major Collector
15	MCKENZIE	-0.06	10.33	Yes	14-Urban Principal Arterial-Other
15		10.33	55.46	Yes	02-Rural Principal Arterial-Other
15		55.46	92.05	No	07-Rural Major Collector

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
15		91.85	92.03	No	07-Rural Major Collector
15		92.03	92.05	No	02-Rural Principal Arterial-Other
15		92.05	110.14	Yes	02-Rural Principal Arterial-Other
15		110.14	112.03	Yes	14-Urban Principal Arterial-Other
16	SANTIAM	-0.03	2.88	No	14-Urban Principal Arterial-Other
16		2.88	11.69	No	06-Rural Minor Arterial
16		11.69	12.23	No	02-Rural Principal Arterial-Other
16		12.23	16.45	No	14-Urban Principal Arterial-Other
16		16.45	26.60	No	02-Rural Principal Arterial-Other
16		26.60	31.32	No	14-Urban Principal Arterial-Other
16		31.32	71.52	No	02-Rural Principal Arterial-Other
16		71.52	100.12	Yes	02-Rural Principal Arterial-Other
17	MCKENZIE-BEND	0.00	17.48	Yes	02-Rural Principal Arterial-Other
17		17.48	20.99	Yes	14-Urban Principal Arterial-Other
18	WILLAMETTE	-0.30	1.25	Yes	14-Urban Principal Arterial-Other
18		1.25	86.45	Yes	02-Rural Principal Arterial-Other
19	FREMONT	0.00	120.57	No	06-Rural Minor Arterial
19		120.57	157.73	Yes	02-Rural Principal Arterial-Other
20	KLAMATH FALLS-LAKEVIEW	-0.14	0.19	No	14-Urban Principal Arterial-Other
20		2.50	3.28	No	16-Urban Minor Arterial
20		3.28	7.20	Yes	14-Urban Principal Arterial-Other
20		7.20	96.37	Yes	02-Rural Principal Arterial-Other
21	GREEN SPRINGS	13.00	13.66	No	06-Rural Minor Arterial
21		0.73	2.50	No	14-Urban Principal Arterial-Other
21		2.50	13.66	No	06-Rural Minor Arterial
21		13.66	57.48	No	06-Rural Minor Arterial
21		57.48	57.93	No	16-Urban Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
21		57.93	58.86	No	14-Urban Principal Arterial-Other
21		58.86	59.05	Yes	14-Urban Principal Arterial-Other
22	CRATER LAKE	29.16	29.18	No	06-Rural Minor Arterial
22		0.05	0.41	No	14-Urban Principal Arterial-Other
22		0.41	6.03	Yes	14-Urban Principal Arterial-Other
22		6.03	11.22	No	16-Urban Minor Arterial
22		11.22	29.18	No	06-Rural Minor Arterial
22		29.18	57.22	No	06-Rural Minor Arterial
22		57.22	103.95	No	07-Rural Major Collector
23	DAIRY-BONANZA	0.00	6.97	No	07-Rural Major Collector
25	REDWOOD	-2.74	3.59	Yes	14-Urban Principal Arterial-Other
25		3.59	41.69	Yes	02-Rural Principal Arterial-Other
26	MT. HOOD	14.22	17.57	Yes	14-Urban Principal Arterial-Other
26		-0.10	0.35	No	16-Urban Minor Arterial
26		0.35	9.96	No	14-Urban Principal Arterial-Other
26		17.57	22.49	Yes	02-Rural Principal Arterial-Other
26		22.49	26.29	Yes	14-Urban Principal Arterial-Other
26		26.29	101.82	Yes	02-Rural Principal Arterial-Other
27	ALSEA	0.00	58.00	No	06-Rural Minor Arterial
27		58.00	58.56	No	16-Urban Minor Arterial
28	PENDLETON-JOHN DAY	0.05	1.70	No	14-Urban Principal Arterial-Other
28		1.70	3.28	Yes	14-Urban Principal Arterial-Other
28		3.28	120.51	Yes	02-Rural Principal Arterial-Other
29	TUALATIN VALLEY	0.05	2.85	No	14-Urban Principal Arterial-Other
29		2.85	17.88	Yes	14-Urban Principal Arterial-Other
29		17.88	19.96	No	14-Urban Principal Arterial-Other
29		19.96	21.85	No	16-Urban Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
29		21.85	42.46	No	06-Rural Minor Arterial
30	WILLAMINA-SALEM	0.00	21.19	Yes	02-Rural Principal Arterial-Other
30		21.19	26.14	Yes	12-Urban Principal Arterial-Other Fwy or Exp
31	ALBANY-CORVALLIS	0.10	2.92	No	14-Urban Principal Arterial-Other
31		2.92	3.77	No	16-Urban Minor Arterial
31		3.77	8.43	No	06-Rural Minor Arterial
31		8.43	11.28	No	14-Urban Principal Arterial-Other
32	THREE RIVERS	0.00	24.97	No	06-Rural Minor Arterial
33	CORVALLIS-NEWPORT	42.07	42.18	Yes	02-Rural Principal Arterial-Other
33		50.72	50.79	Yes	14-Urban Principal Arterial-Other
33		0.00	1.84	Yes	14-Urban Principal Arterial-Other
33		1.84	42.18	Yes	02-Rural Principal Arterial-Other
33		42.18	49.72	Yes	02-Rural Principal Arterial-Other
33		49.72	50.79	Yes	14-Urban Principal Arterial-Other
33		50.79	56.14	Yes	14-Urban Principal Arterial-Other
33		56.14	56.80	Yes	02-Rural Principal Arterial-Other
35	COOS BAY-ROSEBURG	69.36	69.37	Yes	02-Rural Principal Arterial-Other
35		0.00	69.37	Yes	02-Rural Principal Arterial-Other
35		69.37	74.46	Yes	02-Rural Principal Arterial-Other
35		74.46	77.20	Yes	14-Urban Principal Arterial-Other
36	PENDLETON-COLD SPRINGS	0.00	0.74	No	09-Rural Local
36		0.74	30.03	No	07-Rural Major Collector
36		30.03	30.75	No	16-Urban Minor Arterial
37	WILSON RIVER	0.00	51.62	No	06-Rural Minor Arterial
38	OREGON CAVES	0.00	1.33	No	06-Rural Minor Arterial
38		1.33	19.33	No	07-Rural Major Collector
39	SALMON RIVER	-0.22	43.51	Yes	02-Rural Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
39		43.51	48.54	Yes	14-Urban Principal Arterial-Other
39		48.54	52.71	Yes	02-Rural Principal Arterial-Other
40	BEAVERTON-HILLSDALE	0.97	3.41	No	14-Urban Principal Arterial-Other
41	OCHOCO	0.22	2.32	Yes	14-Urban Principal Arterial-Other
41		2.32	14.79	Yes	02-Rural Principal Arterial-Other
41		14.79	20.74	Yes	14-Urban Principal Arterial-Other
41		20.74	98.36	Yes	02-Rural Principal Arterial-Other
42	SHERMAN	-0.43	68.66	Yes	02-Rural Principal Arterial-Other
43	MONMOUTH-INDEPENDENCE	0.00	2.35	No	14-Urban Principal Arterial-Other
44	WAPINITIA	0.18	26.03	No	07-Rural Major Collector
45	UMPQUA	0.00	57.13	Yes	02-Rural Principal Arterial-Other
46	NECANICUM	0.04	19.03	No	07-Rural Major Collector
47	SUNSET	-0.10	61.04	Yes	02-Rural Principal Arterial-Other
47		61.04	73.75	Yes	12-Urban Principal Arterial-Other Fwy or Exp
47		73.75	73.97	No	16-Urban Minor Arterial
48	JOHN DAY-BURNS	0.00	67.61	Yes	02-Rural Principal Arterial-Other
49	LAKEVIEW-BURNS	0.01	90.02	Yes	02-Rural Principal Arterial-Other
50	KLAMATH FALLS-MALIN	-6.87	-2.24	Yes	14-Urban Principal Arterial-Other
50		0.00	2.15	Yes	14-Urban Principal Arterial-Other
50		2.15	16.51	Yes	02-Rural Principal Arterial-Other
50		16.51	27.10	No	07-Rural Major Collector
51	WILSONVILLE-HUBBARD	-0.31	-0.23	No	16-Urban Minor Arterial
51		-0.23	5.63	No	06-Rural Minor Arterial
52	HEPPNER	0.00	83.15	No	06-Rural Minor Arterial
53	WARM SPRINGS	57.45	115.11	Yes	02-Rural Principal Arterial-Other
53		115.11	117.71	Yes	14-Urban Principal Arterial-Other
54	UMATILLA-STANFIELD	0.04	3.78	Yes	02-Rural Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
54		3.78	8.45	Yes	14-Urban Principal Arterial-Other
54		8.45	12.90	Yes	02-Rural Principal Arterial-Other
58	ALBANY-JUNCTION CITY	0.00	6.30	No	14-Urban Principal Arterial-Other
58		6.30	32.37	No	06-Rural Minor Arterial
60	ROGUE RIVER	0.00	2.09	No	14-Urban Principal Arterial-Other
60		2.09	14.95	No	06-Rural Minor Arterial
61	STADIUM FREEWAY	-0.04	4.21	Yes	11-Urban Principal Arterial-Interstate
62	FLORENCE-EUGENE	47.27	47.46	Yes	02-Rural Principal Arterial-Other
62		0.02	0.74	Yes	14-Urban Principal Arterial-Other
62		0.74	47.46	Yes	02-Rural Principal Arterial-Other
62		47.46	52.69	Yes	02-Rural Principal Arterial-Other
63	ROGUE VALLEY	0.00	1.64	No	14-Urban Principal Arterial-Other
63		3.60	5.48	No	14-Urban Principal Arterial-Other
63		8.13	19.46	No	14-Urban Principal Arterial-Other
63		20.84	22.52	No	14-Urban Principal Arterial-Other
63		22.52	24.12	No	06-Rural Minor Arterial
64	EAST PORTLAND FREEWAY	0.00	2.13	Yes	11-Urban Principal Arterial-Interstate
64		2.13	5.11	Yes	01-Rural Principal Arterial-Interstate
64		5.11	26.56	Yes	11-Urban Principal Arterial-Interstate
66	LA GRANDE-BAKER	-0.08	0.19	No	02-Rural Principal Arterial-Other
66		0.19	4.43	No	14-Urban Principal Arterial-Other
66		4.43	16.51	No	06-Rural Minor Arterial
66		16.51	49.27	No	07-Rural Major Collector
66		49.27	51.79	No	16-Urban Minor Arterial
66		51.79	53.91	No	14-Urban Principal Arterial-Other
66		53.91	54.46	No	06-Rural Minor Arterial
67	PENDLETON	-0.03	3.92	No	14-Urban Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
67		4.62	5.03	No	14-Urban Principal Arterial-Other
67		5.03	6.60	No	06-Rural Minor Arterial
68	CASCADE HWY NORTH	0.00	10.18	No	14-Urban Principal Arterial-Other
69	BELTLINE	0.00	1.26	Yes	02-Rural Principal Arterial-Other
69		1.26	4.24	Yes	14-Urban Principal Arterial-Other
69		4.24	12.79	Yes	12-Urban Principal Arterial-Other Fwy or Exp
69		12.79	13.00	No	12-Urban Principal Arterial-Other Fwy or Exp
70	MCNARY	0.00	11.21	Yes	01-Rural Principal Arterial-Interstate
71	WHITNEY	0.00	49.17	No	06-Rural Minor Arterial
71		49.17	50.96	No	14-Urban Principal Arterial-Other
72	SALEM	0.00	3.34	No	12-Urban Principal Arterial-Other Fwy or Exp
72		3.34	5.19	No	14-Urban Principal Arterial-Other
72		5.19	7.92	Yes	14-Urban Principal Arterial-Other
72		7.92	8.48	Yes	12-Urban Principal Arterial-Other Fwy or Exp
81	PACIFIC HIGHWAY EAST (1E)	-6.09	-3.75	Yes	14-Urban Principal Arterial-Other
81		1.00	5.46	Yes	14-Urban Principal Arterial-Other
81		5.46	15.01	No	14-Urban Principal Arterial-Other
81		15.01	19.26	No	06-Rural Minor Arterial
81		19.26	22.05	No	14-Urban Principal Arterial-Other
81		22.05	30.87	No	06-Rural Minor Arterial
81		30.87	33.62	No	14-Urban Principal Arterial-Other
81		33.62	42.21	No	06-Rural Minor Arterial
81		42.21	46.49	No	14-Urban Principal Arterial-Other
91	PACIFIC HIGHWAY WEST (1W)	24.49	24.58	Yes	02-Rural Principal Arterial-Other
91		39.01	39.05	No	14-Urban Principal Arterial-Other
91		77.90	77.94	No	14-Urban Principal Arterial-Other
91		108.89	108.92	No	06-Rural Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
91		-5.76	-4.75	No	16-Urban Minor Arterial
91		-0.44	-0.06	No	16-Urban Minor Arterial
91		1.24	1.67	No	16-Urban Minor Arterial
91		1.67	7.56	No	14-Urban Principal Arterial-Other
91		7.56	19.00	Yes	14-Urban Principal Arterial-Other
91		19.00	19.88	Yes	14-Urban Principal Arterial-Other
91		19.88	21.35	Yes	02-Rural Principal Arterial-Other
91		21.35	24.31	Yes	14-Urban Principal Arterial-Other
91		24.31	24.58	Yes	02-Rural Principal Arterial-Other
91		24.58	29.79	Yes	02-Rural Principal Arterial-Other
91		29.79	35.01	No	06-Rural Minor Arterial
91		35.01	39.05	No	14-Urban Principal Arterial-Other
91		39.05	39.34	No	14-Urban Principal Arterial-Other
91		39.34	62.32	No	06-Rural Minor Arterial
91		62.32	64.09	No	14-Urban Principal Arterial-Other
91		64.09	74.99	No	06-Rural Minor Arterial
91		74.99	77.94	No	14-Urban Principal Arterial-Other
91		77.94	86.50	No	14-Urban Principal Arterial-Other
91		86.50	87.71	No	14-Urban Principal Arterial-Other
91		87.71	108.92	No	06-Rural Minor Arterial
91		108.92	115.04	No	06-Rural Minor Arterial
91		115.04	115.84	No	14-Urban Principal Arterial-Other
91		115.84	117.04	No	14-Urban Principal Arterial-Other
91		117.04	123.37	Yes	14-Urban Principal Arterial-Other
91		125.48	126.37	Yes	14-Urban Principal Arterial-Other
92	LOWER COLUMBIA RIVER (2W)	0.95	1.97	Yes	12-Urban Principal Arterial-Other Fwy or Exp
92		1.97	9.98	Yes	14-Urban Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
92		9.98	26.11	Yes	02-Rural Principal Arterial-Other
92		26.11	29.65	Yes	14-Urban Principal Arterial-Other
92		29.65	45.88	Yes	02-Rural Principal Arterial-Other
92		45.88	49.87	Yes	14-Urban Principal Arterial-Other
92		49.87	94.63	Yes	02-Rural Principal Arterial-Other
92		94.63	99.34	Yes	14-Urban Principal Arterial-Other
100	HISTORIC COLUMBIA RIVER	0.00	1.14	No	16-Urban Minor Arterial
100		1.14	4.42	No	17-Urban Collector
100		4.42	22.25	No	07-Rural Major Collector
100		30.00	31.28	No	06-Rural Minor Arterial
100		31.28	34.49	No	07-Rural Major Collector
100		48.68	51.07	No	16-Urban Minor Arterial
100		51.07	51.26	No	06-Rural Minor Arterial
100		51.26	51.98	N	08-Rural Minor Collector
100		51.98	52.48	No	09-Rural Local
100		52.48	56.91	No	09-Rural Local
100		56.91	57.53	No	08-Rural Minor Collector
100		57.53	58.28	No	07-Rural Major Collector
100		58.28	66.16	No	08-Rural Minor Collector
100		66.16	72.11	No	07-Rural Major Collector
100		72.11	72.37	No	17-Urban Collector
102	NEHALEM	0.18	2.64	No	14-Urban Principal Arterial-Other
102		2.64	2.82	No	17-Urban Collector
102		2.82	53.19	No	07-Rural Major Collector
102		53.19	57.11	No	06-Rural Minor Arterial
102		57.11	76.96	No	07-Rural Major Collector
102		80.83	88.62	Yes	02-Rural Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
102		88.62	90.64	Yes	14-Urban Principal Arterial-Other
103	FISHHAWK FALLS	0.00	9.02	No	07-Rural Major Collector
104	FORT STEVENS	0.00	6.03	No	07-Rural Major Collector
105	WARRENTON-ASTORIA	0.00	6.85	No	07-Rural Major Collector
105		6.85	7.25	No	16-Urban Minor Arterial
110	MIST-CLATSKANIE	0.00	11.89	No	07-Rural Major Collector
120	SWIFT	0.35	0.41	Yes	16-Urban Minor Arterial
120		2.49	2.71	Yes	16-Urban Minor Arterial
123	NORTHEAST PORTLAND	0.00	1.31	Yes	16-Urban Minor Arterial
123		1.31	6.15	No	16-Urban Minor Arterial
123		6.15	10.88	No	14-Urban Principal Arterial-Other
123		10.88	11.25	Yes	14-Urban Principal Arterial-Other
123		11.25	14.76	No	14-Urban Principal Arterial-Other
130	LITTLE NESTUCCA	-0.10	9.30	No	07-Rural Major Collector
131	NETARTS	0.00	9.08	No	07-Rural Major Collector
138	NORTH UMPQUA	-1.13	3.84	No	14-Urban Principal Arterial-Other
138		3.84	100.82	No	06-Rural Minor Arterial
140	HILLSBORO-SILVERTON	20.65	20.73	No	14-Urban Principal Arterial-Other
140		39.31	39.66	No	14-Urban Principal Arterial-Other
140		39.66	40.46	No	06-Rural Minor Arterial
140		0.00	0.64	No	16-Urban Minor Arterial
140		0.64	17.93	No	06-Rural Minor Arterial
140		17.93	20.73	No	14-Urban Principal Arterial-Other
140		20.73	22.19	No	14-Urban Principal Arterial-Other
140		22.19	25.01	No	02-Rural Principal Arterial-Other
140		25.01	36.20	No	06-Rural Minor Arterial
140		36.20	39.29	No	14-Urban Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
140		40.46	49.05	No	06-Rural Minor Arterial
140		49.05	50.72	No	14-Urban Principal Arterial-Other
141	BEAVERTON-TUALATIN	2.57	7.07	No	16-Urban Minor Arterial
141		7.69	8.91	No	16-Urban Minor Arterial
141		11.52	13.14	No	16-Urban Minor Arterial
142	FARMINGTON	5.88	7.38	No	14-Urban Principal Arterial-Other
143	SCHOLLS	9.03	9.13	No	14-Urban Principal Arterial-Other
143		9.13	9.60	No	16-Urban Minor Arterial
144	BEAVERTON-TIGARD	0.00	7.52	Yes	12-Urban Principal Arterial-Other Fwy or Exp
150	SALEM-DAYTON	0.00	17.55	No	06-Rural Minor Arterial
150		17.55	20.78	No	14-Urban Principal Arterial-Other
151	YAMHILL-NEWBERG	0.00	10.94	No	06-Rural Minor Arterial
151		10.94	11.50	No	14-Urban Principal Arterial-Other
153	BELLEVUE-HOPEWELL	0.00	6.23	No	07-Rural Major Collector
153		6.30	14.36	No	07-Rural Major Collector
154	LAFAYETTE	0.00	6.26	No	07-Rural Major Collector
155	AMITY-DAYTON	0.00	9.19	No	07-Rural Major Collector
157	WILLAMINA-SHERIDAN	0.00	8.60	No	07-Rural Major Collector
160	CASCADE HWY SOUTH	3.69	4.00	No	14-Urban Principal Arterial-Other
160		0.00	4.00	No	14-Urban Principal Arterial-Other
160		4.00	5.73	No	14-Urban Principal Arterial-Other
160		5.73	6.75	No	16-Urban Minor Arterial
160		6.75	15.34	No	06-Rural Minor Arterial
160		15.34	16.52	No	16-Urban Minor Arterial
160		16.52	28.54	No	06-Rural Minor Arterial
160		28.54	29.71	No	14-Urban Principal Arterial-Other
161	WOODBURN-ESTACADA	18.24	18.25	No	06-Rural Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
161		0.00	0.43	No	14-Urban Principal Arterial-Other
161		0.43	11.10	No	06-Rural Minor Arterial
161		11.10	13.81	No	16-Urban Minor Arterial
161		13.81	18.25	No	06-Rural Minor Arterial
161		18.25	33.49	No	06-Rural Minor Arterial
162	NORTH SANTIAM	1.17	4.06	Yes	12-Urban Principal Arterial-Other Fwy or Exp
162		4.06	81.81	Yes	02-Rural Principal Arterial-Other
163	SILVER CREEK FALLS	8.78	39.11	No	07-Rural Major Collector
163		39.11	40.84	No	16-Urban Minor Arterial
164	JEFFERSON	0.00	8.54	No	06-Rural Minor Arterial
171	CLACKAMAS	3.82	3.96	Yes	12-Urban Principal Arterial-Other Fwy or Exp
171		4.89	5.18	Yes	14-Urban Principal Arterial-Other
171		-0.01	0.09	No	12-Urban Principal Arterial-Other Fwy or Exp
171		0.09	3.96	Yes	12-Urban Principal Arterial-Other Fwy or Exp
171		3.96	4.36	Yes	12-Urban Principal Arterial-Other Fwy or Exp
171		4.91	5.18	Yes	14-Urban Principal Arterial-Other
171		5.18	8.15	Yes	14-Urban Principal Arterial-Other
171		8.15	9.30	No	14-Urban Principal Arterial-Other
171		9.30	10.52	No	16-Urban Minor Arterial
171		10.52	13.63	No	06-Rural Minor Arterial
171		13.63	13.89	No	16-Urban Minor Arterial
171		13.89	23.36	No	06-Rural Minor Arterial
171		23.36	49.97	No	07-Rural Major Collector
172	EAGLE CREEK-SANDY	-0.23	4.77	No	06-Rural Minor Arterial
172		4.77	5.94	No	16-Urban Minor Arterial
173	TIMBERLINE	0.12	5.49	No	07-Rural Major Collector
174	CLACKAMAS-BORING	0.03	5.55	Yes	14-Urban Principal Arterial-Other

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
174		5.55	6.80	Yes	02-Rural Principal Arterial-Other
174		6.80	7.08	Yes	14-Urban Principal Arterial-Other
174		7.08	8.87	Yes	02-Rural Principal Arterial-Other
180	EDDYVILLE-BLODGETT	0.00	19.18	No	07-Rural Major Collector
181	SILETZ	-0.21	31.24	No	07-Rural Major Collector
182	OTTER ROCK	0.00	0.75	No	07-Rural Major Collector
189	DALLAS-RICKREALL	0.00	2.04	No	14-Urban Principal Arterial-Other
189		2.04	4.32	No	06-Rural Minor Arterial
191	KINGS VALLEY	0.00	1.79	No	06-Rural Minor Arterial
191		1.79	4.85	No	14-Urban Principal Arterial-Other
191		4.85	31.40	No	06-Rural Minor Arterial
193	INDEPENDENCE	0.00	4.86	No	06-Rural Minor Arterial
193		4.86	6.34	No	14-Urban Principal Arterial-Other
194	MONMOUTH	0.00	6.23	No	06-Rural Minor Arterial
194		6.23	7.56	No	14-Urban Principal Arterial-Other
200	TERRITORIAL	-0.03	8.62	No	06-Rural Minor Arterial
200		10.08	20.68	No	06-Rural Minor Arterial
200		20.68	42.08	No	07-Rural Major Collector
201	ALSEA-DEADWOOD	0.00	0.95	No	07-Rural Major Collector
201		0.95	9.49	No	08-Rural Minor Collector
210	CORVALLIS-LEBANON	-0.10	0.13	No	14-Urban Principal Arterial-Other
210		0.13	0.34	No	02-Rural Principal Arterial-Other
210		0.34	10.12	Yes	02-Rural Principal Arterial-Other
210		10.12	16.67	No	02-Rural Principal Arterial-Other
210		16.67	18.13	No	14-Urban Principal Arterial-Other
211	ALBANY-LYONS	0.00	25.71	No	06-Rural Minor Arterial
212	HALSEY-SWEET HOME	0.00	20.58	No	06-Rural Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
212		20.58	21.40	No	14-Urban Principal Arterial-Other
215	CLEAR LAKE-BELKNAP SPRINGS	0.00	19.81	Yes	02-Rural Principal Arterial-Other
222	SPRINGFIELD-CRESWELL	0.35	3.87	No	16-Urban Minor Arterial
222		8.00	11.63	No	06-Rural Minor Arterial
222		5.11	8.00	No	06-Rural Minor Arterial
222		11.63	14.88	No	06-Rural Minor Arterial
225	MCVAY	0.01	2.53	No	16-Urban Minor Arterial
226	GOSHEN-DIVIDE	0.02	0.67	No	17-Urban Collector
226		0.67	13.75	No	07-Rural Major Collector
226		13.75	14.10	No	14-Urban Principal Arterial-Other
226		14.10	16.17	No	14-Urban Principal Arterial-Other
226		16.17	19.92	No	07-Rural Major Collector
227	EUGENE-SPRINGFIELD	0.00	3.49	Yes	11-Urban Principal Arterial-Interstate
227		3.49	9.97	Yes	12-Urban Principal Arterial-Other Fwy or Exp
228	SPRINGFIELD	0.00	1.40	No	16-Urban Minor Arterial
229	MAPLETON-JUNCTION CITY	0.01	45.97	No	07-Rural Major Collector
229		45.97	47.41	No	06-Rural Minor Arterial
229		47.41	51.59	No	06-Rural Minor Arterial
230	TILLER-TRAIL	41.46	52.71	No	07-Rural Major Collector
231	ELKTON-SUTHERLIN	0.00	22.66	No	06-Rural Minor Arterial
231		22.66	25.39	No	16-Urban Minor Arterial
233	WEST DIAMOND LAKE	0.00	23.80	No	06-Rural Minor Arterial
240	CAPE ARAGO	-0.05	2.24	No	14-Urban Principal Arterial-Other
240		4.49	8.73	No	06-Rural Minor Arterial
240		8.73	10.94	No	07-Rural Major Collector
241	COOS RIVER	0.00	0.12	Yes	16-Urban Minor Arterial
241		0.12	0.72	No	16-Urban Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
241		2.19	19.15	No	07-Rural Major Collector
242	POWERS	0.00	18.91	No	07-Rural Major Collector
244	COQUILLE-BANDON	0.01	16.94	No	06-Rural Minor Arterial
250	CAPE BLANCO	3.05	5.57	No	07-Rural Major Collector
251	PORT ORFORD	0.00	0.76	No	07-Rural Major Collector
255	CARPENTERVILLE	341.02	341.22	Yes	02-Rural Principal Arterial-Other
255		334.87	339.68	No	08-Rural Minor Collector
255		341.22	362.26	No	07-Rural Major Collector
255		362.26	362.27	No	17-Urban Collector
260	ROGUE RIVER LOOP	1.30	2.56	No	16-Urban Minor Arterial
260		2.56	22.24	No	07-Rural Major Collector
270	LAKE OF THE WOODS	-8.29	-8.21	No	14-Urban Principal Arterial-Other
270		-8.21	-2.71	No	02-Rural Principal Arterial-Other
270		-2.55	-0.01	No	02-Rural Principal Arterial-Other
270		-0.01	0.00	No	14-Urban Principal Arterial-Other
270		0.00	3.11	Yes	14-Urban Principal Arterial-Other
270		3.11	64.73	Yes	02-Rural Principal Arterial-Other
270		64.73	68.76	Yes	14-Urban Principal Arterial-Other
271	SAMS VALLEY	-0.30	17.48	No	06-Rural Minor Arterial
272	JACKSONVILLE	0.00	2.84	No	14-Urban Principal Arterial-Other
272		2.84	31.09	No	06-Rural Minor Arterial
272		31.09	34.89	No	14-Urban Principal Arterial-Other
272		34.89	37.10	No	02-Rural Principal Arterial-Other
272		37.10	38.75	No	14-Urban Principal Arterial-Other
273	SISKIYOU	0.00	12.42	No	07-Rural Major Collector
281	HOOD RIVER	0.00	1.18	No	16-urban Minor Arterial
281		1.18	5.09	No	06-Rural Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
281		5.09	19.07	No	07-Rural Major Collector
282	ODELL	0.00	3.45	No	06-Rural Minor Arterial
290	SHERARS BRIDGE	-0.05	28.42	No	07-Rural Major Collector
291	SHANIKO-FOSSIL	0.00	42.98	No	07-Rural Major Collector
292	MOSIER-THE DALLES	18.74	18.96	No	14-Urban Principal Arterial-Other
292		18.96	20.24	No	16-Urban Minor Arterial
293	ANTELOPE	8.86	8.95	No	07-Rural Major Collector
293		0.00	8.95	No	07-Rural Major Collector
293		8.95	13.52	No	07-Rural Major Collector
300	WASCO-HEPPNER	-1.97	-0.09	No	07-Rural Major Collector
300		-0.09	40.68	No	06-Rural Minor Arterial
300		40.88	73.33	No	07-Rural Major Collector
300		73.33	84.12	No	06-Rural Minor Arterial
301	CELILO-WASCO	0.00	14.73	No	07-Rural Major Collector
301		14.73	15.57	No	06-Rural Minor Arterial
320	LEXINGTON-ECHO	0.00	27.24	No	06-Rural Minor Arterial
320		27.24	37.13	No	07-Rural Major Collector
321	HEPPNER-SPRAY	0.00	40.96	No	06-Rural Minor Arterial
330	WESTON-ELGIN	-1.32	40.84	No	06-Rural Minor Arterial
331	UMATILLA MISSION	0.00	4.84	No	06-Rural Minor Arterial
332	SUNNYSIDE-UMAPINE	0.00	7.90	No	07-Rural Major Collector
332		7.90	7.93	No	17-Urban Collector
333	HERMISTON	8.28	8.68	No	14-Urban Principal Arterial-Other
333		0.02	4.97	No	06-Rural Minor Arterial
333		4.97	8.68	No	14-Urban Principal Arterial-Other
333		8.68	9.54	No	14-Urban Principal Arterial-Other
333		9.54	17.81	No	06-Rural Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
334	ATHENA-HOLDMAN	0.00	8.44	No	07-Rural Major Collector
334		9.57	18.12	No	07-Rural Major Collector
335	HAVANA-HELIX	0.00	9.79	No	07-Rural Major Collector
339	FREEWATER	0.00	3.43	No	07-Rural Major Collector
340	MEDICAL SPRINGS	0.00	38.94	No	07-Rural Major Collector
341	UKIAH-HILGARD	0.00	47.22	No	06-Rural Minor Arterial
342	COVE	0.00	22.07	No	07-Rural Major Collector
350	LITTLE SHEEP CREEK	0.00	29.36	No	07-Rural Major Collector
351	JOSEPH-WALLOWA LAKE	0.00	6.94	No	02-Rural Principal Arterial-Other
360	MADRAS-PRINEVILLE	0.09	24.74	No	06-Rural Minor Arterial
360		24.74	26.28	No	16-Urban Minor Arterial
361	CULVER	0.00	2.01	No	17-Urban Collector
361		2.01	11.62	No	07-Rural Major Collector
370	O'NEIL	0.00	16.80	No	06-Rural Minor Arterial
370		16.80	17.67	No	16-Urban Minor Arterial
372	CENTURY DRIVE	4.63	21.98	No	06-Rural Minor Arterial
380	PAULINA	0.00	1.67	No	16-Urban Minor Arterial
380		1.67	55.91	No	07-Rural Major Collector
390	SERVICE CREEK-MITCHELL	0.00	24.32	No	07-Rural Major Collector
402	KIMBERLY-LONG CREEK	0.00	34.88	No	07-Rural Major Collector
410	SUMPTER	0.00	3.71	No	07-Rural Major Collector
413		0.00	5.68	No	08-Rural Minor Collector
413	HALFWAY-CORNUCOPIA	5.68	11.45	No	07-Rural Major Collector
414	PINE CREEK	0.00	0.91	No	07-Rural Major Collector
415	DOOLEY MOUNTAIN	0.00	36.62	No	07-Rural Major Collector
420	MIDLAND	1.33	1.78	No	17-Urban Collector
420		1.80	3.77	No	17-Urban Collector

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
420		3.77	5.65	No	07-Rural Major Collector
422	CHILOQUIN	0.00	5.29	No	07-Rural Major Collector
424	SOUTH KLAMATH FALLS	0.00	5.97	Yes	14-Urban Principal Arterial-Other
426	HATFIELD	16.51	18.93	Yes	02-Rural Principal Arterial-Other
429	CRESCENT LAKE	0.00	2.39	No	07-Rural Major Collector
431	WARNER	0.00	65.28	No	07-Rural Major Collector
440	FRENCHGLEN	0.00	73.35	No	06-Rural Minor Arterial
442	STEENS	0.00	91.60	No	06-Rural Minor Arterial
449	HUNTINGTON	0.00	11.09	No	07-Rural Major Collector
450	SUCCOR CREEK	20.11	52.11	No	07-Rural Major Collector
450		0.02	20.11	No	06-Rural Minor Arterial
451	VALE-WEST	0.03	10.39	No	07-Rural Major Collector
453	ADRIAN-ARENA VALLEY	0.00	2.24	No	08-Rural Minor Collector
453		2.24	3.19	No	09-Rural Local
454	ADRIAN-CALDWELL	0.00	4.39	No	08-Rural Minor Collector
454		4.39	5.09	No	09-Rural Local
455	OLDS FERRY-ONTARIO	-0.29	11.65	No	07-Rural Major Collector
455		11.65	24.91	No	06-Rural Minor Arterial
455		24.91	25.13	No	16-Urban Minor Arterial
455		25.13	30.32	Yes	14-Urban Principal Arterial-Other
455		30.32	31.81	Yes	02-Rural Principal Arterial-Other
456	I.O.N.	0.00	121.36	Yes	02-Rural Principal Arterial-Other
480	REDMOND SPUR	119.52	121.62	No	14-Urban Principal Arterial-Other
481	BAKER-COPPERFIELD SPUR	53.55	54.70	No	07-Rural Major Collector
482	REDWOOD SPUR	-0.69	1.99	No	14-Urban Principal Arterial-Other
483	MCMINNVILLE SPUR	46.26	46.85	No	14-Urban Principal Arterial-Other
484	ESPLANADE SPUR	4.97	5.10	No	16-Urban Minor Arterial

Hwy #	HIGHWAY NAME	Beg MP	End MP	NHS	Functional Classification
485	FORT STEVENS SPUR	4.43	5.38	No	07-Rural Major Collector
486	GOLD HILL SPUR	2.36	3.32	No	06-Rural Minor Arterial
487	CELILO-WASCO SPUR	4.80	7.62	No	07-Rural Major Collector
488	CHILOQUIN SPUR	4.39	4.58	No	07-Rural Major Collector
489	PARMA SPUR	12.51	15.26	No	07-Rural Major Collector
490	HOMEDALE SPUR	20.11	22.24	No	06-Rural Minor Arterial
491	WEISER SPUR	11.65	13.66	No	06-Rural Minor Arterial
492	PAYETTE SPUR	19.65	21.30	No	07-Rural Major Collector
493	ONTARIO SPUR	27.37	28.39	No	14-Urban Principal Arterial-Other

The functional classifications shown above were in effect on

March 19, 2012

To verify critical roadway segments, refer to the Functional Classification and NHS Status List at:

https://www.oregon.gov/odot/Data/Documents/FC_NHS_State_Highway_List.pdf

or contact Roadway Inventory & Classification Services via email at:

ODOTRICS@odot.state.or.us

Appendix B

OHP APPENDIX D: HIGHWAY CLASSIFICATION BY MILEPOINT

OHP Appendix D:

Highway Classification by Milepoint

https://www.oregon.gov/odot/Planning/Documents/2_OHP_Appendix_D_4_8_20.pdf

To verify critical roadway segments contact Roadway Inventory & Classification Services via email at:

ODOTRICS@odot.state.or.us

Appendix C

Freight Mobility, Vertical Clearance, and Resources

FREIGHT MOBILITY POLICY

The current procedure to follow ORS 366.514 "*Creation of state highways; reduction in vehicle carrying capacity*" is given in Chapter 6 of the ODOT Mobility Procedures Manual.

A link to the ORS language is provided below:

http://www.oregonlaws.org/ors/366.215

A link to the ODOT Mobility Procedures Manual is provided below:

https://www.oregon.gov/odot/ProjectDel/Pages/Mobility-Planning.aspx

Oregon Vertical Clearance Standards High Route Highways

HWYNAME	HWYNUMB	BEGMP	ENDMP	I_RTE
PACIFIC	001	0.00	308.38	I-5
COLUMBIA RIVER	002	0.00	167.73	I-84
COLUMBIA RIVER	002	184.08	203.28	US-730
THE DALLES-CALIFORNIA	004	67.17	291.73	US-97
OLD OREGON TRAIL	006	167.58	378.01	I-84
CENTRAL OREGON	007	0.51	266.82	US-20
OREGON COAST	009	0.00	21.90	US-101
OREGON COAST	009	110.75	163.35	US-101
OREGON COAST	009	190.24	363.11	US-101
MCKENZIE	015	6.23	54.97	OR-126
MCKENZIE	015	92.28	93.07	US-20
SANTIAM	016	71.52	100.12	US-20
MCKENZIE-BEND	017	0.00	20.99	US-20
WILLAMETTE	018	0.00	86.45	OR-58
FREMONT	019	0.00	157.73	OR-31
KLAMATH FALLS-LAKEVIEW	020	5.54	96.37	OR-140
MT. HOOD	026	14.18	56.11	US-26
ALSEA	027	50.43	53.59	OR-34
WILLAMINA-SALEM	030	0.00	26.14	OR-22
CORVALLIS-NEWPORT	033	49.70	55.67	US-20
COOS BAY-ROSEBURG	035	0.00	76.87	OR 42
WILSON RIVER	037	0.00	51.62	OR-6
SALMON RIVER	039	-0.22	27.17	OR-18
OCHOCO	041	-0.06	15.52	OR-126
SHERMAN	042	-0.43	68.66	US-97
SUNSET	047	53.62	73.75	US-26
JOHN DAY-BURNS	048	0.00	67.61	US-395
KLAMATH FALLS-MALIN	050	0.00	1.78	OR-140
WARM SPRINGS	053	57.45	117.71	US-26
STADIUM FREEWAY	061	-0.04	4.20	I-405
FLORENCE-EUGENE	062	0.02	52.69	OR-126
EAST PORTLAND FREEWAY	064	0.00	26.60	I-205
BELTLINE	069	0.00	3.10	OR-126
MCNARY	070	0.00	10.78	I-82
SALEM PARKWAY	072	0.00	8.48	
PACIFIC HIGHWAY EAST	081	-3.75	-6.09	OR-99E
PACIFIC HIGHWAY WEST	091	43.00	123.37	OR-99W
LOWER COLUMBIA RIVER	092	0.95	99.34	US-30
NORTHEAST PORTLAND	123	1.69	14.76	US-30 BY
CLACKAMAS-BORING	174	0.03	8.87	OR-212
CORVALLIS-LEBANON	210	0.00	10.38	OR-34
CLEAR LAKE-BELKNAP SPRINGS	215	0.00	19.81	OR-126
EUGENE-SPRINGFIELD	227	0.00	9.97	I-105
SOUTH KLAMATH FALLS	424	0.00	5.97	OR-140
STEENS	442	0.00	91.60	OR-78
OLDS FERRY-ONTARIO	455	25.44	31.81	OR-201
I.O.N.	456	0.00	121.36	US-95

Oregon Vertical Clearance Standards Route Maps

A link to the Oregon Vertical Clearance Standards Map is provided below.

https://digital.osl.state.or.us/islandora/object/osl%3A245/datastream/OBJ/view

The Oregon route maps accessible are for reference only.

To verify critical roadway segments and safe routing instructions must contact the Commerce and Compliance Division

MCTD Route Maps

A link to the MCTD Route Maps is provided below.

http://www.oregon.gov/ODOT/MCT/OD.shtml - Route_Maps

The Oregon route maps accessible are for reference only.

To verify critical roadway segments and safe routing instructions must contact the

Motor Carrier Transportation Division

550 Capitol Street NE

Appendix D

Practical Design Strategy

Practical Design Strategy

A link to the Practical Design Web pages is provided below:

http://transnet.odot.state.or.us/hwy/techserv/Web%20Pages/Practical%20Design.aspx#3

A link to the Practical Design Strategy PDF document is provided below:

http://transnet.odot.state.or.us/hwy/techserv/Shared%20Documents/pdf/Practical_Guideline_022410.pdf

Appendix E

Designated Bikeway

E.1 Designated Bikeways

Bicycle tourism is a significant industry in Oregon. Cyclists from across the nation and many other nations come to Oregon to ride on designated bikeways. Information and maps for promoted bikeways are provided below.

E.1.1 Oregon Scenic Bikeways

http://www.oregon.gov/OPRD/PARKS/BIKE/

http://www.oregon.gov/OPRD/PARKS/BIKE/docs/Statewide_Scenic_Bikeways.pdf

E.1.2 Oregon Coast Bike Route

http://oregon.gov/ODOT/HWY/BIKEPED/docs/oregon_coast_bike_route_map.pdf

E.1.3 Historic Columbia River Gorge Bike Route

http://oregon.gov/ODOT/HWY/BIKEPED/docs/columbiagorgebikemap.pdf

http://rideoregonride.com/road-routes/lewis-and-clark-trail/

E.1.4 US Bicycle Route System

As of July 2012, Oregon does not have any US Bicycle Routes in place. However, the AASHTO corridor plan has five routes through Oregon. The following links have information about the US Bicycle Route network with the corridor map.

https://www.adventurecycling.org/routes-and-maps/us-bicycle-route-system/national-corridor-plan/

https://www.adventurecycling.org/routes-and-maps/us-bicycle-route-system/

Many of these designated bikeways run along segments of ODOT highways or cross ODOT highways. A list of ODOT highways that correspond to designated touring bicycle routes is provided in the following table.

DESIGNATED BIKEWAYS									
Highway		Route	Begin MP	Begin St.	Xing MP	Xing St.	End MP	End St.	Designated Bikeway
ID	Suffix	Name							
001	NX	Talbot Rd.	241.93	West of I-5			242.32	East of I-5	Willamette Valley Scenic Bikeway
001	00	I-5			231.89	Grand Prairie Rd.			Willamette Valley Scenic Bikeway 1
001	00	I-5			219.08	Linn West Drive			Willamette Valley Scenic Bikeway 1
001	MN	Frontage Rd.			219.08	Linn West Drive			Willamette Valley Scenic Bikeway
001	MG	Diamond Hill Dr.	208.88	West of I-5			209.14	East of I-5	Willamette Valley Scenic Bikeway
001	00	I-5			174.44	Row River Trail			Covered Bridges (Dorena Lake) Scenic Bikeway 1
002	CJ	Enquist Rd.	35.44	US 30 (100)			36.29	Tumalt Rd.	Historic Columbia River Gorge Bike Route
002	CM	Warrendale Rd.	36.96	Tumalt Rd.			37.65	I-84	Historic Columbia River Gorge Bike Route
002	CL	Frontage Rd.	37.12	Overpass			37.60	I-84	Historic Columbia River Gorge Bike Route
002	CK	Overpass	37.10	Warrendale Rd.			37.15	Frontage Rd.	Historic Columbia River Gorge Bike Route
002	00	I-84	37.60	Exit 37			43.38	Exit 44	Historic Columbia River Gorge Bike Route 2

1 separate grade crossing

2 shared use path within highway right-of-way

DESIGNATED BIKEWAYS										
Highway		Route	Begin MP	Begin St.	Xing MP	Xing St.	End MP	End St.	Designated Bikeway
ID	Suffix	Name							
002	CW	Wyeth Rd.	47.89	Frontage Rd.			47.98	Wyeth Rd.	Historic Columbia River Gorge Bike Route
002	CX	On-ramp	50.99	Overpass			51.23	I-84	Historic Columbia River Gorge Bike Route
002	CY	Overpass	50.97	Wyeth Rd.			51.01	Ramps	Historic Columbia River Gorge Bike Route
002	CZ	Off-ramp	51.17	Overpass			51.35	I-84	Historic Columbia River Gorge Bike Route
002	00	I-84	51.17	Exit 51			61.81	Exit 62	Historic Columbia River Gorge Bike Route
004	00	US 197	0.00	WA Border			0.93	US 30	Historic Columbia River Gorge Bike Route
004	00	US 97	0.00		115.79	B Av.			Sisters to Smith Rock Scenic Bikeway
005	00	OR 19	105.23	OR 402 (402)			124.17	US 26 (005)	Old West Scenic Bikeway
005	00	US 26	124.17	OR 19 (005)			190.67	OR 7 (071)	Old West Scenic Bikeway
006	HT	Campbell St.	304.75	I-84 Ramps			304.83	Windmill Lane	Grande Tour Scenic Bikeway
009	00	US 101	0.00	WA Border			76.84	Sand Lake Rd.	Oregon Coast Bike Route
009	00	US 101	90.37	Brooten Rd.			98.92	Slab Creek Rd.	Oregon Coast Bike Route
009	00	US 101	103.94	Three Rocks Rd.			129.74	Otter Crest Loop	Oregon Coast Bike Route
009	00	US 101	133.01	Otter Crest Loop			138.38	Oceanview Drive	Oregon Coast Bike Route
009	00	US 101	141.31	Naterlin Drive			215.77	8th St.	Oregon Coast Bike Route

DESIGNATED BIKEWAYS										
Highway		Route	Begin MP	Begin St.	Xing MP	Xing St.	End MP	End St.	Designated Bikeway
ID	Suffix	Name							
009	00	US 101	217.04	Old Highway 101			235.04	Florida Av.	Oregon Coast Bike Route
009	00	US 101	257.38	Seven Devils Rd.			260.13	Riverside Drive	Oregon Coast Bike Route
009	00	US 101	277.58	Beach Loop Rd.			324.04	Old Coast Rd.	Oregon Coast Bike Route
009	00	US 101	327.46	Wedderburn Loop			358.13	Lower Harbor Rd.	Oregon Coast Bike Route
009	00	US 101	362.22	Oceanview Drive			363.11	CA Border	Oregon Coast Bike Route
010	00	OR 82	2.41	OR 237 (237)			2.69	McAllister Rd.	Grande Tour Scenic Bikeway
010	00	OR 82	5.08	Booth Lane			6.81	Market Lane	Grande Tour Scenic Bikeway
012	00	OR 7	0.24	Main St.			1.26	I-84 Ramps	Grande Tour Scenic Bikeway
012	00	OR 86			3.02	Lindley / Atwood Rd			Grande Tour Scenic Bikeway
015	00	OR 242	56.86	Limberlost Campground Rd.			92.05	Cascade Av.	McKenzie Pass Scenic Bikeway
015	00	OR 126			92.83	Locust St.			Sisters to Smith Rock Scenic Bikeway
015	00	OR 126	95.84	Camp Polk Rd.			96.48	Cloverdale Rd.	Sisters to Smith Rock Scenic Bikeway
015	00	OR 126			97.46	Goodrich Rd.			Sisters to Smith Rock Scenic Bikeway
017	00	US 20	9.77	Innes Market Rd.			10.13	Tweed Rd.	Twin Bridges Scenic Bikeway

DESIGNATED BIKEWAYS									
Highway		**Route**	**Begin MP**	**Begin St.**	**Xing MP**	**Xing St.**	**End MP**	**End St.**	**Designated Bikeway**
ID	**Suffix**	**Name**							
017	00	US 20			14.69	7th St. (Tumalo)			Twin Bridges Scenic Bikeway
028	00	US 395	23.64	OR 74 (052)			49.54	OR 244 (341)	Blue Mountain Scenic Bikeway
028	00	US 395	77.28	County Rd. 20			90.26	OR 402 (402)	Old West Scenic Bikeway
031	00	US 20 NB			10.58	1st @ Lyon			Willamette Valley Scenic Bikeway
031	00	US 20 NB			10.63	2nd @ Lyon			Willamette Valley Scenic Bikeway
031	00	US 20 SB			10.57	1st @ Ellsworth			Willamette Valley Scenic Bikeway
031	00	US 20 SB			10.61	2nd @ Ellsworth			Willamette Valley Scenic Bikeway
052	00	OR 74	45.89	OR 207 (300)			83.15	US 395 (028)	Blue Mountain Scenic Bikeway
058	00	US 20 / OR 99E WB			1.42	Geary St. @ Pacific Blvd SE			Willamette Valley Scenic Bikeway
058	00	US 20 / OR 99E EB			1.45	Geary St. @ 9th St. SE			Willamette Valley Scenic Bikeway
058	AI	Geary St.	1.30	9th St. SE			1.45	Santiam Rd. SE	Willamette Valley Scenic Bikeway
058	00	OR 99E			14.33	OR 99E			Willamette Valley Scenic Bikeway
066	00	OR 203	6.94	Pierce Rd.			15.93	OR 237 (342)	Grande Tour Scenic Bikeway
066	00	OR 237	15.93	OR 203 (066)			33.00	North Powder River Rd.	Grande Tour Scenic Bikeway

DESIGNATED BIKEWAYS									
Highway		**Route**	**Begin MP**	**Begin St.**	**Xing MP**	**Xing St.**	**End MP**	**End St.**	**Designated Bikeway**
ID	**Suffix**	**Name**							
066	00	US 30	49.95	Pocahontas Rd.			50.98	Campbell St.	Grande Tour Scenic Bikeway
071	00	OR 7	0.00	US 26 (005)			1.13	Upper Middle Fork Rd.	Old West Scenic Bikeway
072	00	OR 99E / OR 22 SB	3.41	Commercial St. @ Salem Parkway			5.43	Commercial St. @ Trade St.	Willamette Valley Scenic Bikeway
072	00	OR 99E / OR 22 SB			5.47	Liberty St. @ Trade St.			Willamette Valley Scenic Bikeway
072	00	OR 99E / OR 22 NB	3.34	Liberty St. @ Salem Parkway			5.47	Liberty St. @ Ferry St.	Willamette Valley Scenic Bikeway
100	00	US 30	0.00	Sandy River			22.03	Enquist Rd.	Historic Columbia River Gorge Bike Route
100	00	US 30	29.71	I-84 Ramps			34.18	Wyeth Rd.	Historic Columbia River Gorge Bike Route
100	00	US 30	48.66	I-84			73.37	1st Av.	Historic Columbia River Gorge Bike Route
140	00	OR 219	34.48	Arbor Grove Rd.			34.65	Arbor Grove Rd.	Willamette Valley Scenic Bikeway
164	00		4.92	Talbot Rd.			7.29	Scravel Hill Rd.	Willamette Valley Scenic Bikeway
210	00	OR 34	2.78	White Oak Rd.			3.03	Riverside Drive	Willamette Valley Scenic Bikeway
212	00	OR 228	6.16	Washburn St.			6.23	Main St.	Willamette Valley Scenic Bikeway

DESIGNATED BIKEWAYS									
Highway		Route	Begin MP	Begin St.	Xing MP	Xing St.	End MP	End St.	Designated Bikeway
ID	Suffix	Name							
226	00	OR 99			14.79	Main St.			Covered Bridges (Dorena Lake) Scenic Bikeway
240	00	OR 540	0.21	Monroe Av.			8.74	Seven Devils Rd.	Oregon Coast Bike Route
292	00	US 30	18.54	Brewery Grade			20.24	US 197	Historic Columbia River Gorge Bike Route
300	00	OR 207	83.20	Willow Creek Rd.			84.12	OR 74 (052)	Blue Mountain Scenic Bikeway
340	00	OR 203	0.00	OR 237 (066)			37.48	Lindley Rd.	Grande Tour Scenic Bikeway
342	00	OR 237	12.35	Lower Cove Rd.			22.07	OR 203 / OR 237 (066)	Grande Tour Scenic Bikeway
402	00	OR 402	0.00	OR 19 (005)			34.88	US 395 (028)	Old West Scenic Bikeway

Appendix F

FAC-STIP Tool Guide

WEB-BASED TOOLS FOR HIGHWAY ATTRIBUTE INVENTORY

As noted in Chapter 11, some form of a roadside inventory shall be made of nonconforming roadside features for 1R, 3R, and 4R projects. Scoping efforts for Statewide Transportation Improvement Program (STIP) projects include the Features, Attributes and Conditions Survey (FACS). The following web-based tools assist in FACS-STIP scoping is only available on the ODOT intranet and for Internal ODOT users only. External users coordinate with the ODOT contact to get reports.

FACS DATA-TO-GO – this application enables downloading ODOT's current highway attribute inventory of up to 29 assets into spreadsheet(s).

FACS-STIP Tool Website, click the Data2Go link.

FACS-STIP WEB MAP – this application allows the user to zoom to a STIP project and view highway inventory attributes.

FACS-STIP Tool Website, click the Map Tool link.

TransGIS – Contains analysis tools such as distance measurement and a street-view style link to the ODOT Digital Video Log. It contains highway attribute inventory for some layers not contained in the FACS-STIP web map.

http://gisintra.odot.state.or.us/TransGIS/

The attribute inventory fields for each asset are displayed in a unique format that is defined in user guides for the corresponding attribute. User guides are available at

FACS-STIP User Guides

FACS DATA-TO-GO RETRIEVAL INSTRUCTIONS

Go to FACS-STIP Tool Website, click the Data2Go link.

1. Select the highway number with suffix code (suffix codes are for connections and frontage roads, mainline is two zeros; for example Powell Blvd in Portland [Mt Hood Highway] would be 02600)
   a. Select roadway ID (usually 1, but couplets and divided highways have 1 & 2).
   b. Select single milepoint or a milepoint range
   c. Select buffer distance. Since this was developed for project scoping, the spreadsheets returns assets that are nearby. (For example, Powell in the vicinity of Cascade Highway [82nd Avenue] would include attributes on 82nd Avenue within the buffer distance). You cannot select a buffer of zero.
2. Select asset filter.
3. Select Go button next to “Get Data2Go”
4. A new window will open up. On the left side, there is a panel with assets that are available. The following three methods may be used to view the data.

Select the "View" button next each attribute of interest. Note that there may be many pages of data.

Check “export” next to each attribute of interest. Scroll to the bottom and select the “export” button. An excel spreadsheet will be generated with each asset in its own tab.

Scroll to the bottom, and select “All assets” and hit the "export" button. An excel spreadsheet will be generated with each asset in its own tab.

Appendix L

Bicycle & Pedestrian Design Guide

The 2011 ODOT Bicycle and Pedestrian Guide will be include in the final publishing of the 2022 Highway Design Manual. For review purposes, the 2011 ODOT Bicycle and Pedestrian Guide is available at:

https://www.oregon.gov/odot/Engineering/Documents_RoadwayEng/HDM_L-Bike-Ped-Guide.pdf

Appendix M

Digital Design Packages

M.1 Digital Design Packages

This appendix provides additional detail regarding content of packages, approximate delivery schedules, and links to additional resources and examples of roadway digital design data packages.

M.1.1 Digital Design Package Checklists

Figure M–1 is a schedule showing the approximate durations needed for developing the associated digital design packages. Additional descriptions of required content to be included in each of these submittals are provided in Section 16.4.

The first checklist is the eBIDS Handoff Package Checklist. This checklist summarizes the required content submitted to the ODOT Project Leader (PL) or Local Agency Liaison (LAL) no later than 1 week prior to the project advertisement milestone. The data provided to the ODOT PL or LAL is uploaded to eBIDS as a bid reference document prior to project advertisement to assist contractors in the bidding process. In order to provide a consistent set of data for bidders, a "How-to" guide on posting the roadway digital design eBIDS Handoff package has been developed. This document is available at the following link: How to post a roadway digital design eBIDS bid reference package.

The second checklist is a Sample Roadway Construction Survey Handoff Deliverable Checklist. This checklist is developed in partnership with the assigned Construction Coordinator before the Construction Survey Handoff Package is prepared based on the specific needs of each project. The Construction Survey Handoff data is due to the assigned ODOT construction PM's office 30 days after Bid Opening and generally coincides with Notice to Proceed for the Contractor. The provided data communicates the design information needed for the administration of the construction contract.

APPROXIMATE DURATIONS - ROADWAY DIGITAL DESIGN DELIVERY SCHEDULE (TYPICAL)

ESTIMATED DURATION	FINAL (PRE-MYLAR) PLANS DISTRIBUTION/ COMPLETION Milestone	2 Weeks	2 Weeks	2 Or More Months	1 Week	PROJECT ADVERTISEMENT Milestone	6-8 Weeks	30 days after BID OPENING Milestone	10-30 Days	PRE-SURVEY MEETING Milestone
TASK	Roadway Designer delivers Final (Pre-Mylar) plans, special provisions, and estimate for review/comment.	Roadway Designer prepares and submits Draft eBIDS Handoff Package* to ODOT Construction Coordinator for Review	Construction Coordinator Reviews Draft eBIDS Handoff package and provides comments to Roadway Designer	Roadway Designer incorporates comments from Construction Coordinator into the eBIDS Handoff package	Roadway Designer provides final eBIDS Handoff package to the Project Leader no later than 1 week prior to Project Advertisement	Project Leader uploads eBIDS Handoff package to eBIDS	Roadway Designer coordinates with Construction Coordinator and prepares Draft Construction Survey Handoff Package*.	Roadway Designer delivers Draft Construction Survey Handoff Package. (30 days after Bid Opening generally coincides with Notice to Proceed)	Roadway Designer and Construction Coordinator work together to revise/finalize Construction Survey Handoff package to be ready for Pre-Survey Meeting.	Roadway Designer attends meeting to provide technical support to Construction Coordinator regarding the Construction Survey Handoff package.

* See [Highway Design Manual Appendix M](#) for information regarding Handoff Packages

Minimum Duration to prepare Construction Survey Handoff package starting from Final Plans Distribution Milestone to Pre-Survey Meeting Milestone is 4 months

Minimum Duration to prepare eBIDS Handoff package starting from Final Plans Distribution Milestone to PL Delivery is 3 months

Figure M–1: Approximate Durations - Roadway Digital Design Delivery Schedule (Typical)

M.1.2 eBIDS File Name Restrictions

There are some restrictions on file names imposed by ODOT's web application platform.

1. You cannot use the following characters anywhere in a file name:
   - Tilde (~)
   - Number sign (#)
   - Percent (%)
   - Ampersand (&)
   - Asterisk (*)
   - Braces ({ or })
   - Backslash (\)
   - Colon (:)
   - Angle brackets(< or >)
   - Question mark (?)
   - Slash (/)
   - Pipe (|)
   - Quotation mark (' or ")
2. You cannot use the period character consecutively in the middle of a file name.
3. You cannot use the period character at the end of a file name.
4. You cannot start a file name by using the period character.
5. Filenames no longer than 28 characters plus the 3 character extension (total 31).
6. In addition, file names and folder names may not end with any of the following strings:
   - .files
   - _files
   - -Dateien
   - _fichiers
   - _bestanden
   - _file
   - _archivos
   - -filer
   - _tiedostot
   - _pliki
   - _soubory
   - _elemei
   - _ficheiros
   - _arquivos
   - _dosyalar
   - _datoteke
   - _fitxers
   - _failid
   - _fails
   - _bylos
   - _fajlovi
   - _fitxategiak

M.1.3 Example Digital Design Packages

The following provides example digital design packages for reference purposes.

M.1.3.1 I-5: Siskiyou Safety Rest Area (KEY #09436)

This project was designed to a 4R design standard is located along I-5 southwest of Ashland. The proposed rest area replaces a recently closed rest area located at milepost 10. The project included entrance and exit ramps, a service access road, parking area for RVs and autos, and other amenities associated with the rest area site development.

Click on the links below to access the example digital design packages for this project:

Example eBIDS Handoff package for Key #09436

Example Construction Survey Handoff package for Key #09436

M.1.3.2 OR140: Bowers Bridge & Quartz Creek Culverts (KEY #19126)

These culvert replacement projects are located about 60 miles apart on OR 140 in the vicinity of Lakeview and were designed to a 4R design standard. The Bowers culvert was originally installed in 1947 and was beyond its design life. Previous attempts to modify / extend the Quartz culvert resulted in sink holes, posing a potential closure and lengthy detours if the culvert failed. The project replaced the Bowers culvert with an 8-foot by 4-foot reinforced concrete box and the Quartz culvert with a 112-inch by 75-inch arch pipe.

Click on the links below to access the example digital design packages for this project:

Example eBIDS Handoff package for Key #19126

Example Construction Survey Handoff package for Key #19126

M.1.3.3 Or224 (Clackamas.): Se 232nd Dr. Sec. (Key #17716)

This project was designed to a 4R design standard. The example project addresses sight distance issues at the intersection of OR224 and Southeast 232nd Drive in Damascus. Proposed improvements include dedicated right-turn and left-turn channelization and realignment of a horizontal curve.

Click on the links below to access the example digital design packages for this project:

Example eBIDS Handoff package for Key #17716

Example Construction Survey Handoff package for Key #17716

Appendix N

Digital Design Quality Control

N.1 DIGITAL DESIGN QUALITY CONTROL (QC)

It is recommended that a qualified roadway designer independently review the digital design data “at the Advance Plans review milestone. For large or complex projects, it may also be beneficial to provide a review of digital design data at earlier milestones, such as DAP or Preliminary plans.” It is recommended that these earlier “pre-bid” reviews include evaluation of the digital data elements needed to prepare the eBIDS Handoff package. Comments provided by the reviewer at the DAP, Preliminary, and/or Advance Plans milestone may then be incorporated into the digital design prior to creating the draft eBIDS Handoff package. Although this Appendix is limited to review of roadway digital data, a qualified reviewer will typically request additional information from the designer, such as:

- Latest set of plan sheets (DAP, Preliminary, Advance, Final, Mylar)
- A no-cost estimate providing quantities only
- The original ground surface digital data file (provided by the Project Surveyor)

It may be helpful to the review if the designer anticipates the need for the additional items listed above and provides them to the reviewer with the roadway digital design data package.

“Pre-bid” items to review are described in Section N.1.1 and N1.2. The Pre-bid Roadway Digital Data Quality Control Checklist also summarizes these items as well as provides suggestions on how to review the data. Review of the Construction Survey Handoff package includes elements requested by the Construction Coordinator based on the specific needs of each project. Often the elements requested include the items listed in Section N.1.1 and N.1.2 as well as N.1.3. A summary of these items, as well as suggestions on how to review the data, are provided on the Construction Survey Handoff Roadway Digital Data Quality Control Checklist. These digital data QC checklists are not required, but are provided as tools to assist with organization and communication between designer and reviewer when evaluating roadway digital design data.

The information provided here is offered to assist the reviewer in providing feedback to the designer regarding the quality of the data as it pertains to the bid process and/or construction. As design and construction technologies continue to evolve, the review process will also evolve. The following subsections provide guidelines and best practices on how to perform a QC review of roadway digital design data. It is the intent that the discussion, checklists, and examples provide a solid foundation for the reviewer to begin the work.

N.1.1 DAP / PRELIMINARY / ADVANCE MILESTONE

Review of "pre-bid" roadway digital data at DAP/Preliminary/Advance Plans milestones may include the following:

1. Alignment Data
    - Horizontal bearings and curve data match plan sheets
    - Profile grades and vertical curves match plan sheets
    - PC, PI and PT stations match plan sheets
    - Vertical alignment profile grades match Finish Grade (FG) surfaces
    - Integrity of each horizontal and vertical alignment
2. Surface Data
    - Sufficient surface detail to define project R/W and easements, including ditches, ponds, finish ground at abutments and other graded areas
    - Displayed features match horizontally against design file plan view
    - Surfaces reviewed for triangulation errors
    - Adjacent corridor model FG surfaces tie into each other
    - FG surface ties into Original Ground (OG) surface
    - FG cross slope/curbs match OG elevations at project limits
    - Ensure positive drainage to inlets and low points
    - Component depths match typical section thicknesses
3. Surface Quantity Calculations
    - Quantity calculations for earthwork, asphalt, aggregate, drain rock, etc.
    - Hand/spreadsheet calculations match quantities on plan sheets
    - Surface-generated quantities (inroads volume reports) match quantities on plan sheets
    - Quantities on estimate match quantities on plan sheets for earthwork, asphalt, aggregate, drain rock, etc.

EBIDS HANDOFF PACKAGE

The eBIDS Handoff package review is the final stage of the "pre-bid" roadway digital data review. The items reviewed include elements listed on the eBIDS Handoff Package Checklist as well as other items related to soliciting quality bids at the bid advertisement milestone. The data reviewed typically includes all items listed in Section N.1.1 as well as the following:

1. Computer File Index

- Files listed are included in submittal
- Alignment file names listed in the computer file index match the alignment names on plan sheets and inroads files
- Project data (name, highway, county, contract number, key number, project limits and bid date) provided
- File naming is consistent, logical and no longer than 28 characters plus the 3 character extension (total 31)
- Files do not include restricted characters (see section m.1.2)

2. Alignment Data

- Horizontal and vertical alignments not used for final design removed from alignment data, such as alternative or "working" design alignments

3. Cross Section Data

- Cross sections included for each alignment
- Cross sections include labels to identify associated alignments and station
- Spacing no more than 25 feet apart, matches spacing used for quantity calculations
- Cross sections included at key stations (typical section changes, alignment cardinal points, drainage facilities, taper start and stop locations, guardrail/barrier start/stop locations, centerline of approaches, curb/pavement return points, luminaire and signal pole locations)
- Key features labeled with offset and elevation (centerline, edge of pavement, top face of curb, etc.)

4. Corridor Map Index

- Surface boundaries and names and locations on map index match surface names shown on map

5. Corridor Data

- Superelevation data matches horizontal curve information on plan sheets and superelevation diagrams

6. Surface Data

- Separate landxml files provided for each surface created
- Feature names appropriate and consistent with ODOT naming convention

As stated in Section M.1.1, submit the eBIDS Handoff Package to the ODOT Project Leader no later than 1 week prior to the project Advertisement milestone. A schedule showing the approximate durations for preparing and reviewing the eBIDS Handoff Package is shown on Figure M-1 in Appendix M.

N.1.2 CONSTRUCTION SURVEY HANDOFF PACKAGE

As stated in Section M.1.1, the roadway designer and construction coordinator agree on deliverables needed to administer the project. The Sample Roadway Construction Survey Handoff Deliverable Checklist provides a good starting point for this discussion. Items that are often requested by the construction Project Manager's office include the following:

- Final original ground surface (.dtm and .dgn) from Survey
- Design files included for roadway, storm, structures etc.
- Final CAD sheet files (.dgn) included for all sheets in plan set
- CAD Files (.dgn) which show triangles, features and contours included for all surfaces
- CAD Alignment files (.dgn) included showing all primary alignments and profiles
- Inroads .xin, .ird,. Itl and .alg files (if requested by the PM office)
- ADA ramp grade exhibits
- Driveway grade exhibits
- Additional documents such as rendered views and labeled field photos, which communicate the intent of the designer or illustrates use of the design files

Once the roadway designer and construction coordinator agree upon the deliverables, the roadway designer prepares the draft Construction Survey Handoff package for QC review. This package is often tailored to meet the needs of the awarded contractor's surveyor as well as the needs of the associated Project Manager's office. In addition to the elements described in Sections N.1.1 and N.1.2, the following items are recommended to be reviewed:

1. <u>Alignment Data</u>

    - Items listed in N.1.1
    - Additional secondary alignments included and checked against plan sheets
    - Temporary traffic control alignments (i.e., alignments for barrier, striping, traffic diversions, etc.) Match plan sheets

2. <u>Bid Item Quantity Calculations</u>

    - Quantity calculations for roadway-related bid items
    - Linework on cad files (.dgn) files match quantities on plan sheets

3. <u>Grade Reports</u>

    - Offsets and elevations match cross sections and plans
    - Features checked against surface data
    - Additional surface (top of rock, subgrade, etc.) Elevations (depth below fg) checked against typical section thicknesses

As stated in Section M.1.1, the Construction Survey Handoff Package is submitted to the assigned ODOT construction PM's office within 30 days after Bid Opening and generally coincides with Notice to Proceed for the Contractor. Figure M-1 in Appendix M shows the approximate durations needed for developing the Construction Survey Handoff Package.

N.1.3 EXAMPLE QUALITY CONTROL (QC) REVIEWS

The following provides links to example projects that utilized QC guidelines described above on roadway digital design packages prepared for the purpose of bidding and construction.

N.1.3.1 OR38: LUDER CREEK CULVERT REPLACEMENT (KEY #18264)

This project was designed to a 4R design standard. This project is located in Douglas County on Highway 45 (OR 38) between mile points 11.67 and 11.98. The Umpqua Highway (OR 38) crosses Luder Creek. This project constructed a new bridge for the highway to cross Luder Creek, and realign the creek to a more historic flow location.

Click on the links below to access products generated from an independent QC review of roadway digital design data related to this project.

QC of "Pre-bid" package for Key #18264

QC of Construction Survey Handoff package for Key #18264

(Under Development – to be provided with January 2017 update)

N.1.3.2 I-5 SB: BROADWAY-WEIDLER EXIT RAMP (KEY #18262)

This project was designed to a 4R design standard. This urban Interstate exit ramp project is located in the vicinity of four closely spaced intersections (within 300 feet) in the City of Portland. The project reduced conflicts between bicycles, pedestrians, transit (buses and streetcars), and passenger vehicles.

Click on the links below to access products generated from an independent QC review of roadway digital design data related to this project.

QC of "Pre-bid" package for Key #18262

QC of Construction Survey Handoff package for Key #18262

(Under Development – to be provided with January 2017 update)

Appendix P

Analysis for Roundabout Entrance & Exit Geometry

P.1 WHITE PAPER; ROUNDABOUT ENTRANCE AND EXIT GEOMETRY

Entrance and exit geometries play an important role in controlling speed and movement of a vehicle through a roundabout. In general, providing roundabout alignments that increase flow at the exit may provide increased gaps in the circulating traffic stream and may provide greater opportunities for entering vehicles. Currently, there is significant discussion between roundabout designers about the best method to determine exit geometry and to control exit speed within design parameters. The discussion centers around the prediction of vehicle speed and how to calculate appropriate values for design. The standard method has been to utilize the speed, radius relationship as shown in Figure P–1. The graph was derived using the basic equation for velocity and minimum radius from the AASHTO document A Policy on Geometric Design of Highways and Streets; V= $\sqrt{15R(e+f)}$, where superelevation, e, is held to +2% and -2% with side friction factor, f, values assumed for general design.

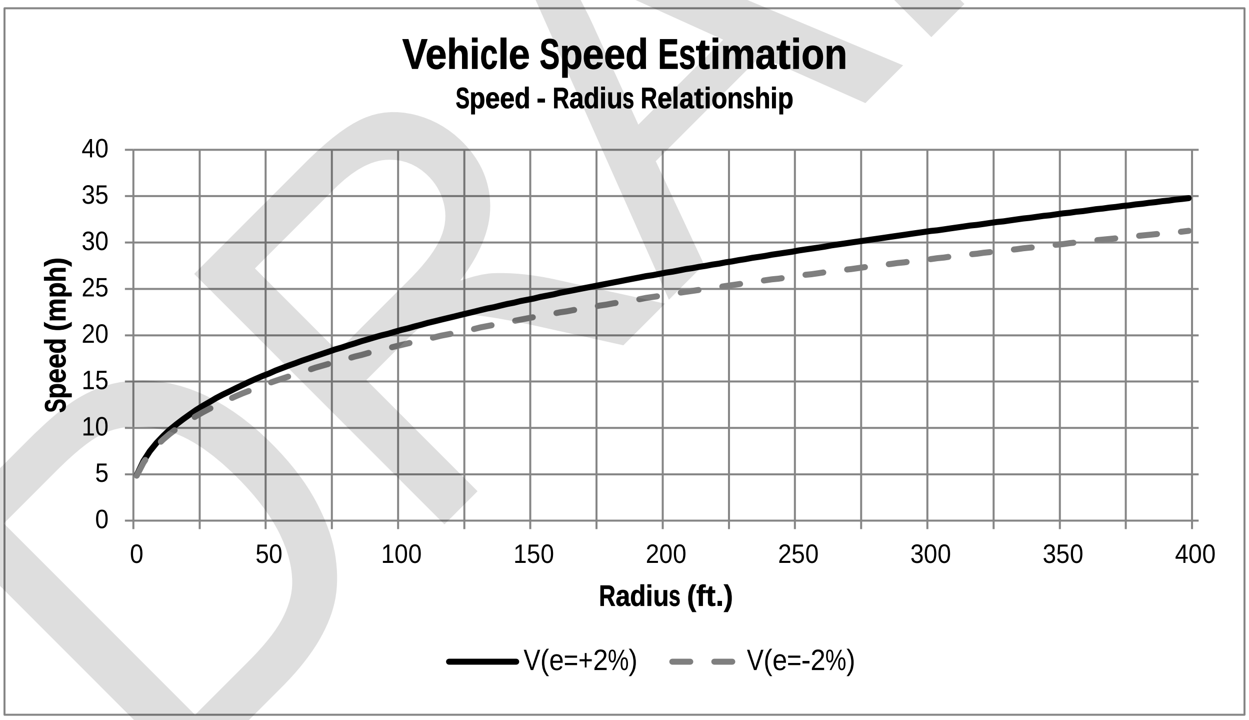


Figure P–1: Estimated Vehicle Speed and Radius Relationship

Table P–1 is a tabular form of the values in Figure P–1 reported at 25 ft. radius intervals. In addition, NCHRP Report 672 Roundabouts: An Informational Guide, provides simplified equations to calculate speeds for given radii as well. Equation 1 is for +2% superelevation and Equation 2 is for -2% superelevation.

Table P–1: Speed, Radius Relationship

Speed (V), Radius (R) Relationship Equations

Equation 1

NCHRP Report 672

$V=3.4415R^{0.3861}$; e= 2%

Equation 2

NCHRP Report 672

$V=3.4614R^{0.3673}$; e= -2%

Radius (ft.)	V(+2%) (mph)	V(-2%) (mph)
25	12	11
50	16	15
75	18	17
100	20	19
125	22	20
150	24	22
175	25	23
200	27	24
225	28	25
250	29	26
275	30	27
300	31	28
325	32	29
350	33	30
375	34	31
400	35	31

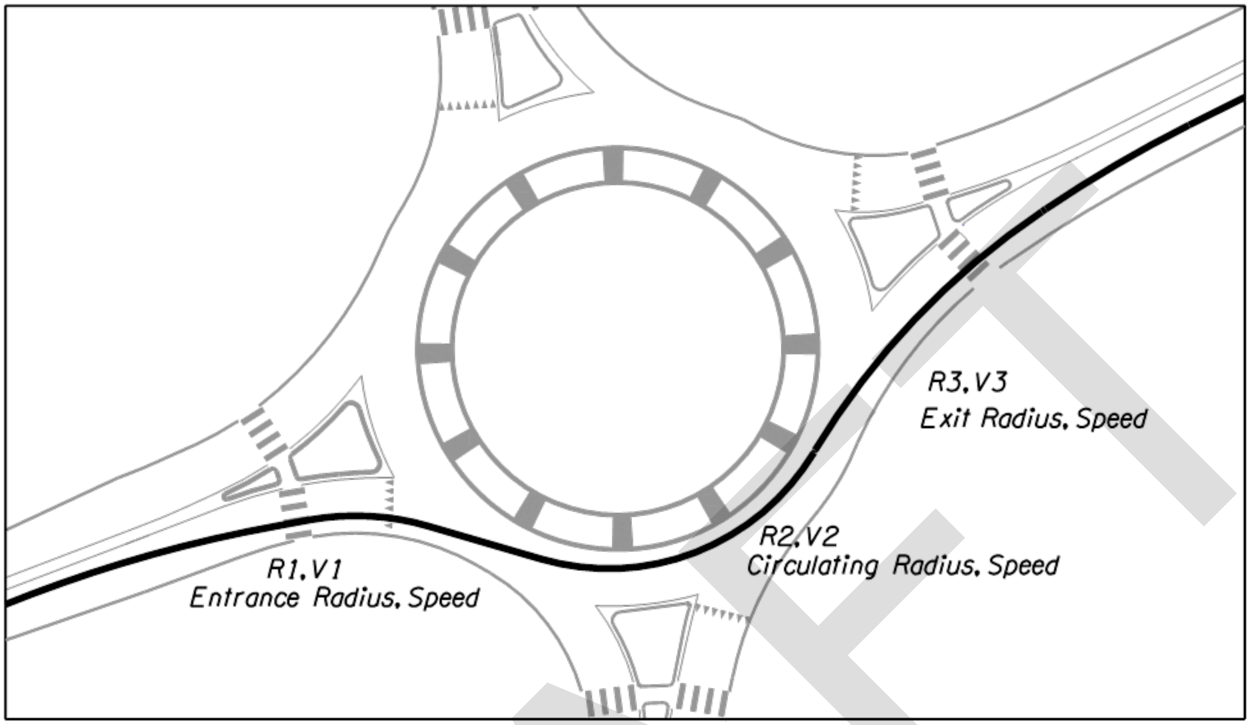


Figure P–2: Vehicle Path Through a Roundabout - Speed, Radius

For superelevation other than +/- 2%, Equation 3, AASHTO Minimum Radius needs to be used with an appropriate side friction factor, f.

However, there is thought that exit radii designed too small to reduce predicted exit speed in an attempt to focus on pedestrian safety may unnecessarily limit overall roundabout capacity. This leads to the question, then, how to calculate appropriate exit radii to maximize capacity and still protect pedestrian movements at the downstream crosswalk?

P.1.1 Research for Alternate Calculation Method

Alternate Design Methods for Pedestrian Safety at Roundabout Entries and Exits: Crash Studies and Design Practices in Australia, France, Great Britain and the USA Bill Baranowski, Edmund Waddell (2004)

Research done in 2004 by Bill Baranowski of Roundabouts USA and Edmund Waddell of Michigan DOT investigated entrance and exit geometry in order to determine appropriate roundabout alignments to increase capacity without negatively effecting pedestrian safety. The investigation determined that R_1 and R_2 values along with vehicle acceleration from R_2 through R_3 may play more of a role in exit speed than exit radius, R_3, alone. The researchers looked at the circulation radius, speed; R_2,V_2 relationship, the distance from the end of the R_2 radius to the exit crosswalk and the potential acceleration of a vehicle over that distance.

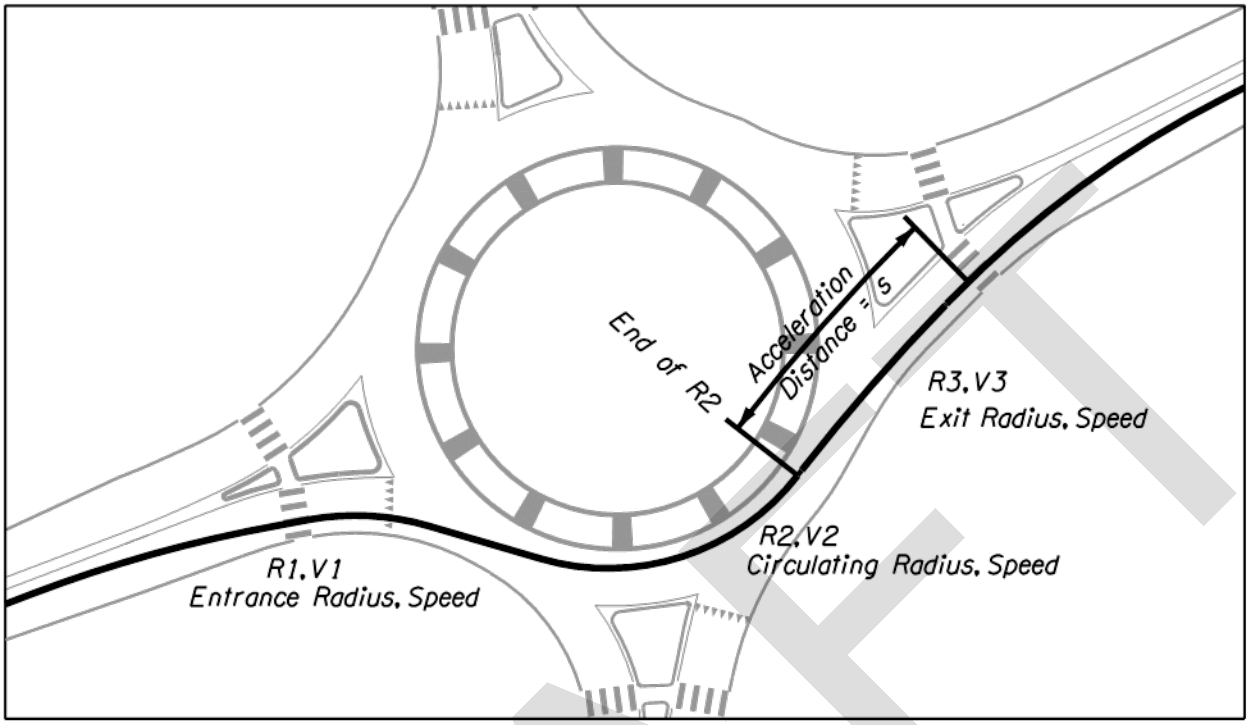


Figure P–3: Vehicle Path Through a Roundabout Speed,Radius, Acceleration Distance

The research assumed an exiting vehicle is capable of accelerating along a given R_3 radial path with an acceleration rate of 3.5 ft/s^2 and also assumed acceleration starts at the end point of R_2. The standard Newtonian equation for uniform acceleration was used to compute potential vehicle speeds at the exit crosswalk.

Newtonian Equation for Speed and Acceleration

$$\mathbf{V_f^2 = V_i^2 + 2aS}$$

Where: V_f = Final R_3 Speed, ft/s (V_3, Exit Speed)

V_i = Initial R_2 Speed (V_2, Circulating Speed)

a = Acceleration, (3.5 ft/s^2)

S = Distance, ft (End of R_2 to Crosswalk)

After analyzing theoretical roundabout layouts and investigating several existing roundabouts, the researchers concluded that the R_2,V_2 radius, speed relationship and vehicle acceleration from R_2 to the crosswalk as a vehicle exits a roundabout has more effect on the vehicle speed at the exit crosswalk than a tighter exit radius using only the radius, speed relationship for R_3 alone. The theory then is that exit geometry (radius) can be relaxed to increase overall capacity and not appreciably affect pedestrian activity or safety at the exit crosswalk by increased vehicle speed. This may prove to be true for small acceleration distance values coupled with relative radius values in order to predict and control maximum potential exit speed. However, effectively controlling this relationship may not always be easily accomplished

While the theory may have validity, it is only one analysis and appropriate application is critical to its effectiveness for speed prediction and control. Two key variables in the calculation are the distance available to accelerate prior to the exit crosswalk and the acceleration rate itself. If available acceleration distance is kept short, the exit speed may not be greatly affected. However, in larger diameter roundabouts, the available distance to accelerate may have an appreciable effect on exit speed. This may be particularly true for multi-lane roundabouts. The acceleration rate chosen for design will also have an effect on the predicted speed. The research used a rate of 3.5 ft/sec^2 for exit speed calculations. This is not a particularly fast rate of acceleration and may be acceptable for a curvilinear acceleration rate for small to moderate radii transitioning to the exit. However, some roundabout designs are utilizing large exit radii that become almost tangential. In these designs, it would be expected that vehicles would be accelerating from R_2 to the exit at a rate greater than 3.5 ft/sec^2. NCHRP Report 672, Roundabouts: An Informational Guide uses 6.9 ft/sec^2 for an acceleration rate in similar equations. This is nearly twice the rate used in the Baranouski/Waddell research and may be a better estimation when considering that the current vehicle fleet is capable of maximum performance, straight line acceleration rates of 9 ft/sec^2 for a four cylinder compact car to over 20 ft/sec^2 for a high performance eight cylinder vehicle with the average for all vehicles about 13 ft/sec^2. (See Table P–2 attached, Maximum Performance – Straight Line Acceleration by Vehicle)

The Baranowski/Waddell research is significant in that it shows the role R_2 can play in controlling exit speed when alignments incorporate smaller curvilinear radii and short acceleration distances between R_2 and the exit crosswalk. However, for larger radius or tangential exits, the acceleration rate for predicted speed calculations may need to be increased to better represent conditions as available acceleration distances increase.

P.1.2 NCHRP Report 572, Roundabouts in the United States

Rodegerdts, Blogg, Wemple, Myers, et al (2007)

NCHRP Report 572 was a research project that investigated roundabouts in the United States and analyzed their operation. Authors of NCHRP Report 572 collected data from 103 roundabouts from around the United States. One of their findings indicated that observed entry and exit speeds did not always correlate well to the predicted entry and exit speeds determined for a given roundabout using the speed, radius relationship. The predicted speeds tended to be greater than the observed speeds. This was particularly evident for roundabouts with tangential or large entrance or exit radii. However, the speed, radius relationship did well in predicting observed circulating speeds through the R_2 and the R_4 pathways around the central island. It is unclear as to why the speed, radius relationship is effective to predict speeds for pathways around the central island radius, but is not as effective when predicting speeds in relation to entry and exit radii when correlated to observed speeds at specific roundabouts. From their observations and analysis, the authors developed equations that, in some locations, may better predict entry and exit speeds based on vehicle deceleration and acceleration ability. Like the previous research work done in 2004, these equations include vehicle deceleration and acceleration parameters based on observations and analysis and use the standard equation for uniform acceleration as a basis. These equations are also presented in NCHRP 672, Roundabouts: An Informational Guide, second edition (2010) to calculate predicted values for V_1 and V_3 along a vehicle's fastest path as it enters and exits a roundabout. The guide suggests these equations can be used as an alternative to using values derived from the simplified speed, radius relationships. However, as a cautionary statement, since predicted V_2 values derived from the speed, radius relationship seem to correlate to observed V_2 values, there may be other factors involved like driver behavior, driver expectation, driver familiarity, etc. affecting the correlation of predicted exit speeds and observed exit speeds rather than straight forward correlations to radial path, speed or acceleration.

Equation 4 – Alternative Entrance Speed Calculation, V_1

$$\boldsymbol{V_1} = \frac{\mathbf{1}}{\mathbf{1.47}}\sqrt{(\mathbf{1.47}\boldsymbol{V_2})^2 + \mathbf{2}\boldsymbol{a_{1,2}}\boldsymbol{d_{1,2}}}$$

V_1 = entry speed, mph

V_2 = circulating speed based on path radius, mph

$a_{1,2}$ = deceleration between point of interest along v_1 path and mid-point of V_2 path, = -4.2 ft/s^2

$d_{1,2}$ = distance between point of interest along V_1 path and mid-point of V_2 path, ft.

The deceleration rate of -4.2 ft/s^2 for entry speed was developed from the observed driver/vehicle behavior at the researched sites. While this equation had better correlation predicting entry speed with observed speed, the authors also included the following statement in NCHRP 572:

> *"However, given the hesitancy currently exhibited by drivers under capacity conditions, the observed entry speeds may increase over time after drivers acclimate further. Therefore, the research team believes that an analyst should be cautious when using deceleration as a limiting factor when establishing entry speeds for design. Furthermore, the research team believes that a good design should rely more heavily on controlling the entry path radius as the primary method for controlling entry speed, particularly for the fastest combination of entry and circulating path (typically the through movement)."*

NCHRP Report 672, Roundabouts: An Informational Guide, second edition also addresses this concern and states:

> *"Analysts should use caution in using deceleration as a limiting factor to establish entry speed for design. To promote safe design, deflection of the R_1 path radius should be the primary method for*

controlling entry speed. Therefore, while Equation 6-3 may provide an improved estimate of actual speed achieved at entry, for design purposes it is recommended that predicted speeds from Equation 6-1 be used."

(Note: In this White Paper, NCHRP Report 672 Equation 6-3 and Equation 6-1 are reported as Equation 4 and Equation 1 respectively)

Similar to entry speed, NCHRP Report 572 developed an equation that utilizes vehicle acceleration ability for predicting exit speed based on the standard uniform acceleration equation to better correlate predicted exit speed with observed exit speed for investigative purposes. As with the deceleration rate for entry speed, the report developed a vehicle exit acceleration value of 6.9 ft/s^2 from observed information.

Equation 5 – Alternative Exit Speed Calculation, V_3

$$\boldsymbol{V_3} = \frac{\mathbf{1}}{\mathbf{1.47}}\sqrt{(\mathbf{1.47}\boldsymbol{V_2})^{\mathbf{2}} + \mathbf{2}\boldsymbol{a_{2,3}d_{2,3}}}$$

V_3 = Exit Speed, mph

V_2 = circulating speed based on path radius, mph

$a_{2,3}$ = average acceleration between midpoint of V_2 path and the point of interest along V_3 path = 6.9 ft/s^2

$d_{2,3}$ = distance along vehicle path between midpoint of V_2 path and the point of interest along the V_3 path, ft..

The authors of NCHRP 572 did not provide a caveat for not using the alternate V_3 calculation method for design as was provided for the alternate V_1 calculation method. There is no explanation provided in the report to indicate why one calculation may be considered more valid than the other. One must remember the reason for the derivation of these equations. The intent was to provide a prediction of exit speed that better correlated to observed exit speed at roundabout locations. The use of these equations lies in the assumption that since the predicted exit speed using the speed, radius relationship is greater than the observed speed, there must be something affecting the speed, radius relationship at exits. Acceleration rates were determined to make a better correlation. However, it works fine for R_2,V_2 and R_4,V_4 predicted and observed values. There may be other driver behavior factors that also affect observed R_1,V_1 and R_3,V_3 relationships. The authors are concerned this is the case with entrance speed and the same may be true for exit speed. The derived equations use a single deceleration or acceleration rate determined from observed data. Applying these acceleration rates to large radius or tangential exits and small radius, tight curvilinear exits equally may not produce effective design results in both cases. Using the same rates for both exit types assumes acceleration in a straight line or in a large radius is the same as acceleration in a tighter curvilinear path. This may not be the case. Therefore, lowering the acceleration rate for smaller radius paths seems reasonable. The research done in 2004 used 3.5 ft/s^2 as an acceleration rate for their investigation into exit geometry. This seems a more reasonable acceleration rate for smaller radial paths. NCHRP 572 uses 6.9 ft/s^2 as an acceleration rate. This seems reasonable for larger radius or tangential exits and seems to represent where, by observation, American drivers currently feel comfortable when exiting a roundabout. However, will this rate increase as drivers become more familiar with roundabouts? This is a concern of the authors of NCHRP Report 572 for V_1 values.

In addition to determining an acceptable acceleration rate, the other two critical variables in these equations are the V_2 speed and the distance, d, over which the deceleration or acceleration can take place. Therefore, if a large radius or tangential exit is designed for a roundabout, the R_2 value must provide the appropriate design V_2 and the acceleration distance must be effective in limiting a vehicle's potential downstream speed to design values.

Figure P–4 is a hypothetical roundabout layout based on real roundabout dimensions that portrays potential differences in speed between a smaller curvilinear exit and a more tangential exit. The vehicle path alignment shown from lower left to upper right (green) assumes radii for R_1 and R_2 that provide a 20 mph V_1 and V_2. The curvilinear R_3 exit radius is shown as both 175 ft. and 125 ft. for illustrative purposes and correlates to a V_3 speed of 25 mph and 22 mph respectively. These V_3 values are based on the speed, radius equations discussed previously in this report and is shown in Table P–1, Figure P–1. For comparison, the speed, acceleration equation was used to calculate a predicted V_3 exit speed along the radial R_3 path. Since the exit radius is small, using the 3.5 ft/s² acceleration rate discussed previously and coupled with the relatively short acceleration distance shown, a predicted V_3 of 25 mph was determined. This is equal to the value predicted for V_3 using the speed, radius relationship for a 175 ft. exit radius. This is in line with the conclusions of the 2004 research report. However, keep in mind, this geometry has a smaller curvilinear alignment with a short acceleration distance that helps limit a vehicle's ability to accelerate. For comparison, increasing the acceleration rate for the calculation to the NCHRP Report 572 value of 6.9 ft/s² yields a predicted speed of 29 mph at the crosswalk. This is beginning to reach the unacceptable level for speed at the crosswalk when considering pedestrian safety.

Large radius or tangential exit geometry set for increased capacity or exit geometry opened up due to skewed approach alignments or other site specific parameters that might dictate positioning of roundabout elements may have equal or greater impact to potential vehicle speeds at the crosswalk.

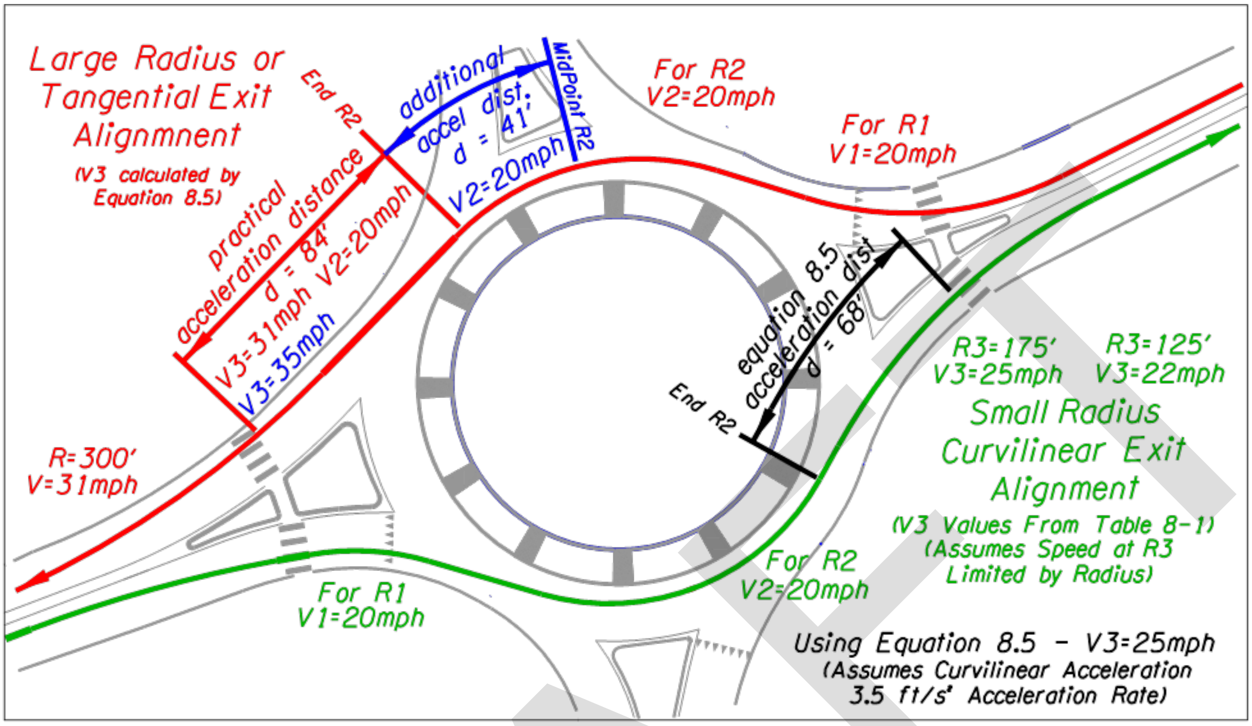


Figure P–4: Exit Geometry – Comparison Tangential and Small Radius

The vehicle path shown on the opposite side of the roundabout from upper right to lower left (red) in Figure P–4 also assumes radii for R_1 and R_2 that provide a 20 mph V_1 and V_2. However, the V_3 value of 31 mph is based on the potential for vehicle acceleration from the end of R_2 to the crosswalk. This distance is shown as a “practical acceleration distance”, d, and for this layout is equal to 84 ft. This distance assumes a driver does not accelerate until reaching the end of the circulating path radius R_2. This is the approach the researchers in 2004 preferred. However, the equation parameters listed in NCHRP 672, Roundabouts: An Informational Guide, second edition define the acceleration distance as the distance from the midpoint of the V_2 path and a point of interest along the V_3 path. The point of interest is the downstream crosswalk in this analysis. Adding the additional acceleration distance back along the path to the midpoint of R_2 and assuming a vehicle is capable of accelerating at 6.9 ft/s^2 along this reversing radial to tangential path, yields a total distance of 124 ft. that a vehicle can accelerate prior to the downstream crosswalk increasing the calculated V_3 speed to 35 mph. These calculated speeds are 6 mph and 10 mph faster than the predicted V_3 speed of 25 mph at the tighter curvilinear exit on the opposite path of the roundabout. Either of these speeds would be considered excessive for design at the downstream crosswalk. This exemplifies the need to limit the acceleration distance, d, to provide acceptable exit speed if a tangential or large radius design is used.

P.1.3 Conclusion

The two research projects discussed both used uniform acceleration in their calculations. However, they each used different rates of acceleration. Baranowski and Waddell used 3.5 ft/s² for acceleration. NCHRP Report 573 used 6.9 ft/s², which is almost double the rate used by Baranowski and Waddell. Both these rates appear to be rates that were field observed by the authors of the reports. The difference may be attributed to the focus of the individual research. Baranowski and Waddell were studying roundabout locations where they considered exit radii to be excessively tight to restrict speeds. Therefore, the observed rates of acceleration were compatible with the geometry. In the case of NCHRP Report 572, the authors were trying to correlate observed exit speed with predicted speed and they noted there was a greater discrepancy when the exit radius was large – predicted speed greater than actual observed speed. In these cases, it appears the acceleration rate was determined to match the observed speed and the 6.9 ft/s² value they determined in 2007 may in fact be a comfortable rate for American drivers at larger radius exits. This is further borne out when looking at potential 0 – 60 mph maximum performance characteristics of the current vehicle fleet. Table P–2 is a listing of maximum performance and straight line acceleration of various late model production vehicles ranging from 4 cylinder compact cars to high performance 10 cylinder "muscle cars". The data was collected from the on-line automotive sight AutoRooster at http://www.autorooster.com. The site reports 0-60 times for a variety of current vehicles. The corresponding accelerations were calculated and added to the table as 60 mph acceleration values in ft/s². The acceleration values ranged from 9.09 ft/s² for a 2008 Honda Civic, 4-cylinder vehicle to 24.50 ft/s² for a 2010 Dodge Viper, 10-cylinder vehicle. The mathematical average for all the vehicles in the table is 12.89 ft/s². This indicates that the 6.9 ft/s² value determined from observed speeds in NCHRP Report 572 may be an acceptable overall value as a "comfortable" acceleration rate to most drivers, since the average in Table 2 of 12.89 ft/s² was determined from maximum, straight line performance.

Currently, there is no definitive answer to what is the best method to predict entrance and exit speed when designing a roundabout. Research has shown that in some cases where exit radii are smaller and/or acceleration distances are short limiting a vehicle's ability to accelerate prior to the exit crosswalk, opening up exit geometry may not have a great effect on exit speed. However, relaxed exit geometry that increases acceleration distances and acceleration rates can potentially have significant effects on the exit crosswalk impacting pedestrian movements. This is particularly true for multi-lane roundabouts in off-peak times when a vehicle's fastest path may cross adjacent lanes. In any roundabout layout, it is the designer's responsibility to provide vehicle alignments that consistently control vehicle speeds from entrance to exit in an effective manner for all modes of transportation utilizing the roundabout. For this reason, after the above discussion, it seems reasonable to use roundabout entrance and exit alignments that limit a driver's ability to accelerate prior to the exit crosswalk and it appears that a good method to do that is the standard radius, speed relationship.

Table P–2: Maximum Straight Line Acceleration Performance by Vehicle

Maximum Performance - Straight Line Speed, Acceleration

Data From AutoRooster (autorooster.com/0-60-times)

Vehicle Data	0-60 (sec)	1/4 mile (sec)	60 mph dist (ft)	60 mph acel (ft/sec²)
2008 Honda Civic, 4cyl	9.7	17.1	427.8	9.09
2010-12 Nissan Versa, 4 cyl	9.4	18.3	414.5	9.38
2013 Ford Escape, 4 cyl	9.3	17.4	410.1	9.48
2011-14 Chevy Cruze, 4 cyl	9.0	16.5	396.9	9.80
2009-12 Toyota Corolla. 4 cyl	8.9	16.7	392.5	9.91
2010-13 Chevy Tahoe, 8 cyl	8.5	16.9	374.9	10.38
2013 Ford Fusion, 4 cyl	8.5	16.9	374.9	10.38
2014 Ford Focus, 4 cyl	8.5	16.7	374.9	10.38
2012 Toyota Camry, 4 cyl	8.3	15.6	366.0	10.63
2011-12 Dodge Caravan, 6 cyl	8.1	16.7	357.2	10.89
2014 Chevy Impala, 6 cyl	8.1	16.3	357.2	10.89
2012-14 Ford Explorer, 4 cyl	7.8	15.9	344.0	11.31
2013 Honda Accord, 4cyl	7.7	15.8	339.6	11.45
2013 Nissan Altima, 4 cyl	7.1	15.5	313.1	12.42
2012 Mercedes S Class, 6 cyl(D)	7.0	15.3	308.7	12.60
2013 Toyota Avalon, 6 cyl	6.8	15.3	299.9	12.97
2012 Mercedes C Class, 4 cyl	6.8	15.3	299.9	12.97
2011-13 Ford F-150, 6cyl	6.5	15.3	286.7	13.57
2012-13 BMW 5 Series, 4 cyl	6.1	14.5	269.0	14.46
2012-13 Chevy Camero, 6 cyl	6.0	14.4	264.6	14.70
2009-12 Nissan Maxima, 6 cyl	5.8	14.4	255.8	15.21
2012-12 BMW 3 Series, 4 cyl	5.6	14.4	247.0	15.75
2011-13 Ford Mustang, 6 cyl	5.3	14.0	233.7	16.64
2014 Chevy Corvette, 8 cyl	3.9	12.1	172.0	22.62
2008-10 Dodge Viper, 10 cyl	3.6	11.9	158.8	24.50

Avg, 12.89 ft/s²

Appendix Q

Analysis for Roundabout Entrance & Exit Geometry

MAP 21 - NHS STANDARDS NHS EXPANSION WORKING GROUP

A..1 Roles and Responsibilities (FHWA, ODOT, LOCAL AGENCY)

Some of the current process and procedures (Local Agency Guidelines) established between local agencies and ODOT for project review have changed with the additional National Highway System (NHS) routes. FHWA, through a letter of authority dated March 13 2013, authorizes ODOT to allow certified Local Public Agencies to perform work, in areas in which they have been certified, on federal-aid projects when the projects are on locally owned arterials that are part of the National Highway System. Additionally, ODOT may, at the discretion of FHWA and ODOT, allow Certified Local Public Agencies to administer federal-aid projects that are part of the National Highway system on ODOT-owned arterials subject to the Stewardship Agreement between FHWA and ODOT. ODOT shall assure that the projects on the NHS will follow AASHTO design standards or ODOT design standards if on an ODOT facility.

Other Certified Agency projects (federally funded), non-certified local agency projects (regardless of funding source) on state jurisdiction roadways, and non-certified local agency projects on local agency jurisdiction projects (federally funded) will continue to use the current processes and procedures in place between the local agency and the ODOT Regions. The addition of NHS routes will not change how these projects are processed. The only remaining type of projects that will follow a new procedure are those local agency projects on local agency jurisdiction roadways that have no federal or state funding associated with those projects, and are on roadways that were added to the NHS by MAP-21. These local projects will need to be submitted to ODOT's Technical Services Traffic-Roadway Section for review via the established audit process outlined below. Certified Agency NHS projects on local agency jurisdiction roadways, which have no federal dollars, will also need to be submitted to ODOT Technical Service's Traffic-Roadway Section for review via the audit process. Below is a matrix to assist in providing direction for local agencies and ODOT to address MAP-21 and the addition of NHS routes, followed by a discussion on roles and responsibilities.

Table Q-1: MAP-21 NHS Roles / Responsibility Matrix

PROJECT CATEGORY	**PROJECT TYPE (CERTIFIED AND NON-CERTIFIED) ON NATIONAL HIGHWAY SYSTEM**			
	CERTIFIED AGENCY (CA)	NON-CERTIFIED AGENCY		NON-CERTIFIED AGENCY AND CERTIFIED AGENCY (CA)
PROJECT JURISDICTION (STATE/LOCAL AGENCY)	Local Agency Project on Local Agency Roadway	Local Agency Project on State Jurisdiction Roadway	Local Agency Project on Local Agency Roadway	Local Agency Project on Local Agency Roadway
FUNDING SOURCE	Federal	Local/State/or Federal	Federal	Local
TYPES of PROJECTS	New Construction/Reconstruction (4R), Reconstruction, Resurfacing, Restoration, Rehabilitation (3R), Development Review			
DESIGN EXCEPTIONS	**Approved by CA** · ODOT will approve design exceptions for all projects on an ODOT facility and on bridges on the ODOT inventory list · Audit process as identified by Local Program agreements. No change in process for CA's	**Approved by ODOT** · No change from current process used by Local Agency and ODOT Region	**Approved by ODOT** · No change from current process used by Local Agency and ODOT Region	**Approved by Local Agency** · Local Agency provides ODOT with list of projects, contract plans, specifications, and design exceptions on project by project or yearly basis for audit. Local Agencies submit information to ODOT Technical Services Traffic-Roadway Section for audit procedures.
PLAN REVIEWS (New Construction Reconstruction) (Resurfacing, Restoration, Rehabilitation-3R) (Development Review)	**Approved by CA** · Audit process as identified by Local Program agreements. No change in process for CA's	**Reviewed by ODOT** · No change from current process used by Local Agency and ODOT Region	**Reviewed by ODOT** · No change from current process used by Local Agency and ODOT Region	**Reviewed by Local Agency** · As with Design Exceptions, Local Agency provides ODOT with a list of projects, contract plans on a project by project or yearly basis for audit. Local Agencies submit information to ODOT Technical Services Traffic-Roadway Section for audit procedures.

AUDIT PROCEDURES				Audit Procedure- ODOT shall select a percentage of projects to perform a quality assurance type audit. Projects selected should consist of a sample of modernization, preservation, and developmental review projects.

A..2 Local Agencies

A..2.1 CERTIFIED AGENCIES

Certified Agencies are to use the same review process for projects as they do today with the following caveat. Those Certified Agency projects on the NHS that use local agency dollars only and are on local agency jurisdiction roadways are to submit those projects to ODOT Technical Services' Traffic-Roadway Section for audit purposes. Submittals are to include a listing of project or projects (if on a yearly basis), contract plans, specifications, and signed design exceptions. Submittals are also to include a design narrative providing justification for those projects that use lane widths less than 12 feet and vertical clearances of less than 16 feet. Types of projects to be submitted include: new construction and reconstruction (4R); resurfacing, restoration, and rehabilitation (3R); and development review. Design exceptions are to be approved by the Certified Agency.

A..2.2 Non-Certified Local Agencies

Non-Certified Local Agencies are to use the current process development for non-certified local agencies projects that use federal, state, or local dollars on state jurisdiction roadways and non-certified local agency projects that use federal dollars on local agency jurisdiction roadways. Those non-certified local agency projects on the NHS that use local agency dollars, and are on local agency jurisdiction roadways are to submit those projects to ODOT Technical Services' Traffic-Roadway Section on a project by project or yearly basis for audit purposes. Design exceptions are to be approved by the local agency. Submittals are to include a listing of project or projects (if on a yearly basis), contract plans, and signed design exceptions. Submittals are also to include a design narrative providing justification for those projects that use lane widths less than 12 feet and vertical clearances of less than 16 feet. Types of projects to be submitted include: new construction and reconstruction; all resurfacing, restoration, and rehabilitation (3R); and development review.

A..3 Region Tech Centers

Region Tech Centers are to continue with the review process that is currently in place today for Certified and Non-Certified Local Agency projects with the following caveat: Local projects on the NHS that use local agency funding and on local agency jurisdiction roadways will be submitted by the Local Agency directly to Technical Services' Traffic-Roadway Section. Information submitted to Techical Services will include; a listing of project or projects (if on a yearly basis), project plans, and signed design exceptions. This same procedure will be used for Certified Agency NHS projects on local jurisdiction roadways that use local agency only funding.

A..4 Technical Services (Traffic-Roadway)

Technical Services Staff shall perform an audit on those projects received. Initially, a percentage of the projects received will be selected for audit. Primary purpose of the audit is to review the projects for compliance with AASHTO design standards and to review local agency approved design exceptions for adequacy. Audit results will be used by ODOT to determine the effectiveness of current process and to determine if adjustments in the establish project review process are needed.

MAP 21 – NHS IMPACT AASHTO STANDARDS

A..1 Lane Width / Truck Volume Guidance

At the 1/30/2013 MAP 21- NHS Standards impact meeting with FHWA, ODOT, City and County Agency, and Local Program, discussion occurred concerning interpretation of AASHTO standards. One of the areas where the local agencies requested AASHTO interpretation was guidance of AASHTO lane width requirements when trucks are present. Below is a general discussion on the subject and recommended guidance. ODOT uses the Highway Design Manual for lane and shoulder width requirements on state highways. The discussion outlined below does not change the ODOT requirements for any project on the state highway system, and is only intended to provide guidance to local agencies who are looking for direction for local agency projects that are on local agency jurisdiction roadways only, do not have any state or federal funding involved, and the roadway in question is on the NHS.

AASHTO's *"A Policy on Geometric Design of Highways and Streets"* (Green Book), provides guidance on rural and urban arterials. Rural and Urban Principal arterials are the highest level of roadway functional classification (interstates, other freeways and expressways, and other principal arterials) and have the following characteristics: corridor movement with trip and length density for substantial statewide or interstate travel; movements between areas with populations over 25,000; carry most of the trips entering and leaving an urban area; carry important intra-urban as well as intercity bus routes; and provide continuity for all rural arterials that intercept the urban boundary. AASHTO provides separate discussion between rural arterials and urban arterials.

A..1.1 Rural Arterials

Section 7.2.3 (Cross-Sectional Elements) outlines roadway width requirements for rural arterials. Roadway widths (lane and shoulder) to be provided are related to traffic volume, design speed, and Average Daily Traffic (ADT). Table 7-3 outlines the minimum lane and shoulder width. For any design speed and ADT of over 2000, lane width and usable shoulder width requirements are 12' and 8' respectively. AASHTO does allow existing travel roadway widths to be maintained where alignments are satisfactory and where there is no crash pattern suggesting the need for widening. This section does not note specific requirements for trucks, although reference to chapter 4 notes that 12' lanes predominately being used on most high-speed, high volumes highways. The section also notes the 12' lane provides desirable clearances between large commercial vehicles traveling in opposite directions on two-lane, two-way rural highways when high traffic volumes and particularly high percentages of commercial vehicles are expected.

A..1.2 Urban Arterials

Section 7.3.3 (Cross-Sectional Elements) outlines the lane width requirements for urban arterials. Below is AASHTO text regarding lane width:

"Lane widths may vary from 3.0 to 3.6 m [10 to 12 ft]. Lane widths of 3.0 m [10 ft] may be used in more constrained areas where truck and bus volumes are relatively low and speeds are less than 60 km/h [35 mph]. Lane widths of 3.3 m [11 ft] are used quite extensively for urban arterial street designs. The 3.6 m [12 ft] lane widths are desirable, where practical, on high-speed, free-flowing, principal arterials."

"Under interrupted-flow operating conditions at low speeds (70 km/h [45 mph] or less), narrower lane widths are normally adequate and have some advantages. For example, reduced lane widths allow more lanes to be provided in areas with restrictive right-of-way and allow shorter pedestrian crossing times because of reduced crossing distances. Arterials with reduced lane widths are also more economical to construct. A 3.3 m [11-ft] lane width is adequate for through lanes, continuous two-way turn lanes, and lanes adjacent to a painted median. Left-turn and combination lanes used for parking during off-peak hours and for traffic during peak hours may be 3.0 [10 ft] in width. If provision for bicyclists is to be made, see the AASTHO Guide for the Development of Bicycle Facilities."

"If substantial truck traffic is anticipated, additional lane width may be desirable. The widths needed for all lanes and intersection design controls should be evaluated collectively. For instance, a wider right-hand lane provides for right turns without encroachment on adjacent lanes may be attained by providing a narrower left-turn lane. Local practice and experience regarding lane widths should also be evaluated."

A..1.3 Lane Width Guidance

In addition to AASHTO guidance, research has looked at lane widths. In literature review on the subject, the lane width topic, similar to AASHTO, discusses other features of the roadway and surrounding area in choosing an appropriate lane width. For example, truck volume is a significant feature that should be considered when arriving at a lane width. Although not specifically prescribing a lane width, research has indicated that there appears to be general agreement that narrower lanes do not lead to operational problems when truck volumes are less than 5 percent and use of narrower lanes should be discourage on streets with more than 10 percent trucks. TRB Special Report 214, "Designing Safer Roads" is the base document for 3R standards and uses the 10% trucks (defined as heavy vehicles with six or more tires) as the measure of using a narrower lane width for preservation projects. Trucks are a greater concern on streets with horizontal curves and tractor-trailer combination trucks typically being wider than single-unit trucks, trucks have off-tracking and encroachment considerations regarding turning at intersections. AASHTO notes that speeds should be low, less than 35 mph and bus volumes should be low.

Below are some general guidance and some additional factors that should be considered when arriving at a lane width for urban areas. As previously mentioned, this guidance is intended for local agencies that are looking for direction for local agency projects that are on local agency jurisdiction roadways only, do not have any state or federal funding involved, and the roadway in question is on the NHS. In discussions with FHWA, general direction has been to allow the Engineer to make a professional decision. The roadway jurisdiction's Engineer of Record is responsible for demonstrating that the selected lane width is within AASHTO guidance and includes consideration of the parameters below. Although a specific lane width is not prescribed, the parameters (not all inclusive) discussed below are intended to provide a thought process to use when arriving at a lane width.

A. GENERAL GUIDANCE - AASHTO

- 12' lane widths are desirable, where practical, on high-speed, free-flowing, principal arterials
- 11' lanes are used quite extensively for urban arterial street designs
- ADT- AASHTO (Rural Arterials) - Uses ADTS over 2000 (at any speed) as the threshold for use of 12' lanes.
- Additional lane width is desirable when significant truck traffic is anticipated
- Speed- AASHTO- Lower speed areas (< 35 mph) may be locations to consider a narrower lane

B. JURISDICTIONAL DESIGN GUIDANCE

- Does the jurisdiction have design standards?
  - What are the principal arterial standards?
- Does the jurisdiction have truck accommodation guidance?
- Does the jurisdiction have planning design guidance outside of design standard guidance?

C. OTHER CONSIDERATIONS

1. Trucks - Consider the width of a standard truck (10.5' mirror to mirror)

   - Truck Volumes- <10% trucks (Six or more tires) has been used as the point where a narrower lanes are considered
   - Is the roadway a truck route?
   - Is the roadway part of a freight corridor?

Is the roadway in an area where land uses (commercial, industrial) have regular freight deliveries made?
Are the trucks that use the roadway single-unit vehicles or tractor-trailer combinations?
Do over-dimensional loads use the route?
Are there multiple turns to and from the roadway? (off-tracking)

2. Transit

Is the roadway part of a bus route?
Are there multiple bus routes on the roadway?
Are there multiple turns to and from the roadway? (off-tracking)

3. Bicycle/Pedestrian

Does the roadway have bicycle lanes?
Are there significant numbers of bicyclists?
Does the roadway have sidewalks?

4. Roadway Typical/Geometrics

Is the roadway a couplet or is it a two-way roadway?
Is the roadway multiple lanes?
Are there turn lanes separating opposing through lanes?
Is the route used by emergency response vehicles?
Does the roadway have on-street parking?
Do curb extensions impact off-tracking at intersections?
Is “shy” distance used?
Does the roadway have horizontal curvature? (off-tracking)
Is the roadway superelevated? (off-tracking)

5. Land Use/Context

Are the land uses primarily residential, commercial, or industrial?
What are the primary land uses of the corridor?
Is the corridor used by thru vehicles that serve commercial and industrial vehicles?