Oregon Department of Transportation

# Highway Design Manual

Delivery & Operations Division | Traffic Roadway Section

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## Preface

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# 2023 HIGHWAY DESIGN MANUAL

## PREFACE

The 2023 Highway Design Manual provides uniform standards and procedures for the Oregon Department of Transportation (ODOT). It is intended to provide the standards and guidance for the design of all projects, and is used in conjunction with Technical Bulletins, Technical Directives, Technical Advisories, and relevant guidance documents. It is generally in agreement with the American Association of State Highway and Transportation Officials (AASHTO) document "A Policy on Geometric Design of Highways and Streets – 2018". However, sound engineering judgment must continue to be a vital part in the process of applying the design criteria to individual projects. The flexibility contained in the 2023 Highway Design Manual supports the use of Performance-Based Practical Design concepts and Context Sensitive Design practices.

The 2023 Highway Design Manual is to be used for all projects that are located on the State highways. National Highway System or Federal-aid projects on roadways that are under the jurisdiction of cities or counties will typically use the 2018 AASHTO design standards or ODOT 3R design standards. State and local planners will also use the manual in determining design requirements as they relate to the state highways in Transportation System Plans, Corridor Plans, and Refinement Plans.

Use of the 2023 Highway Design Manual is required on all projects with the Plans, Specifications, and Estimates (PS&E) milestone on and after January 1, 2023. Projects that reach the PS&E milestone before January 1, 2023 may implement the 2012 or 2023 Highway Design Manual. The 2023 Highway Design Manual will replace previous versions of the Highway Design Manual. It is not a legal document.

Michael J. Kimlinger, P.E.

Chief Engineer

# ACKNOWLEDGEMENTS

Many teams and individuals contributed to this body of work in writing and reviewing. This effort was completed in addition to the existing workload those people have and that is very much appreciated by the users of this manual.

Review teams included the Region Technical Centers, ODOT Maintenance, Engineering and Technical Services Branch, Statewide Project Delivery, ACEC, and members of those groups.

Federal Highway Administration, Oregon Division reviewed and approved the use of this manual.

The Roadway Engineering Unit in the Engineering and Technical Services Branch led the effort in writing, editing, and formatting the text of this document. Specifically these dedicated individuals:

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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 for urban projects 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.

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.

# 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.

**Certified Local Public Agency** - A local agency that has achieved or maintains certification per the processes in Section B of the ODOT Local Agency Guidelines for Certified Local Public Agencies. https://www.oregon.gov/odot/LocalGov/Pages/LAG-Manual.aspx

**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 judgment 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. | - | 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)

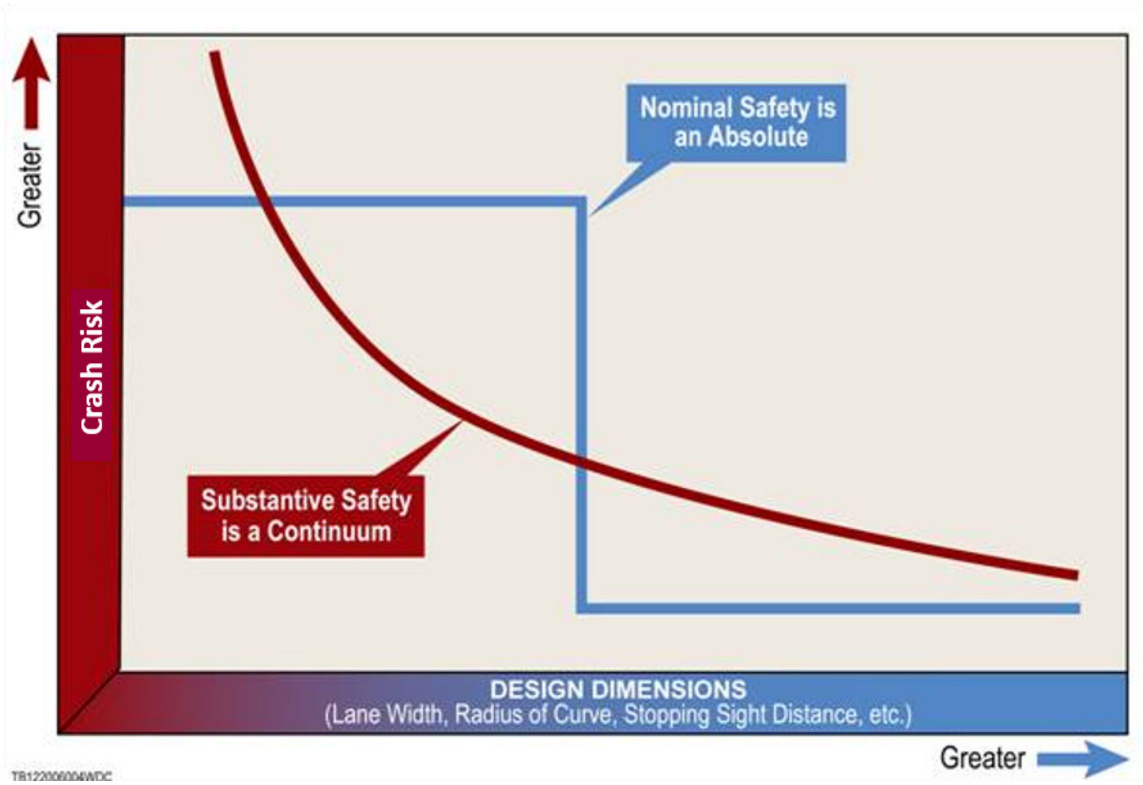
In addition to ODOT's Practical Design philosophy and multi-modal transportation design, the BUD and its context and majority of content was an interim document bridging the gap between its inception and the update of the HDM. The BUD content is incorporated into this HDM update.

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 concepts with Practical Design as Performance-Based, Practical Design.
4. Starts at the highest level of protection for pedestrians, bicyclists, and other users of the pedestrian and transition cross-section realms (Cross-section Realms, see Section 107).
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 is it 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. However, design and operation focused on the crossroad that allows some queuing on the ramp is an acceptable trade-off to accommodate and balance the urban modal needs on the crossroad.

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 or preservation projects 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, for urban projects, 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. In many cases, it is beneficial to not only document what the project is accomplishing, but to also document what isn't being done or can't be done with the specific project and why. This is particularly important on preservation type projects where project scope is limited. As previously noted, the Roadway designer is responsible for the final compilation of the Urban Design Concurrence document. The Urban Design Concurrence (UDC) 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 design 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.

## 105.1 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 integration 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 Bicycle and Pedestrian website.

Recent federal requirements and guidance have provided the ability to use flexible design to meet project goals and outcomes when integrating design for all road users. Incorporating guidance from innovative sources provides opportunities for enhanced facilities to accommodate specific needs. However, some documents are good on the concepts of what, but do not provide details on the how to actually design the elements into a roadway cross-section. As a result, while these innovative documents are a source of information and allowed with provisions as stated in the FAST Act, Section 1404(b), the final design must still meet state and/or federal design criteria when federal funds are being used. This is particularly true for roadways on the National Highway System, whether locally owned, state owned or federally owned. For questions relating to specific design criteria requirements for projects on local jurisdiction roadways, contact the ODOT Statewide Delivery Branch for information.

## 105.1.1 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.

## 105.1.2 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.

## 105.1.3 Americans With Disabilities 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.

## 105.1.4 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 predominant 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 23 USC Section 120(e) and FHWA website Special Federal Funding provides additional information on emergency relief and betterments. Work with the regional FHWA office to determine and document eligibility of emergency relief sites to describe and agree on the damage, scope of work to be performed, and estimated cost. For more information, see Section 120.

# 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 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

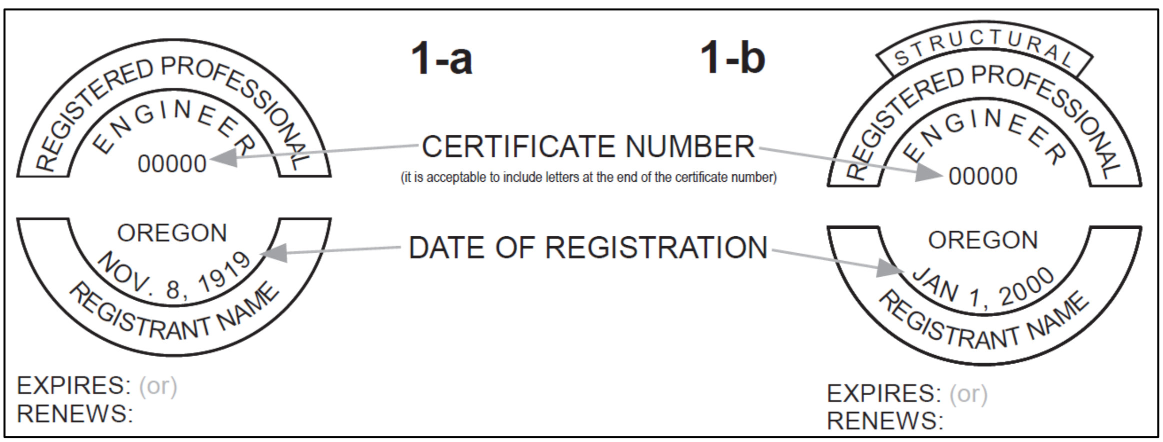


Figure 100-3: Land Surveyor and Photogrammetrist Seals from OAR 820-025-0005

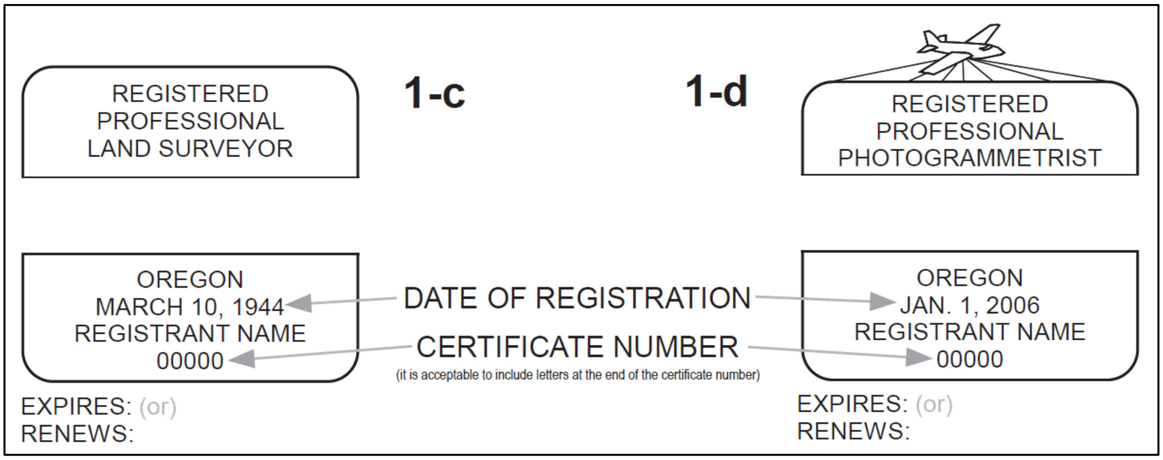



Figure 100-4: Water Right Examiner and Traffic Engineer Seals from OAR 820-025-0005

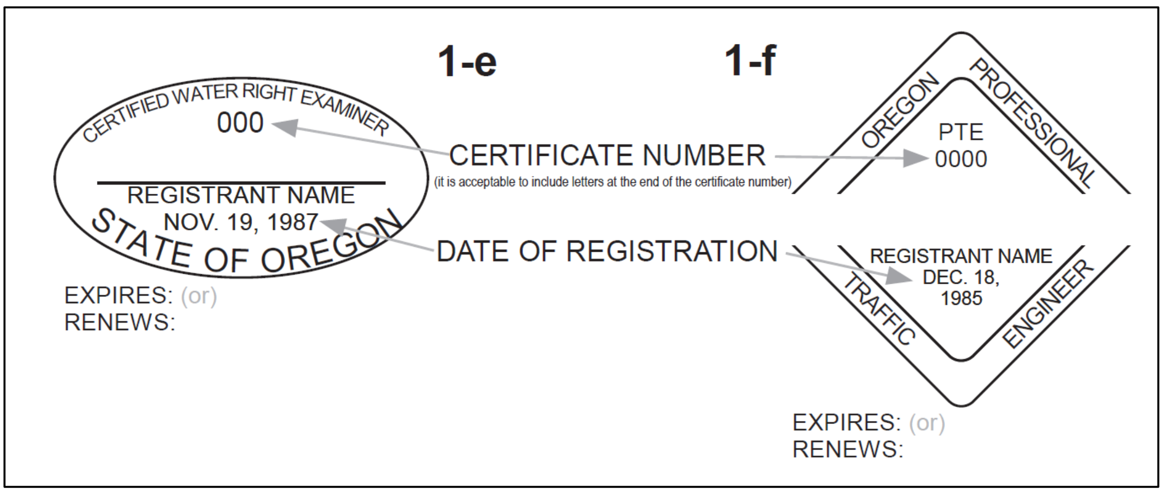
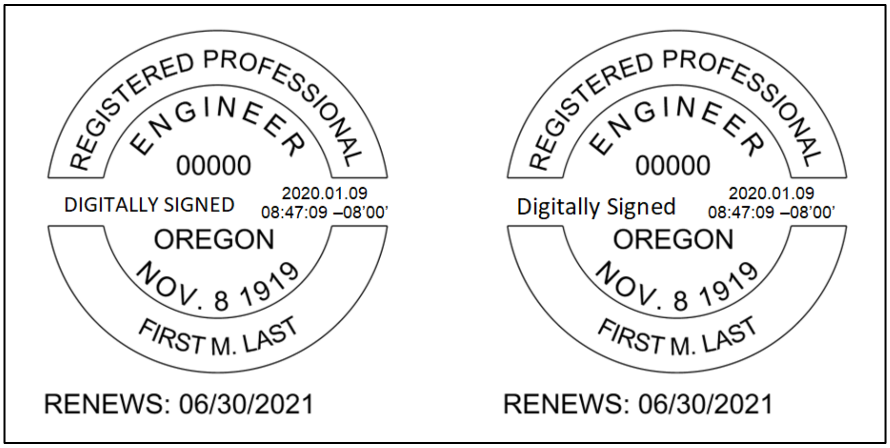


Figure 100-5: OSBEELS Digital Seal Examples




# 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".

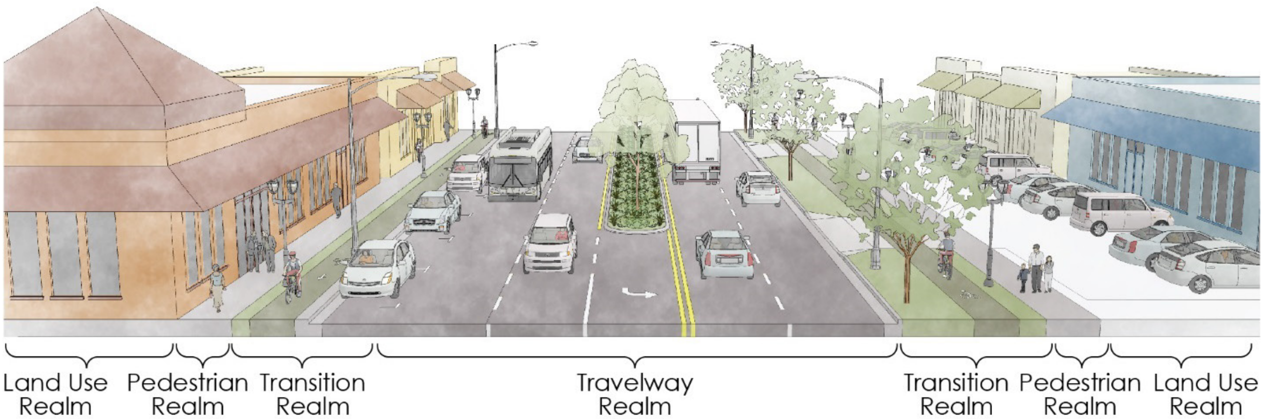
Performance-Based Practical Design is the next step in the evolution of roadway design from a contextual basis. Performance-Based Practical Design takes the concepts and principles of Practical Design and incorporates performance information to emphasize outcomes of design decisions as the primary measure 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 2023 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 judgment 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.

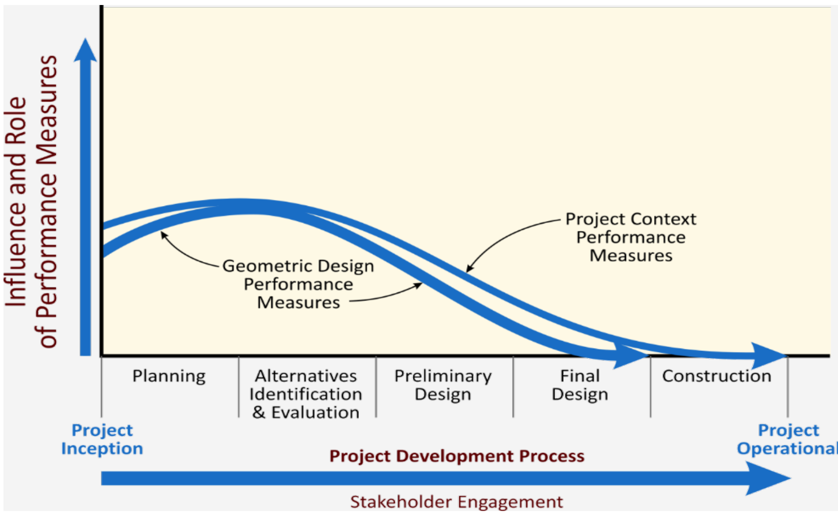
1. **Safety** - Overall system safety will not be compromised. The goal is to make the system as safe as practical. This does not mean settling for a lower level of safety, but instead,

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. **<u>Corridor Context</u>** - Practical Design takes the S.C.O.P.E. concept across a system, down to a corridor level, and applies 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. **<u>Optimize the System</u>** - 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. **<u>Public Support</u>** - 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. **<u>Efficient Cost</u>** - 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. Thereby, utilizing existing resources to establish appropriate project scopes that include different perspectives and discuss pertinent project information early in the project development flow. This helps 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 sections 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:

*2023 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 to when projects 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, county, regional, or MPO 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. In order to accommodate freight mobility, planning efforts should also consider the types and frequency of permitted freight loads through a corridor.

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

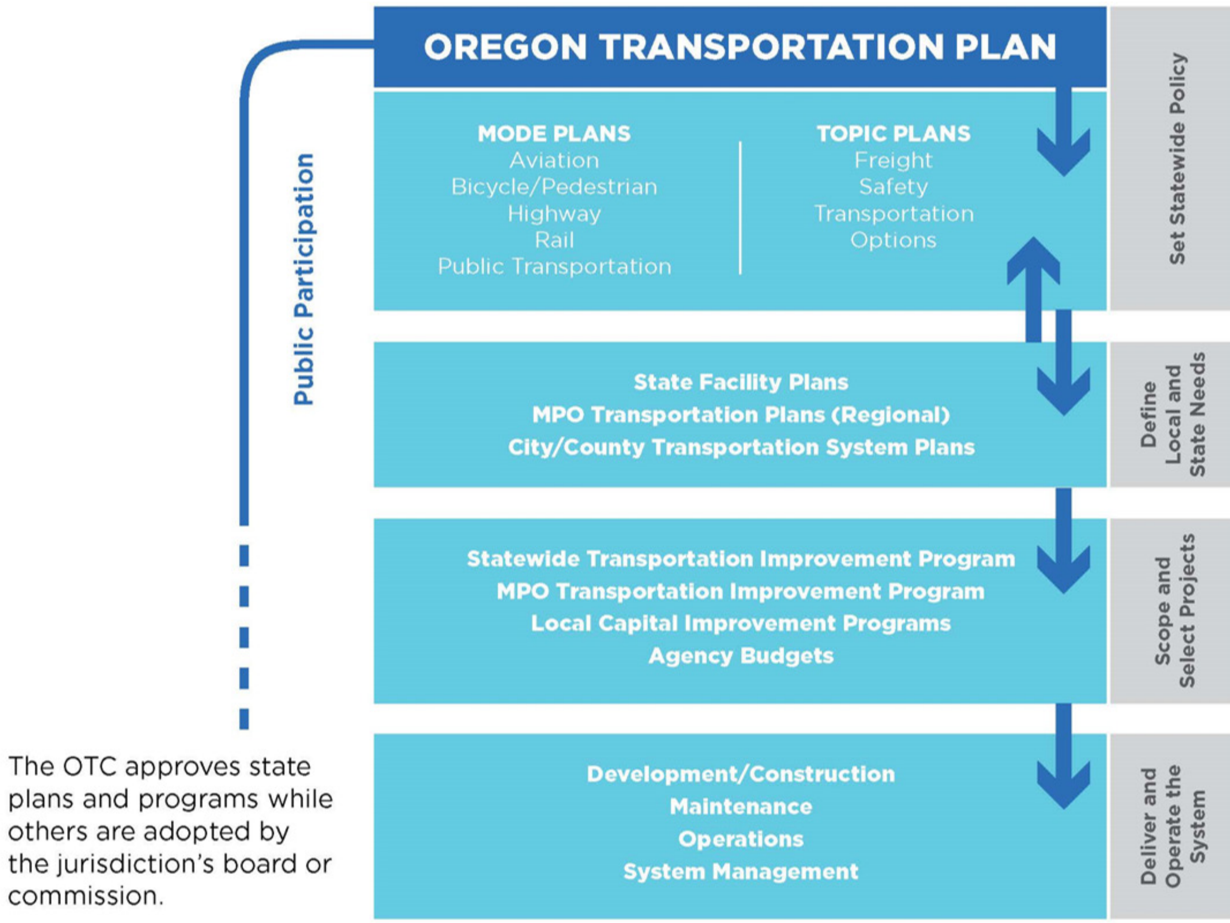
1. Bicycle and Pedestrian Bill (ORS 366.514)
2. Freight Reduction in Carrying Capacity Review (ORS 366.215) (OAR 731-012)
3. Transportation Planning Rule (TPR) (OAR 660-012-0060), including Section 8 and Section 10 related to Multimodal Mixed-Use Areas (MMA)
4. Oregon Highway Plan mobility standards/targets
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 provides 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 primarily for the state system. 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 Section 122 and is considered 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.

Projects may include a variety of design criteria. Utilizing a flexibility in design approach to projects, coupled with different funding sources available that may also be bundled for economy, 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)

Table 100-2: Potential Applicable Design Standards

| Work Type | 1R | 3R | 4R | AASHTO |
|---|---|---|---|---|
| **Modernization** | | | ✓ | |
| **Preservation:** Resurfacing | ✓ | ✓ | | |
| **Preservation:** Interstate Maintenance | ✓ | ✓ | | |
| **Safety Improvements** | | ✓ | ✓ | |
| **Operations** | | ✓ | ✓ | |
| **Maintenance** | ✓ | ✓ | ✓ | |
| **Misc./Special Programs:** Grant Project | | | ✓ | ✓ |
| **Misc./Special Programs:** Property Development Permit Projects | | ✓ | ✓ | |
| **Misc./Special Programs:** 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. However, it is important that permanent repairs should incorporate current design standards that do not materially change the function or character of the facility.

✓** - On or along the state highway

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.

# 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 of service. Since these are considered alterations and not reconstruction projects, the Oregon statute 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, safety analysis and inclusion of safety improvements or safety countermeasures is an important aspect of the 1R program. 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 funding is used and the added work will not delay the scheduled bid date. Additionally, 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 Documentation 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. For preservations design life expectation see ODOT Pavement Design Guide (ODOT PDG) Section 7.1 and other related guidance in the ODOT PDG.
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 used for 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 Preventive 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 several Parts of the HDM. ODOT 3R design criteria are located in Parts 200 and 300, which contain information dealing with pavement widths, horizontal curvature, superelevation, and other design areas 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, Guidelines for Integrating Cost-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 incidental benefit 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 project scopes, the application of 3R standards will typically involve substantial engineering judgment 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 all combine to determine trade-offs in respect to 3R projects and 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. However, 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 judgment, 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 judgment 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, sidewalk, walkways 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 be used 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-sensitive 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 as defined in the AASHTO Green Book.

New construction projects are projects constructed in a new location, new alignments where no existing roadway is present. Other New construction projects may include 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 projects can 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. Rural new construction projects typically achieve a 20 year service life for pavements. A 30 year pavement service life is required for urban corridors, bridge approaches, grade constrained underpasses, and railroad crossing.

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/New or upgraded facilities, including pedestrian, bicycle and transit 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

See the 2018 AASHTO Green Book, Section 1.7 for additional information on the definitions for New Construction, Reconstruction, and Construction Projects on Existing Roads.

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 is not 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 and federally funded. The FAST Act, Section 1404(b) provides for additional flexibility by providing for the use of other design guidance documents in conjunction with the AASHTO Green Book on locally owned NHS roadways where it is applicable.

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 in conjunction with other recognized guidance provided by provision from the FAST Act, Section 1404(b).

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 the following considerations:

- maintaining the existing roadway if the roadway in question is performing well or,
- making spot improvements to address crashes or,
- making operational improvement for specific needs, or
- making cost-effective design improvements that would be expected to reduce crashes

Chapter 1 of the 2018 Green Book, 7th Edition, 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 next update of the AASHTO Green Book, the 8th edition, will be a wholesale change from previous versions and will fully incorporate these concepts throughout the revision. The remainder of AASHTO's 2018 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 the AASHTO Green Book study and understand the concept of functional classification. The 2018 AASHTO 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 the AASHTOs Green Book without the correct functional class being known. When determining context, functional classification is balanced with land use classification. A functional classification of a roadway through a rural town might be considered as a rural arterial, since the town may not reach the minimum defined population density to be considered urban under federal classification guideline. However, the land use classification may be more urban with adjoining properties being commercial and retail businesses centered around a core. In this case, an urban context would be appropriate for design criteria decisions, balancing the functional roadway classification with the urban feel and needs of the adjacent land use.

# Section 115 Design Standards for Special Cases

Depending on the work to be done that does not 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 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 S.C.O.P.E. 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 prioritized 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 S.C.O.P.E. 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 federally funded 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 | Interstate State Highways | Urban State Highways | Rural State Highways | Urban Local Agency Roads [1] | Rural Local Agency Roads [1] |
|---|---|---|---|---|---|
| Modernization | ODOT 4R/New [2] Freeway | ODOT 4R/New [2] Urban | ODOT 4R/New [2] Rural | AASHTO/ or Other Federally Recognized Criteria | AASHTO/ or Other Federally Recognized Criteria |
| Preservation | ODOT 3R Freeway | ODOT 3R Urban | ODOT 3R Rural | AASHTO [3] Or Other Federally Recognized Criteria | ODOT 3R Rural [4] |
| Preventive Maintenance[5] | 1R | 1R | 1R | NA | NA |
| Safety-Operations-Miscellaneous/ Special Programs | ODOT Freeway [5] | ODOT Urban [5] | ODOT Rural [5] | AASHTO/or Other Federally Recognized Criteria | 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, with approval, select a standard of their own choice. Federal-aid projects must still comply with all applicable federal laws and regulations (e.g. ADA and historic preservation) when selecting standards for design. This discretion is given by ORS 368.036.and by provisions of the FAST Act, Section 1404(b), AASHTO standards are preferred to be used for all local agency jurisdiction roadway projects on the National Highway System (NHS). However, the FAST Act, Section 1404(b) provides guidance on flexibility and the use of other appropriate design guidance that can be used in conjunction with AASHTO design criteria, with approval.
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, other federally recognized criteria 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 contextual information around project outcomes and goals 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

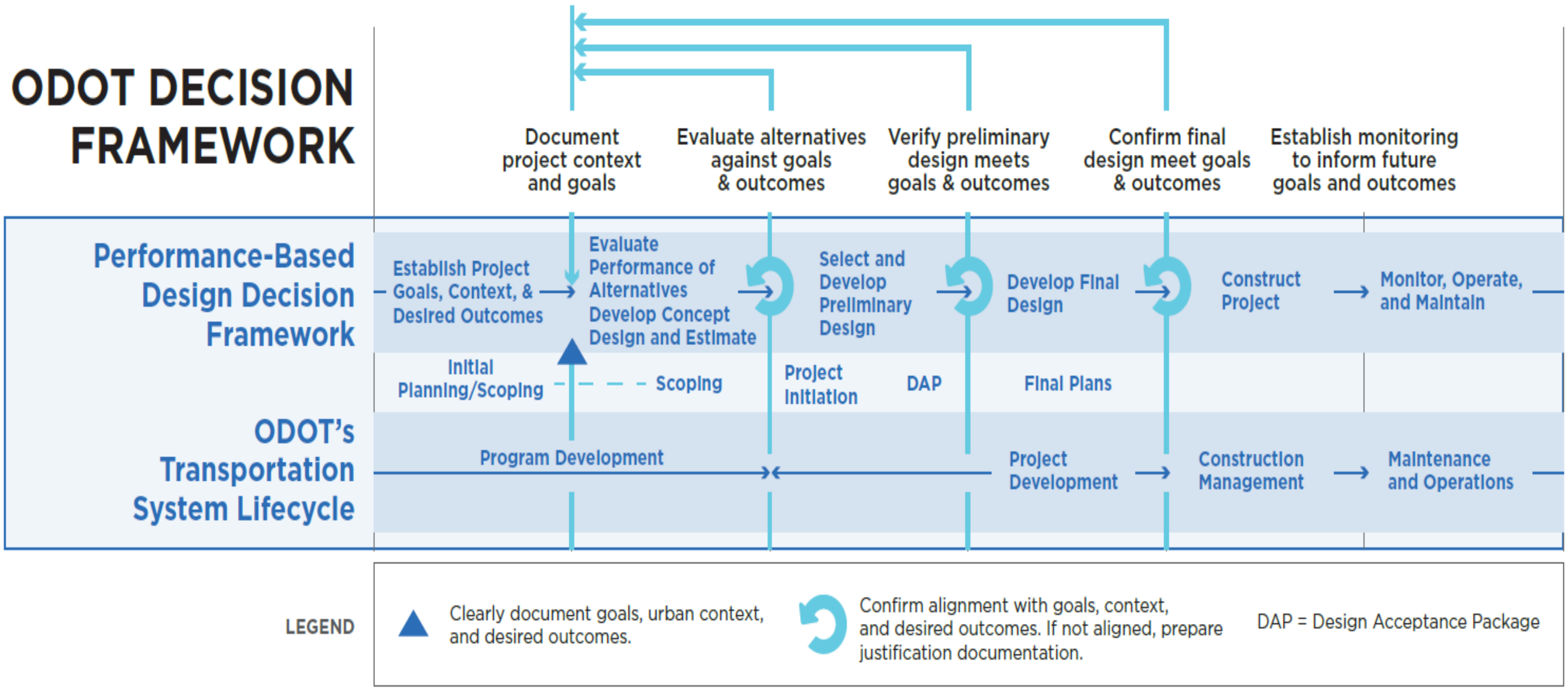


Figure 100-9 provides a multimodal decision-making framework and shows how this approach may become iterative at specific stages of the project. The process establishes links between planning and design to integrate and balance modal needs early in the decision-making. A draft UDC is produced from the scoping process to establish a concept design. The decision-making framework includes the following six stages:

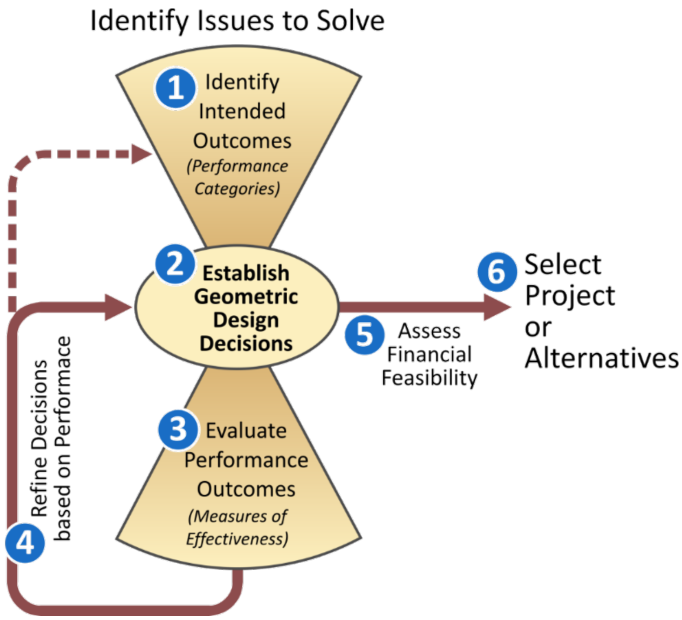
- Establish Project Goals, Context, and Desired Outcomes
- Evaluate Performance of Alternatives
- Select and Develop Preliminary Design
- Develop Final Design
- Construct Project
- Monitor, Operate, and Maintain

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. For urban projects, 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 recommended but does not meet HDM design criteria, an approved design exception is required (see Part 1000). If the change is approved by the team and it is deemed a scope change, a Change Management Request (CMR) may be needed.

## 117.1.1 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, Performance-Based Analysis of Geometric Design of Highways and Streets presents a performance-based model focused 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)

This performance-based approach is based on:

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 focused on safety and operational needs of all road users through qualitative analysis of trade-offs between design alternatives. 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 to make maximum use of techniques that provide safety performance analysis of the base design and design alternatives. 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. Table 100-4 shows the primary ODOT programs to fund and deliver transportation projects.

Table 100-4: 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)<br>• 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<br>• Leverage other projects to address multiple needs in project area<br>• 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, optimize safety impact (cost-benefit) | • Approved safety countermeasures list provides multiple options to encourage context appropriate design solutions | ODOT or Certified Local Agency |
| 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)<br>ODOT or Certified Local Agency (if federalized) |

Table 100-4 (Continued): Primary ODOT Programs to Fund and Deliver Transportation Improvements

| Program Type | Program Focus | How Are Projects Selected | Design Opportunities1 | Who Develops Project |
|---|---|---|---|---|
| State-Funded Programs | Preserve and/or enhance transportation system (generally smaller projects than STIP Fix-It or Enhance)<br>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<br>• Most flexible timeline (e.g., "Quick Fix" Safety or Pedestrian/Bicycle funds can be used for immediate improvements)<br>• Not subject to Federal requirements or required to be in STIP<br>• Can leverage other projects to address multimodal needs in project area or fund stand-alone projects | ODOT or Local Agency |
| 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<br>• Not subject to Federal requirements or required to be in STIP<br>• Consider opportunities to address needs through innovative design and/or to leverage developer funded improvements | ODOT or Local Agency |
| 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 |

Table 100-4 (Continued): Primary ODOT Programs to Fund and Deliver Transportation Improvements

| Program Type | Program Focus | How Are Projects Selected | Design Opportunities1 | Who Develops Project |
|---|---|---|---|---|
| Public Transit 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<br>• Can leverage other projects to address multimodal needs in project area or fund standalone projects | ODOT or Certified 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.

## 117.3.1 Establishing Project Goals and Desired Outcomes

Project goals and desired outcomes are identified early in the project flow. At a core, projects will have specific goals based on funding categories as in 1R Paving, 3R Preservation, 4R Enhance/Modernization or Safety focused projects. Safety and operational needs of all road users determined through performance analysis is also fundamental to project outcomes. 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.

## 117.3.2 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.

## 117.3.3 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. However, safety performance is primary to any set of project performance measures. For instance, a community may want to implement bicycle lanes on an ODOT arterial while minimally impacting traffic mobility. Along with safety performance measures of the proposed bicycle facility, 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.

While the concepts and design criteria from the Blueprint for Urban Design have been incorporated into the HDM, both volumes of the Blueprint for Urban Design remains as a reference document on the HDM web page. 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.

# 117.3.4 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 adjacent to 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.

## 117.3.5 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 S.C.O.P.E. 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 are 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 projects 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 in 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 of final plans 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.
    a. For preservation projects, contact ODOT Pavement Services as part of the Project Initiation tasks. This allows ODOT Pavement Services to schedule testing, complete testing, and complete Preliminary Design work prior to project kick-off with remaining project team members.
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. 1R+ projects are 1R projects that include additional items outside the scope of pavement preservation paving. The initial design criteria determination is based on the project being either preservation or modernization, so ensure that ODOT Pavement Preservation was contacted during the Project Initiation phase. 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 program 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 at project initiation and becomes part of the permanent project documentation. 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. Roadside safety is fundamental to the inventory process. Enough detail of the collected roadside items needs to be included for analysis to determine effects on roadway departure crashes and determine appropriate project scope for mitigation. 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 the ODOT "Virtual Highway Corridor" tool;
- 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. However, complete roadside inventory for 3R projects is important for identifying deficiencies and determining final scope. 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 may not need to be inventoried on every project. However, if objects are within the established clear zone, options to prevent or lessen potential vehicle impacts like delineation or shielding are a necessary consideration for need and feasibility.

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.

## 119.4.1 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
9. Drop-offs at Pavement Edge
10. Cattle and/or Equipment Pass Headwalls

# 119.4.2 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
7. Drop-offs at Pavement Edge
8. Cattle and/or Equipment Pass Headwalls

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 curb ramp and pedestrian ramp upgrades is an absolute minimum regardless of jurisdictional ownership of the sidewalks or walkway. Driveways, gaps deficiencies or obstacles in the sidewalk or walkway 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 pedestrians. 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.

## 119.5.1 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. Curb Ramps & Pedestrian Ramps
11. Bicycle Facilities
12. Sidewalks and Walkways

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, 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 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 is 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 Preventive 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 evaluating project context, asset condition, initial budget, identified risks, and potential 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 estimated 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, scoping team members should gather a large amount of asset information 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. Although, these will most probably need to be accurately identified and located during design phases. Only those objects near the roadway that constitute a substantial hazard should be inventoried for scoping. However, if there is a location with a number of run-off-the-road crashes (e.g. 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, early field work should be limited to the amount needed for estimated 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.

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

# Section 120 Motor Carrier Freight Considerations

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 Oregon Highway Plan (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. In addition, there are OHP designated Intermodal Connectors that are part of the National Highway System (NHS) connecting freight origin and destination points like ports, rail terminals or major industrial areas to arterial networks and interstate highways. These various designated routes are to provide a higher level of service and mobility than other statewide highways.

These Freight Routes will often be the most important facilities to local jurisdictions or small towns as their main street in addition to serving as connections for through truck traffic. As such, they should maintain an appropriate level of functionality for not only freight movements, but for all road users as well. 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 order to accommodate freight mobility, planning and design efforts should also consider the types and frequency of permitted freight loads through a corridor.

In addition to designated freight routes, 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. Although Route Map 7 includes all highways, it identifies those highways where the use of interstate size trucks are allowed and where design should accommodate those vehicles.

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.

# Section 121 FHWA Emergency Relief Program-Betterments

## 121.1 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 predominant 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. 23 USC Section 120(e) and FHWA website Special Federal

Funding provide additional information pertaining to the Emergency Relief - Betterments program application and funding.

# 121.2 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.

# 121.3 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 higher level of evaluation 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.

# 121.4 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.

# 121.5 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 122 References

## 122.1 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*

## 122.2 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. While ramp access and mobility are important for freeway (expressway) operation, in urban locations, some queuing may be desirable to allow for needed modal operations focused on the crossroad between the ramp terminals. There needs to be a balance between ramp operations, freeway mobility and the urban street network for overall safety of all road users. 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 need 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. Section 205 and Section 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 discusses 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 contexts and related 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 areas, ports, and major recreation areas | Provide connections for intra-urban and intra-regional trips | Provide safe and efficient, high-speed, continuous-flow operations |
| 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; ORS 366.215 and OAR 731-012 | • Anything that constitutes a permanent change to overall roadway horizontal and vertical clearance |
| Level of Access Management[1] | • Driveway density[2]<br>• Intersection density[2] | • Median type<br>• Median opening spacing<br>• Signal spacing<br>• Intersection spacing<br>• Frequency of pedestrian crossings<br>• Bicycle facility design<br>• Target speed |
| Freight Activity | • Percent and volume of heavy vehicles<br>• Need for loading/unloading zones | • Design vehicle<br>• Lane width<br>• Intersection curb-return radii<br>• Bicycle facility design |
| Transit Activity | • Presence of transit routes/stops<br>• Transit ridership<br>• Local transit plans – Transit Development Plan, Transit Master Plan or Coordinated Plan | • Lane width and use restrictions<br>• Sidewalk and bicycle connections<br>• Frequency of pedestrian crossings<br>• Bicycle facility design<br>• Transit stop location and layout |
| Seismic Lifeline Route / Tsunami Evacuation Route | • Oregon designation | • Lane width<br>• 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 highway system. They include: a state highway 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 become part of the overall ODOT design documentation.

# 205.1 Urban Context and Land Use

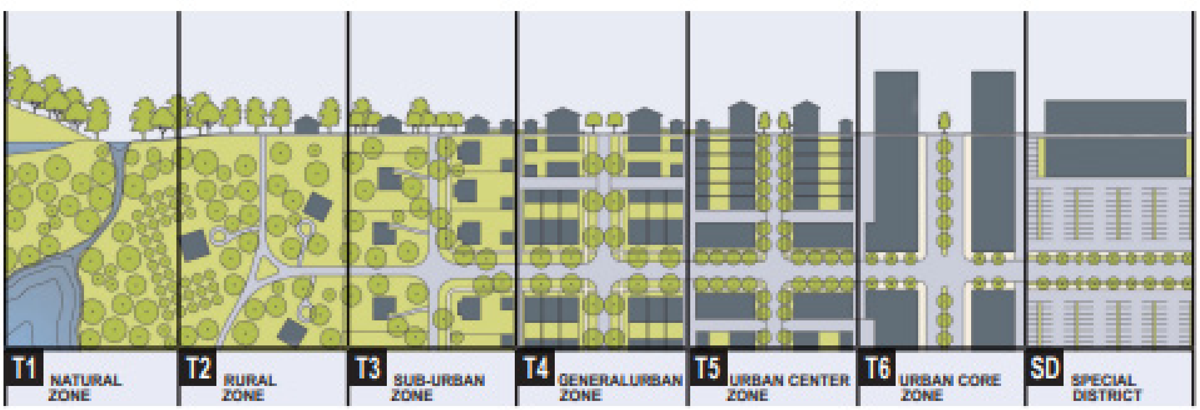
Oregon has been at the forefront of linking land use and transportation planning for several decades. Policy 1B in the 1999 OHP recognizes that state-owned roadways can be the main streets of many communities. The policy strives to maintain a balance between serving those main streets and the through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

- **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 established in the SmartCode in 2003 and has been evolving since. ([Center for Applied Transit Studies])

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 the National Cooperative Highway Research Program (NCHRP) Report 855: *An Expanded Functional Classification System for Highways and Streets*. Information from this document is included in Chapter one of the 2018 Green Book, seventh edition and will be the basis for the next update of the Green Book as the 8th edition when it is published.

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.

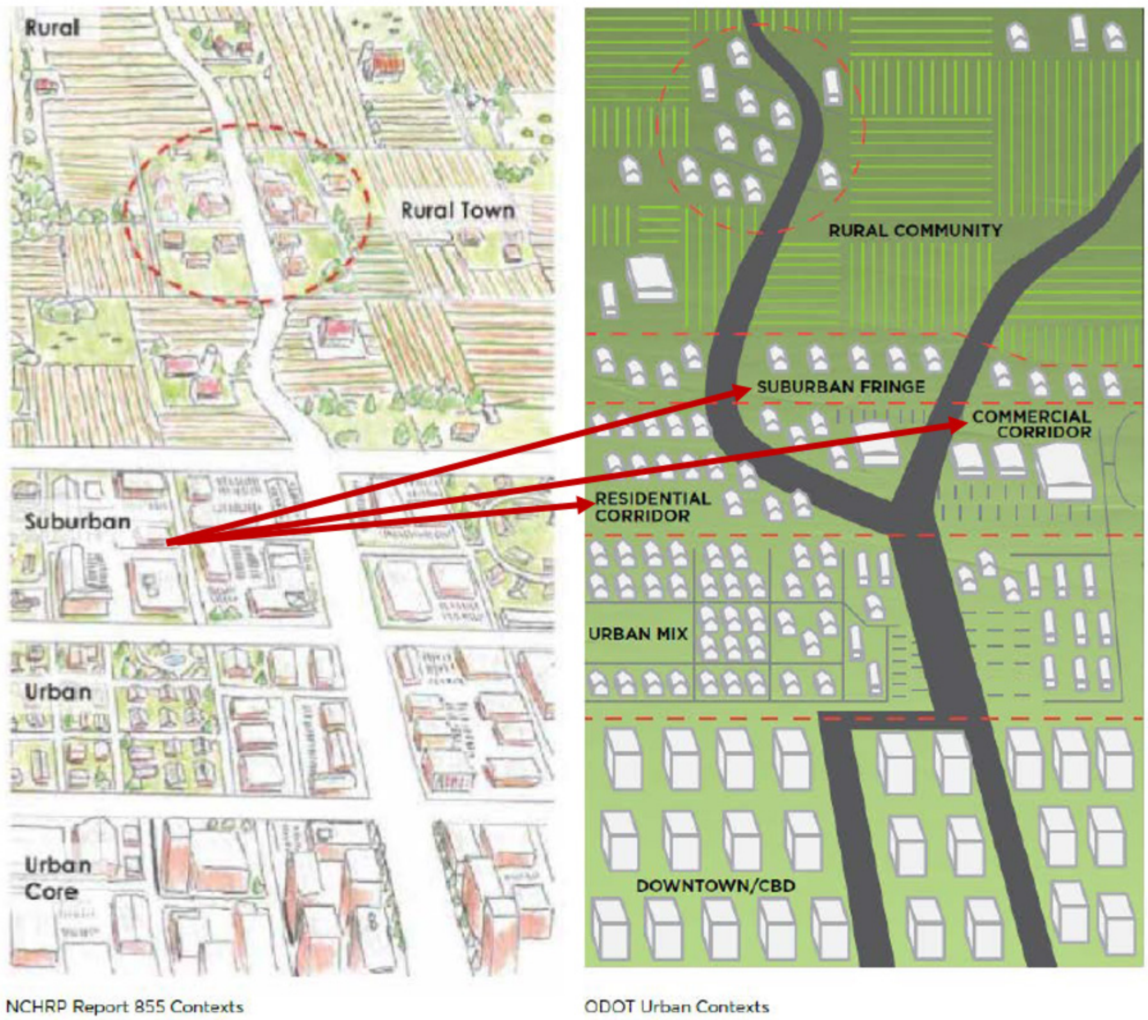
The six ODOT Urban Contexts build off the NCHRP Report 855, with a few changes to reflect Oregon-specific conditions. The suburban context was split into two contexts to distinguish between commercial and residential-focused areas. The Suburban Fringe context was added to draw attention to areas transitioning 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 Report 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



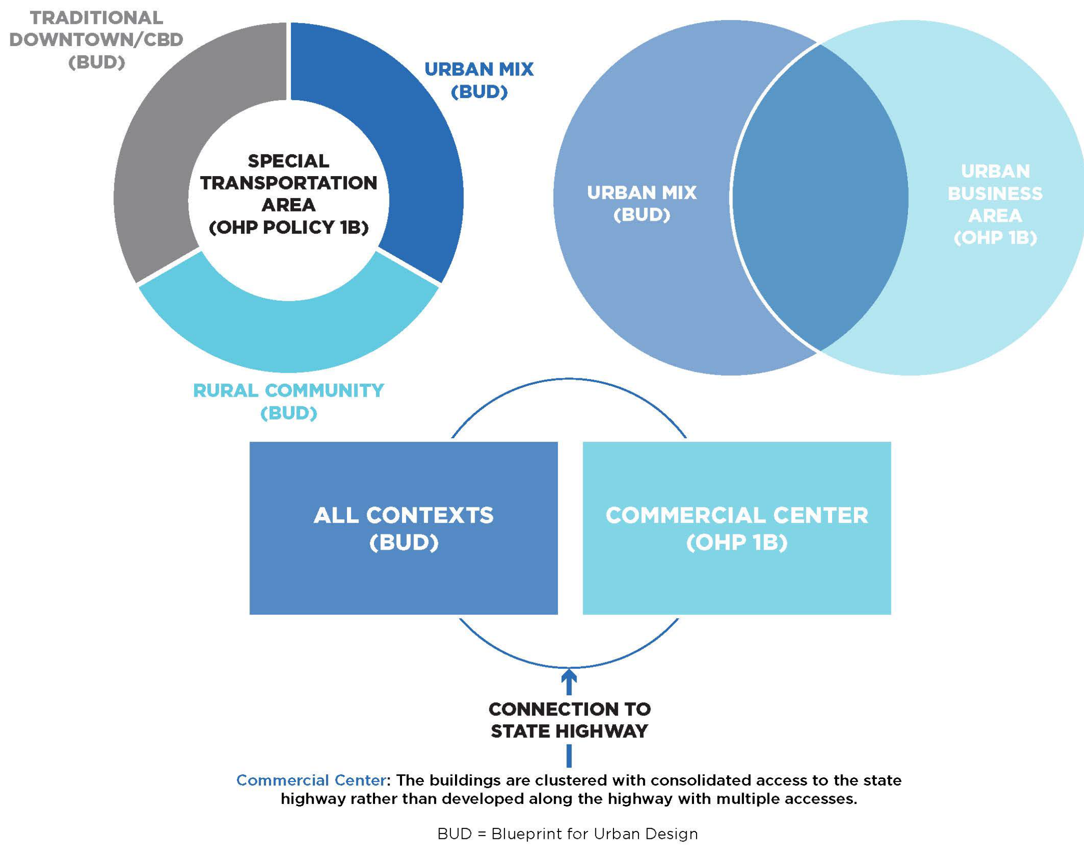

NCHRP Report 855 suggests a Suburban context. When developing the ODOT urban contexts, it was felt that a more nuanced approach to the suburban area was needed. As a result, the ODOT suburban context is separated into Commercial Corridor, Residential Corridor and Suburban Fringe contexts.

# 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 field visits, 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.

Table 200-4 ODOT Urban Context Matrix

| **Land Use Context** | **Building 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 |

# 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 properties adjacent to the highway 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 and Figure 200-5 illustrate the Traditional Downtown/Central Business District context.

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

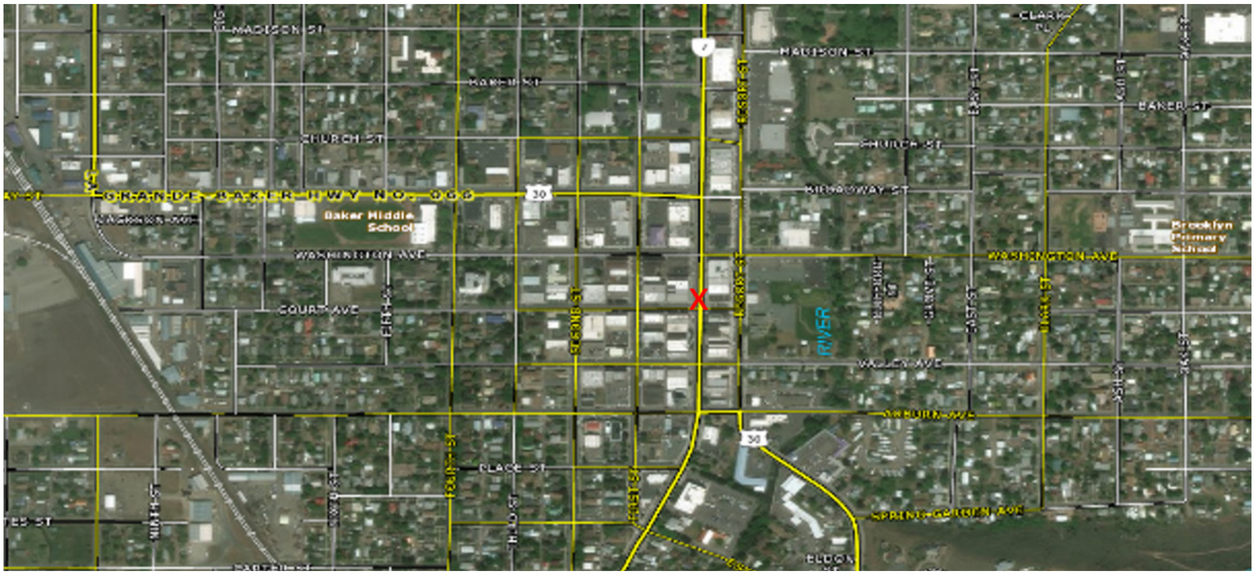
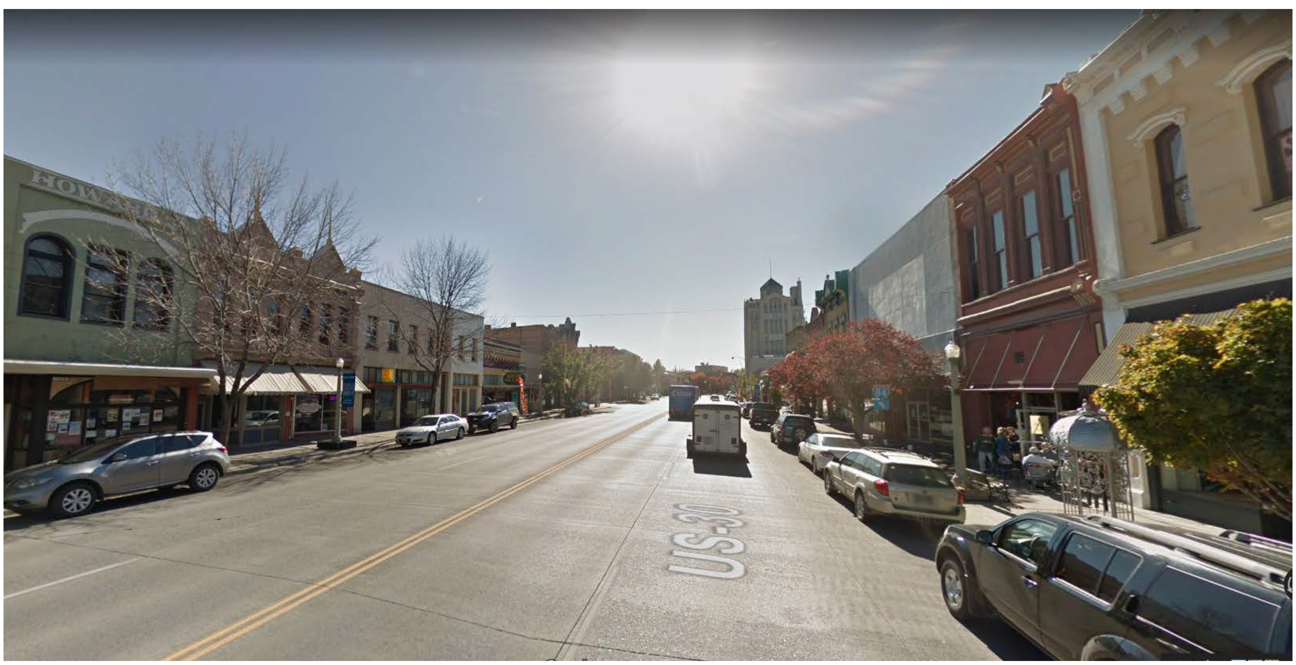



Figure 200-5 Baker City Downtown (US30)



# 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 and Figure 200-7 illustrate the Urban Mix context.

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

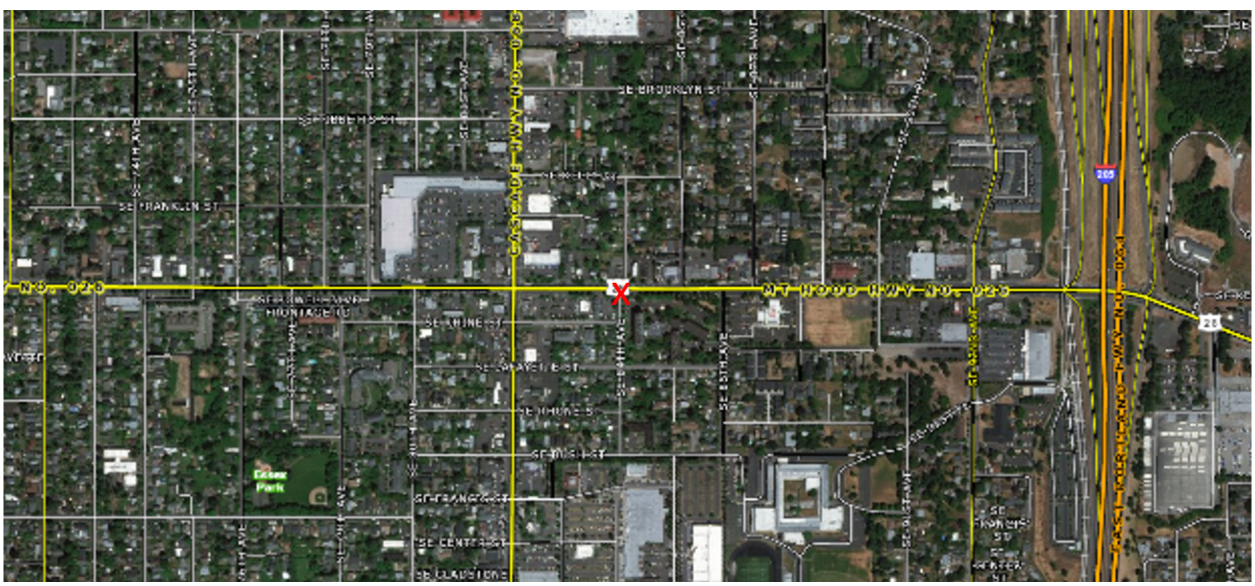


Figure 200-7 Urban Mix - Portland US26, Powell Blvd.


# 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 and Figure 200-9 illustrate the Commercial Corridor context.

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. **Error! Reference source not found.** and Figure 200-11 illustrate the Residential Corridor context.

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. **Error! Reference source not found.** and Figure 200-13 illustrate the Suburban Fringe context.

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

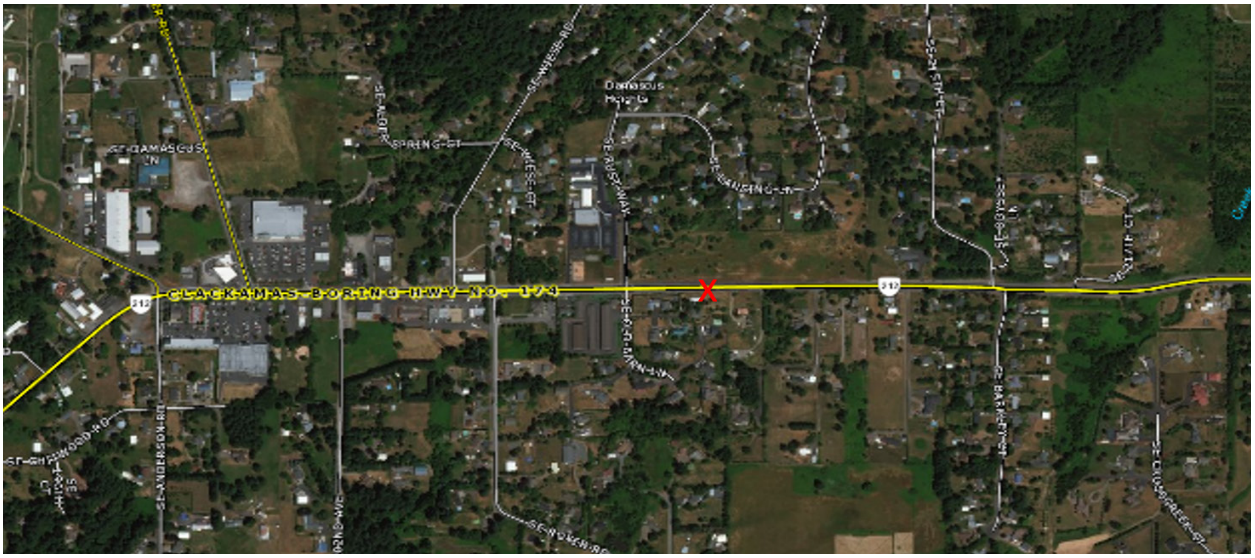



Figure 200-13 Suburban Fringe - OR 212 Damascus


# 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 and Figure 200-15 illustrate the Rural Community context.

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

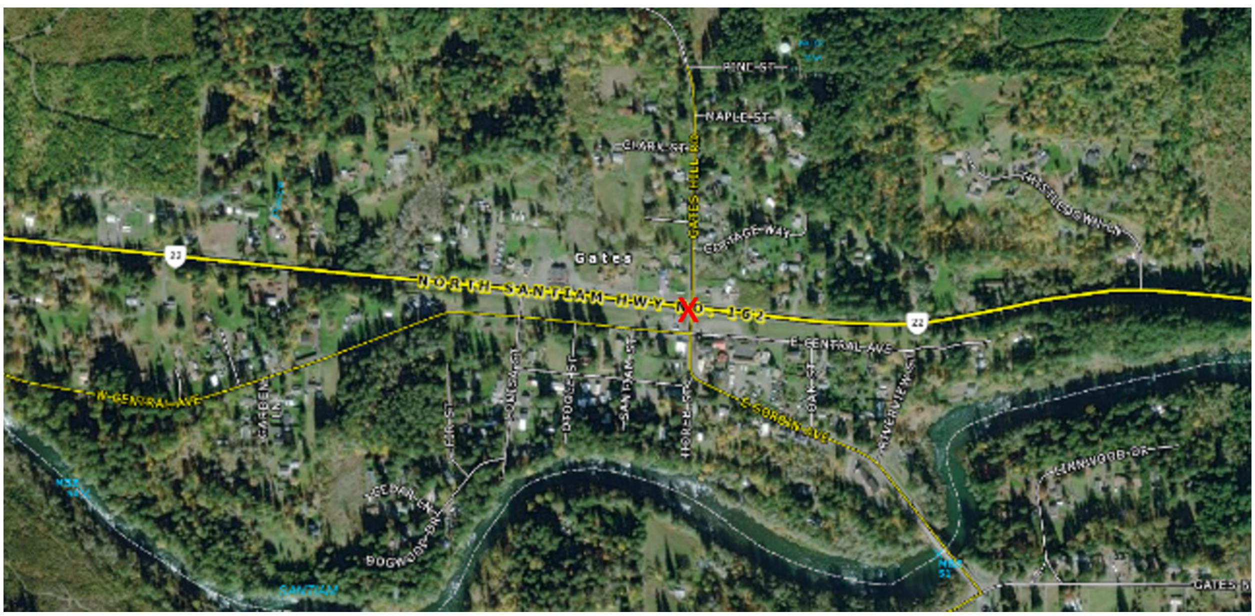


Figure 200-15 Rural Community, OR 22 Gates


# 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.

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

| Context | Typical Speed Ranges (MPH)[4] | Travel Lanes[1,2] | 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<br>Rural - Start With Standard | Urban - Use Context<br>Rural - Start With Standard | Urban - Use Context<br>Rural - Start With Standard | Urban - Use Context<br>Rural - Start With Standard | Urban - Use Context<br>Rural - Start With Standard<br>See Part 900 | Urban - Use Context<br>Rural - Start With Standard<br>See Part 800, 900 | Urban - Use Context<br>Rural - Start With Standard | Urban - Use Context<br>Rural - Start With Standard |

Table 200-6 (Continued): Designing based on context, considering roadway designations and activity of different modes

| Context | Typical Speed Ranges (MPH)[4] | Travel Lanes[1,2] | 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] |
|---|---|---|---|---|---|---|---|---|---|
| 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 | Evaluate, start with preferred 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 | Evaluate, start with preferred 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 |

Table 200-6 (Continued): Designing based on context, considering roadway designations and activity of different modes

| Context | Typical Speed Ranges (MPH)[4] | Travel Lanes[1,2] | 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] |
|---|---|---|---|---|---|---|---|---|---|
| Commercial Corridor | 30-35 | Evaluate, start with preferred 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 | Evaluate, start with preferred 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 character |
| Suburban Fringe | 35-40 | Evaluate, start with preferred 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 | 750-1,500 | Not typical |

Table 200-6 (Continued): Designing based on context, considering roadway designations and activity of different modes

| Context | Typical Speed Ranges (MPH)[4] | Travel Lanes[1,2] | 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] |
|---|---|---|---|---|---|---|---|---|---|
| Rural Community | 25 - 35 | Evaluate, start with preferred 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, 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 and 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

## 207.10.1 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, $50^{th}$ and $85^{th}$ 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. Some projects may cross over different contexts. In these instances, more than one design speed may be appropriate for the project. 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.

## 207.10.2 Selecting Project Design Speed

For all projects on state highways, the design speed is selected by the Region Roadway Manager and the Region Traffic 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 speed 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.

## 207.10.3 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.

## 207.10.4 Recommendations for Target Speed

A goal in urban locations, is for the target speed, the posted speed and design speed to 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”. However, rarely is this the case at project scoping or project initiation and lowering operating speeds to aspirational target speeds then becomes a project goal. Ideally, the target speed is intended to be used as the posted speed limit in urban locations after projects are complete. When the target speed is less than the posted speed limit and/or the design speed, 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.

This is a general discussion about setting posted speeds. Newer strategies are being developed for urban locations to determine appropriate posted speeds that augment the 85th percentile criteria. For more detailed and current information on how posted speeds are set for urban locations, 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 or in urban areas, 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 operating speeds 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 and Section 207.10 for Design Speed; Section 217 for Sight Distance; Section 218 for Horizontal Alignment;

Section 219 for Vertical Alignment; Section 220 for Combined Horizontal and Vertical Alignment; and Section 221 for 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 Section 205 and Section 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 and Section 216 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 and Section 207 (207.10) for Design Speed; Section 217 for Sight Distance; Section 218 for Horizontal Alignment; Section 219 for Vertical Alignment; Section 220 for Combined Horizontal and Vertical Alignment, and Section 221 for 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 and Section 207 (207.10) for Design Speed; Section 217 for Sight Distance; Section 218 for Horizontal Alignment; Section 219 for Vertical Alignment; Section 220 for Combined Horizontal and Vertical Alignment; and Section 221 for 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 for Sight Distance; Section 218 for Horizontal

Alignment; Section 219 for Vertical Alignment; Section 220 for Combined Horizontal and Vertical Alignment; and Section 221 for 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 "S.C.O.P.E." 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. However, the two design types should not be intermixed. Consistency of design elements should be carried for reasonable distances for continuity and driver expectancy and understanding. 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 potential for available 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 provides 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 and Section 207 (207.10) for Design Speed; Section 217 for Sight Distance; Section 218 for Horizontal Alignment; Section 219 for Vertical Alignment; Section 220 for Combined Horizontal and Vertical Alignment; and Section 221 for 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 discusses 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. Since expressways are specifically designated from the overall planning of the state highway system, design of expressways must maintain the functionality of the roadway. In higher speed rural settings, vehicle mobility is a high function. In lower speed urban settings where the expressway may fit into one of the ODOT six urban contexts, vehicle mobility is still of high importance; However, overall vehicle mobility must also be balanced against other urban transit, bicycling, and pedestrian needs. In balancing these needs, trade-offs are necessary to provide appropriate facilities and safe access for all users and in some cases, not all modes will be able to be accommodated. When the expressway functionality of the highway is determined the greater need, transit riders, bicyclists, and pedestrians may need to be served in another manner or on adjacent facilities. The project development team must determine appropriate design that accomplishes project goals and outcomes, while producing a final design that minimizes conflicts between transportation modes and provides access to the highway system for all users. Part 300, Section 310.13 provides guidance for pedestrian design on expressways. Part 800 and Part 900 also provide design considerations for pedestrians and for bicyclists on expressways, as well as for other roadway types.

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 requirements for expressways are 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 for Sight Distance; Section 218 for Horizontal Alignment; Section 219 for Vertical Alignment; Section 220 for Combined Horizontal and Vertical Alignment; and Section 221 for 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 Part 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. Low-cost safety mitigation measures should also be considered with these projects.

Non-freeway 3R projects should be developed in line with the S.C.O.P.E. values of Practical Design presented in Part 100. A feature not meeting the standards as specifically noted for the following items: 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

## 215.2.1 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.

### 215.2.2 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.

### 215.2.3 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 requirements for rural arterials, collectors, and local routes are 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 provide effective safety countermeasure or include 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 and the Region Traffic 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 Design Speed

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 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 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. 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 and target speed are discussed in Section 207.10, Speed, Context and Design. Table 200-8 provides suggested design speed values for various roadways.

Table 200-8 Design Speed Selection

<table>
<tr><th colspan="5">DESIGN SPEED</th></tr>
<tr><th rowspan="2">FUNCTIONAL CLASSIFICATION/CONTEXT</th><th colspan="4">Terrain or Characteristic</th></tr>
<tr><th>Flat</th><th>Rolling</th><th>Mountainous</th><th>Urban</th></tr>
<tr><td>Interstate/Freeway</td><td>70</td><td>70</td><td>50-70</td><td>50-70</td></tr>
<tr><td>Urban Expressway</td><td colspan="4">45-70</td></tr>
<tr><td>Rural Expressway</td><td colspan="4">50-70</td></tr>
<tr><td>Rural Arterial</td><td colspan="4">45-70</td></tr>
<tr><td>Rural Collector</td><td colspan="4">45-70</td></tr>
<tr><td>Rural Local Route</td><td colspan="4">45-50</td></tr>
<tr><th>ODOT URBAN CONTEXTS</th><th colspan="4">DESIGN SPEED/TARGET SPEED</th></tr>
<tr><td>Traditional Downtown/CBD</td><td>20-25</td><td colspan="3" rowspan="6">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.<br><br>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.</td></tr>
<tr><td>Urban Mix</td><td>25-30</td></tr>
<tr><td>Commercial Corridor</td><td>30-35</td></tr>
<tr><td>Residential Corridor</td><td>30-35</td></tr>
<tr><td>Suburban Fringe</td><td>35-40</td></tr>
<tr><td>Rural Community</td><td>25-35</td></tr>
</table>

# Section 217 Sight Distance

## 217.1 General

Sight distance is the 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.

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. 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. Required stopping sight distance is shown in Table 200-9. Figure 200-16 indicates how sight distances are measured.

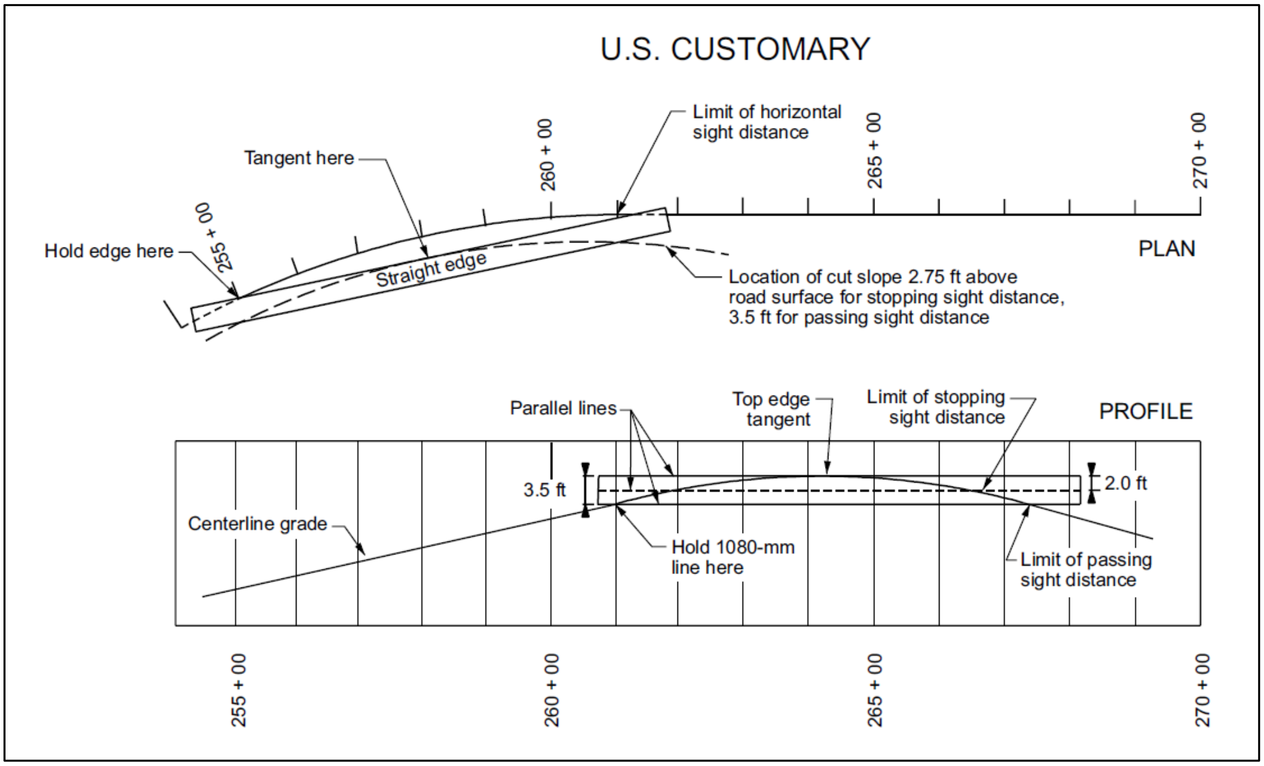
# 217.2 Stopping Sight Distance

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 200-52 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 200-18 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 for manually determining Stopping Sight Distance. Table 3-1 on page 3-4 of the 2018 AASHTO Green Book provides Stopping Sight Distance values for level roadways. For 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-foot object height that is also used for stopping sight distance. Pages 3-7 thru 3-9 of the 2018 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 200-18 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. Potential options for traffic calming could include reallocation of roadway space or roadside features, roundabouts, possible reduction of travel lane widths or changes to roadway lane configuration, as well as installing urban features to the roadside to indicate to drivers they are in an urban context. These features could include: curb and sidewalk, if non-existent, street trees where appropriate, raised medians, on-street parking where applicable, improved pedestrian crossings, and bicycle facilities.

# 218.3 3R Freeway Horizontal Curvature and Superelevation

Horizontal alignment, superelevation, 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 from 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

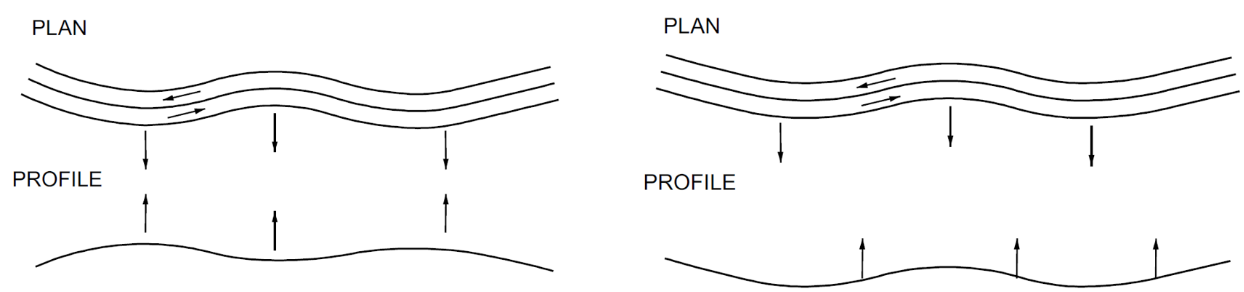
Each horizontal curve should be evaluated for design sufficiency compared to the ODOT Urban Standards. Deficient curves should be evaluated against criteria below to determine what level of corrective action, if any, is appropriate.

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)

This section focuses on horizontal curvature. Vertical curvature is discussed in later sections. However, horizontal and vertical alignments must coordinate to provide effective, comfortable and aesthetic roadways. Figure 200-17 shows examples of good and weak horizontal and vertical alignment.

Figure 200-17: Coordination of Horizontal and Vertical Alignment (FHWA, 2018)




The classic case of coordination between horizontal and vertical alignment in which the vertices of horizontal and vertical curves coincide, creating a rich effect of three-dimensional S-curves composed of conves and concave helixes

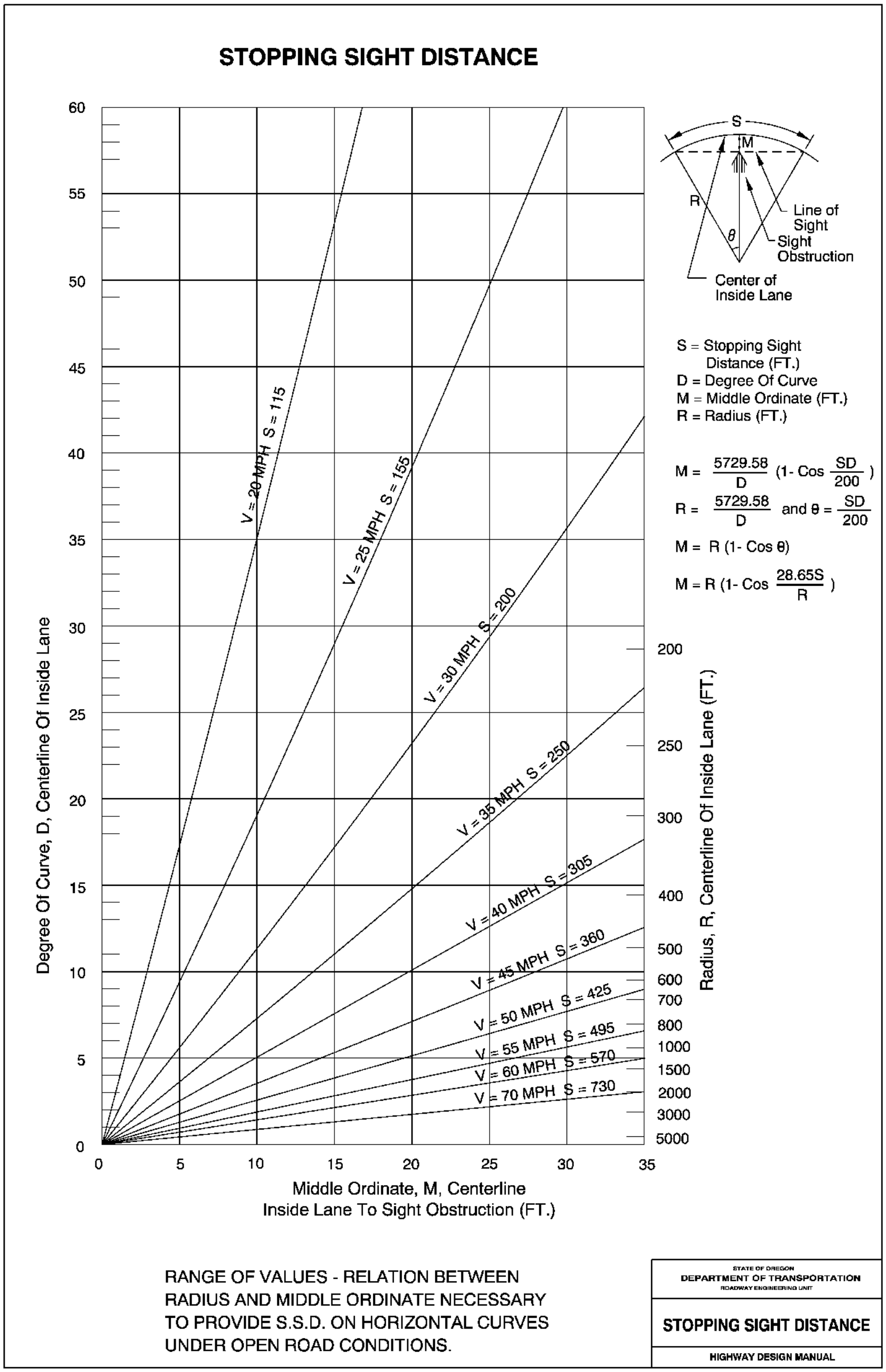
Weak Coordination of Horizontal and Vertical Alignment

Horizontal 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 200-20). Generally this treatment is required when the length of the tangent is 500 feet or less.

Figure 200-18: SSD on Horizontal Curves



# 218.7 Spirals Transitions

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 200-21. 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 feet.

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 the ramp centerline.

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 location 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 contexts 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. Smooth curvature is still required and angle points require an approved design exception. In some narrow lane locations where spiral transition is not provided, widening of the outside shoulder may be of benefit for smoother curve transition for drivers. 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 200-21 and Figure 200-23. 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 200-22 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 200-21).

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

| | 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)($V^3$/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;

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)($V^3$/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 200-19: Standard Superelevation

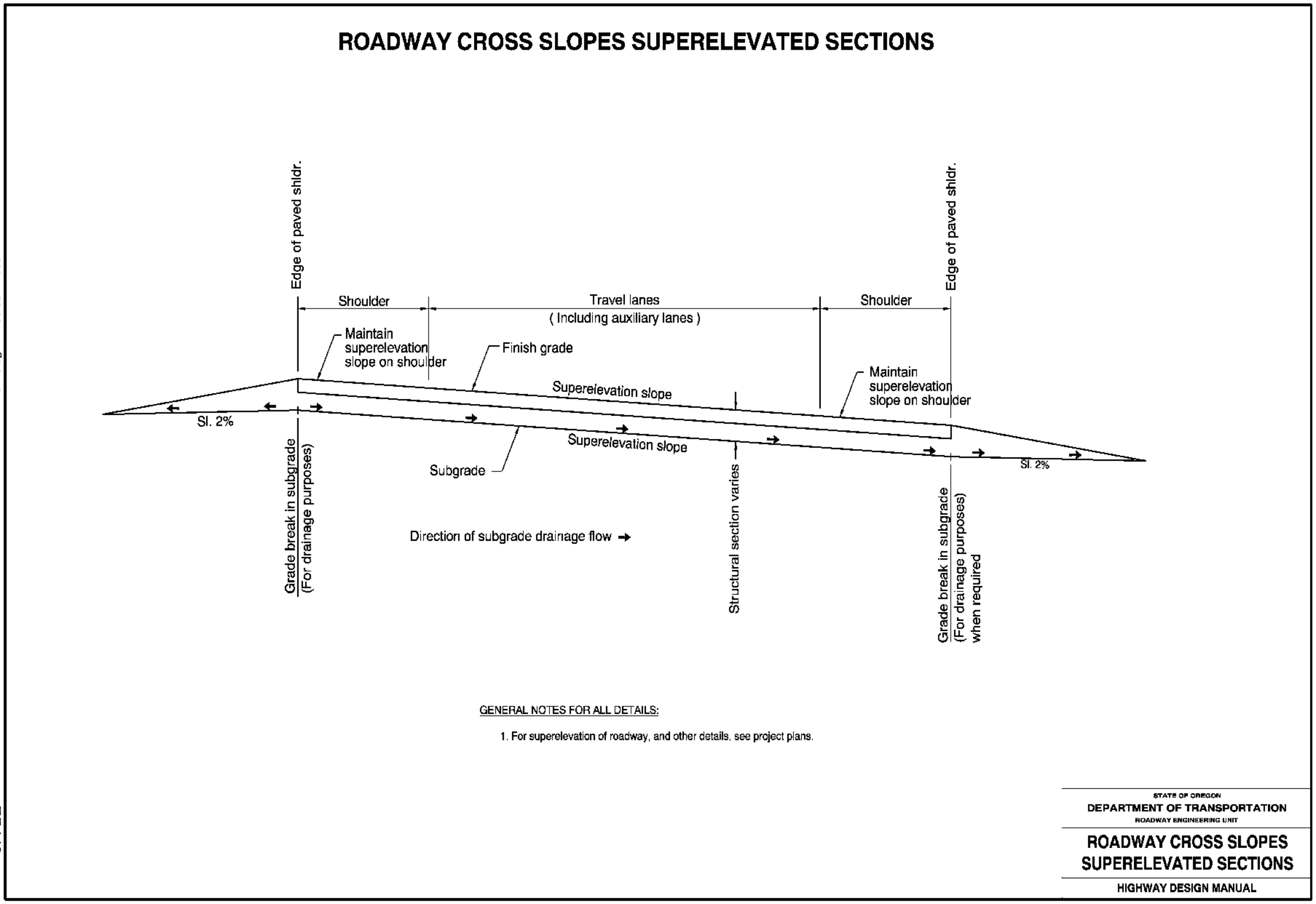


Figure 200-20: Developing Superelevation on 2-Lane Highways

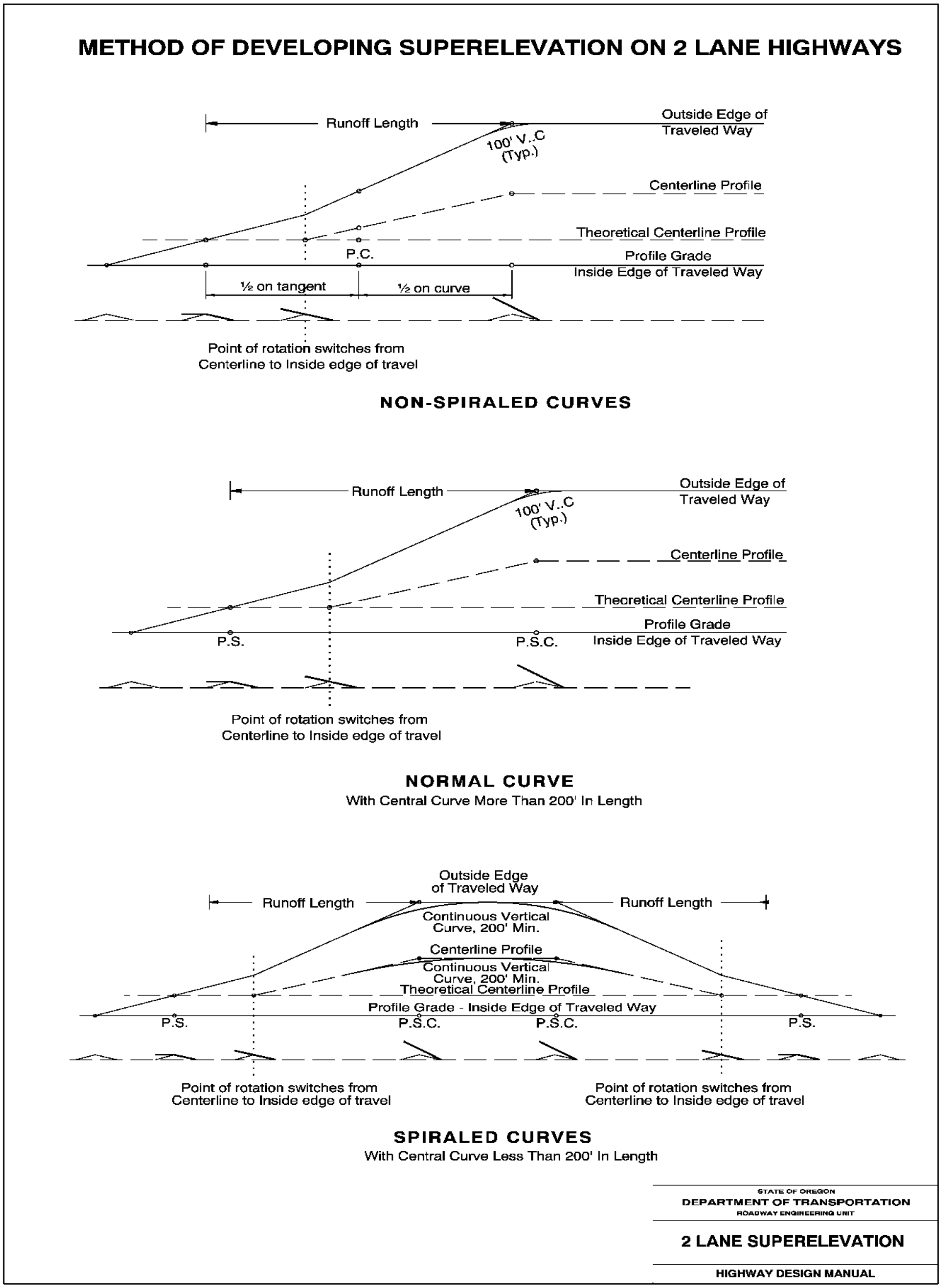


Figure 200-21: Developing Superelevation on 2-Lane Highways (Cont'd)

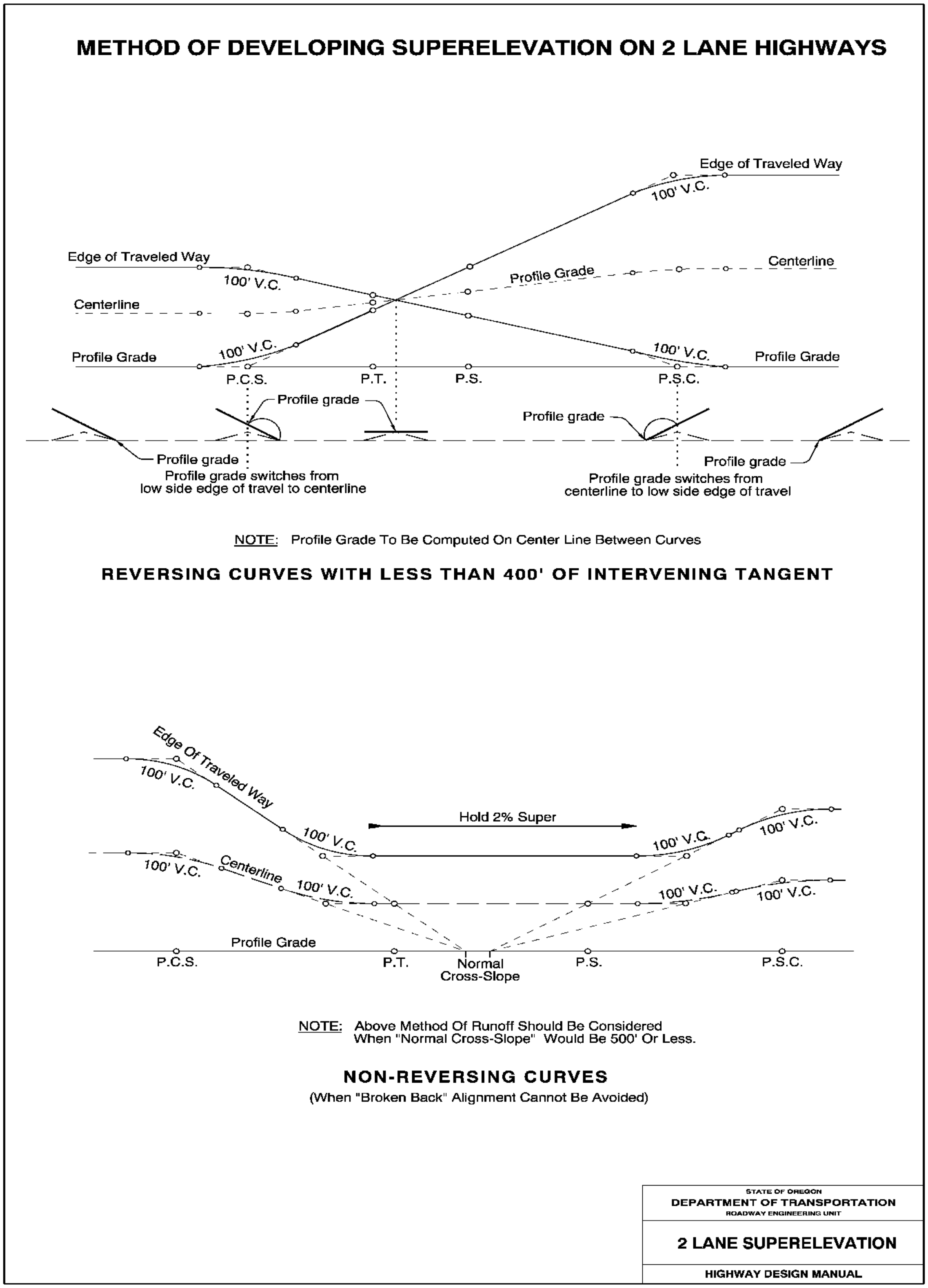


Figure 200-22: Examples of Additional Methods for Developing Superelevation

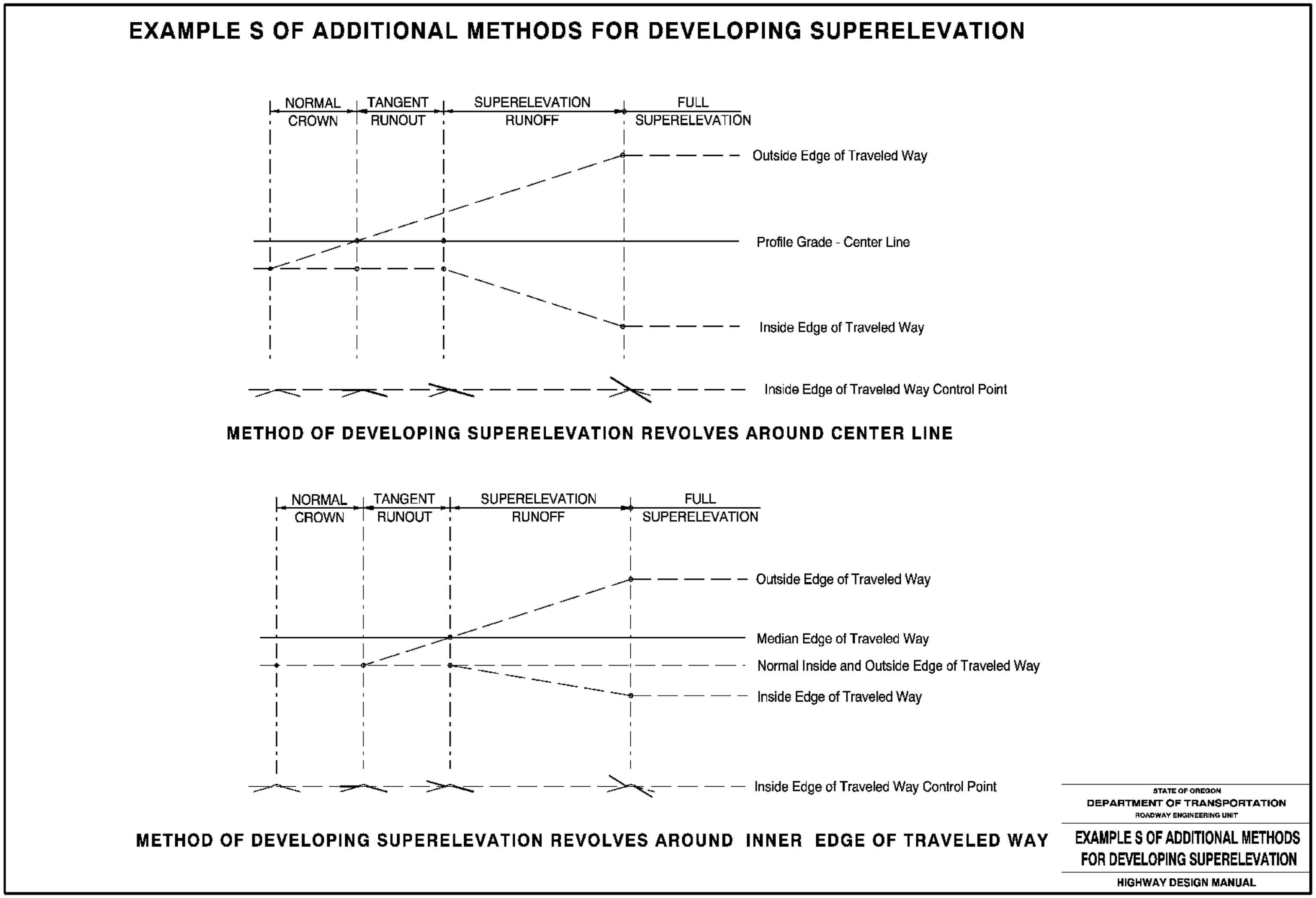
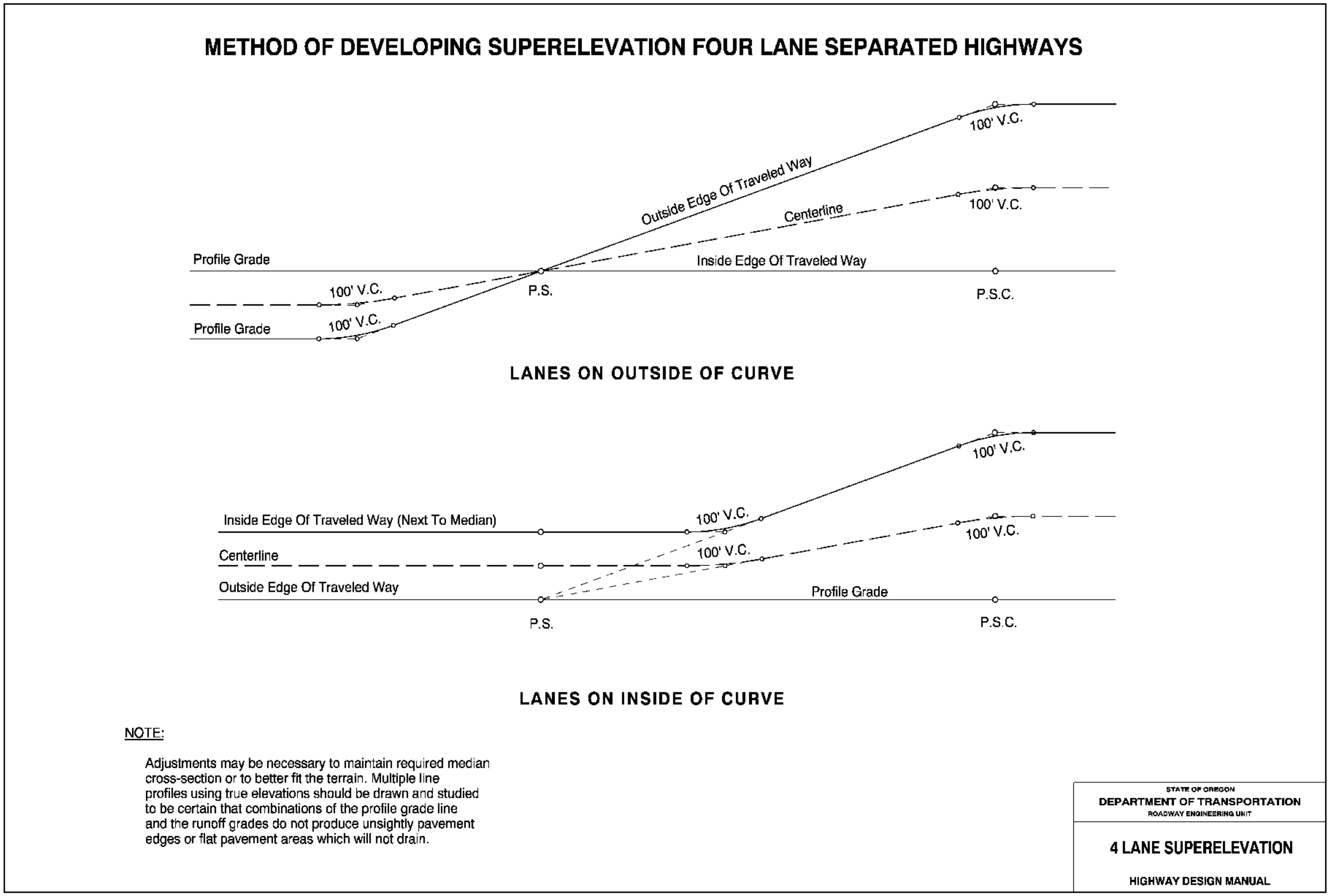


Figure 200-23: Developing Superelevation on 4-Lane Highways



# 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.

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

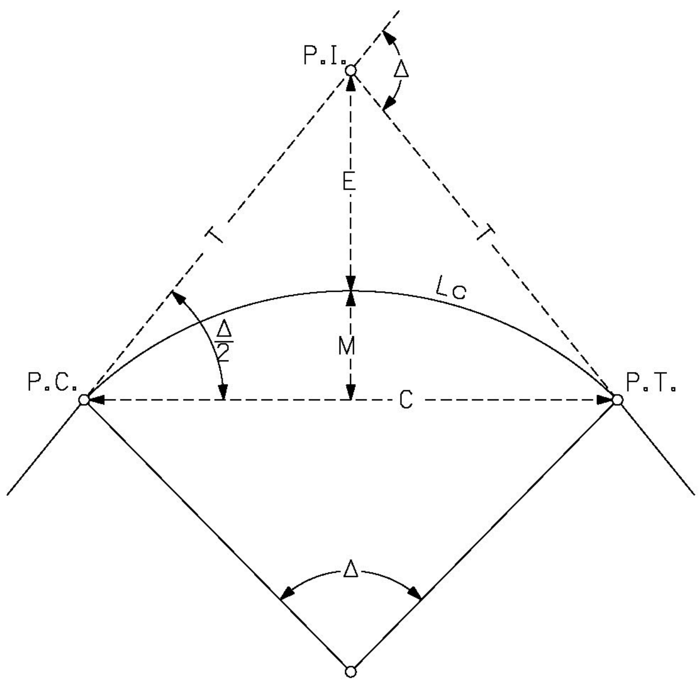
| Speed | Friction Factor |
|---|---|
| 25 | 0.23 |
| 30 | 0.20 |
| 35 | 0.18 |
| 40 | 0.16 |
| 45 | 0.15 |
| 50 | 0.14 |
| 55 | 0.13 |
| 60 | 0.12 |
| 65 | 0.11 |
| 70 | 0.10 |

# 218.10 Horizontal Curve Equations and Examples

ODOT standard horizontal alignments typically use transition spirals instead of the basic circular curve. The following figures present the circular curve definitions, spiral curve definitions, basic curve formulas, and accompanying nomenclature. Figure 200-24 describes the circular curve definition, Figure 200-25 through Figure 200-27 describe the spiral curve definition, and Figure 200-28 and Figure 200-29 describe the basic curve formulas. Figure 200-30 through Figure 200-50 provide detailed information and potential solutions for reversing horizontal curves and spiral segment layout.

Figure 200-24: 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.

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

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

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

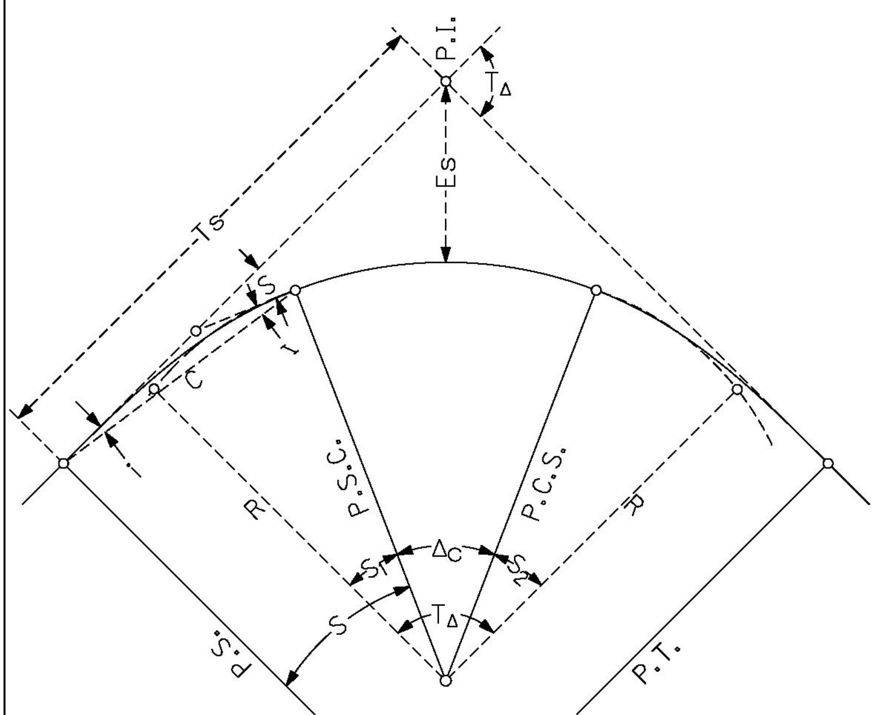
$$M = R - \left(R \cos \frac{\Delta}{2}\right)$$

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

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

Figure 200-25: Spiral Curve Definitions

## SPIRAL CURVE DEFINITIONS




$T_\Delta$ = 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.

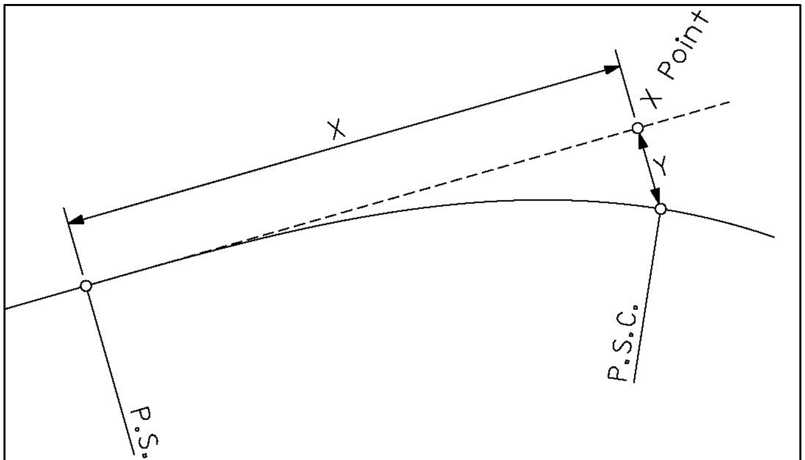
Ls = The length of the spiral from the P.S. to the P.S.C. or P.C.S. to P.T.

$\ell$ = 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.

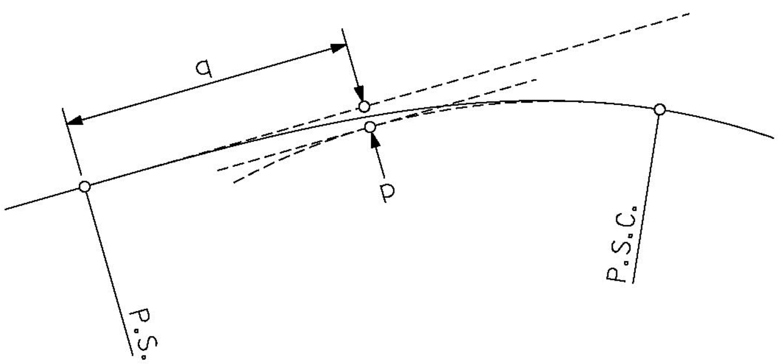
Figure 200-26: Spiral Curve Definitions (Cont'd)




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.

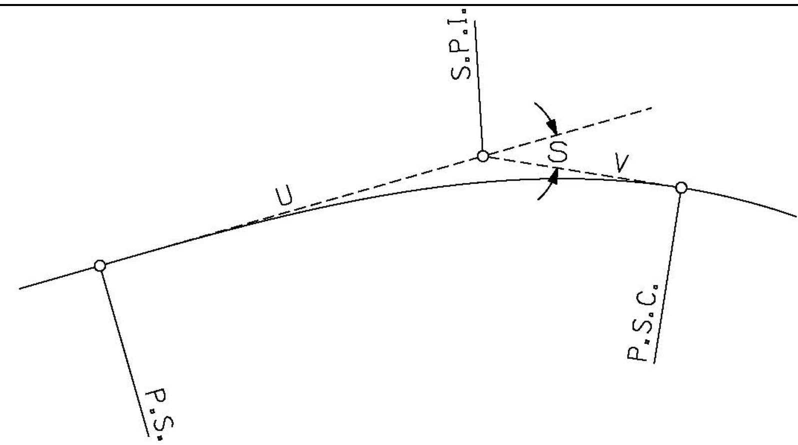
X Point = Point on the semi-tangent at X distance from the P.S. or P.T. Intersection of X and Y distances.




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 200-27: 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 200-28: 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)

$\Theta$ = 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 200-29: 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 200-30: Parallel Tangents - Equal Length Reversing Curves

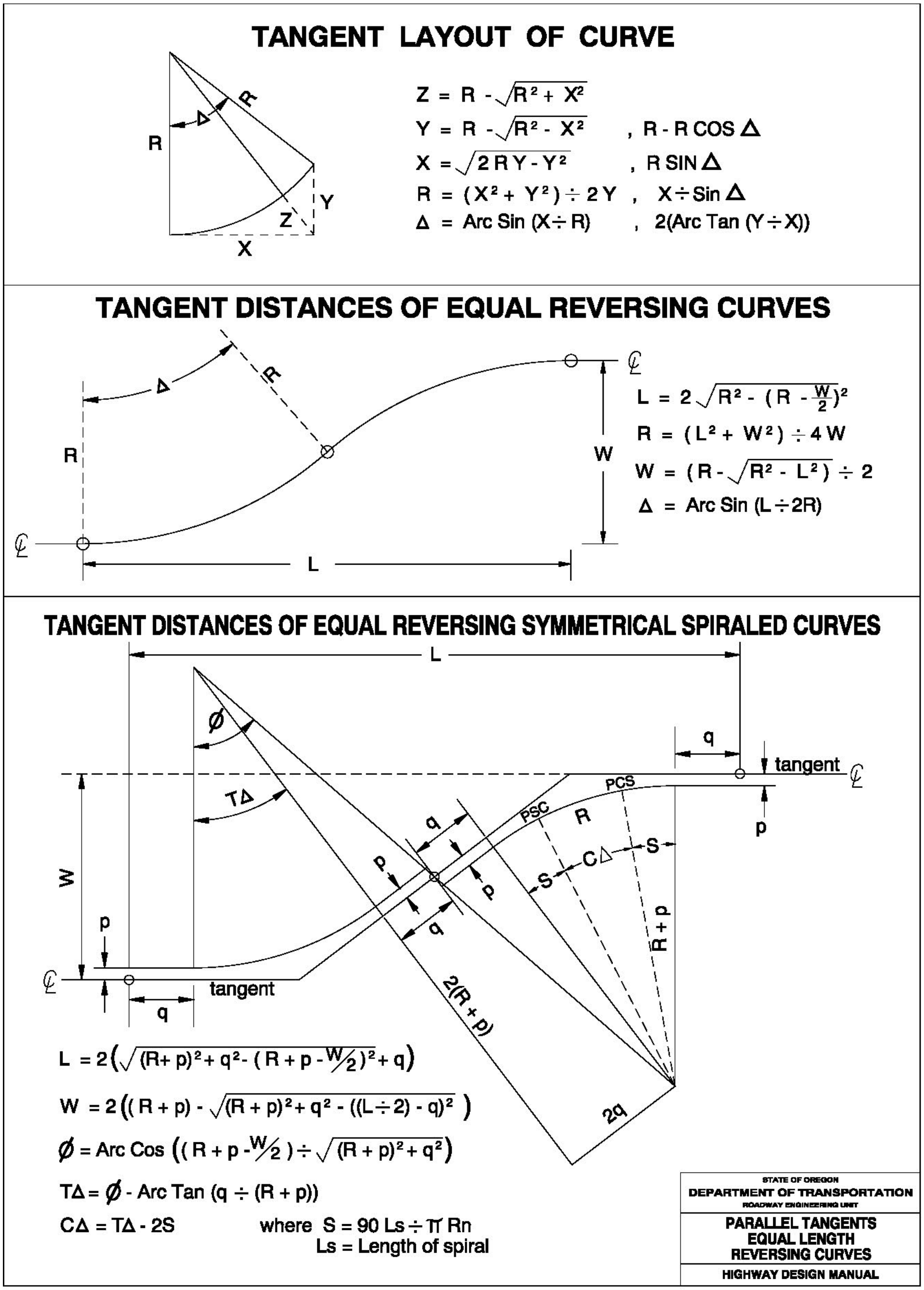
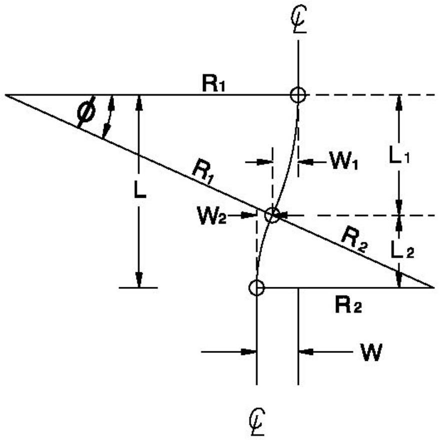


Figure 200-31: Parallel Tangents - Unequal Length Reversing Curves

## TANGENT DISTANCES OF UNEQUAL REVERSING CURVES

$\phi = \text{SIN}^{-1}\,[L \div (R_1 + R_2)]$




$L = \sqrt{(R_1 + R_2)^2 - (R_1 + R_2 - W)^2}$

$\quad = (R_1 + R_2)\ \text{COS}\,\phi$

$W = R_1 + R_2 - \sqrt{(R_1 + R_2)^2 - L^2}$

$\quad = (R_1 + R_2) - (R_1 + R_2)\ \text{SIN}\,\phi$

$L_1 = R_1\,[L \div (R_1 + R_2)]$

$\quad = R_1\ \text{SIN}\,\phi$

$L_2 = L - L_1$

$\quad = R_2\ \text{SIN}\,\phi$

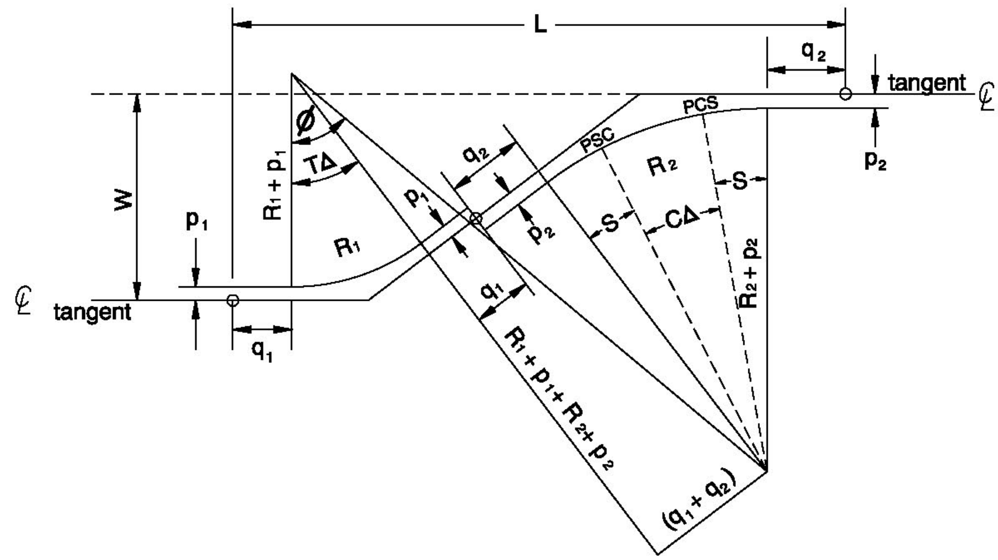
$W_1 = \sqrt{R_1^2 - L_1^2}$

$\quad = R_1 - R_1\ \text{COS}\,\phi$

$W_2 = W - W_1$

$\quad = R_2 - R_2\ \text{COS}\,\phi$

## TANGENT DISTANCES OF UNEQUAL REVERSING SYMMETRICAL SPIRALED CURVES




$L = \sqrt{(R_1 + p_1 + R_2 + p_2)^2 + (q_1 + q_2)^2 - (R_1 + p_1 + R_2 + p_2 - W)^2} + (q_1 + q_2)$

$W = (R_1 + p_1 + R_2 + p_2) - \sqrt{(R_1 + p_1 + R_2 + p_2)^2 + (q_1 + q_2)^2 - (L - (q_1 + q_2))^2}$

$\phi = \text{Arc Cos}\left((R_1 + p_1 + R_2 + p_2 - W) \div \sqrt{(R_1 + p_1 + R_2 + p_2)^2 + (q_1 + q_2)^2}\right)$

$T\Delta = \phi - \text{Arc Tan}\left((q_1 + q_2) \div (R_1 + p_1 + R_2 + p_2)\right)$

$C\Delta = T\Delta - 2S$ where $S = 90\,Ls \div \pi Rn$

$Ls$ = Length of spiral

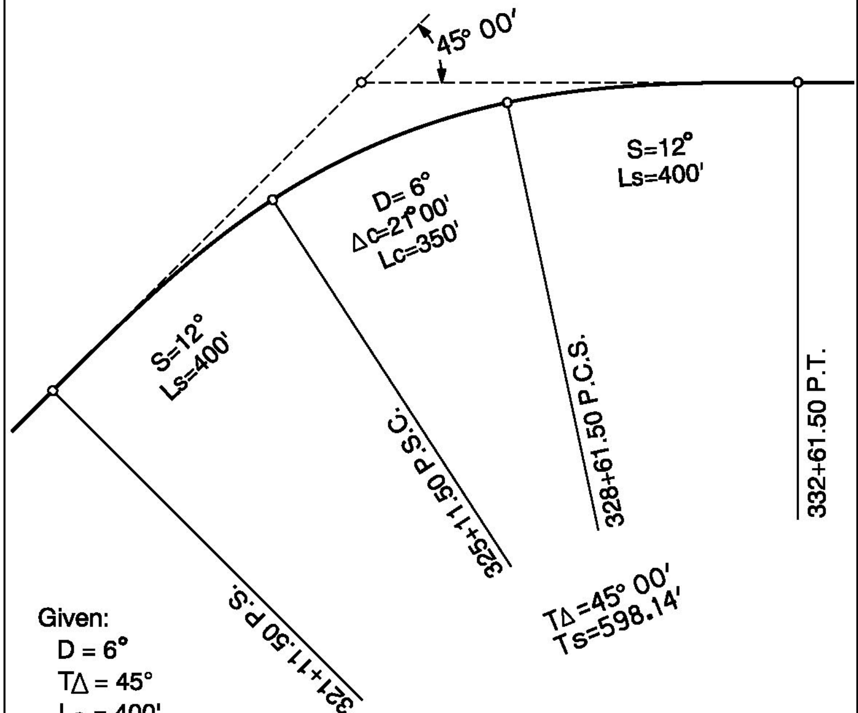
STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

PARALLEL TANGENTS
UNEQUAL LENGTH
REVERSING CURVES

HIGHWAY DESIGN MANUAL

Figure 200-32: Spiral Solution - Example 1

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




Given:
- $D = 6°$
- $T\Delta = 45°$
- $L_s = 400'$
- 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:

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

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

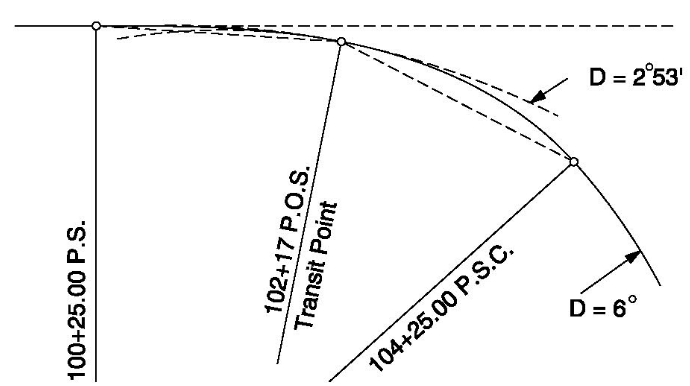
$$i = \text{ArcTan}\frac{Y}{X} = 4°26'36''$$

$$Ts = q + (R+p)\ \text{Tan}\frac{T\Delta}{2} = 598.14'$$

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

Figure 200-33: 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:

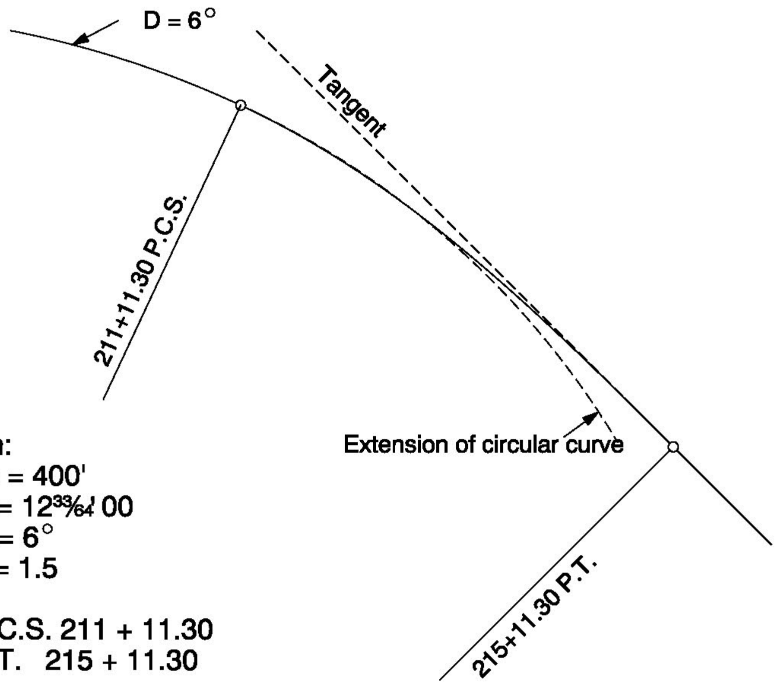
RULE: A spiral deviates from the circular curve common to it at any point at the same rate as it deviates from the tangent at the P.S. Therefore, at any point on the spiral the deflection angle from the tangent at that point to any other point on the spiral is equal to the deflection angle for a circular 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 200-34: Spiral Solution - Example 3

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




Given:

Ls = 400'
S = 12 33/64 00
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.:

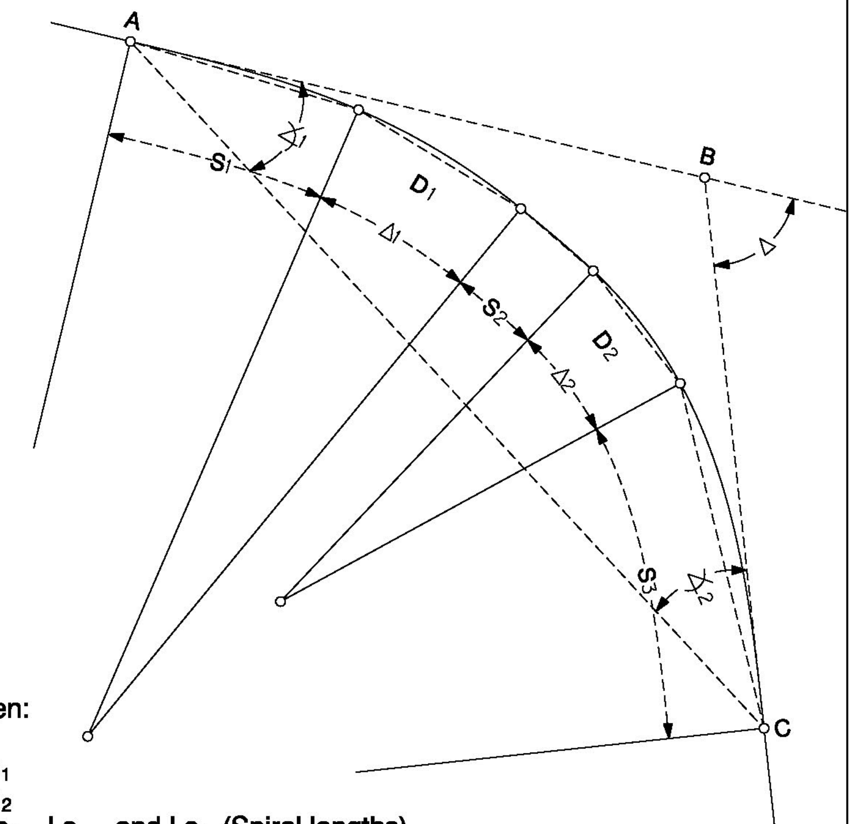
RULE: A spiral curve and a circular curve which coincide at any point (as at the P.C.S.) deviate from each other at the same rate as the spiral does from the tangent at the P.S.

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 200-35: Spiral Solution - Example 4

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




Given:

- $\Delta$
- $D_1$
- $D_2$
- $Ls_1$, $Ls_2$, and $Ls_3$ (Spiral lengths)

Find:

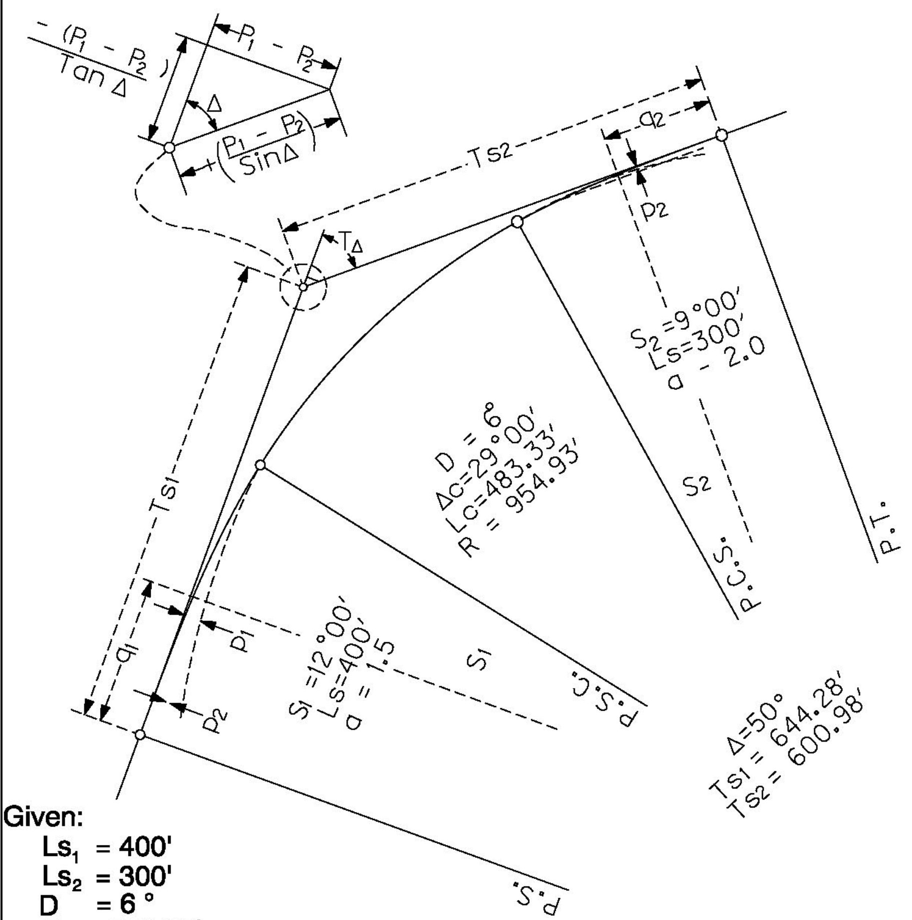
- Semi-tangents

Solution:

(1) Ascertain $\Delta_1$ (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 200-36: 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'
Δ = 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

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

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

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

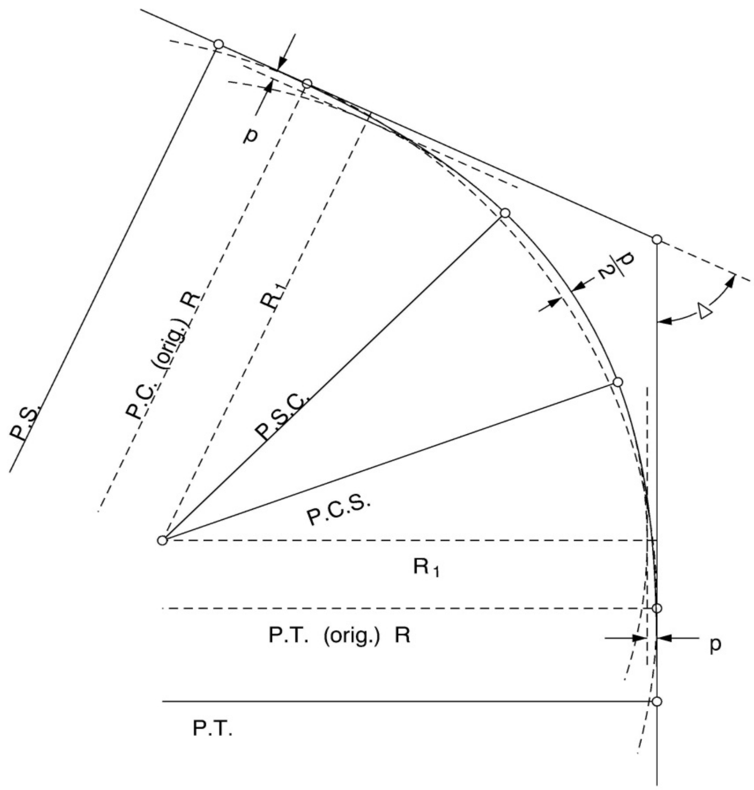
$$Ts_1 = 199.71' + (954.93' + 3.92') \times 0.466\,307\,7 - \frac{(6.97' - 3.92')}{1.191\,754} = 644.28'$$

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

Rule: $Ls_1$ = Longer spiral

Figure 200-37: 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, $\frac{p}{2}$

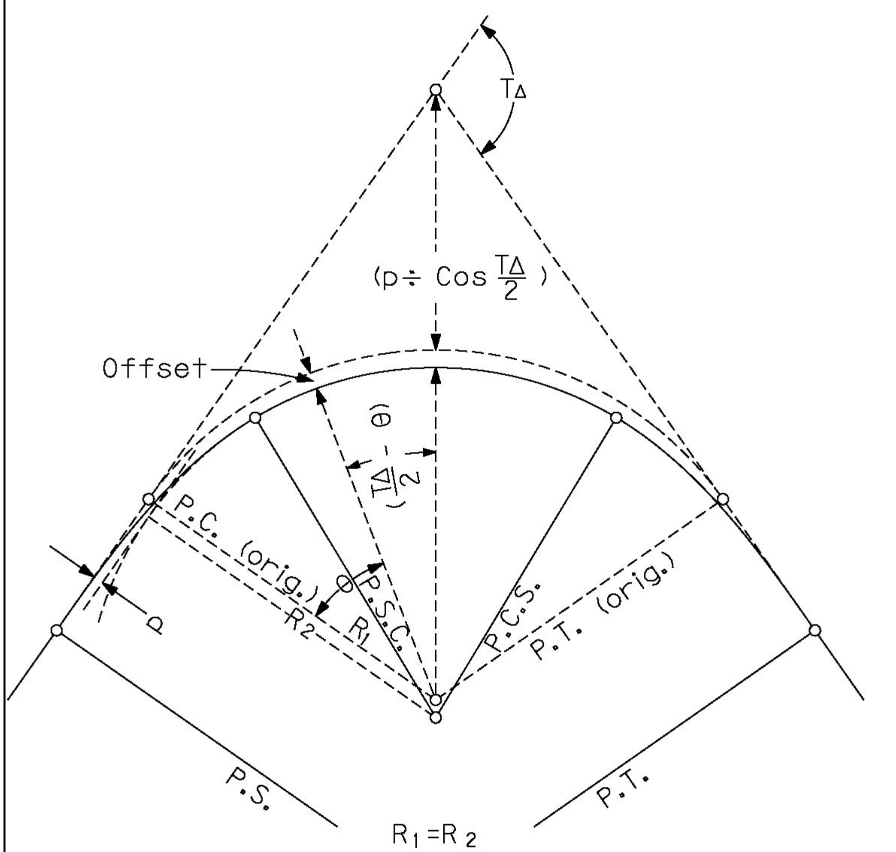
$$\text{Then } R_1 = R - \frac{p + \frac{p}{2}\cos\frac{\Delta}{2}}{1 - \cos\frac{\Delta}{2}}$$

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 200-38: Spiral Solution - Example 7

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



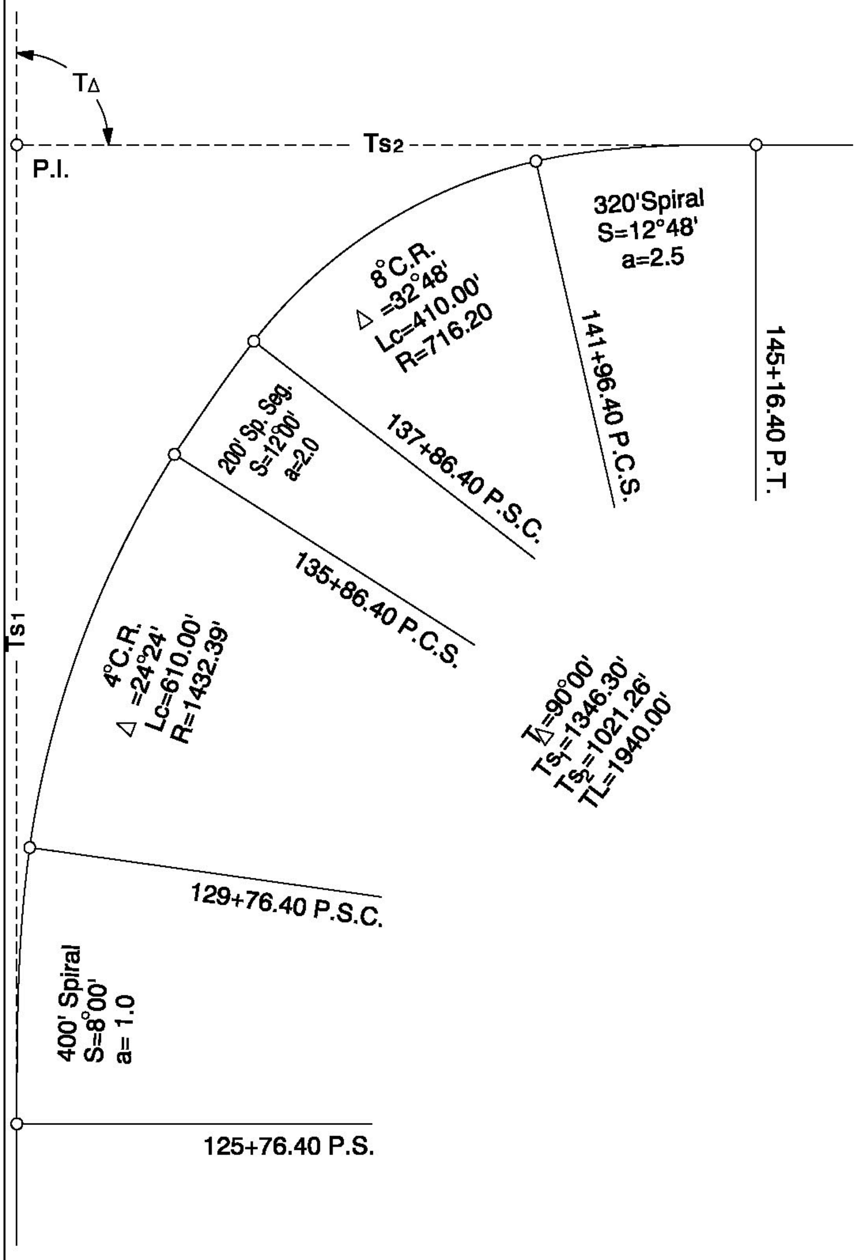

In fitting spiraled alignment to existing circular curve alignment, while retaining the same degree of main curve and the original tangents, it will be found that the new main curve will not be concentric with nor parallel to the original curve. The offset varies from a value of "p" as shown on the sketch 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 $\theta$ = angle from the P.C. or P.T. of original circular curve to the point desired.

Figure 200-39: Spiral Solution - Example 8

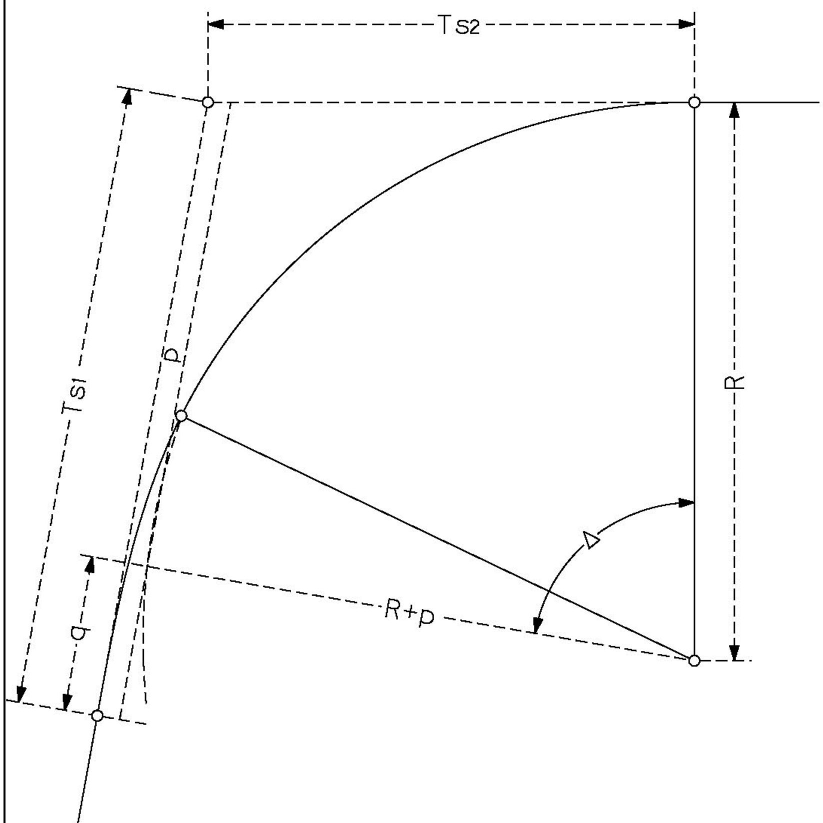
**STANDARD METHOD OF SHOWING ALIGNMENT ON MAPS**




Show stationing to the nearest hundredth of a foot. Show angles and bearings to the nearest second. When calculating the "S" angle, carry at least four places so coordinates are accurate to three places.

Figure 200-40: Spiral Solution - Example 9

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




Given:
$\Delta$, R, p. and q.

Find:
Semi-Tangents.

Solution:

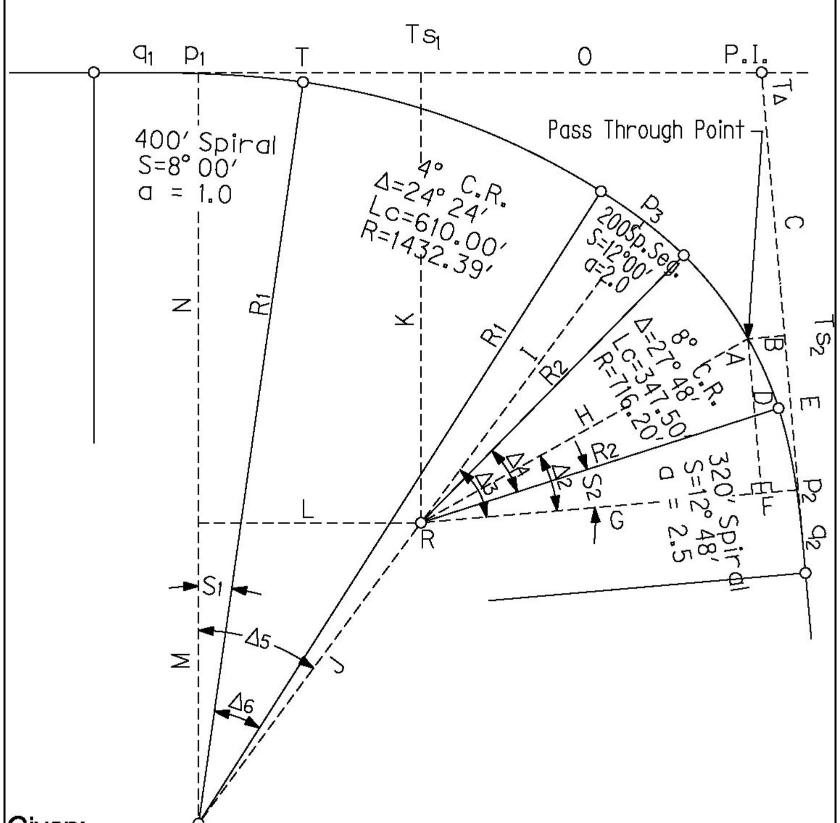
$$Ts_1 = \frac{R - (R + p)\ Cos\Delta}{Sin\ \Delta} + q$$

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

When $\Delta$ is over 90°, the cosine function has a negative value.

Figure 200-41: 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>

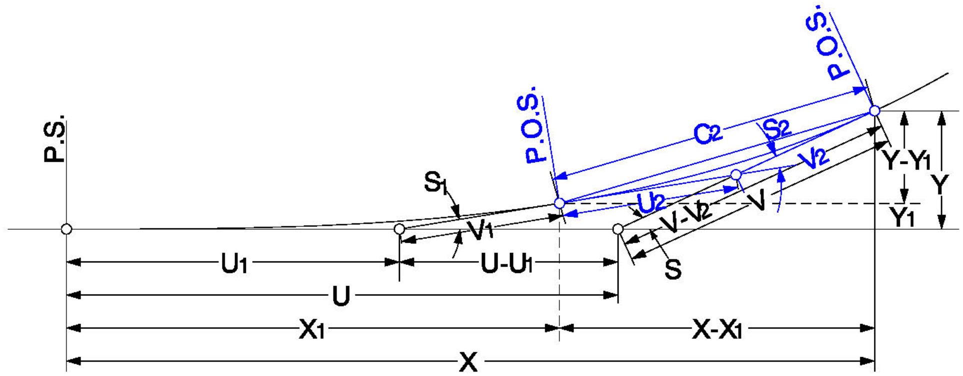
Calculate coordinates for the radius point of " $R_2$ " from $Ts_2$. Calculate O and K along and perpendicular to the $Ts_1$, semi-tangent. '$p_3$' is the perpendicular distance between $R_1$ and $R_2$, when tangent to each other. Then $I = R_2 + p_3$.

$J = R_1 - I$, 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 200-42: 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'

$$S_2 = S - S_1 \qquad V_2 = V - \frac{(U - U_1)\sin S_1}{\sin S_2}$$

$$U_2 = \frac{(U - U_1)\sin S}{\sin S_2} - V_1 \qquad C_2 = \sqrt{(X_1 - X)^2 + (Y_1 - Y)^2}$$

$$S_2 = 12°\,30' - 4°\,30' = 8°\,00'$$

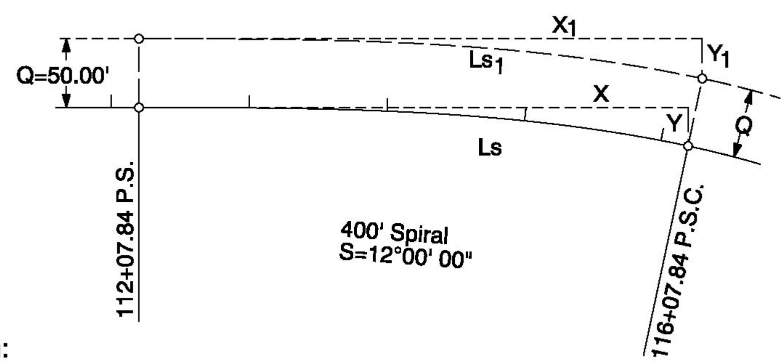
$$U_2 = \frac{(334.17' - 200.06')\sin 12°30'}{\sin 8°00'} - 100.06' = 108.506'$$

$$V_2 = 167.43' - \frac{(334.17' - 200.06')\sin 4°30'}{\sin 8°00'} = 91.83'$$

$$C_2 = \sqrt{(36.24' - 7.85')^2 + (497.63' - 299.81')^2} = 199.847'$$

Figure 200-43: 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:

$\theta$ = 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:

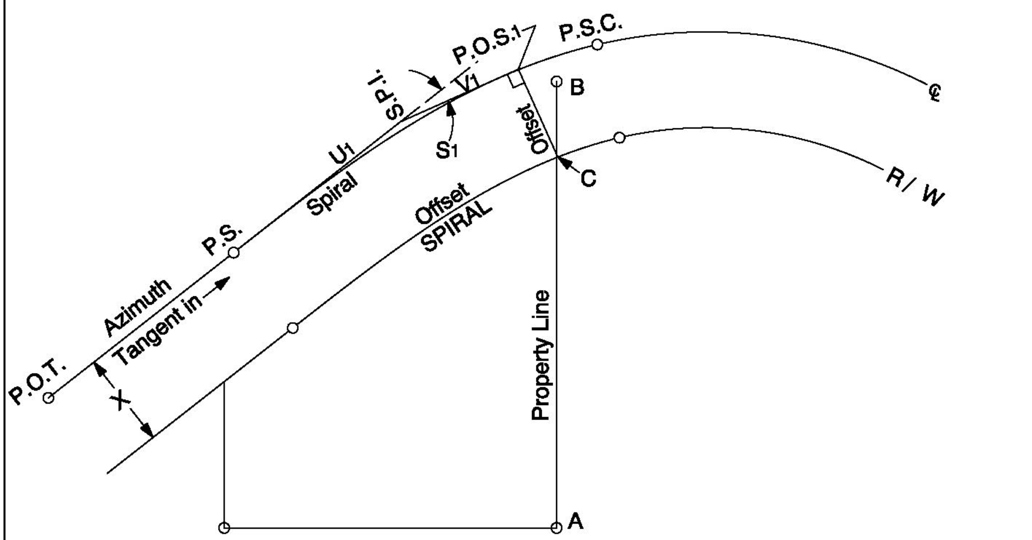
(1) Find the S angle for each station.
(2) Determine length of the offset spiral, $Ls_1$, from P.S. or P.T. to each station.
(3) Using S angles found in step 1, determine the corresponding X and Y values for each station of the base spiral.
(4) Determine the $X_1$ and $Y_1$ values for the offset spiral.
(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 200-44: 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

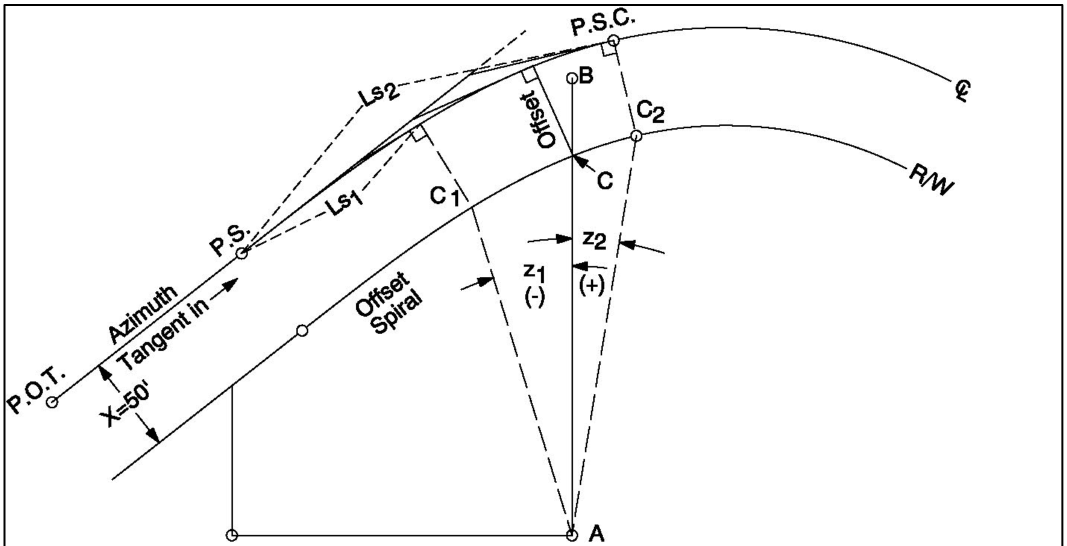
"Equation" is all calculations to produce difference in azimuths ($d_1$ , $d_2$).

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 200-45: 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' $Lg_2$ = $Guess_2$ = 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

$Lg_1$ $Lg_2$ $Ls_3$

$Lg_1$ $Lg_2$ $Ls_3$ $Lg_2$ becomes new $Lg_1$, and $Ls_3$ becomes, new $Lg_2$.

$Lg_1$ $Lg_2$ $Ls_3$

Figure 200-46: Establish Local Tangent on Horizontal Curves

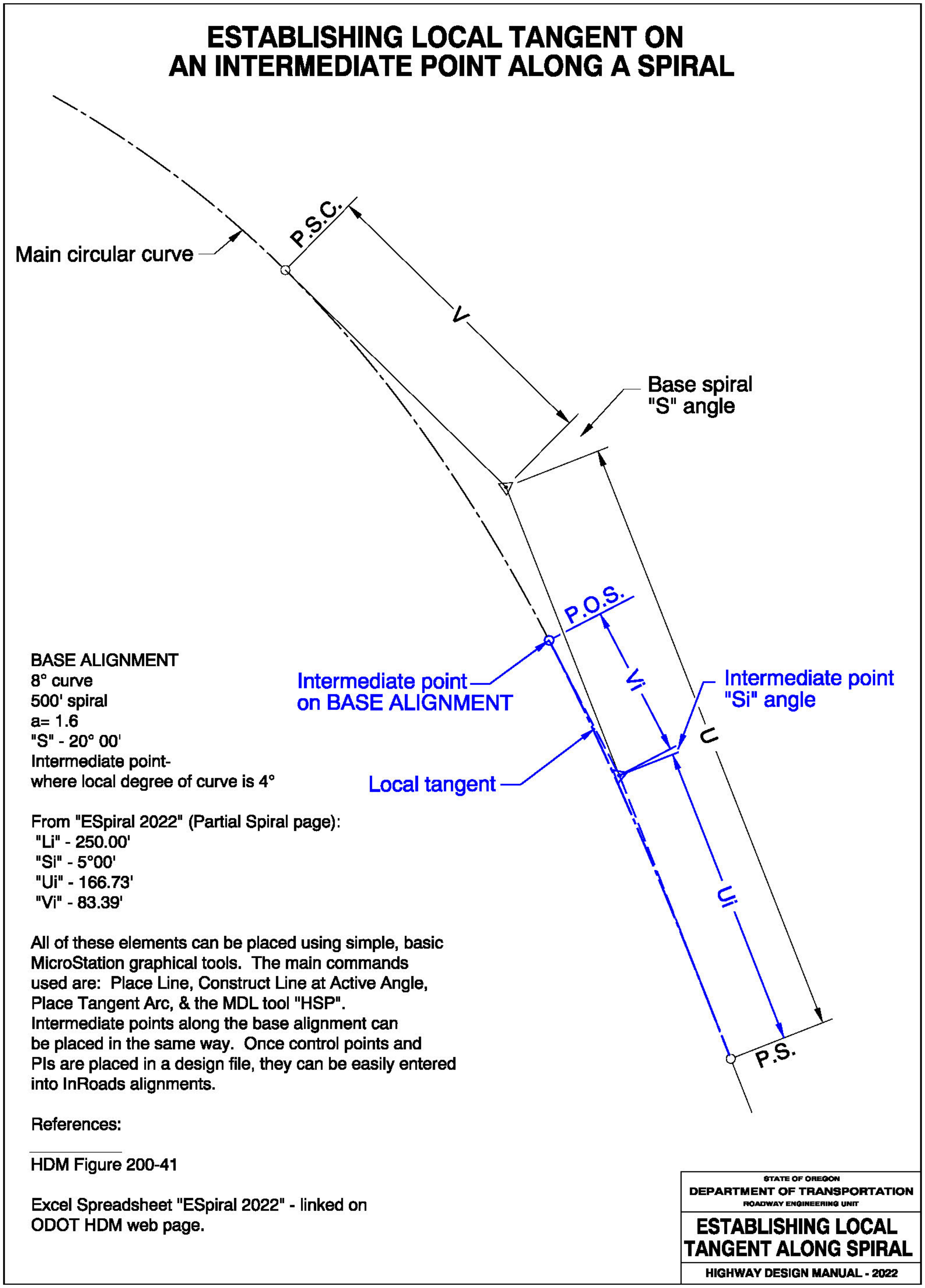


Figure 200-47: Using Spiral Segment in Compound Horizontal Curve Situations

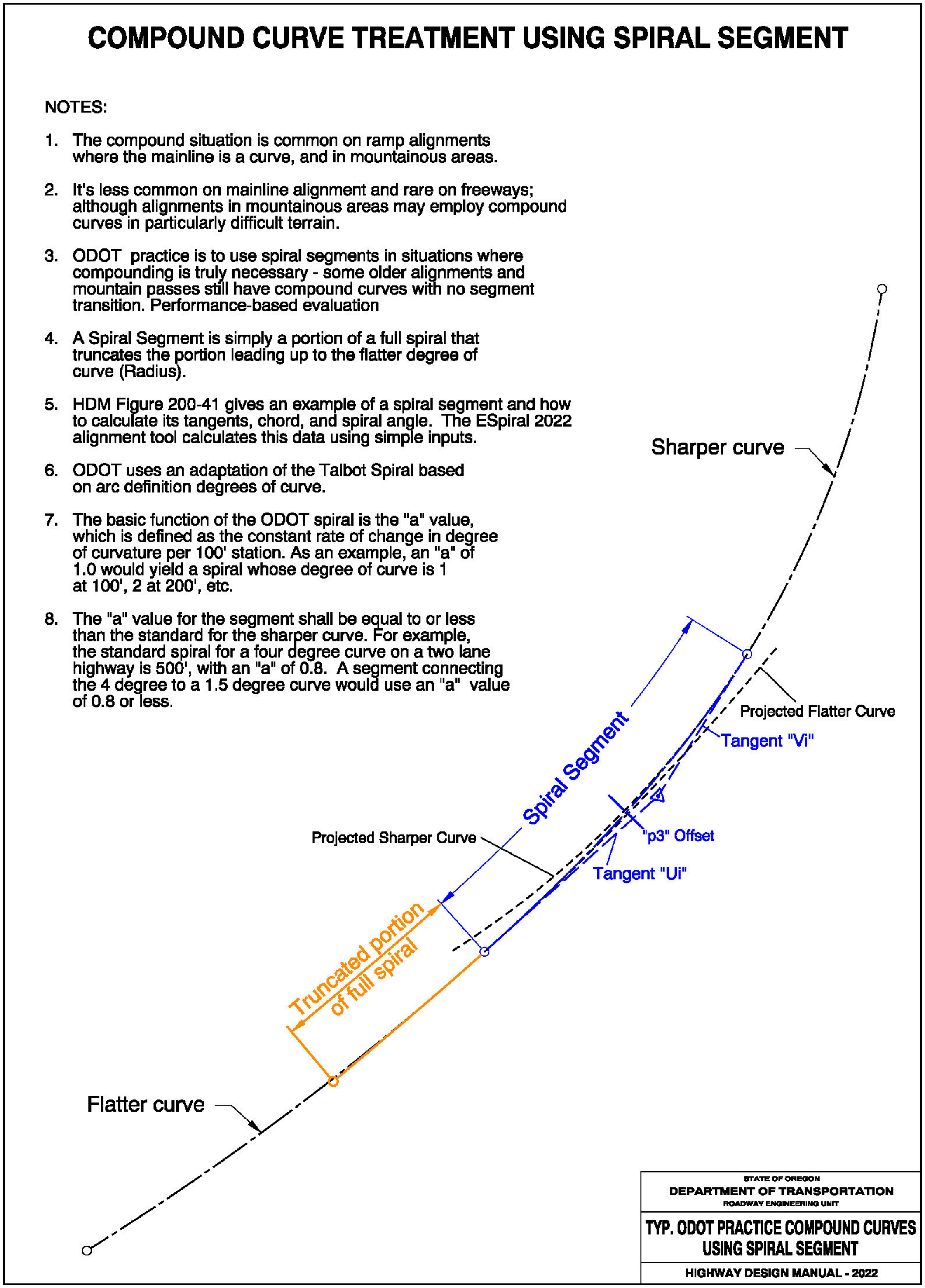


Figure 200-48: Establishing Ramp Takeoff/Touchdown Points and Ramp Angles from Local Tangent

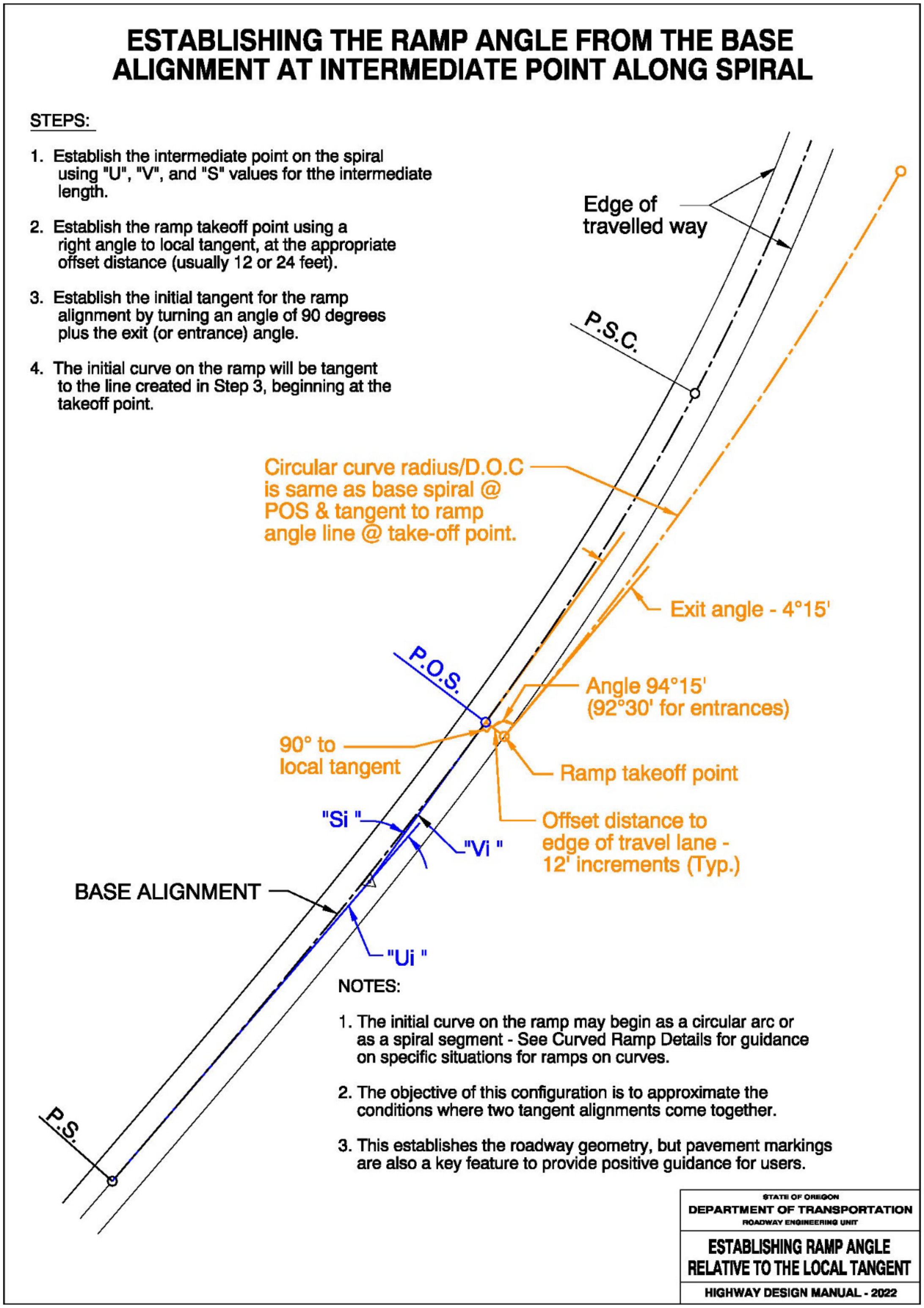


Figure 200-49: Establishing Spiral Segment Control Points
(in conjunction with ESpiral 2022 spreadsheet)

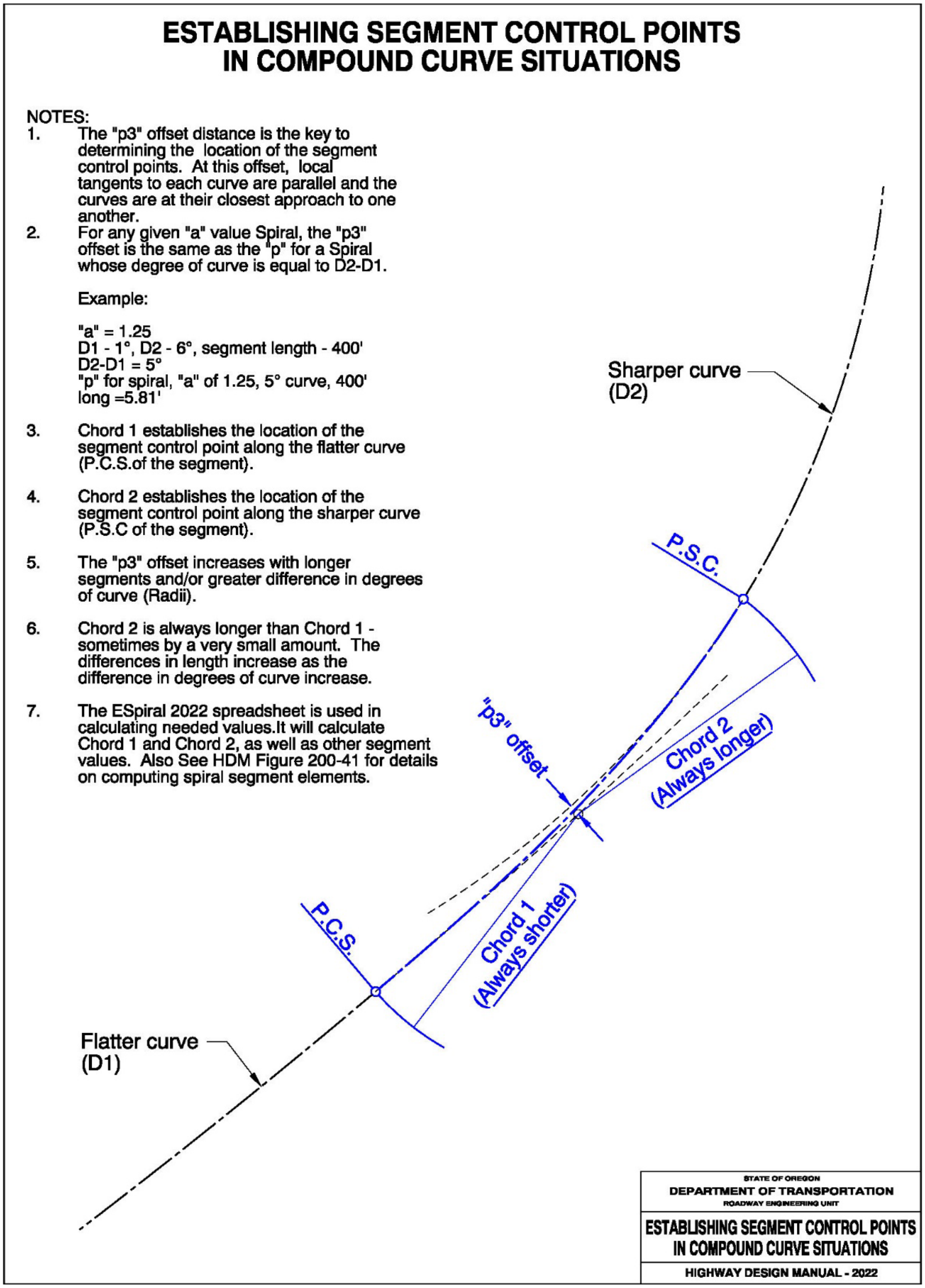
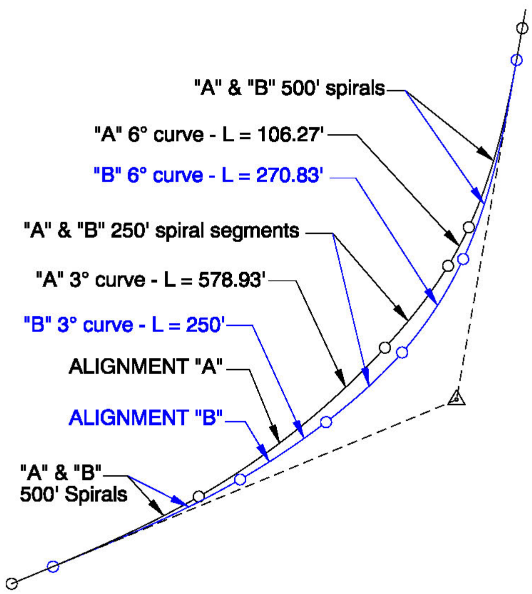


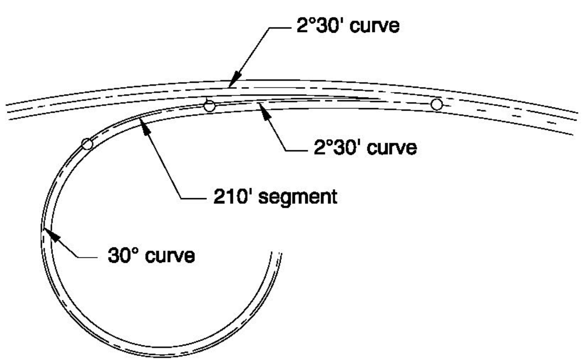
Figure 200-50: Example of Spiral Segment in a Mainline Alignment Situation

## DETERMINING MINIMUM AND MAXIMUM SEGMENT LENGTHS




### DETAIL "A"

This example illustrates identical combinations of curve radii, spirals, segment & total delta; alignment "B" elements have balanced lengths.




### DETAIL "B"

NOTES:

1. Spiral Segments have practical minimum and maximum lengths. The absolute minimum is the length needed to provide for super runoff. As a rule, the length of the segment needs to provide at least 2 seconds of transition time at the design speed of the flatter curve.

   Example:

   Find segment needed to transition from a 2 degree curve to a 5 degree curve on a ramp, based on transition time.
   2 deg. curve - 70 mph (103 fps)
   (103 fps)(2 Sec)=206' ("a" - 1.4563; should be 2.0 or less)
   Check against HDM Table 3-2 alternate formulas.
   2 Deg Curve - 6.5% super, 5 Deg. - 9.5% super
   Ls = (24)(3)/(2)(0.40) = 90 feet - Runoff Control
   Ls = (2)(343000/3638) = 189 feet - Centrifugal Control
   L2 = (2.9)(70) = 203 feet - Aesthetic Control
   2 Seconds @ Design Speed (fps)
   Meets/exceeds all alternate formula criteria.

2. Maximum segment lengths are usually not exact values. Providing longer segment transitions uses up delta angle fairly rapidly. It's equally important to provide circular curves of adequate length within the curve set, otherwise users are continually driving a transition rather than the actual curves. The maximum segment length is often a function of the delta angle available, and the relative sharpness of the two circular curves. See Detail "A".

3. Using appropriate Spiral Segments makes it possible to use radius combinations outside the "usual" ratio of 2:1. For example, a 30° loop entrance ramp can be connected to a curved mainline with a 2.5° curve using a 210' segment. See Detail "B".

4. Both alignments "A" & "B" meet the "Letter of the Law", but balanced lengths of individual elements provide a smoother transition. If necessary, degree of curve (Radii) can be adjusted to fit required exact location of alignment.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

DETERMINING MINIMUM AND MAXIMUM SEGMENT LENGTHS

HIGHWAY DESIGN MANUAL - 2022

# 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 feet above the pavement. While objects less than 2 feet 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 feet. The minimum lengths of vertical curves which may be used for the various design speeds are shown in Figure 200-51 and Figure 200-52.

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 200-51 and Figure 200-52. 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. However, analysis of potential safety benefits is performed to determine the need to include vertical curve improvements.

## 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 Chapter 3 of the Green Book for sight distance information.

## 219.2 3R Vertical Curvature and Stopping Sight Distance (All Highways Except Freeways)

For 3R projects, evaluate reconstruction of crest vertical curves if:

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.

After evaluation, if reconstruction of the vertical curve is not justified or cost effective, or the curve is not reconstructed to new construction standards, a design exception is required.

# 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 200-51 and Figure 200-52. 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 200-51 and Figure 200-52. An angle point is considered a curve with a length of zero, and therefore, does not meet the minimum standard. Figure 200-53 and Figure 200-54 provide information for sag and crest vertical curve formulas and design.

Figure 200-51: SSD Crest Vertical Curve

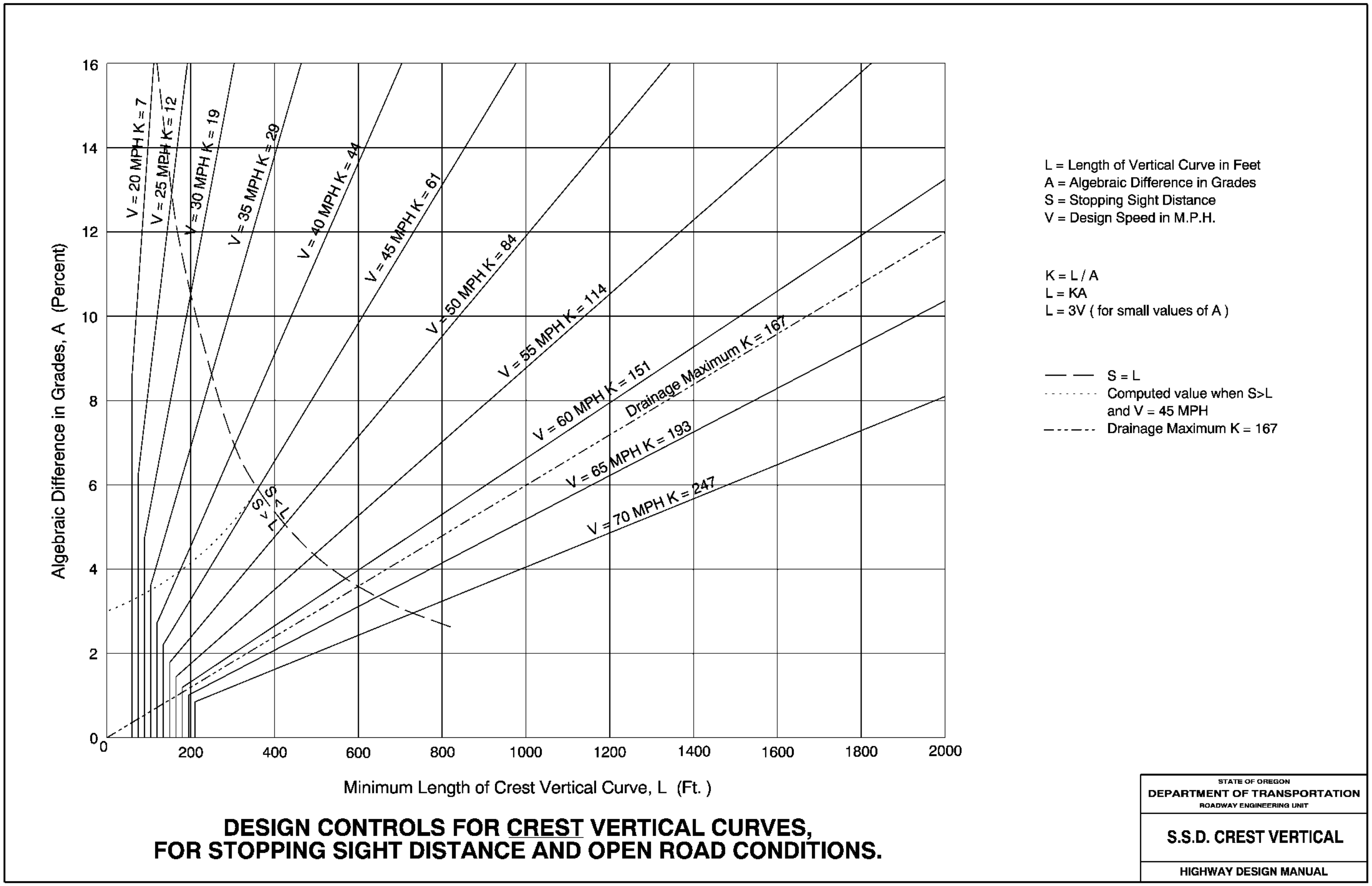
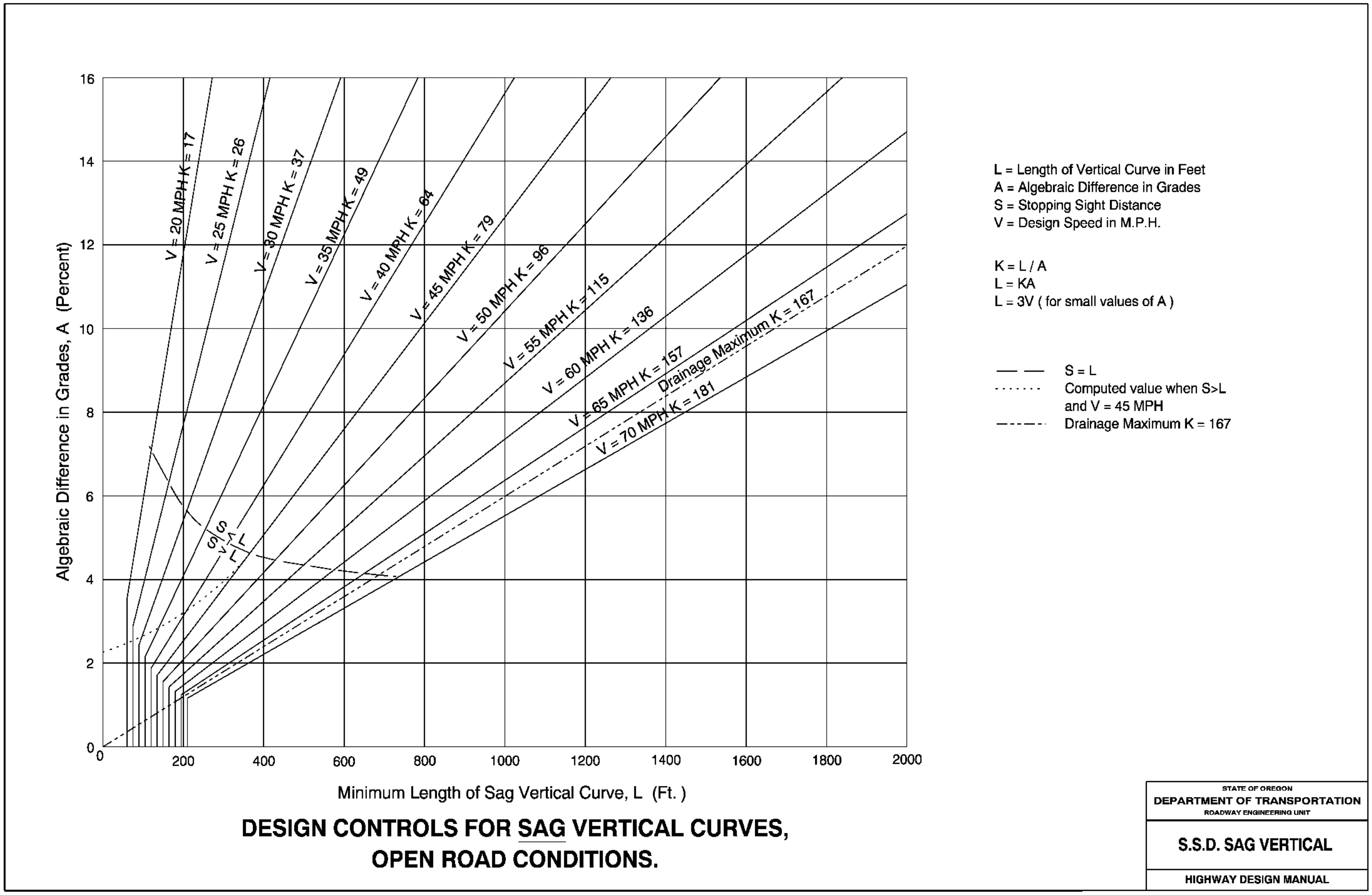


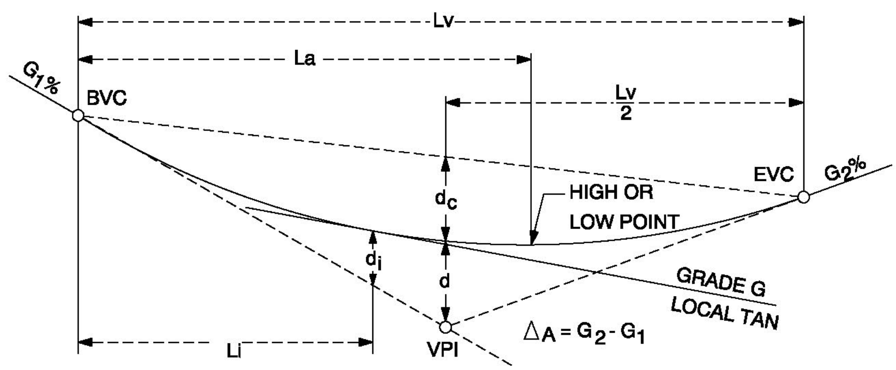
Figure 200-52 : SSD Sag Vertical Curve



# 219.4 Vertical Curve Formulas

Figure 200-53: 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.
$\Delta$A = 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.

$$\Delta_A = G_2 - G_1 \qquad K = \frac{Lv}{\Delta_A}$$

$$d = d_c = \frac{\Delta_A \, Lv}{800} = \frac{K \, \Delta_A^2}{800}$$

$$d_i = \frac{L_i^2}{\left(\frac{Lv}{2}\right)^2} d = \frac{\Delta_A \, L_i^2}{200 \, Lv} = \frac{L_i^2}{200 \, K}$$

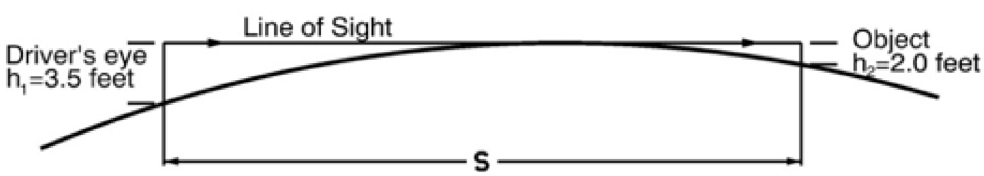
$$G = G_1 - \frac{L_i}{K} \qquad L_a = G_1 K$$

Note: Distances Lv, d, $d_c$, $L_a$, $L_i$, $d_i$, are in feet.
Grades $G_1$, $G_2$, $\Delta$A, G are in percent.

Figure 200-54: 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 |

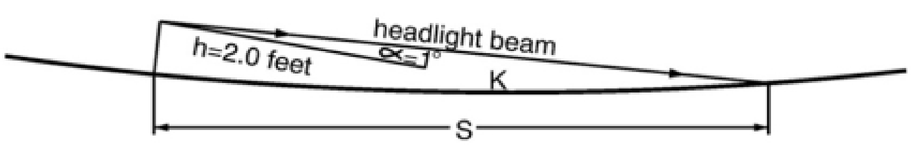



$$K = \frac{S^2}{200\ h_1\ (1 + \sqrt{h_2 / h_1})^2}$$

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/s²

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 $\quad K = \frac{2\,S}{\Delta A} - \frac{200\,h}{\Delta A^2}(1 + \sqrt{h_2 / h_1})^2$ 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.

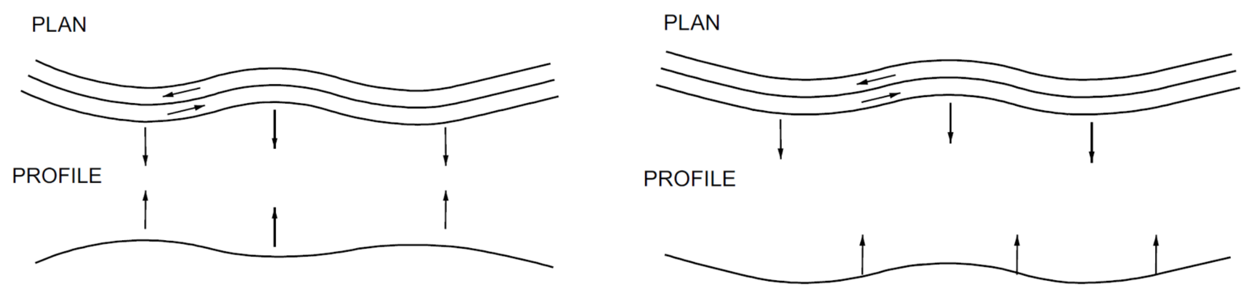
When designing for the coordination of horizontal and vertical alignment, the following issues need to be considered.

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.

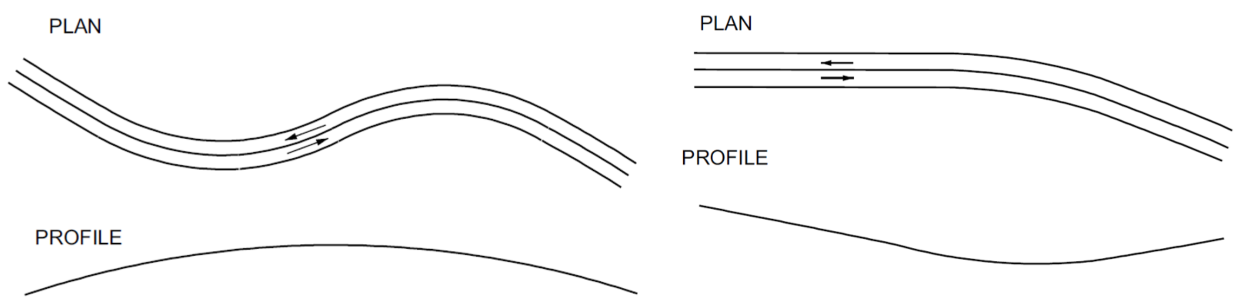
Figure 200-55: Coordination of Horizontal and Vertical Curves (AASHTO, 2018)




The classic case of coordination between horizontal and vertical alignment in which the vertices of horizontal and vertical curves coincide, creating a rich effect of three-dimensional S-curves composed of conves and concave helixes

Weak Coordination of Horizontal and Vertical Alignment

Figure 200-56: Examples of Poor Combined Horizontal and Vertical Alignment (AASHTO, 2018)




This combination is undesirable for two reasons. The tangent between the curves is too short, and the reverse occurs on a crest.

Short Tangent on a Crest between Two Horizontal Curves

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

Sharp Angle Appearance

# Section 221 Grades

## 221.1 General

On grades of 4% or greater, 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. Table 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 require 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: 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, collector and local highways can be found in Table 200-16, Table 200-17, and Table 200-18. 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.

Table 200-16: Rural Arterial Maximum Grades (%) for Specific Design Speed

| Design Speed (mph) | 45 | 50 | 55 | 60 | 65 | 70 |
|---|---|---|---|---|---|---|
| Level Terrain | 5 | 4 | 4 | 3 | 3 | 3 |
| Rolling Terrain | 6 | 5 | 5 | 4 | 4 | 4 |
| Mountainous Terrain | 7 | 7 | 6 | 6 | 5 | 5 |

Table 200-17: Rural Collector Maximum Grades (%) for Specific Design Speed

| Design Speed (mph) | 45 | 50 | 55 | 60 | 65 | 70 |
|---|---|---|---|---|---|---|
| Level Terrain | 5 | 4 | 4 | 3 | 3 | 3 |
| Rolling Terrain | 6 | 5 | 5 | 4 | 4 | 4 |
| Mountainous Terrain | 7 | 7 | 6 | 6 | 5 | 5 |

Table 200-18: Rural Local Route Maximum Grades (%) for Specific Design Speed

| Design Speed (mph) | 45 | 50 | 55 | 60 | 65 | 70 |
|---|---|---|---|---|---|---|
| Level Terrain | 5 | 4 | 4 | 3 | 3 | 3 |
| Rolling Terrain | 6 | 5 | 5 | 4 | 4 | 4 |
| Mountainous Terrain | 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 (%) 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. Space allocation for all modes of transportation must be considered, not just the needs of the largest vehicles. 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 will it be designed 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 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 is a lower need 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.

In addition to Oregon statutes, FHWA also provides policy based on various sections in the United States Code (U.S.C.) and the Code of Federal Regulations (CFR) in Title 23 - Highways, Title 49 - Transportation, and Title 42 - Public Health and Welfare to incorporate safe and convenient walking and bicycling facilities into transportation projects. Every transportation agency, including the federal department of transportation, has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation systems.

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.

However, restriping of paving only projects can afford opportunities to make incremental improvements to bicycle facilities at low or no cost to the project. Adding a bike lane or buffered bike lane with restriping where one did not exist can be a big improvement to the system.

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.

## 224.1.1 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.

## 224.1.2 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.
    - Bicycle accommodation needs to be continuous on both sides of the roadway.
2. Bicycles are vehicles and are 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 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.

**National Truck Network** - The National Network was authorized by the Surface Transportation Assistance Act of 1982 (P.L. 97-424) and specified in the U.S. Code of Federal Regulations (23 CFR 658) to require states to allow conventional combinations on "the Interstate System and those portions of the Federal-aid Primary System serving to link principal cities and densely developed portions of the United States on high volume routes.

**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 exceptions 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. The Project Leader’s role is to coordinate the process.

# Section 303 Cross Section Elements

The Standard Roadbed Sections and the ODOT 4R/New Standards outlined in Section 304 through Section 322 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

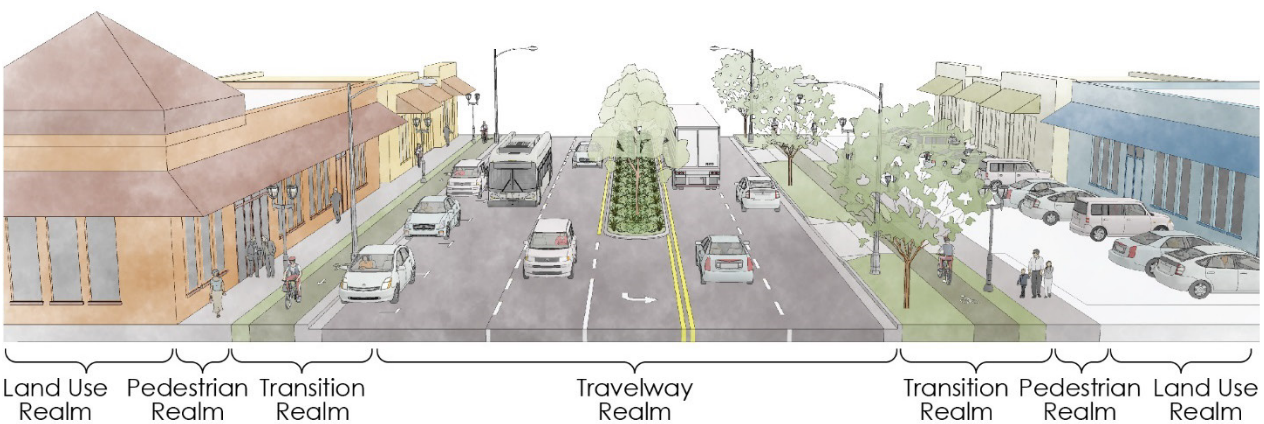


Table 300-1 Summary of Cross Section Realms

| 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.<br>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.<br>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<br>Buffer/furniture zone often used as a place for utilities, lighting, signs, street trees, and other furnishings<br>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<br>May serve multiple functions in same block or location, may vary by time of day.<br>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.)<br>Can provide or manage vehicular access through turn lanes, medians, and other treatments<br>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 the context, evaluate the desired project goals and outcomes, and design the cross-sectional elements as an iterative process. 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. 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

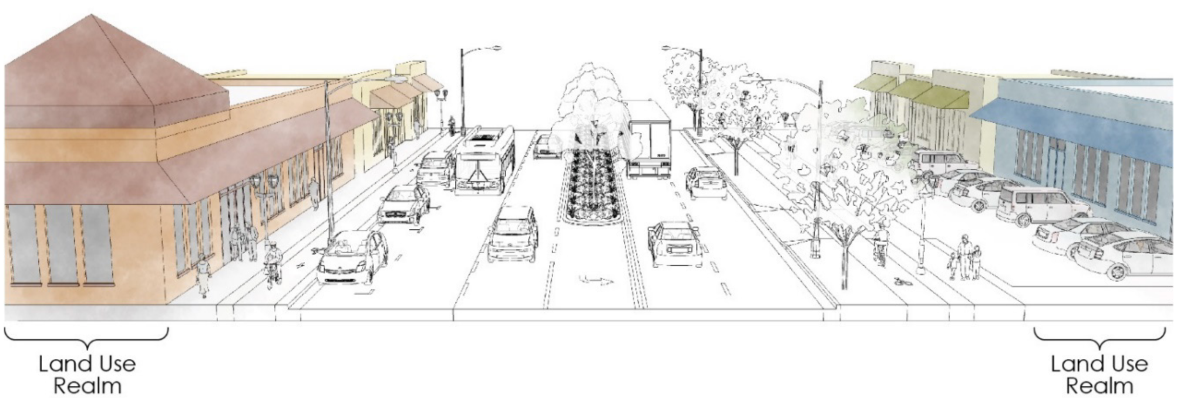


Table 300-2 Design Element Considerations within the Land Use Realm

| 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.<br>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:<br>Additional sidewalk width<br>Pedestrian plazas / parks<br>Landscaping adjacent to the sidewalk<br>Stormwater facilities (green streets)<br>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.<br>Consider whether it would be appropriate to rely on the adjacent land use for parking.<br>In many cases, local jurisdiction development code requires property owners to provide bicycle parking.<br>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. To help determine final decisions on crossing spacing needed by pedestrian activity in the area, look at pedestrian origins and destinations within adjacent blocks to help evaluate 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

| Urban Context | Target Spacing (ft.) |
|---|---|
| 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

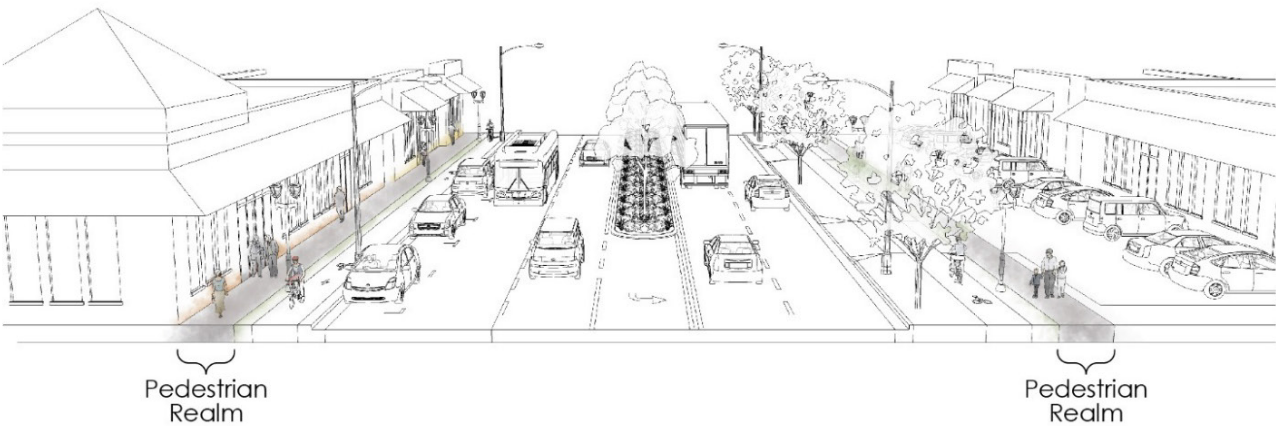



Exhibit 300-1, Pedestrian Realm Zones

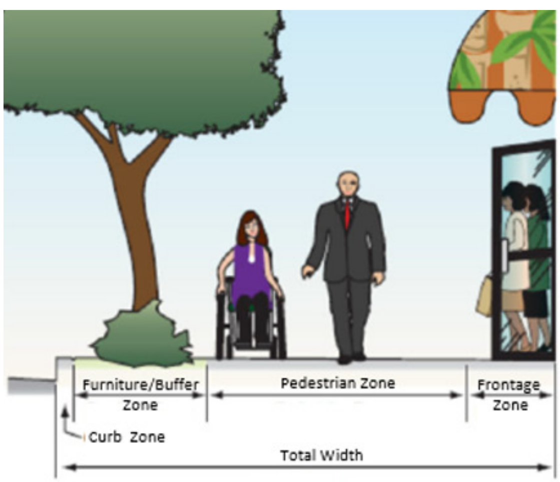



Table 300-4 Design Element Considerations within the Pedestrian Realm

| Design Element | Considerations |
|---|---|
| **Frontage Zone** | The frontage zone is located between the pedestrian zone and the right-of-way.<br>Depending on the available space, this zone may include items such as sandwich boards (if sidewalk locally owned), bicycle racks, and benches.<br>This area is used by window shoppers and is where people enter and exit buildings.<br>• 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.<br>• 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?<br>Is the street a high priority for pedestrian activity, based on community input and local jurisdiction planning efforts?<br>• If so, prioritize serving pedestrians with a high-quality facility (width and buffer).<br>What level of pedestrian activity is occurring today? Is there a desire or potential for higher pedestrian activity?<br>• Select sidewalk widths with sufficient space to accommodate anticipated/desired level of activity.<br>What is the target pedestrian level-of-traffic-stress for this location?<br>A pedestrian accessible route is provided in the pedestrian zone. |
| **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.<br>Permitted items such as sandwich boards, bicycle racks, and other street furniture are typically placed in this zone.<br>Additional design elements to consider in sidewalk design include:<br>• Pedestrian scale lighting<br>• Utility pole placement<br>Do transit stops need extra buffer?<br>• Where vehicle speeds or volumes are high, sufficient buffer is important.<br>• Downtown area may have parked cars that can serve as a buffer.<br>Suburban areas have no parking but may include a planter strip. |

Table 300-4 (continued) Design Element Considerations within the Pedestrian Realm

| Design Element | Considerations |
|---|---|
| **Curb Zone** | The curb zone is the transition between a sidewalk to the roadway at a crosswalk or intersection.<br>• The design of the gutter pan (apron) is important for ADA access standards.<br>• A curb and gutter is typically 2 feet, and the gutter portion can be part of the adjacent transition realm.<br>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.<br>Most urban streets with sidewalks are typically curbed.<br>A vertical curb channelizes drainage and prevents vehicles 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

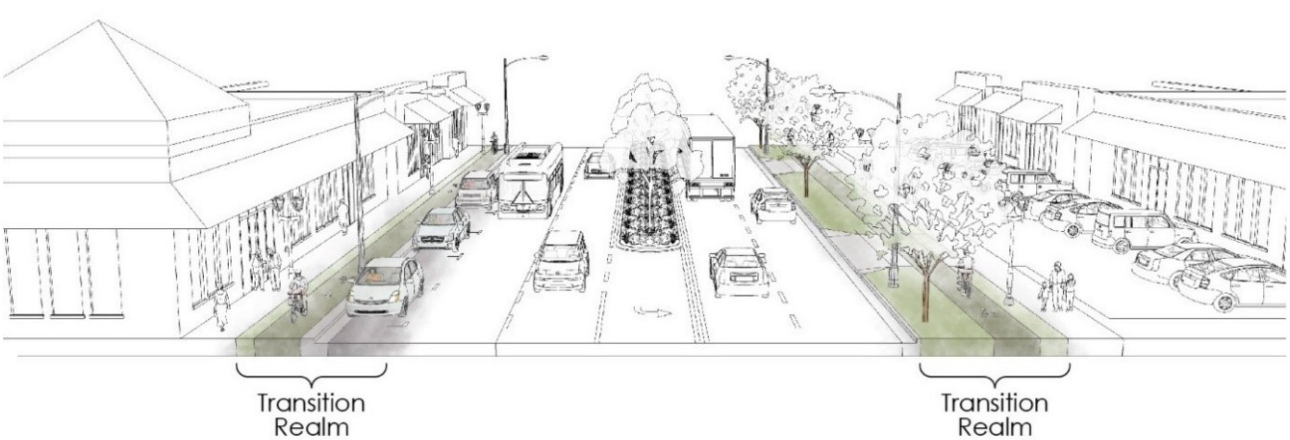


Table 300-5 Design Element Considerations within the Transition Realm

| Design Element | Considerations |
|---|---|
| **Right Side Shoulder** | What is the purpose of this space?<br>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?<br>Is storm water allowed to encroach into travel lanes (spread) given the context and target speed? |
| **Bicycle Facility (See Part 900 for Design Details)** | What cross-sectional elements are next to the bicycle lane (e.g. narrow travel lane with higher percentage of trucks)?<br>What are speeds?<br>• When speeds are higher, the project team needs to consider additional separation, such as extra buffer or moving bicycles behind the planter strip.<br>• 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.<br>Is the street part of the regional bicycle network?<br>• If so, prioritize serving bicycle access and mobility.<br>What type of bicyclist is currently served? What are the forecast volumes of bicyclists, and is the width sufficient to serve them?<br>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.<br>What level of facility is needed to serve riders of all ages and abilities?<br>• 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.<br>What are the forecast volumes of bicyclists, and is the width sufficient to serve them?<br>Can buffer widths be minimized by providing greater physical protection?<br>Is there a parallel route that is equally direct/accessible and/or that has been identified in a local jurisdiction plan?<br>Can anticipated volumes of bicyclists and pedestrians be served with a multi-use path on one or both sides of the street? |

Table 300-5 (Continued): Design Element Considerations within the Transition Realm

| Design Element | Considerations |
|---|---|
| **Bicycle / Street Buffer Zone** | Stormwater/Landscape Strip<br>What are the green street treatment locations that present the fewest trade-offs on this street?<br>• Curb extensions work well with on-street parking, but are more challenging to implement in conjunction with separated bicycle facilities.<br>• 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 sight distance standards and be permitted by ODOT.<br>• Basins can be implemented in right-of-way remnants.<br>Are there opportunities to reduce impermeable surface to reduce run-off volumes?<br>Transit Stops<br>Are buses stopping in the travel lane or in a bus pullout? What is the transit agency's guidance along the specific corridor?<br>Are bus stops upstream or downstream of intersection?<br>What would be the interaction between the bus stop and the bicycle facility, as well as access to pedestrian facilities?<br>Transit stops may be incorporated in the buffer and curb zones that are part of the pedestrian zone. |
| **On-Street Parking** | What is the off-street parking situation? What about parking availability on side streets?<br>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.<br>Ensure availability of ADA spaces.<br>Identify the need to allocate space for the following:<br>• Bicycle parking<br>• On-street loading/unloading<br>• Freight<br>• 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:<br>• Sweeping, snow removal, and maintaining constrained cycle track facilities.<br>• Restriping and maintaining markings for buffered bicycle lanes.<br>• Maintaining vertical elements like tubular markers used for delineation and separation of the bicycle facility and the travel lane.<br>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

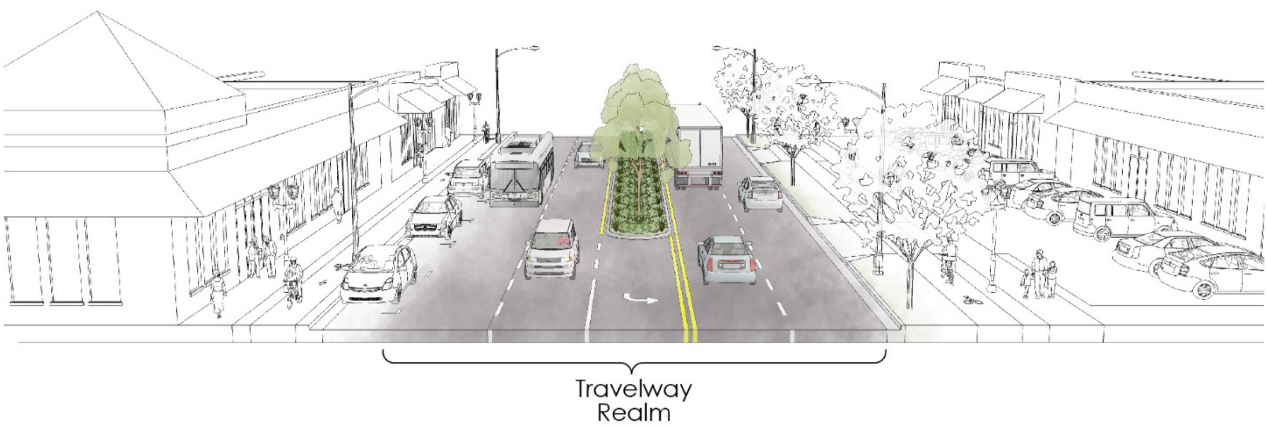


Table 300-6 Design Element Considerations within the Travelway Realm

| Design Element | Considerations |
|---|---|
| **Travel Lane Width** | What is the land use context and target speed for the street?<br>• In slower, denser urban contexts, consider narrow, minimum lane widths.<br>• In suburban contexts, consider narrower lane width.<br>• In higher speeds, maintain wider lane.<br>• Maintain typical lane width for the context.<br>What design elements are adjacent to the lane?<br>• Evaluating the appropriate lane width may depend on the design elements adjacent to the lane.<br>• 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.<br>• A travel lane directly adjacent to a curb may benefit from a full width to allow for adequate width for users on the roadway.<br>What are the appropriate number of through travel lanes?<br>• 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.<br>• Consider if it is appropriate to accept higher levels of congestion.<br>What role does this street play in the regional transit network?<br>• If the street is part of the frequent bus network (or any rail or High Capacity Transit), prioritize designs that prioritize transit.<br>What role does this street play in the freight network?<br>• If the street is part of the regional or statewide freight network, prioritize designs that preserve adequate vehicular capacity for the demand.<br>What role does this street play in Reduction Review Route?<br>• Follow the appropriate process outlined in OAR 731-012 |
| **Turn Lane Width** | What design elements are adjacent to the left-turn lane?<br>• Is there a median with a shy distance that may provide an opportunity to narrow the lane width?<br>• What is the median striping width in the opposing direction?<br>What design elements are adjacent to the right-turn lane?<br>• How are bicycles addressed at right-turns? |

Table 300-6 (continued): Design Element Considerations within the Travelway Realm

| Design Element | Considerations |
|---|---|
| **Left Side Shy Distance** | In low-speed urban contexts, consider minimizing additional width needed for shy distance (e.g. median or curb).<br>• Lower target speeds<br>• Use fewer vertical elements (which require shy distance)<br>• Zero shy distance 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?<br>• Access management.<br>• Landscaping to create “boulevard” effect. |

# Section 305 Cross-Section and Realm Design Guidance

As noted previously in Section 304, 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. Section 305.1 through Section 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 described 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 100are 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 and preference, the higher end of the dimension range should be the starting point for evaluation, as shown first in the tables. For travel lanes, the intent is to begin evaluation with the generally preferred lower width dimension and increase as needed depending on the context, users, and roadway characteristics. This would include consideration for large vehicles and freight needs. Final dimensions chosen from within the acceptable ranges are determined by project goals and design outcomes in conjunction with all 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 Section 304, Cross Section Realms for information.

# 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

| Realm | Design Element | Width |
|---|---|---|
| Pedestrian Realm | Frontage Zone | 4′ to 2′ |
| | Pedestrian Zone | 10′ to 8′ |
| | Buffer/Furniture Zone | 6′ to 0′ |
| | Curb/Gutter[1] | 2′ to 0.5′ |
| Transition Realm[6] | Separated Bicycle Lane Width (Curb Constrained Facility)[2] | 8′ to 7′ |
| | On-Street Bicycle Lane Width (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 306 and Part 900) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. Except for right-turn channelizations, 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.

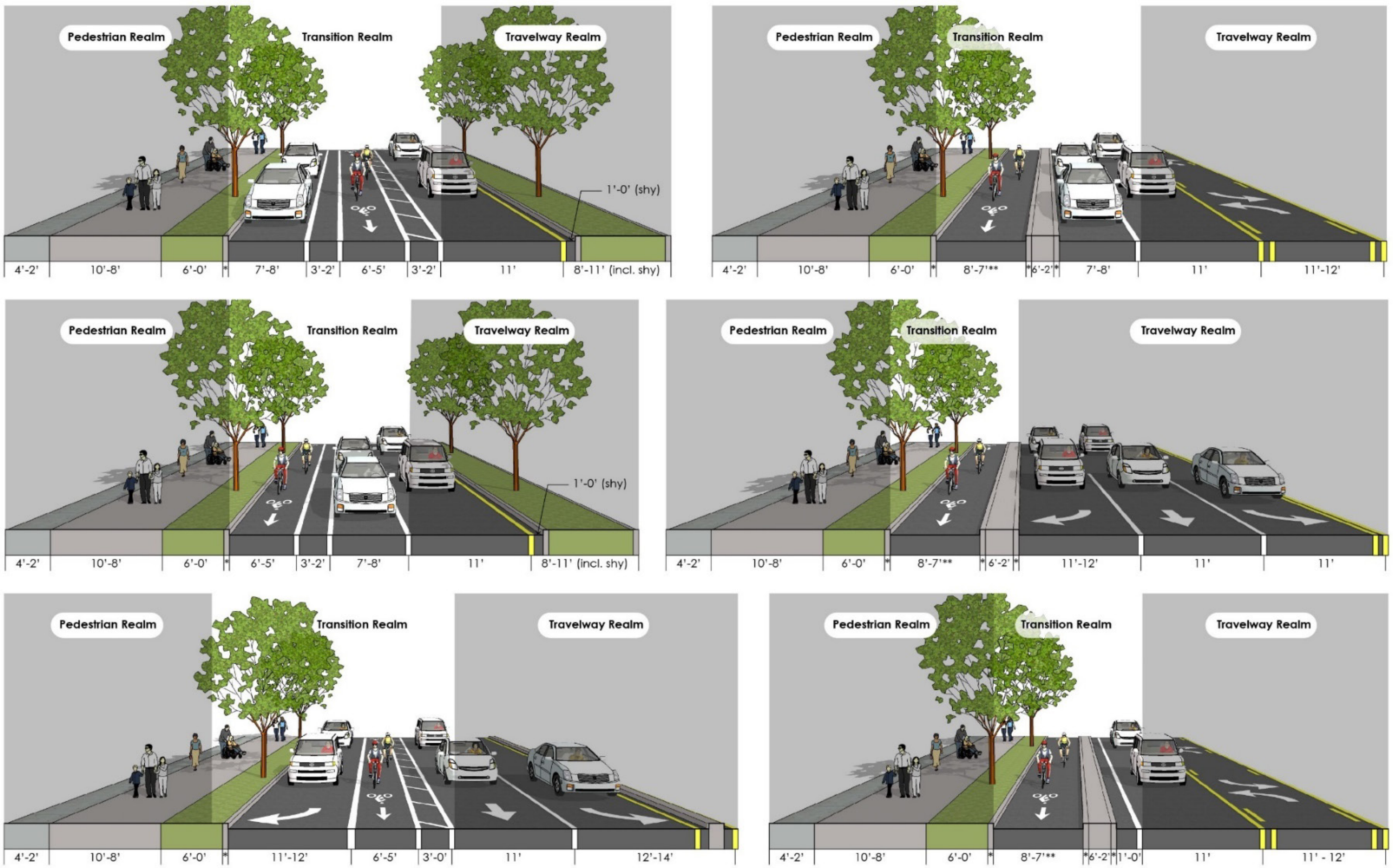
[3] Overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), 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; 12-foot lane optional, where needed; 10-foot lane width requires a formal design exception 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 300-3 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

| Realm | Design Element | Width 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 Width (Curb Constrained Facility)[2] | 8′ to 7′ |
| | On-Street Bicycle Lane Width (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 306 and Part 900) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. Except for right-turn channelizations, 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.

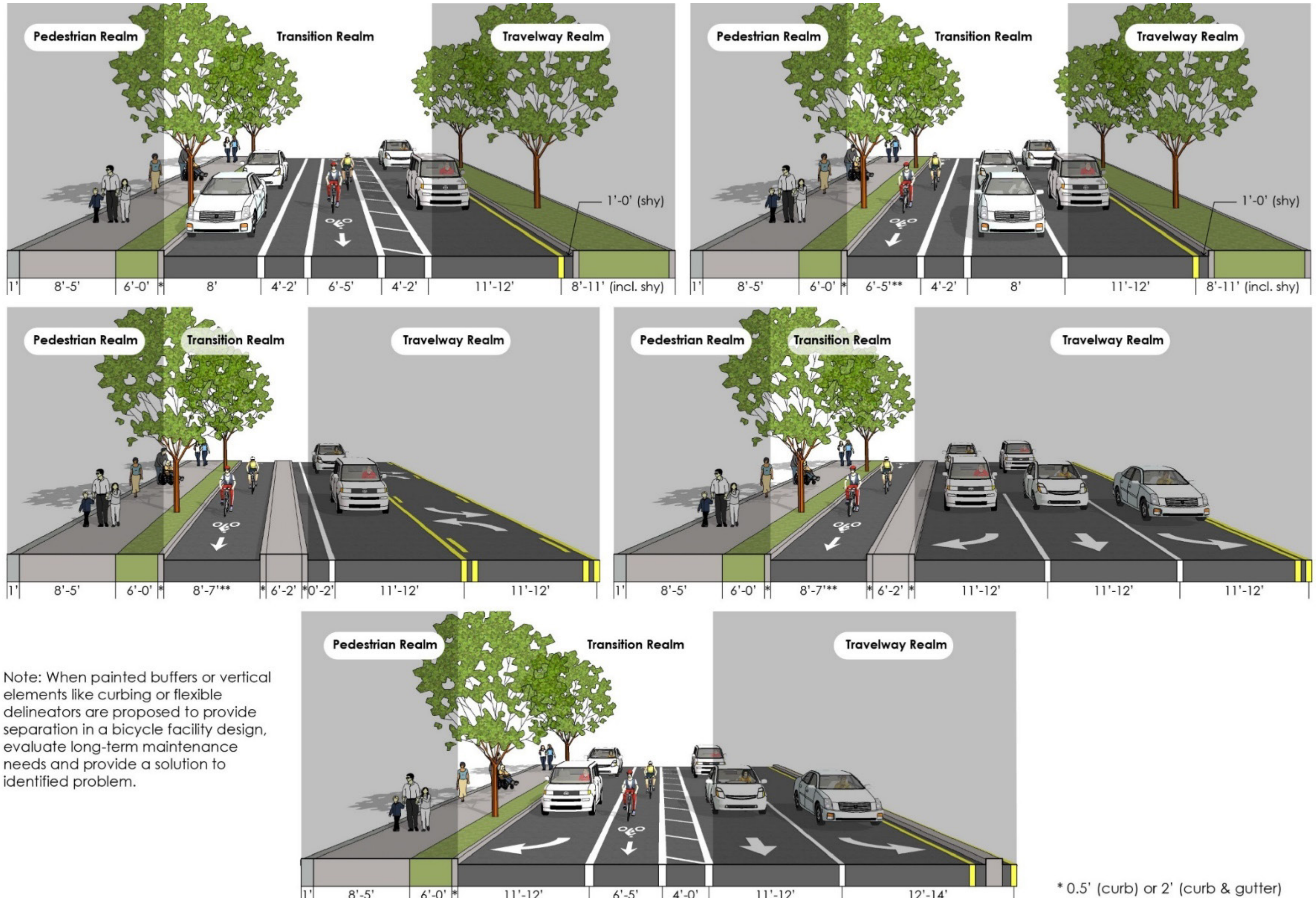
4 11-foot lane width preferred; at 40 mph and above, a 12-foot lane width preferred; 10-foot lane width requires a formal design exception from the State Roadway Engineer. On freight- or transit-oriented streets, a 10-foot travel lane is generally not appropriate without a buffer zone or shoulder.

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




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 problem.

* 0.5' (curb) or 2' (curb & gutter)
** Consider raised bicycle lane

# 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 300-4 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

| Realm | Design Element | Width 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 Width (Curb Constrained Facility)[2] | 8′ to 7′ |
| | On-Street Bicycle Lane Width (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 306 and Part 900) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. Except for right-turn channelizations, 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] At 40 mph and above, a 12-root lane is preferred; 10-foot lane width requires a formal design exception 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.

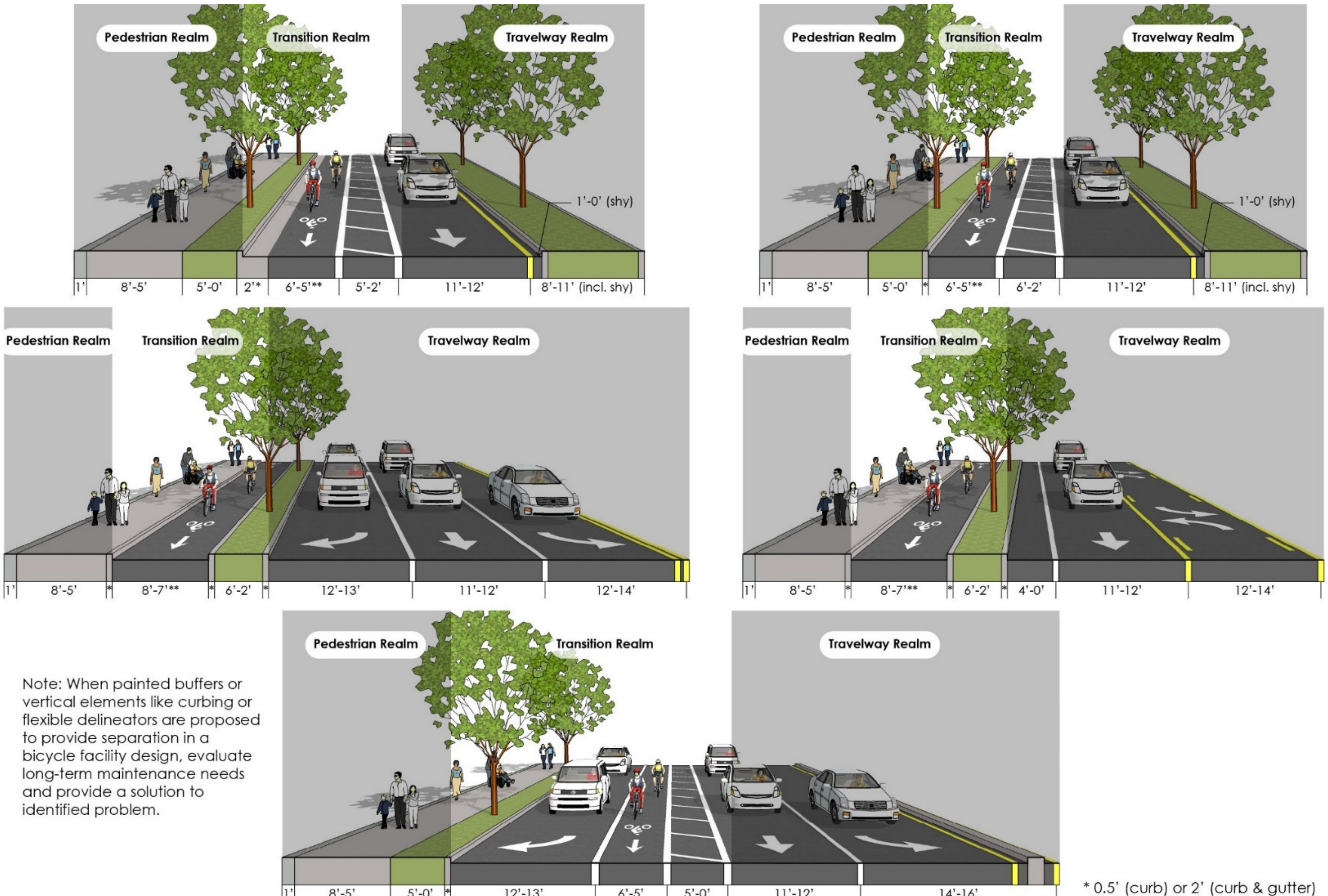
[6] At 40 mph and above, a 14-foot lane is preferred.

[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




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 problem.

* 0.5' (curb) or 2' (curb & gutter)
** Consider raised bicycle lane

# 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 300-5 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

| Realm | Design Element | Width 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 Width (Curb Constrained Facility)[2] | 8′ to 7′ |
| | On-Street Bicycle Lane Width (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 306 and Part 900) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. Except for right-turn channelizations, 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] At 40 mph and above, a 12-foot lane is preferred; 10-foot lane width requires a formal design exception 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.

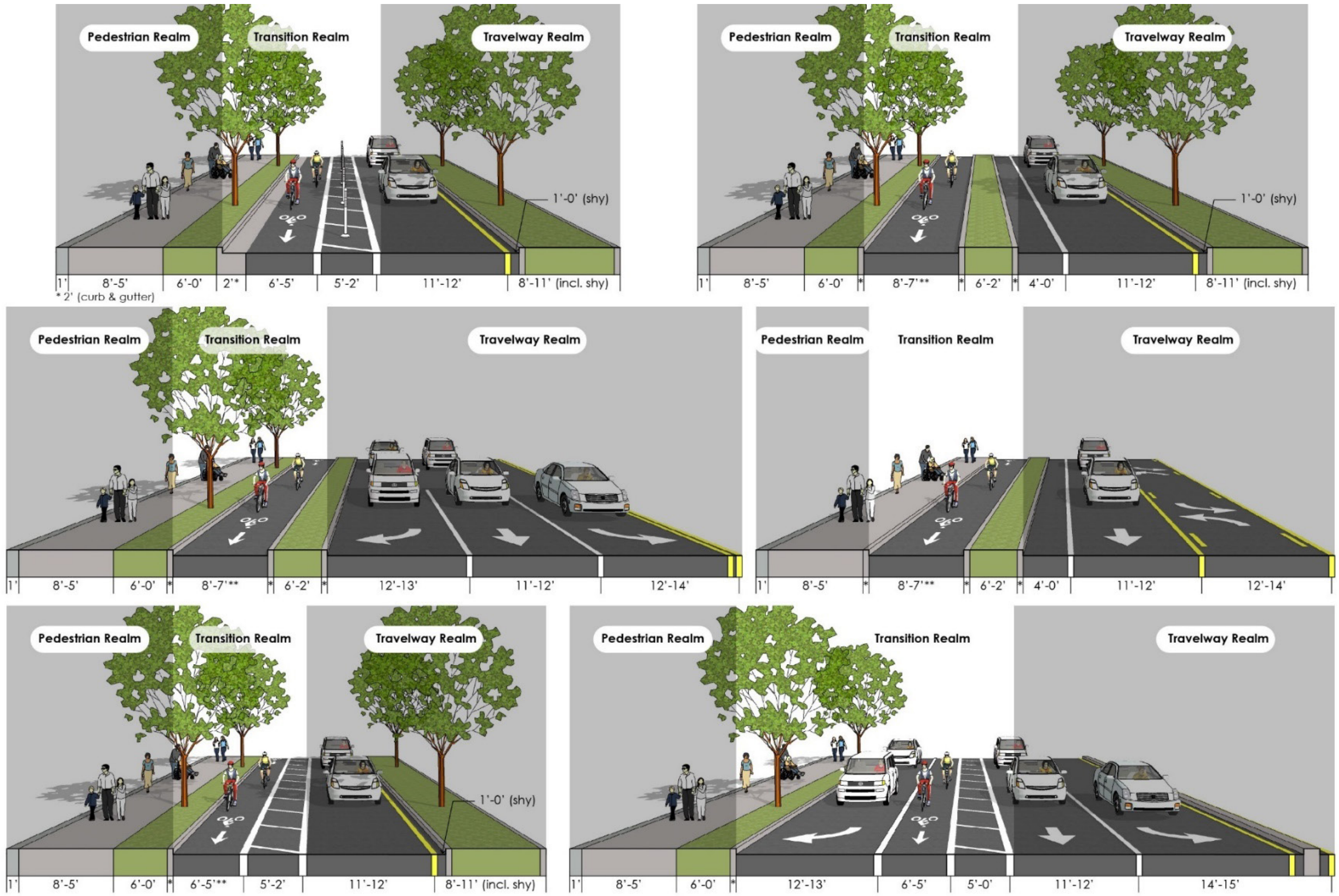
[6] At 40 mph and above a 14-foot lane is preferred.

[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

| Realm | Design Element | Width 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 Width (Curb Constrained Facility)[2] | 8′ to 7′ |
| | On-Street Bicycle Lane Width (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 306 and Part 900) 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. Except for right-turn channelizations, 5-foot on-street bicycle lane allowed only with a street buffer.

[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] At 40 mph and above, a 12-foot lane is preferred; 10-foot lane width requires a formal design exception 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.

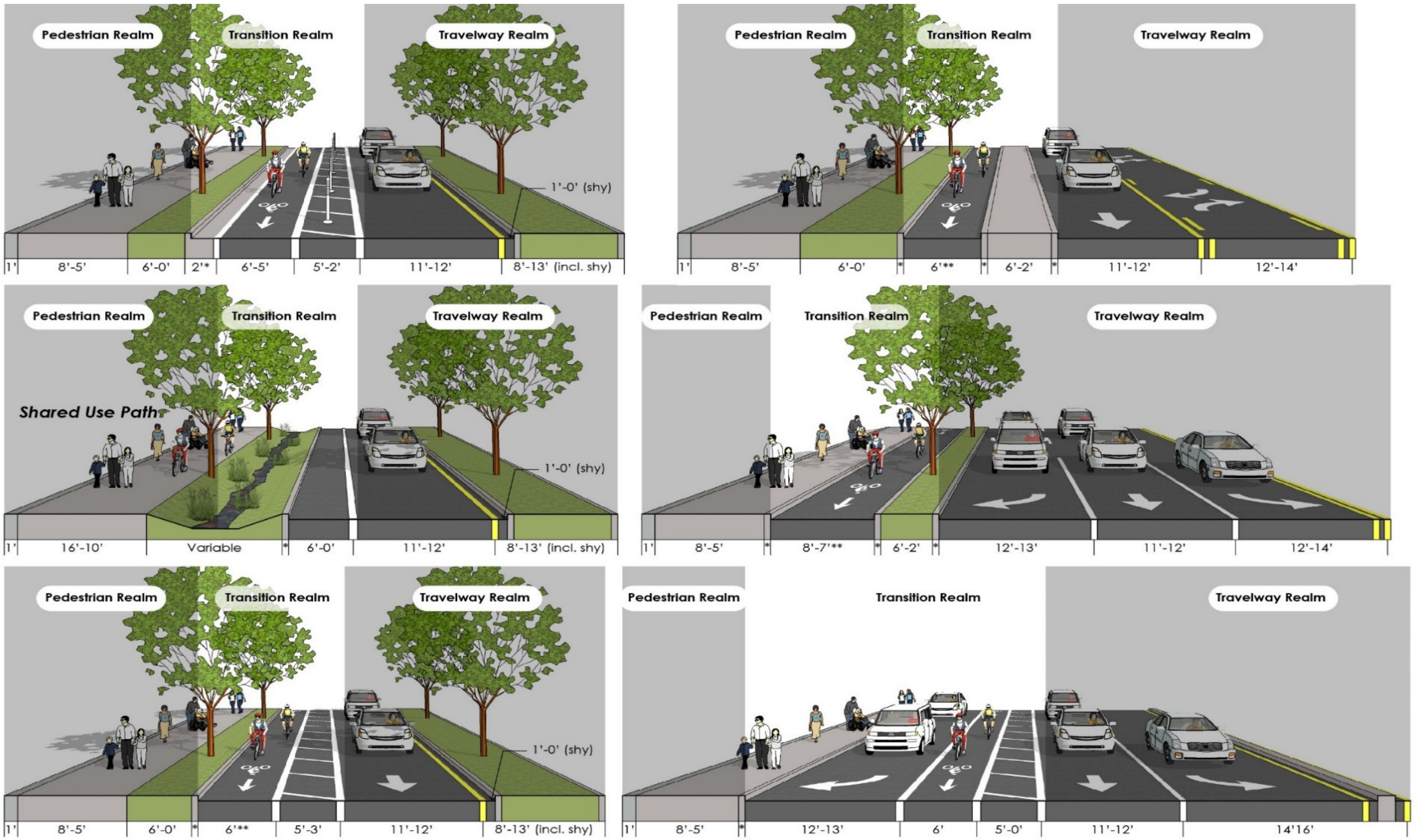
[6] At 40 mph and above a 14-foot lane is preferred.

[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 are 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. A variety of techniques 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

| Realm | Design Element | Width 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 Width (Curb Constrained Facility)[2] | 8′ to 7′ |
| | On-Street Bicycle Lane Width (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 306 and Part 900) to determine appropriate bicycle facility type. Consider raised bicycle lanes where appropriate. Except for right-turn channelizations, 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 a formal design exception 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.

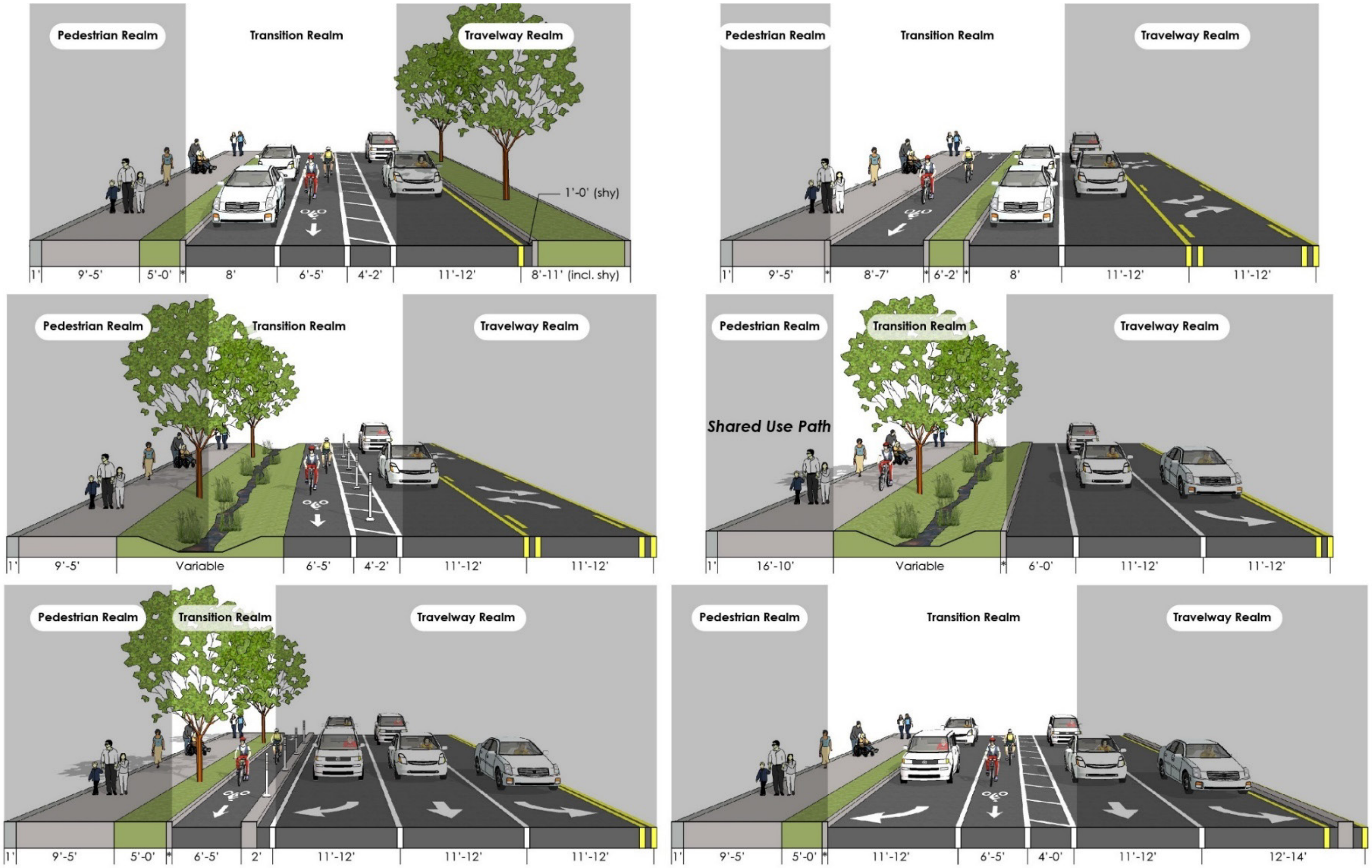
[5] On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

[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



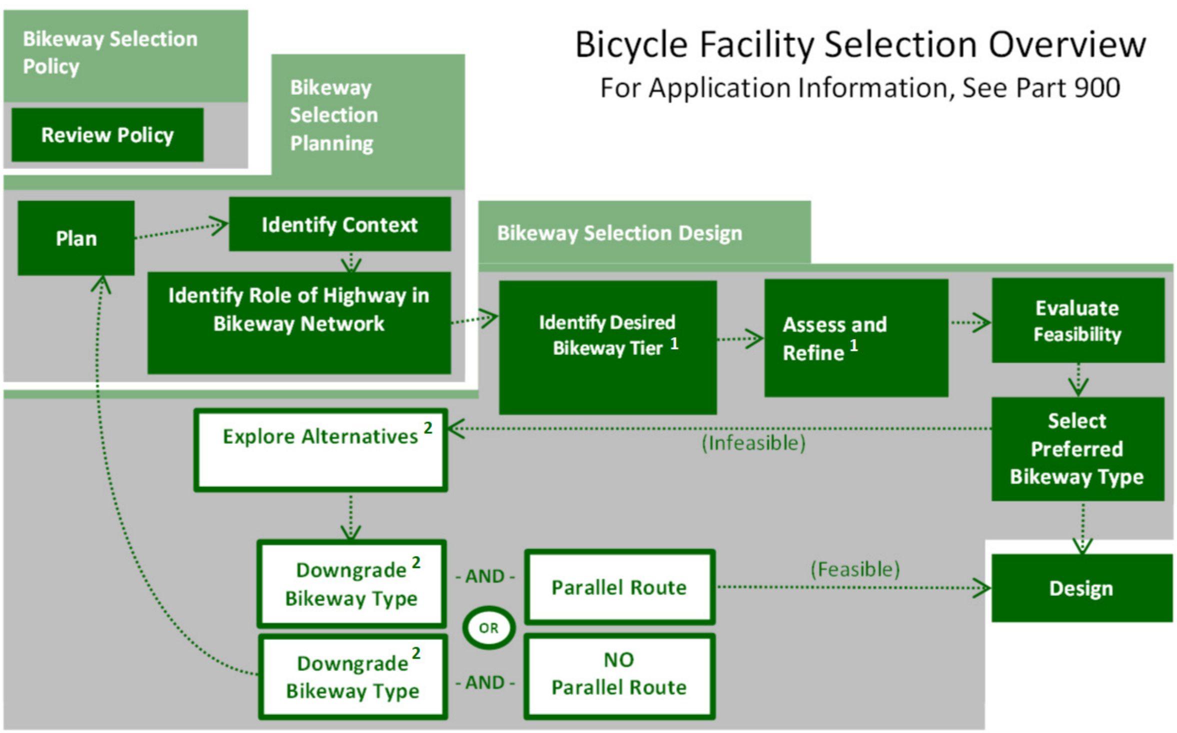

* 0.5' (curb) or 2' (curb & gutter)    ** Consider raised bicycle lane

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 providing a facility with riders of all ages and abilities 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.

Figure 300-12 Bicycle Facility Selection Process



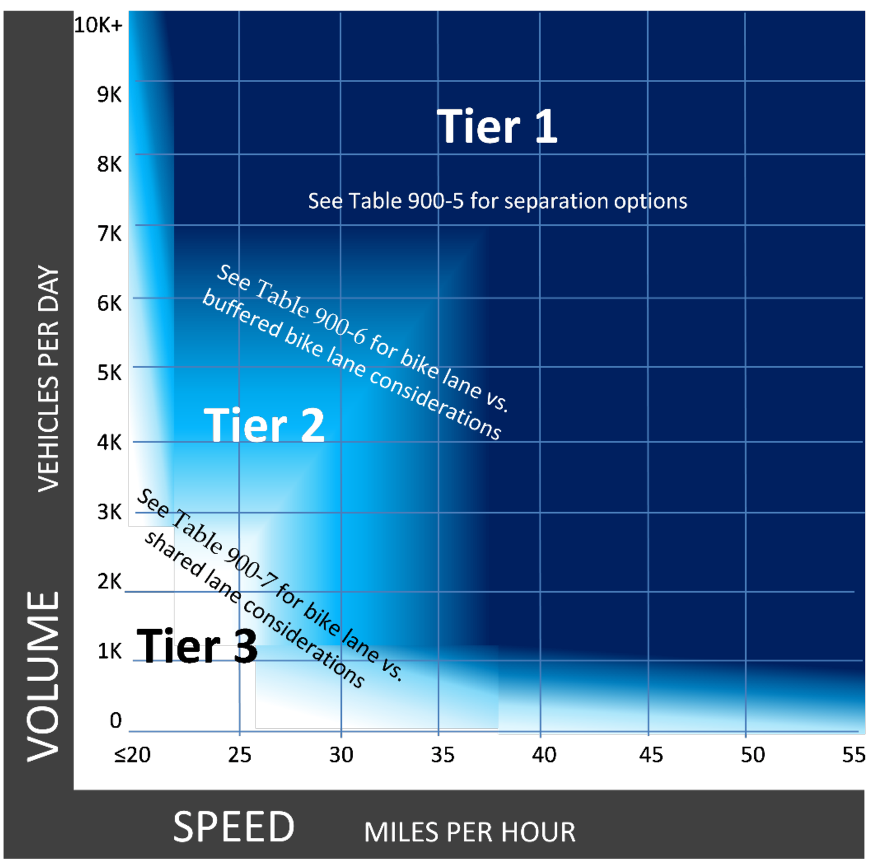

1 See Figure 300-13. For application, see Part 900 and Figure 900-3.

2 See Part 900

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.

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 pedestrian target 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. Convenient permeability of an area is a major point to be evaluated. In some cases, an existing crossing might be better if relocated. When considered as part of a larger project, such as a corridor project, strive to meet the spacing targets at a minimum. 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 that 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 crash 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

## 308.5.1 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 raised 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.

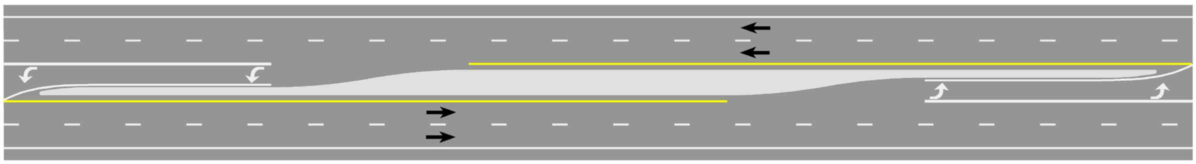
2. When crossing 4 lanes of traffic, analysis is performed to determine the need for pedestrian accommodation in the median. However, when crossing more than 6 lanes or 6 lanes and a 20-degree skew angle or more, the medians and median traffic separators must be designed to accommodate pedestrians mid-way 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 |

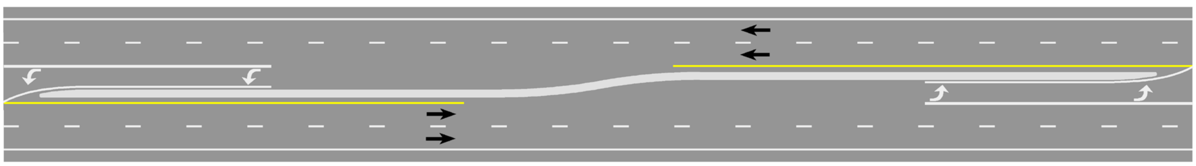
4. Where left turns are not accommodated over a significant length, one-half mile or longer, the minimum raised curb median width should be no narrower than 6 feet. Where left turn accommodation is provided at intersections the minimum median width preferred provides a 4 foot median traffic separator, 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 Raised Median Width



FULL WIDTH MEDIAN SECTION



NOT A FULL WIDTH MEDIAN SECTION

# 308.5.2 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 300-26 and 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) | Curb 12 ft. Lane (feet) | Curb 11 ft. Lane (feet) | Concrete Barrier All Lane Width (feet) |
|---|---|---|---|
| 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

## 308.5.3 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.

## 308.5.4 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.

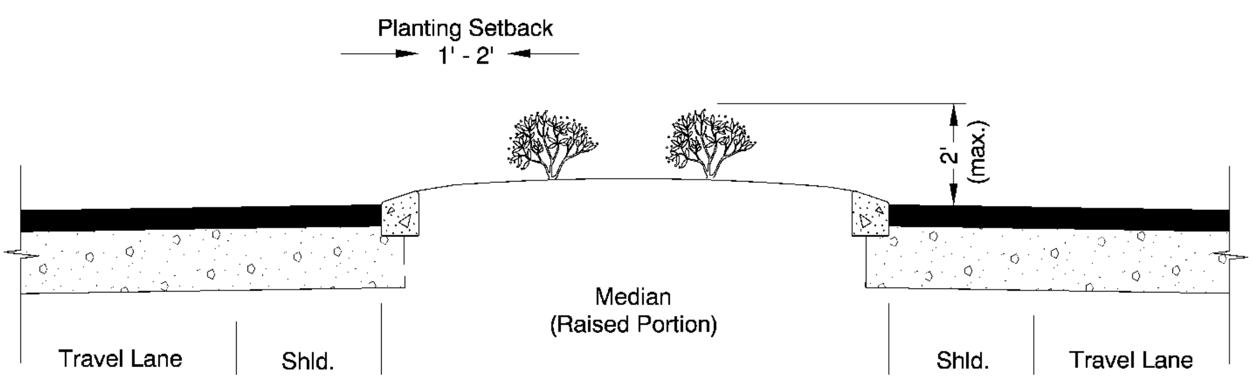
The following are important design elements to consider when landscaping medians:

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.

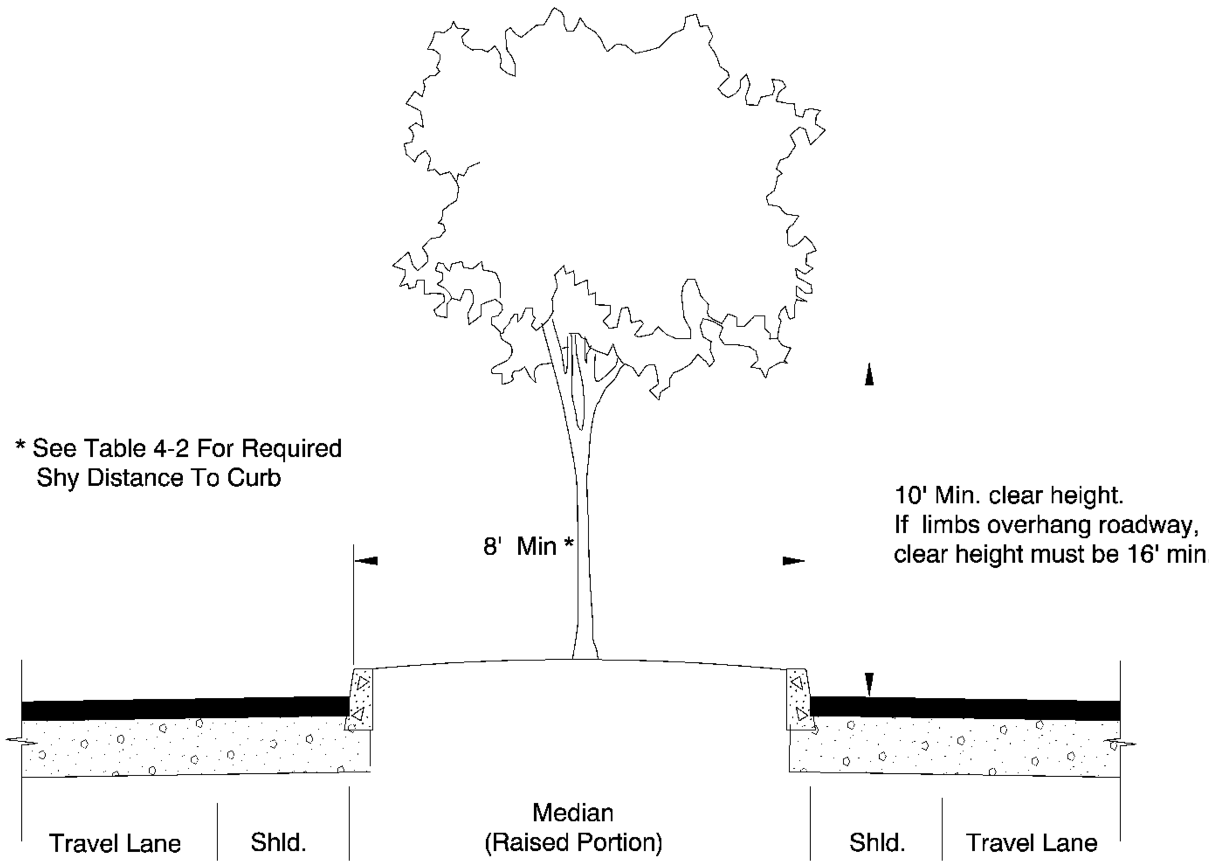
2. The minimum median width to accommodate landscaping is 6 feet. Care should be taken to not use landscaping that impairs sight distance. There should also be a planting setback. The use of trees in a raised median are typically not recommended and should only be considered in urban situations where 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




## 308.5.5 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 crash 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.

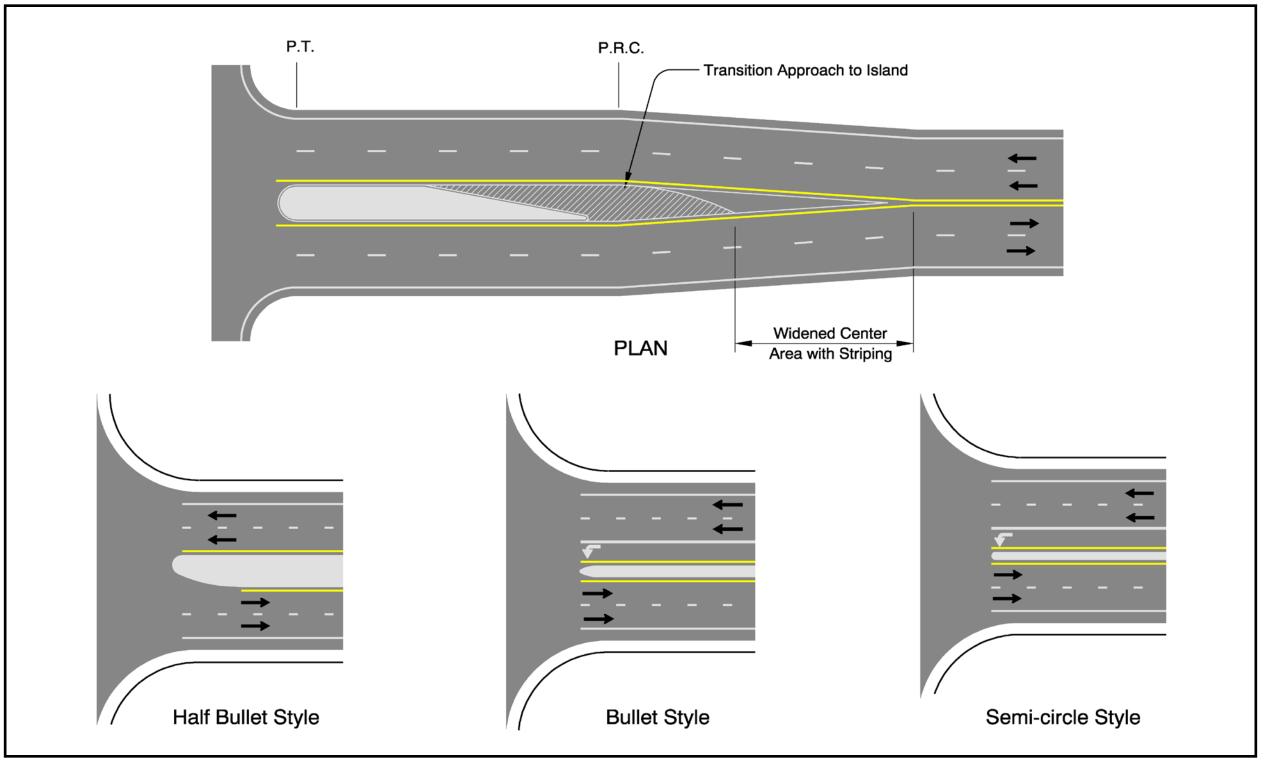
Concrete barriers generally require an impact attenuator to protect the ends. The type of attenuator used must conform to the ODOT approved materials list. AASHTO's *"Roadside*

*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




## 308.5.6 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.

### 308.5.7 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.

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.

## 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 "Have To" | Corrective Measure "Like To" | Technical Resource |
|---|---|---|---|
| Guardrail | • Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard.<br>• Provide transitions at unconnected bridge ends.<br>• Install protection at unprotected bridge ends<br>• Adjust MGS guardrail to 31 inches where the height to the top of the rail is 28 inches or less.<br>• Adjust 350 guardrail to at least 29 inches where the top of the rail is 28 inches or less.<br>• Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection. | | Roadway Section |
| Concrete Barrier | • Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard.<br>• Pre-NCHRP Report 350 concrete shoulder or median barrier that retains earth behind the barrier may remain in service.<br>• All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset. | | Roadway Section |
| Interchange Ramps | • Ramp surfacing to the ramp termini. | | Roadway Section |
| 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 |

Table 300-15 (Continued): Interstate Maintenance Have To/Like To

| Project Element | Corrective Measure "Have To" | Corrective Measure "Like To" | Technical Resource |
|---|---|---|---|
| Delineators | • Install missing delineators.<br>• Replace damaged delineators. | | Roadway Section |
| Fencing | • Replace damaged or rotting fencing. | Fill in incomplete sections | |
| Attenuators | • Replace damaged or non-standard (not meeting NCHRP 350 or MASH) attenuators.<br>• Adjust attenuators as needed.<br>• Install attenuators if warranted. | | Roadway Section |
| Rumble Strips | • Install on rural portions as per ODOT Rumble Strip Standards and Policies. | | Roadway Section |
| Pavement Life | • Project Dependent | | Pavement Unit |
| Striping | • High volume, Urban areas would have all durable lines<br>• Mountainous sections with lots of curves would have all durable lines<br>• Flat tangent sections will have durable skip lines only | | Region Traffic |
| Drainage | • See Hydraulics Manual | | Fish Program Manager & Hydraulics Unit |
| Signal Loops | • Project Dependent | | Traffic Section |

Table 300-16: ODOT 3R Freeway Design Standard Minimums

| Design Feature | Flat Terrain | Rolling Terrain | Mountainous Terrain | Urban Characteristics |
|---|---|---|---|---|
| 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 Width 4 Lane Section | 4′ | 4′ | 4′ | 4′ |
| Left Shoulder Width 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 |

| Design Feature | Minimum Width (all terrains) |
|---|---|
| Bridges to Remain in Place (Less than 200′ in length) | 12′ Lane<br>10′ Right Shoulder<br>3.5′ Left Shoulder |
| Bridges to Remain in Place (200′ or more in Length) | 12′ Lane<br>3.5′ Right Shoulder<br>3.5′ Left Shoulder |
| Tunnels (Desirable Width) | 44′<br>12′ Lane<br>5′ Left Shoulder<br>10′ Right Shoulder<br>Two- 2.5′ Safety Walks |
| Tunnels (Minimum Widths) | 30′<br>12′ Lane<br>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

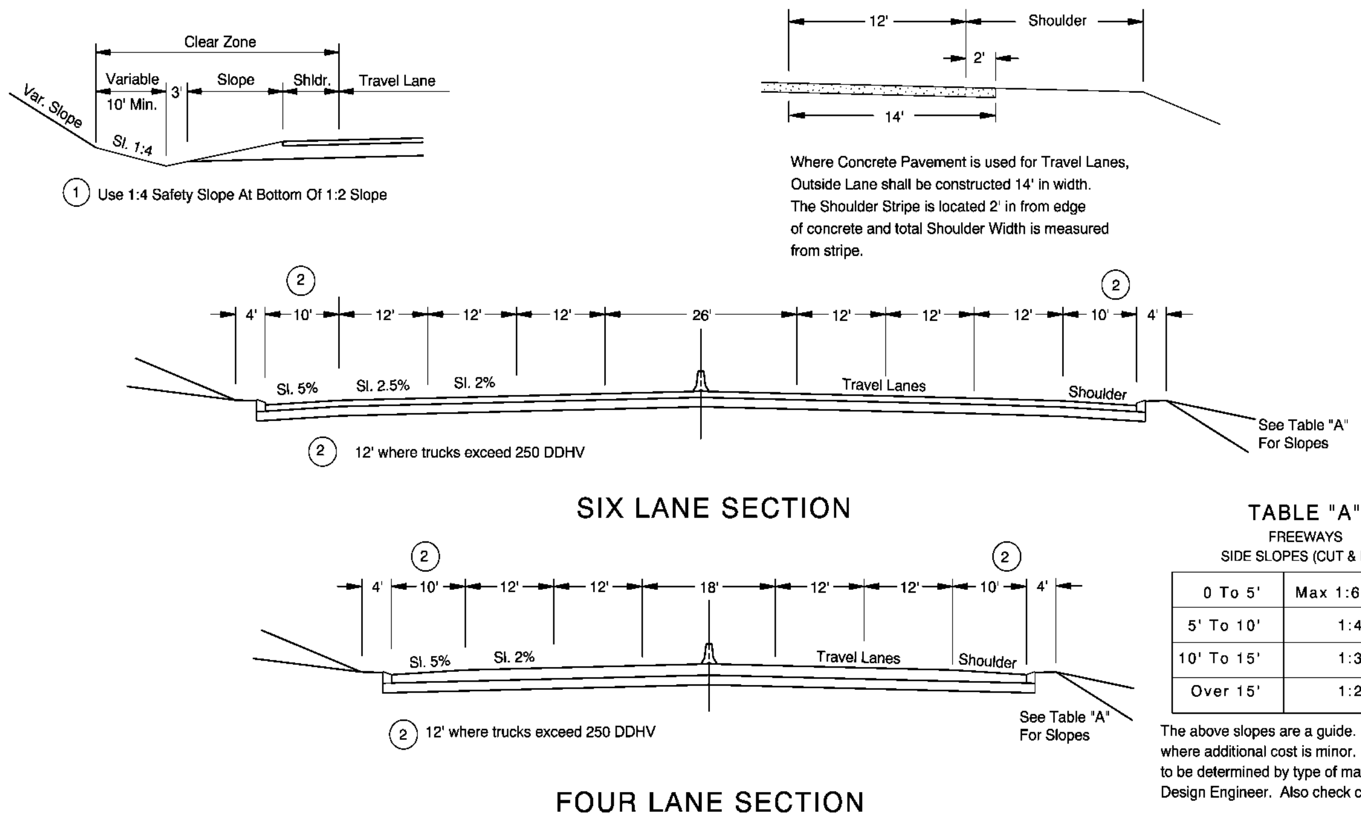
The desirable width for tunnels is at least 44 feet. This width consists of two 12 foot lanes, 10 foot right shoulder, 5 foot left shoulder, and 2.5 foot safety walk on each side. However, because of the high cost, a reduced tunnel width can be accepted, but it must be at least 30 feet wide, including 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. See Figure 300-18 and Figure 300-19.

Figure 300-18: Standard Urban Freeway Section (Includes Non-Interstate Facilities)

## STANDARD URBAN FREEWAY SECTION




### TABLE "A"

FREEWAYS
SIDE SLOPES (CUT & FILL)

| | |
|---|---|
| 0 To 5' | Max 1:6 |
| 5' To 10' | 1:4 |
| 10' To 15' | 1:3 |
| Over 15' | 1:2 (See 1) |

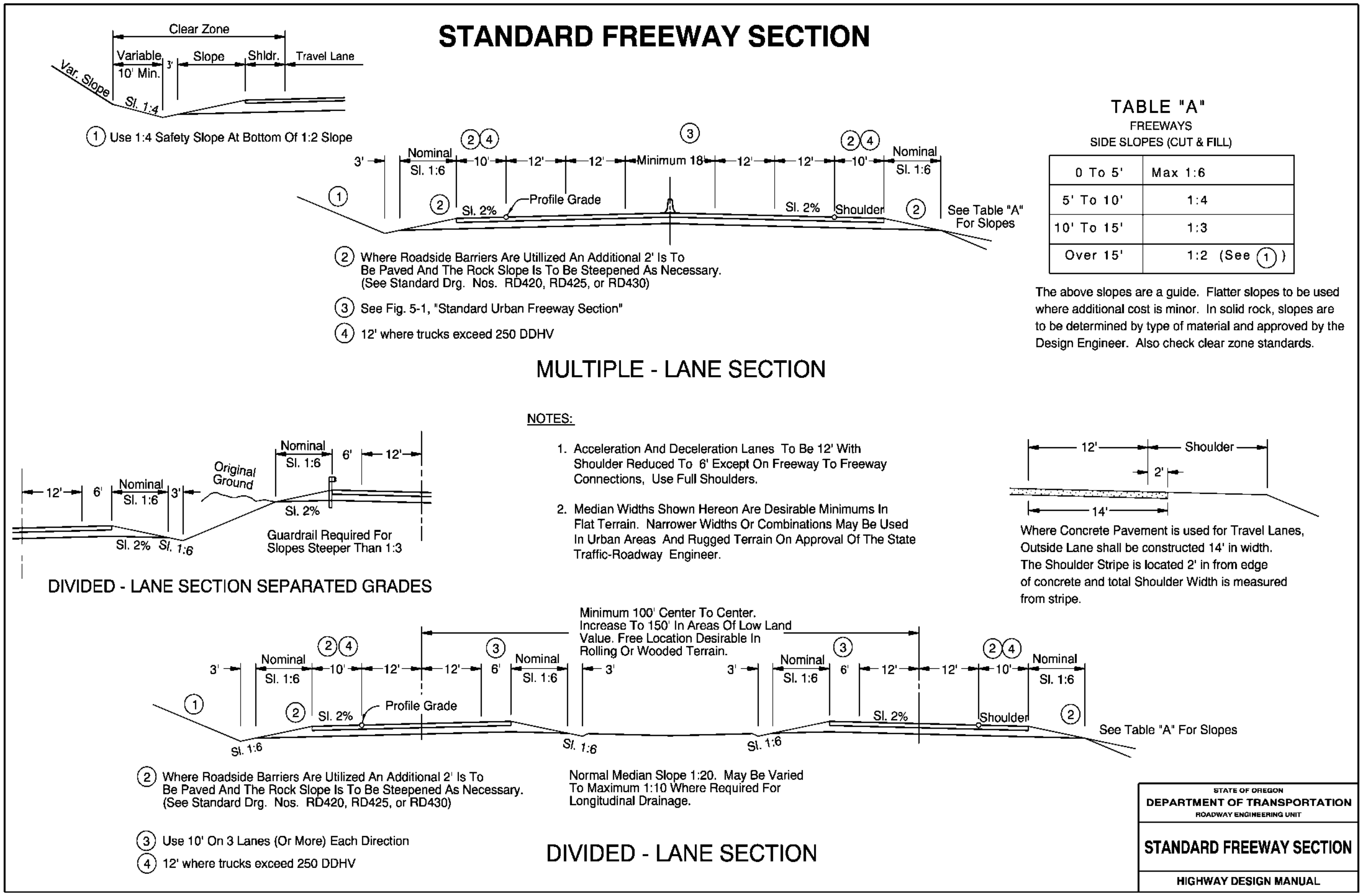
The above slopes are a guide. Flatter slopes to be used where additional cost is minor. In solid rock, slopes are to be determined by type of material and approved by the Design Engineer. Also check clear zone standards.

NOTES:

1. Shoulders adjacent to curbs and medians to be full depth surfacing.
2. Curbs on Freeways shall be mountable.
3. Acceleration and deceleration lanes to be 12' with shoulders reduced to 6'.
4. See Freeway Multiple-Lane Section for roadbed section without curb.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT
STANDARD URBAN FREEWAY SECTION
HIGHWAY DESIGN MANUAL

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, it is preferred that new construction shoulder width (minimum 8′) be installed. 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 2008 through 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. (Section 204 through Section 209 and Section 310)
- If the expressway section has grade-separated intersections (interchanges), then design decisions are based on freeway and higher operating speed design criteria.

Expressways that fit into the six identified contexts are designed from the design criteria for the context the expressway section fits. While expressways in general are expected by OHP definition to provide greater vehicle mobility, expressways located in the Traditional Downtown/Central Business District, Urban Mix, or Residential Corridor contexts must balance vehicle mobility with pedestrian, bicycle and transit mobility and safety as well.

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.

# 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 310 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 Section 205 through Section 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]<br><10% Trucks [2]<br>>10% Trucks [2] | <br>10′<br>10′ | <br>10′<br>11′ | <br>11′<br>12′ | <br>11′<br>12′ |
| Left Turn Lane [3] | 12′ | 13′ | 13′ | 14′ |
| Right Side Shoulder [4] | 2′ | 3′ | 4′ | 6′ |
| Left Side Clearance (Shy Distance) [5]<br>posted speed 40-45 mph<br>posted speed ≥ 45 mph | <br>1′<br>2′ | <br>1′<br>2′ | <br>1′<br>2′ | <br>1′<br>2′ |
| Curbside Sidewalk[5] | 6′ | 6′ | 6′ | 6′ |
| Cross Slope (crown) [6] | 2% | 2% | 2% | 2% |
| Maximum Superelevation [7]<br>design speed ≤ 40 mph<br>design speed ≥ 45 mph | <br>4%<br>6% | <br>4%<br>6% | <br>4%<br>6% | <br>4%<br>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 300-19Table 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

| Deficiency | Mandatory Corrective Measure |
|---|---|
| ADA/Sidewalk Ramps | • Ramps shall be added at intersections where absent.<br>• 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.<br>• Provide transitions at unconnected bridge ends.<br>• Install protection at unprotected bridge ends<br>• 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.<br>• 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.<br>• Pre-350 concrete barrier with earth support behind the barrier may remain in service.<br>• 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

| Item | Low-Cost Safety Measure | |
|---|---|---|
| Narrow Lanes and/or Shoulders | - Pavement edge lines | - Raised pavement markers |
| Steep Sides-lopes/Roadside Obstacles | - Remove or relocate obstacle<br>- Roadside hazard markings<br>- Round ditches | - Install guardrail<br>- Slope flattening<br>- Breakaway hardware |
| Narrow Bridges/Deficient Rails | - Install supplementary signing | - Hazard and pavement markings |
| Sharp Horizontal Curve | - Install supplementary signing<br>- Correct superelevation<br>- Gradual side-slopes | - Pavement anti-skid treatment<br>- Obstacle removal or shielding<br>- Install post delineators |
| Poor Sight Distance at Hill Crest | - Install supplementary signing<br>- Fixed-hazard removal | - Driveway relocation<br>- Illumination |
| Intersection | - Install supplementary signing<br>- Signalization<br>- Speed control (traffic calming, visual cues, etc.) | - Pavement anti-skid treatment<br>- Illumination |
| Bicycle Access | - Restripe roadway to include a buffered bike lane<br>- Signal timing changes to improve bicycle progression | |
| Pedestrian Access | - Vehicle speed control (traffic calming measures, visual cues, continental striping crosswalks)<br>- Reduce crossing distance (striping or curb radius reduction options)<br>- Improve visibility of pedestrian (Illumination, curb extensions) | |

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 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 300-20 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.

Along with preservation paving, urban 3R projects provide opportunities to make improvements to facilities for other roadway users. When determining project scope on 3R urban project, perform evaluation and include feasible improvements to bicycle and pedestrian facilities within 3R guidelines. Restriping after paving may provide a low-cost opportunity within a 3R 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. In some cases, additional funding from specific sources can be added to a 3R project to make greater improvements for vulnerable road users. The Urban Design Concurrence document is used on 3R urban projects to document project context and decisions to establish the final design.

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 | • Install pavement markings with materials selected according to Chapter 5 of the ODOT pavement Markings Design Guidelines. | | Region Traffic |
| Signing | • Replace or add signs according to the ODOT Sign Design Manual. | | Traffic-Roadway Section |
| Utilities (manholes, valves, vaults) | • Adjust. | | Traffic-Roadway Section |
| Drainage | • Adjust as necessary to maintain basic system.<br>• Address high priority fish culverts identified in Salmon program. | • Reroute bridge drains which drain directly into waterway.<br>• 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.<br>• Relocate to meet standards where practical. | • Meet required clear zone standards for obstacles behind curb. Relocate if necessary. | Traffic-Roadway Section |

Table 300-20 (Continued): Urban Preservation Design Features

| Project Element | Corrective Measure | | Technical Resource |
|---|---|---|---|
| | "Have To" | "Like To" | |
| 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.<br>• 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 316 | • Meet required vertical clearance. | Bridge Section |
| Narrow Bridges/ Deficient Rails | • See BDM | • Widen bridge, where practical<br>• Meet current standard for bridge rails and connections | Bridge Section |
| Guardrail | • Upgrade all guardrail and end terminals and transitions not meeting NCHRP Report 350 or MASH to the current standard.<br>• Provide transitions at unconnected bridge ends.<br>• Install protection at unprotected bridge ends<br>• 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.<br>• Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection. | • Meet required standard. | Traffic-Roadway Section |

Table 300-20 (Continued): Urban Preservation Design Features

| Project Element | Corrective Measure | | Technical Resource |
|---|---|---|---|
| | "Have To" | "Like To" | |
| Roadside obstacles with demonstrated safety issues | • Remove or mitigate. | | Traffic-Roadway Section |
| Concrete Barrier | • Upgrade all concrete barrier not meeting NCHRP Report 350 or MASH to the current standard.<br>• Pre-350 concrete barrier with earth support behind the barrier may remain in service.<br>• 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 |
| 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.<br>• 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. (Where demonstrate need – broken curb, tracks on sidewalk, etc.)<br>• Islands (replacing, adding or removing).<br>• Install/upgrade traffic control devices. | Traffic-Roadway Section |
| Safety Issues | • SPIS site addressed.<br>• Rumble strips, pavement markings, slope flattening, illumination, etc. | Transportation Safety & Traffic-Roadway Section |
| Pedestrian | • Sidewalk infill - If less than 10% missing in length of project.<br>• Curb extensions, Modified curb radius<br>• Illumination (with local agreements)<br>• Work with Traffic Section to identify potential ARTS, HSIP or other options that could be included | Traffic-Roadway Section |
| Bicycle | • Incremental of permanent improvements as additional funding allows (buffered bike lanes, separated facilities, protected intersections)<br>• Work with Traffic Section to identify potential ARTS, HSIP or other options that could be included | 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 Year 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′ |
| 750 to 2000 Vehicles | 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 expressway 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. See Part 800 for more information |
| 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.<br>• Provide transitions at unconnected bridge ends.<br>• Install protection at unprotected bridge ends<br>• 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.<br>• 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.<br>• Pre-350 concrete barrier with earth support behind the barrier may remain in service.<br>• All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset. |

# 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

| Design Element | Low-Cost Safety Measure | |
|---|---|---|
| Narrow Lanes and/or Shoulders | • Pavement edge lines<br>• Raised pavement markers<br>• Post delineators | • Rumble strips<br>• Safety Edge |
| Steep Sideslopes/<br>Roadside Obstacles | • Roadside hazard markings<br>• Round ditches<br>• Install guardrail<br>• Remove or relocate obstacle | • Slope flattening<br>• Breakaway hardware<br>• Rumble Strips |
| Narrow Bridges/<br>Deficient Rails | • Install supplementary signing | • Hazard and pavement markings |
| Sharp Horizontal Curve | • Install supplementary signing<br>• Shoulder widening<br>• Shoulder paving<br>• Lane Widening<br>• Correct superelevation<br>• Gradual side slopes | • Pavement antiskid treatment<br>• Obstacle removal or shielding<br>• Raised Pavement Markers<br>• Install post delineators<br>• Rumble Strips |
| Poor Sight Distance At Hill Crest | • Install supplementary signing<br>• Fixed-hazard removal<br>• Shoulder widening | • Driveway relocation<br>• Illumination |
| Intersections | • Install supplementary signing<br>• Illumination | • Pavement antiskid treatment<br>• Speed control |
| Bicycle Access - Work with Traffic Section to identify potential ARTS, HSIP or other options that could be included | • Restripe roadway to include a buffered bike lane<br>• Signal timing changes to improve bicycle progression | |
| Pedestrian Access - Work with Traffic Section to identify potential ARTS, HSIP or other options that could be included | • Vehicle speed control (traffic calming measures, visual cues, continental striping crosswalks)<br>• Reduce crossing distance (striping or curb radius reduction options)<br>• Improve visibility of pedestrian (Illumination, curb extensions) | |

# 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. Discuss eligibility of historic determination with the State Historic Preservation Office (SHPO). A design exception may be required based on final determination. 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

| 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 FHWA bicycle and Pedestrian Program promotes safe, comfortable, and convenient walking and bicycling for people of all ages and abilities. 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. Also, consider that land uses along roadways change over time. While the current land uses during project development may not encourage walking or biking, future changes could bring development that does. Consider potential future needs when determining the pedestrian and bicycle needs along a facility.

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 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

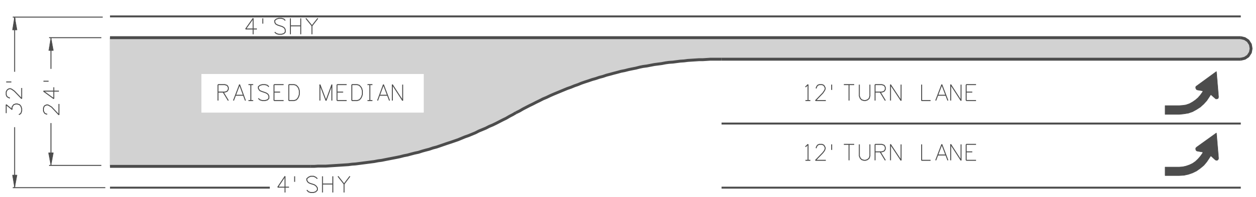
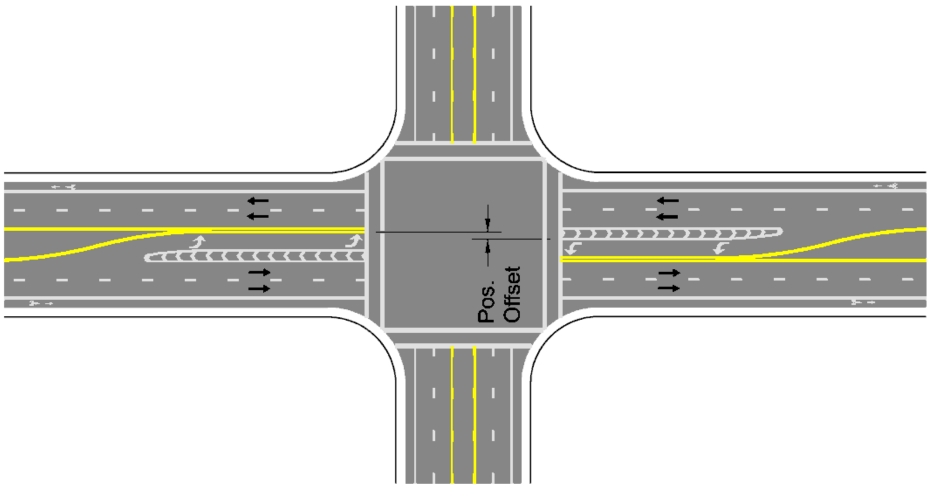


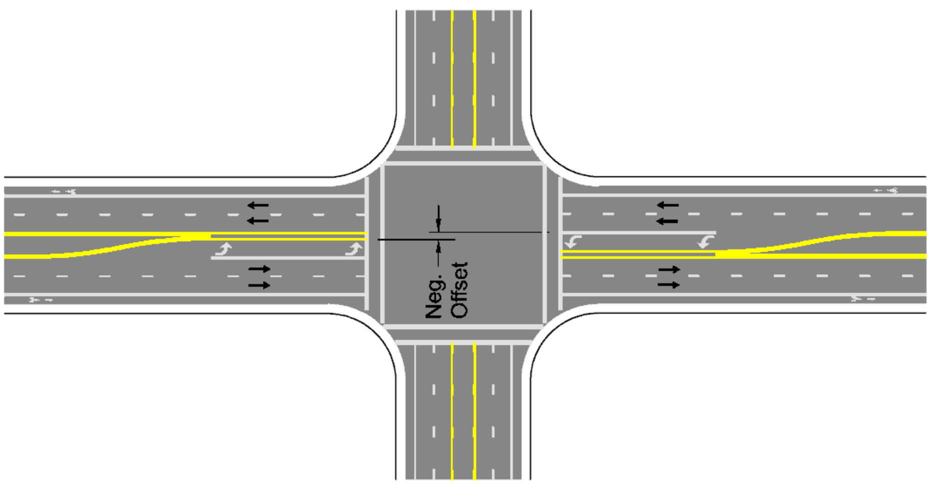

Figure 300-20 shows the different element widths for a double left turn. Even where only single left turn lanes are needed, the 32 foot width allows for future widening and also provides a positive off-set to oncoming traffic. To make a safe left turn, sight distance is important to a driver in order 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. Positive offset is preferred at most intersections with left turns to improve sight lines and minimize potential for crashes. This is particularly critical on high-speed roadways where impact velocities create greater potential for serious injury and fatal crashes. (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




POSITIVE OFFSET BETWEEN LEFT-TURN LANES




NEGATIVE OFFSET BETWEEN LEFT-TURN LANES

# 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. These are high speed, limited access facilities focused on vehicle mobility and 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 800 for pedestrian design and Part 900 for bicycle design and the Oregon Bicycle and Pedestrian Plan provide additional guidance to the design of bicycle and pedestrian facilities in these areas. Consult with the ODOT bicycle and pedestrian Design Engineer for specifics of design for pedestrians in urban expressway locations.

Pedestrian crossings need to occur at signalized intersections or with grade-separation in order to maintain the intended function of the expressway. Expressways, by OHP definition, are generally designed for vehicle mobility rather than access. . Pedestrian activated crossings at uncontrolled locations are not appropriate on higher speed urban expressways and require special approvals for installation. Generally, the breakpoint between higher speed and lower speed expressways is considered to be 40 – 45 mph.

# 310.14 ODOT 4R Urban Expressway Typical Section

As established previously in Part 200 and in Part 300, Section 310, 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 Section 205 through Section 211 as well as Section 306 and Section 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)

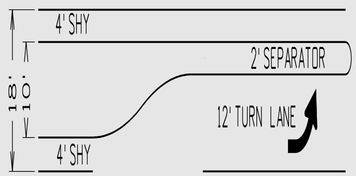
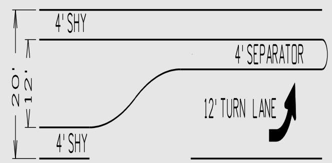
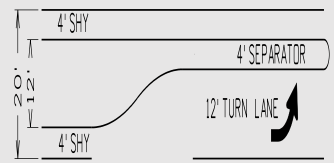
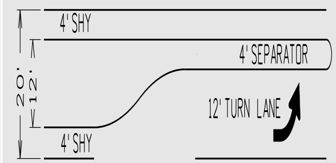
| Design Elements | Design Speed | | | |
|---|---|---|---|---|
| | 45 mph [1] | 50 mph | 55 mph | 60 - 70 mph |
| Travel Lane | 12′ | 12′ | 12′ | 12′ |
| Right Turn Lane | 12′ plus shoulder [2] | 12′ plus shoulder [2] | 12′ plus shoulder [2] | 12′ plus shoulder [2] |
| Left Turn Lane |  |  |  |  |
| Right Side Shoulder | 8′ | 8′ | 8′ | 8′ |
| Median<br>Striped Median<br>Raised Curb Median [3]<br>Conc. Barrier Median | 10′<br>18′ Travel lane to travel lane<br>10′ (4 lane)<br>18′ (6 lane) | 10′<br>20′ Travel lane to travel lane<br>10′ (4 lane)<br>18′ (6 lane) | 10′<br>20′ Travel lane to travel lane<br>10′ (4 lane)<br>18′ (6 lane) | 10′<br>20′ Travel lane to travel lane<br>10′ (4 lane)<br>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% |

Table 300-26 (Continued): 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 |
| 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-foot 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 safety evaluation is a critical part of determining whether a project belongs in the 1R or 3R categories and is integral to the process. The 1R/3R Record of Decision form is used to aid the decision process to determine if a 1R project should be upgraded to a 3R project to provide immediate safety improvements.

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 upgrades, pedestrian and/or bicycle concerns, in no case shall safety, pedestrian and/or bicycle conditions 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.

## 310.18.1 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.

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.

## 310.18.2 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.

## 310.18.3 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.

## 310.18.4 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.

## 310.18.5 ADA Requirements for 1R Projects

All projects that include resurfacing (except for chip seals) shall install or upgrade curb ramps where applicable.

### 310.18.6 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.

### 310.19.1 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. 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.

## 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 Year 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 3R Rural Arterial, Collector Local Routes

| 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.<br>• Provide transitions at unconnected bridge ends.<br>• Install protection at unprotected bridge ends<br>• 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.<br>• 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.<br>• Pre-350 concrete barrier with earth support behind the barrier may remain in service.<br>• All barrier in which the proposed finish grade exceeds the 3" vertical lip (reveal) of the barrier shall be replaced or reset.<br>• |

* 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

| Design Element | Low-Cost Safety Measure |
|---|---|
| Narrow Lanes and/or Shoulders | • Pavement edge lines<br>• Raised pavement markers<br>• Post delineators<br>• Rumble strips<br>• Safety Edge |
| Steep Sideslopes/Roadside Obstacles | • Roadside hazard markings<br>• Round ditches<br>• Install guardrail<br>• Remove or relocate obstacle<br>• Slope flattening<br>• Breakaway hardware<br>• Rumble Strips |
| Narrow Bridges/Deficient Rails | • Install supplementary signing<br>• Hazard and pavement markings |
| Sharp Horizontal Curve | • Install supplementary signing<br>• Shoulder widening<br>• Shoulder paving<br>• Lane Widening<br>• Correct superelevation<br>• Gradual sideslopes<br>• Pavement antiskid treatment<br>• Obstacle removal or shielding<br>• Raised Pavement Markers<br>• Install post delineators<br>• Rumble Strips |
| Poor Sight Distance At Hill Crest | • Install supplementary signing<br>• Fixed-hazard removal<br>• Shoulder widening<br>• Driveway relocation<br>• Illumination |
| Intersections | • Install supplementary signing<br>• Illumination<br>• Pavement antiskid treatment<br>• Speed control |

# 311.6 4R Rural Arterial, Collector, and Local Routes Medians

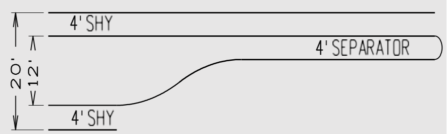
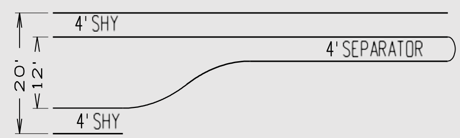
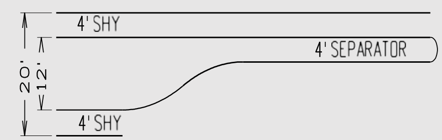
All multi-lane rural highways shall include a median. The preferred design for these types of highways is a non-traversable type of median. A non-traversable median may consist of a wide depressed median (similar to expressways), a raised mountable curb, cable barrier, or a concrete barrier. Of these, 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)<br>10′ (6 lane) | 8′ (4 lane)<br>10′ (6 lane) | 8′ (4 lane)<br>10′ (6 lane) |
| Left Side Shoulder | 4′ (4 lane)<br>6′ (6 lane) | 4′ (4 lane)<br>8′ (6 lane) | 4′ (4 lane)<br>8′ (6 lane) |
| Median<br>Striped Median Raised Curb<br>Median[2]<br>Concrete Barrier Median | <br>14′ Minimum<br>20′ Travel lane to travel lane<br>10′ (4 lane)<br>18′ (6 lane) | <br>16′ Minimum<br>20′ Travel lane to travel lane<br>10′ (4 lane)<br>22′ (6 lane, includes 2′ shy) | <br>16′ Minimum<br>20′ Travel lane to travel lane<br>10′ (4 lane)<br>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 or Reconstruction - Rural Design Standards

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 feet for 70 mph or less ------- | | | | | | | | | | | | | | | | | |

Table 300-32 (Continued): ODOT 4R/New or Reconstruction - Rural Design Standards

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 |
| 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 | Max 1:4 |
| | 6 - 8 | 1:3 |
| | 8 - 12 | 1:2 |
| | over 12 | 1:½ (See 1) |
| ADT 1500 AND OVER | 0 - 5 | Max 1:6 |
| | 5 - 10 | 1:4 |
| | 10 - 15 | 1:3 |
| | over 15 | 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"

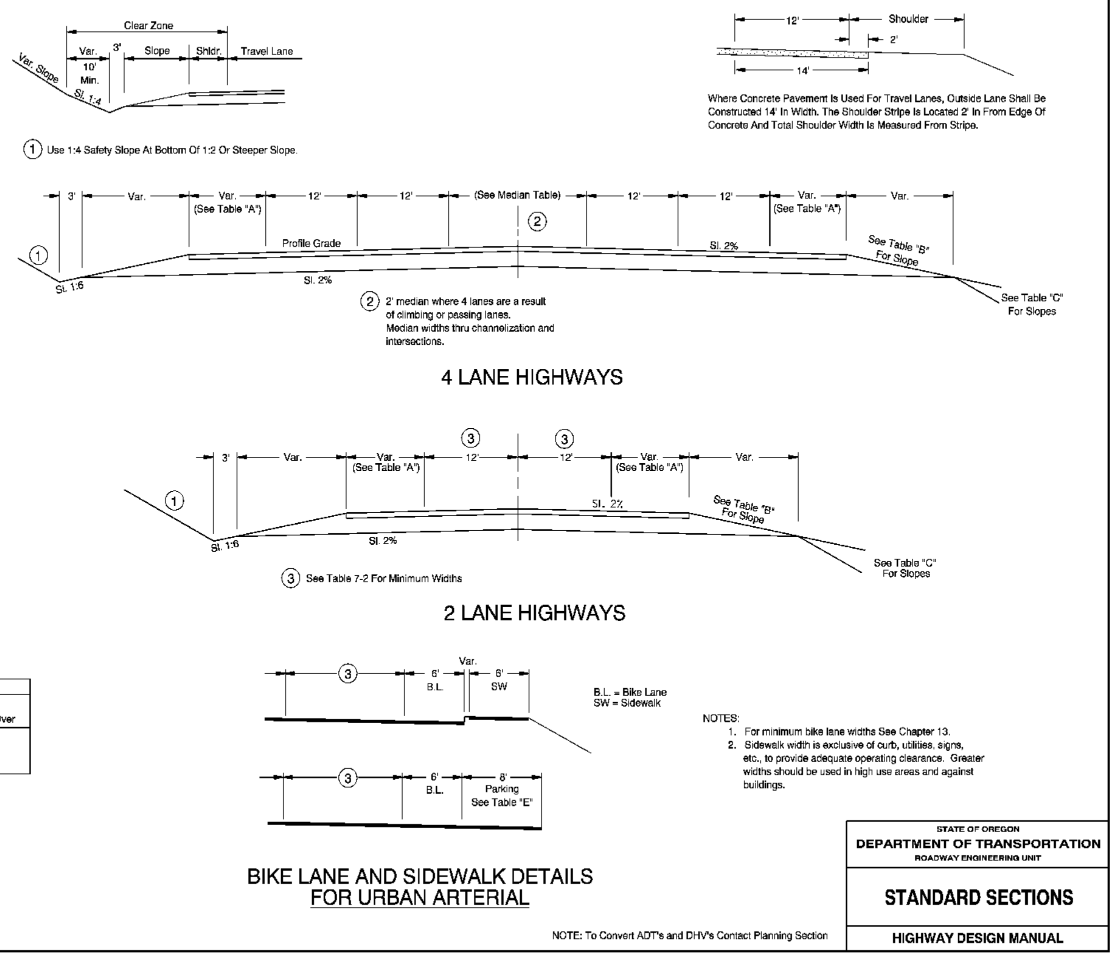
MEDIAN WIDTH TABLE

| 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 |



# 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.

## 311.11.1 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.

## 311.11.2 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.

## 311.11.3 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.

## 311.11.4 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.

## 311.11.5 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.

## 311.11.6 ADA Requirements For 1R Projects

All projects that include resurfacing (except for chip seals) shall install or upgrade curb ramps where applicable.

## 311.11.7 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.

## 311.12.1 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.

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.

# 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.<br>• 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.<br>• Provide transitions at unconnected bridge ends.<br>• Install protection at unprotected bridge ends<br>• 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.<br>• 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.<br>• Pre-350 concrete barrier with earth support behind the barrier may remain in service.<br>• 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

| Design Element | Low-Cost Safety Measure |
|---|---|
| Narrow Lanes and/or Shoulders | • Pavement edge lines<br>• Raised pavement markers |
| Steep Sideslopes/Roadside Obstacles | • Roadside hazard markings<br>• Round ditches<br>• Install guardrail<br>• Remove or relocate obstacle<br>• Slope flattening<br>• Breakaway hardware |
| Narrow Bridges/Deficient Rails | • Install supplementary signing<br>• Hazard and pavement markings |
| Sharp Horizontal Curve | • Install supplementary signing<br>• Correct superelevation<br>• Gradual sideslopes<br>• Pavement anti-skid treatment<br>• Obstacle removal or shielding<br>• Install post delineators |
| Poor Sight Distance at Hill Crest | • Install supplementary signing<br>• Fixed-hazard removal<br>• Driveway relocation<br>• Illumination |
| Intersections | • Install supplementary signing<br>• Signalization<br>• Illumination<br>• Pavement anti-skid treatment<br>• Speed control (traffic calming, visual cues, etc.) |
| Bicycle Access - Work with Traffic Section to identify potential ARTS, HSIP or other options that could be included | • Restripe roadway to include a buffered bike lane<br>• Signal timing changes to improve bicycle progression |
| Pedestrian Access - Work with Traffic Section to identify potential ARTS, HSIP or other options that could be included | • Vehicle speed control (traffic calming measures, visual cues, continental striping crosswalks)<br>• Reduce crossing distance (striping or curb radius reduction options)<br>• Improve visibility of pedestrian (Illumination, curb extensions) |

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 |
| Signal Loops | • Adjust or replace with non-invasive detection (e.g., radar detection) as necessary. | | Traffic-Roadway Section |
| Striping | • Install pavement markings with materials selected according to Chapter 5 if the ODOT Pavement Marking Design Guide. | | Region Traffic |
| Signing | • Replace and/or add signs according to the ODOT Sign Design Manual | | Traffic-Roadway Section |
| Utilities (manholes, valves, vaults) | • Adjust. | | Traffic-Roadway Section |
| Drainage | • Adjust as necessary to maintain basic system.<br>• Address high priority fish culverts identified in Salmon program. | • Reroute bridge drains which drain directly into waterway.<br>• 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.<br>• Relocate to meet standards where practical. | • Meet required clear zone standards for obstacles behind curb. Relocate if necessary. | Traffic-Roadway Section |

Table 300-35 (Continued): Urban Preservation Design Features

| Project Element | Corrective Measure | | Technical Resource |
|---|---|---|---|
| | "Have To" | "Like To" | |
| Roadside obstacles with demonstrated safety issues | • Remove or mitigate. | | Traffic-Roadway Section |
| ADA/<br>Sidewalk Ramps | • Ramps shall be added where absent. Existing Pedestrian Control locations may require special treatment to meet compliance.<br>• Upgrade or Replace Existing Sub-Standard Ramps to meet accessibility requirements as shown on ODOT Standard Drawing RD755 | • Meet ADA standards on sidewalks and driveways. | Traffic-Roadway Section |
| 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.<br>• Provide transitions at unconnected bridge ends.<br>• Install protection at unprotected bridge ends<br>• 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.<br>• Removal of guardrail and replacement with concrete barrier where minimum offsets are not met for bridge column protection. | • Meet required standard. | Traffic-Roadway Section |

Table 300-35 (Continued): Urban Preservation Design Features

| 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.<br>• Pre-350 concrete barrier with earth support behind the barrier may remain in service.<br>• 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<br>• 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.<br>• Minimize cross slope to meet standards where practical.<br>• 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.<br>Islands (replacing, adding or removing).<br>Install/upgrade traffic control devices. | Traffic-Roadway Section |
| Safety Issues | SPIS site addressed.<br>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 when 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, triggering 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 by using the safety analysis and utilizing the 1R/3R Record of Decision form.

# 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 Network as established in the Surface Transportation Act of 1982 (23 CFR 658). 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 300-18 and 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)

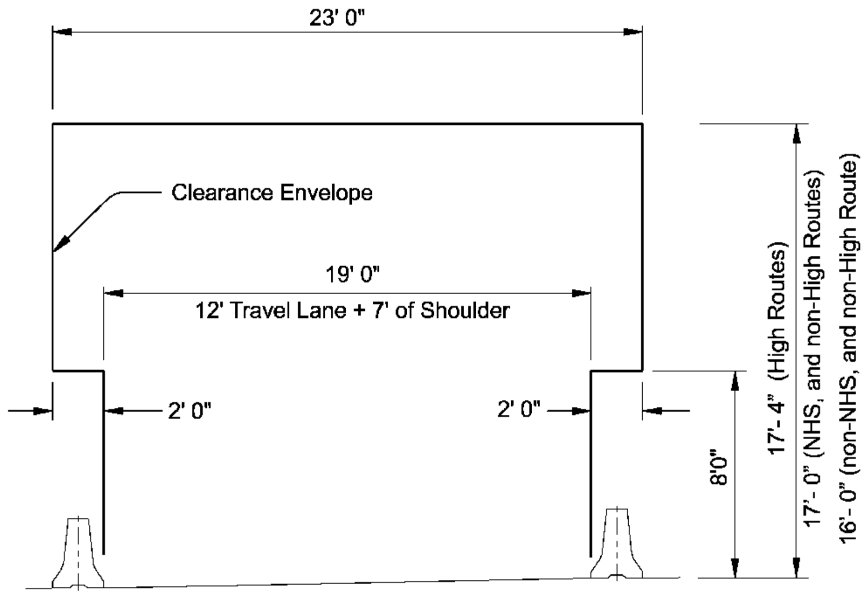
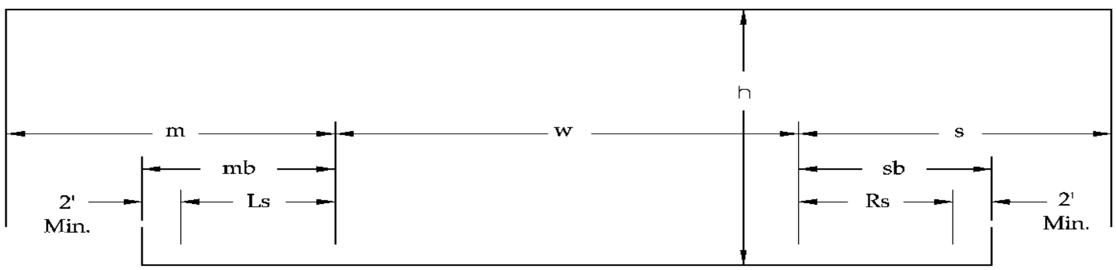


Figure 300-24: Freeway & Highway Clearances

## 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.

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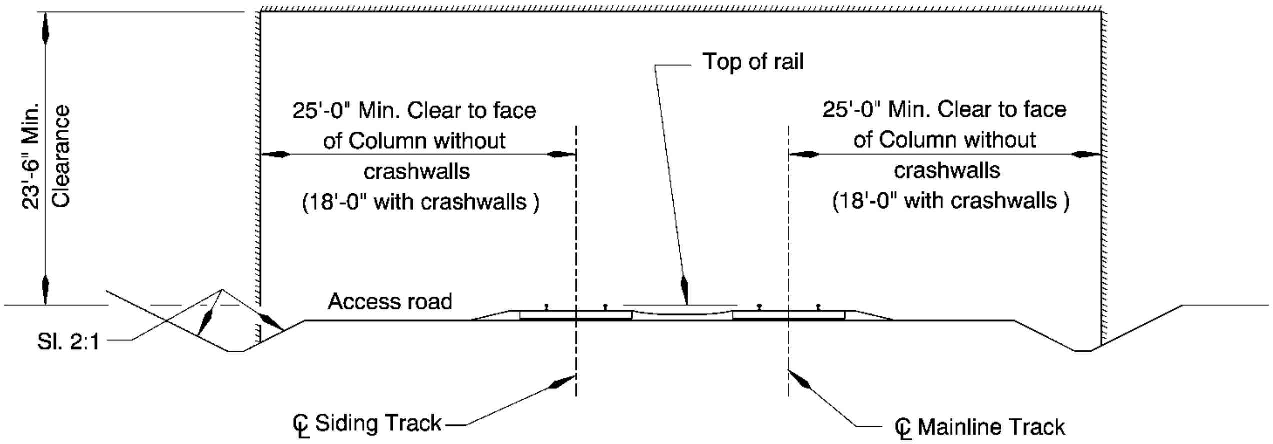
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

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 CCD 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 CCD 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 CCD. 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 Commerce and Compliance Division (CCD).
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 (CCD) 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 CCD. As with the 4R vertical clearance requirements, communication and coordination with CCD 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 feet clearance over the entire roadway width (including travel lanes and paved shoulders). Existing clearances of 14 feet may be retained. In highly urbanized areas, a minimum clearance of 14 feet may be provided if there is an alternate route with 16 feet 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 RD700 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 Interstate highways, freeways, or higher speed rural arterial 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 urban roadway sections that fit into one of the six defined urban contexts, see Section 305 for guidance on shy distances to be applied in the urban contexts.

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 rural arterials, except expressways. Table 300-38 also applies to left side shy distance for other conditions such as curbed sections on one-way roadways.

Table 300-38: Left Side Shy Distance (Rural Arterials)

| Design Speed (mph) | Rural Arterial 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 |

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.

# 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. When safety edge is omitted on projects with shoulders less than 6 feet in width, a design exception is required.

# 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. For preliminary design, cut and fill slopes steeper than 1V:2H should not be considered. Recommendations for final slope configurations are provided by the Geotechnical Engineer in the Geotechnical Report. The design shall be based on soil tests and other factors and must have the approval of the Geotechnical Engineer.

When designing individual cuts and fills and varying the rate of slope due to height variations, use care to avoid irregular faces, ponding of water, and poor aesthetics. Embankment and cut slopes greater than 10 feet in height need to be identified and communicated to the geotechnical staff early in the design process, because subsurface investigation, laboratory testing and analyses is required prior to making final slope configuration recommendations. Embankment height is measured as the difference in elevation between the subgrade at the shoulder and the toe of the slope. The toe of existing embankments and cut slopes should not be altered without recommendations from the Geotechnical Engineer. The recommendations provided by the geotechnical EOR establish the engineered embankment prism.  Non-structural elements shall not infringe on the engineered embankment prism. Non-structural elements placed outside the engineered embankment prism are the sole responsibility of the discipline requesting the elements.

Table 300-39 provides guidance for additional width for fill sections where there is a concern for the stability of slopes. For additional information about earthwork design, see Section 1202, Geotechnical Design as well as consulting the Geotechnical section for guidance as needed. Earthwork often involves water runoff and drainage issues. See Section 1211, Hydraulics and Section 1214, Temporary and Permanent Erosion Control for additional guidance.

Table 300-39: Additional Embankment Widening on High Fills

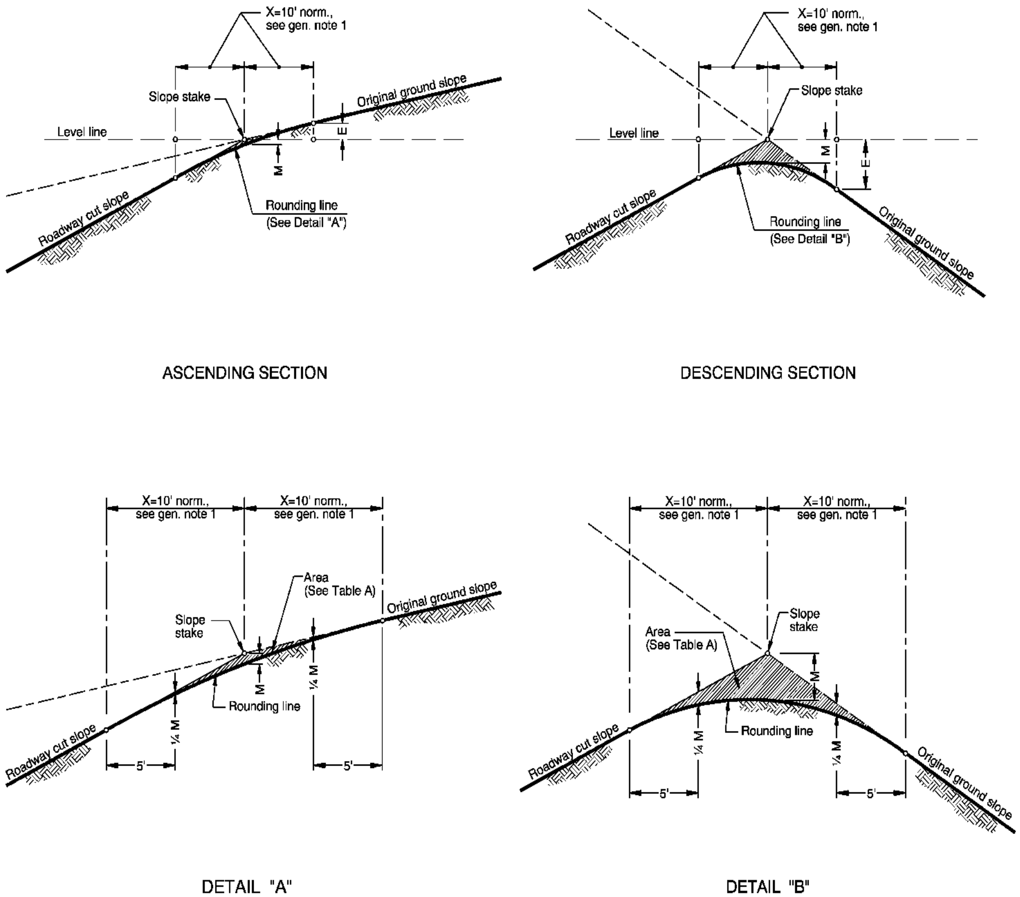
| Fill Height (Feet) | Widening of Subgrade as Appropriate, Each Side of Centerline (Feet) |
|---|---|
| 0-20 | No Widening |
| 20-30 | 1 |
| 30-40 | 2 |
| 40-50 | 3 |
| Over 50 | 4 |

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.

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 | Rounding not required within these limits. | | | | | | | |
| | 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 |

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

# 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.

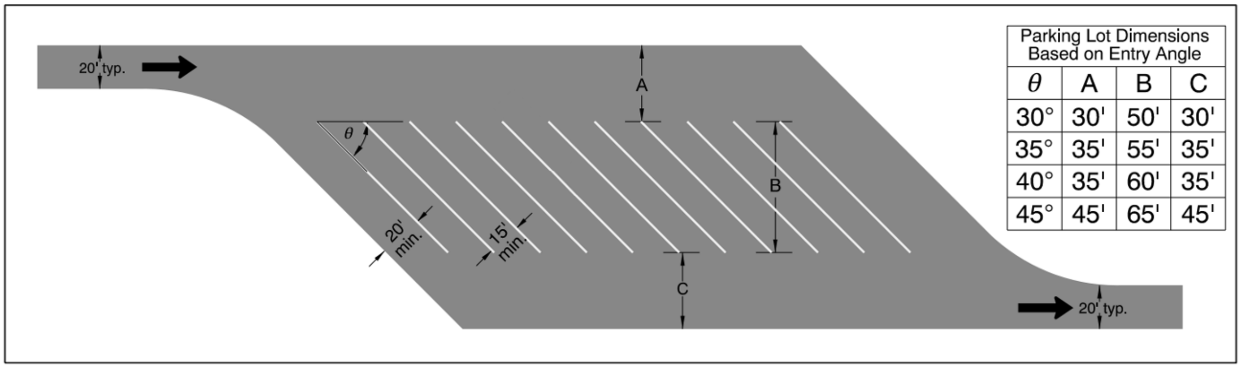
The design of rest areas will vary depending upon location and need. Some rest areas are quite large while other rest areas only serve a few vehicles and are more of a wayside. Roadway Engineering should be contacted concerning design guidance for rest areas.

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.

## 324.1 Large Vehicle Parking in Rest Areas

Figure 300-27 shows the minimum dimension layouts for large vehicle parking in new rest parking areas. This is not always attainable when modifying current rest area parking areas due to limits of right of way, current paved surface, and funding. It is also not desirable to remove current parking spaces to get closer to this standard. When repaving current rest areas it can be a good opportunity to evaluate the current layout of the parking area to see if there can be an improvement to the design without reducing the number of parking spaces.

Figure 300-27: Typical Large Vehicle Parking Space Dimensions for New Rest Area Parking Areas




| θ | A | B | C |
|---|---|---|---|
| 30° | 30' | 50' | 30' |
| 35° | 35' | 55' | 35' |
| 40° | 35' | 60' | 35' |
| 45° | 45' | 65' | 45' |

# 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.

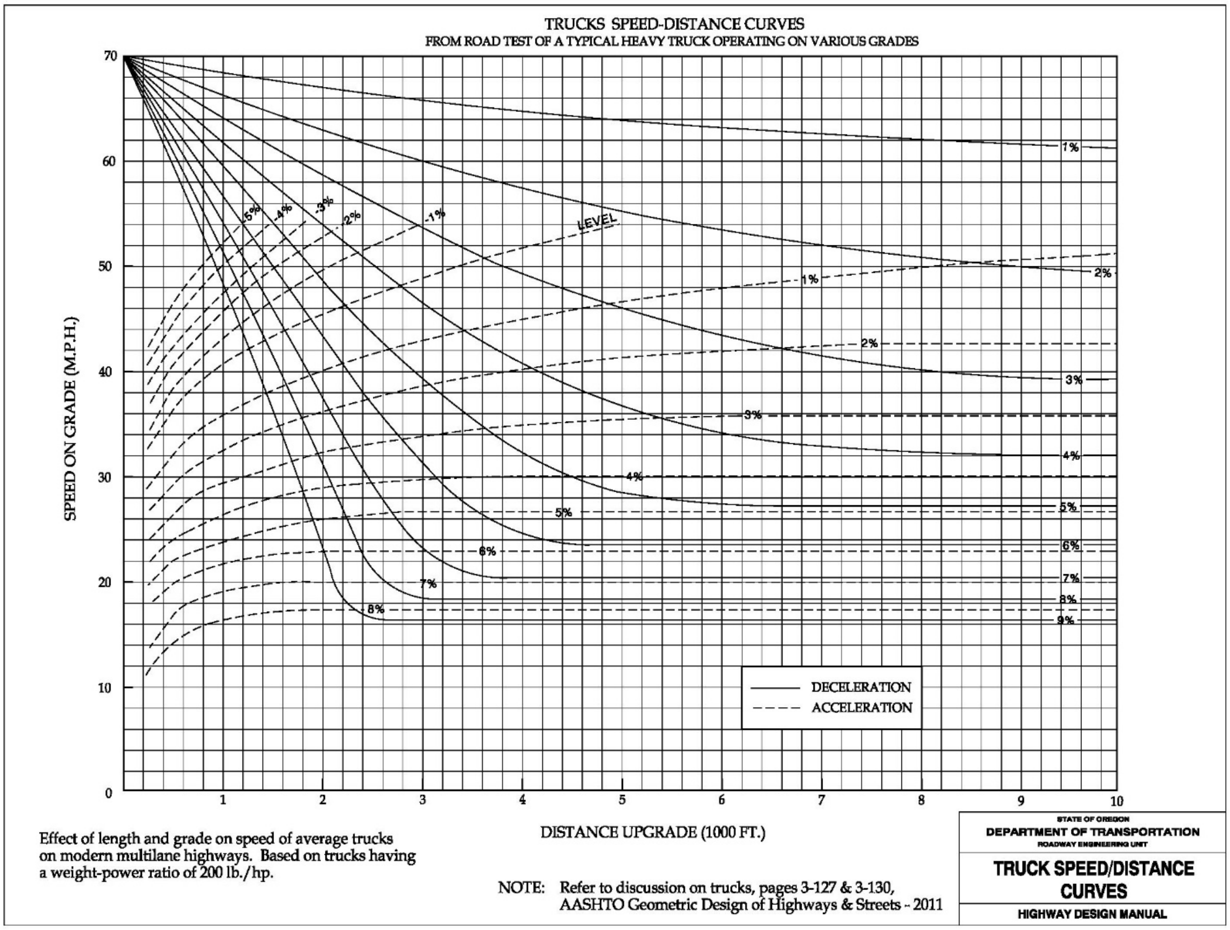
# Section 327 Climbing Lanes

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 300-28: 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 1,250 feet, plus tapers. The taper section at the end of a passing lane should be computed by the following formula:

$$\boxed{\boldsymbol{L = WS}}$$ (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. Part 400401.1 and 0 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 401.1 and 0. 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.

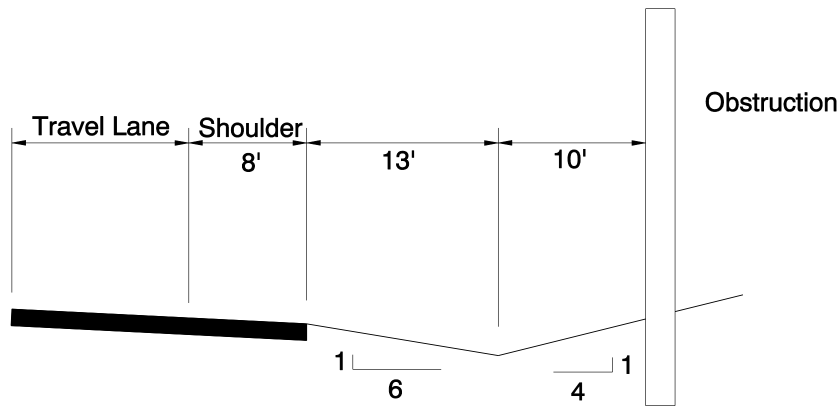
Example:

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 Speed (mph) | Design ADT | Fill Slopes | | | Cut Slopes | | |
|---|---|---|---|---|---|---|---|
| | | 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 | 7 - 10 | 7 - 10 | [b] | 7 - 10 | 7 - 10 | 7 - 10 |
| | 750 - 1500 | 10 - 12 | 12 - 14 | [b] | 10 - 12 | 10 - 12 | 10 - 12 |
| | 1500 - 6000 | 12 - 14 | 14 - 16 | [b] | 12 - 14 | 12 - 14 | 12 - 14 |
| | OVER 6000 | 14 - 16 | 16 - 18 | [b] | 14 - 16 | 14 - 16 | 14 - 16 |
| 45 - 50 | UNDER 750 [c] | 10 - 12 | 12 - 14 | [b] | 8 - 10 | 8 - 10 | 10 -12 |
| | 750 - 1500 | 14 - 16 | 16 - 20 | [b] | 10 - 12 | 12 - 14 | 14 - 16 |
| | 1500 - 6000 | 16 - 18 | 20 - 26 | [b] | 12 - 14 | 14 - 16 | 16 - 18 |
| | OVER 6000 | 20 - 22 | 24 - 28 | [b] | 14 - 16 | 18 - 20 | 20 - 22 |
| 55 | UNDER 750 [c] | 12 - 14 | 14 - 18 | [b] | 8 - 10 | 10 -12 | 10 - 12 |
| | 750 - 1500 | 16 - 18 | 20 - 24 | [b] | 10 - 12 | 14 - 16 | 16 - 18 |
| | 1500 - 6000 | 20 - 22 | 24 - 30 | [b] | 14 - 16 | 16 - 18 | 20 - 22 |
| | OVER 6000 | 22 - 24 | 26 - 32 [a] | [b] | 16 - 18 | 20 - 22 | 22 - 24 |
| 60 | UNDER 750 [c] | 16 - 18 | 20 - 24 | [b] | 10 - 12 | 12 - 14 | 14 - 16 |
| | 750 - 1500 | 20 - 24 | 26 - 32 [a] | [b] | 12 - 14 | 16 - 18 | 20 - 22 |
| | 1500 - 6000 | 26 - 30 | 32 - 40 [a] | [b] | 14 - 18 | 18 - 22 | 24 - 26 |
| | OVER 6000 | 30 - 32 [a] | 36 - 44 [a] | [b] | 20 - 22 | 24 - 26 | 26 - 28 |
| 65 - 70 | UNDER 750 [c] | 18 - 20 | 20 - 26 | [b] | 10 - 12 | 14 - 16 | 14 - 16 |
| | 750 - 1500 | 24 - 26 | 28 - 36 [a] | [b] | 12 - 16 | 18 - 20 | 20 - 22 |
| | 1500 - 6000 | 28 - 32 [a] | 34 - 42 [a] | [b] | 16 - 20 | 22 - 24 | 26 - 28 |
| | OVER 6000 | 30 - 34 [a] | 38 - 46 [a] | [b] | 22 - 24 | 26 - 30 | 28 - 30 |

[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.

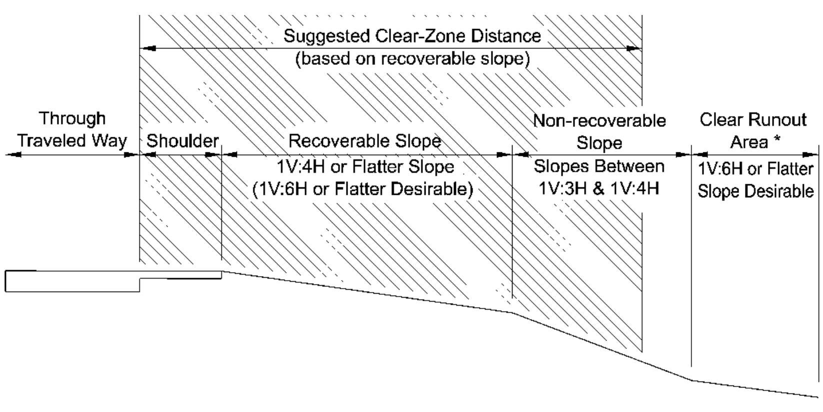
While the application may be limited by several factors, the foreslope parameters that may enter into determining a maximum desirable recovery area are illustrated in Table 400-2. A 10-ft recovery area at the toe of slope should be provided for all traversable, non-recoverable fill slopes.

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.

# 403.1 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 backslope 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.

Figure 400-1 AASHTO 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

# 403.2 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 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

## 405.1.1 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.

## 405.2.1 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 lower than 28", 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 lower than 28″ 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 lower than 28″ must be raised to 31″
- NCHRP 350 guardrail may remain in place. Where the height is lower than 28″, 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 lower than 28″ must be raised to 31″
  - NCHRP 350 guardrail may remain in place. Where the height is lower than 28″, 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″.

**Major Bridge Maintenance (MBM):**

- Address all unconnected and unprotected bridge rail end treatments as follows:
  - Seek additional funding to upgrade unconnected and unprotected bridge rail end treatments
  - Where it is not possible to include bridge rail end treatments in the project, prioritize and address in a future project through the 1R Roadside Safety Feature Upgrade Program
  - Where unprotected bridge ends cannot be upgraded due to site conditions, document with a design exception.
- Guardrail height adjustment is not required for resurfacing treatments that do not impact guardrail height.
  - Concrete deck sealing and multi-layer polymer concrete overlays (MPCO's) are examples of deck preservation activities that are considered to have on impact guardrail height.
- For projects that impact rail height (i.e. overlays):
  - MGS guardrail that is lower than 28″ must be raised to 31″
  - NCHRP 350 guardrail may remain in place. Where the height is lower than 28″, 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″.

## 405.2.2 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. Any length of guardrail upstream from the length of need point is not included in the distance provided by the length of need calculation.

$$X = \frac{L_A + \left(b/_a\right)(L_1) - L_2}{\left(b/_a\right) + \left(L_A/_{L_R}\right)}$$

Example:

Given: ADT = 7,500 vpd

Speed = 50 mph

Select: $b/_a$ = 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:

$$X = \frac{L_A - L_2}{\left(L_A/_{L_R}\right)}$$

$$X = \frac{15 - 6}{\left(15/_{190}\right)} = \frac{9}{.0789} = 114\ ft.$$

## 405.2.3 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.

## 405.2.4 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 RD419).

## 405.2.5 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.

Table 400-3: Desired Recovery Area Dimensions

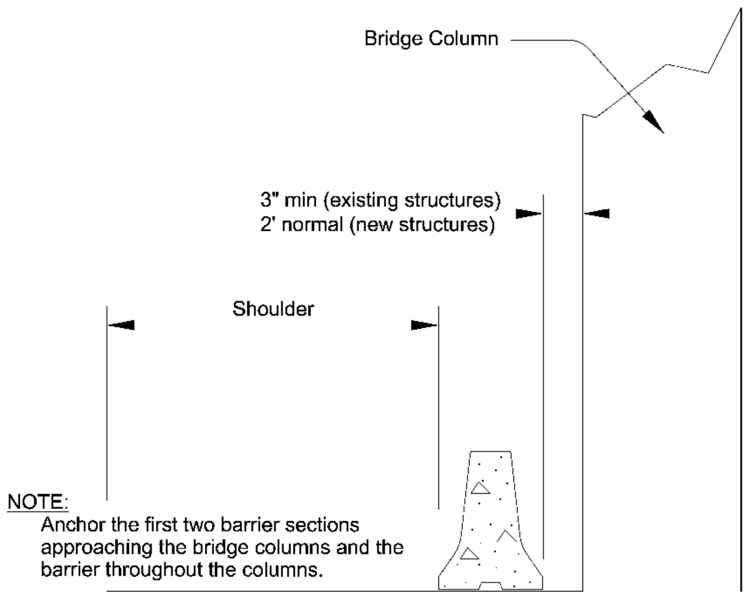
| DESIGN SPEED (MPH) | WIDTH (FT.) | LENGTH (FT.) |
|---|---|---|
| 50 + | 20 | 75 |
| 35-45 | 18 | 50 |
| < 35 | 16 | 40 |

# 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 400-2. 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.

Figure 400-2: Concrete Barrier Placement at Bridge Column




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.

## 405.4.1 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.

## 405.4.2 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.

## 405.4.3 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. All cable barrier systems approved for installation on Oregon State Highways are proprietary, so it is necessary to refer to the manufacture's specifications for installation.

### 405.5.1 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.

### 405.5.2 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-3. Barrier moment slabs must be designed in accordance with AASHTO LRFD and the current 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 400-4: Interstate/Freeway List

| Hwy | Route | Highway Name | Begin MP | End MP | Interstate/ Freeway |
|---|---|---|---|---|---|
| 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 400-5: 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 Assumed at least MASH TL 3 (assumed) | 30 inches (unanchored) | 8'-4" | Anchored deflection estimated to be 0 – 6 inches. Requires asphalt pad for placement. Only tested under NCHRP 350. |
| 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

Impact Attenuators are protective devices that significantly reduce the severity of impacts with fixed objects. This is accomplished by absorbing much of the crash energy and decelerating a vehicle to a safe stop for head on impacts, or by redirecting a vehicle away from the fixed object for a side impact. Impact attenuators are used where fixed objects cannot be removed, relocated, or made to break away, and where fixed objects cannot be adequately shielded by a longitudinal barrier. Impact attenuators may also be used to terminate median barriers. Low maintenance impact attenuators are designed to be relatively easy to repair after an impact with the repair taking 2 hours or less. When selecting an Impact Attenuator that approved for use on Oregon State Highways, there may be a tradeoff between the initial cost and low maintenance. A low maintenance device should be selected where there is a history or high likelihood of multiple impacts and the location and/or high traffic volumes make it desirable to limit exposure to maintenance workers. On the other hand, a device with a lower initial cost may be installed where there is a low likelihood of multiple impacts and the repair or replacement after a crash will not expose maintenance workers to especially hazardous conditions.

# Section 406 Roadside and Median Trees

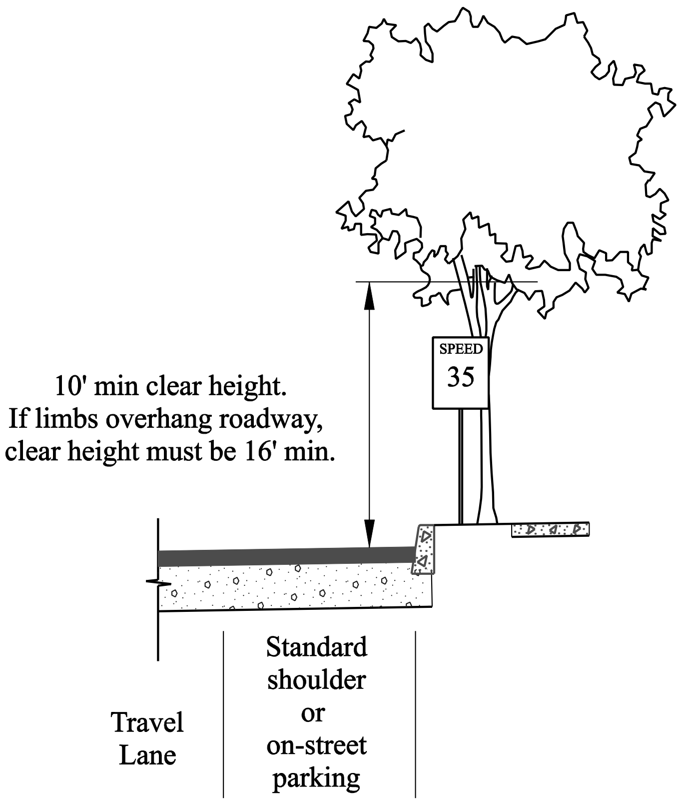
## 406.1 Roadside Trees

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

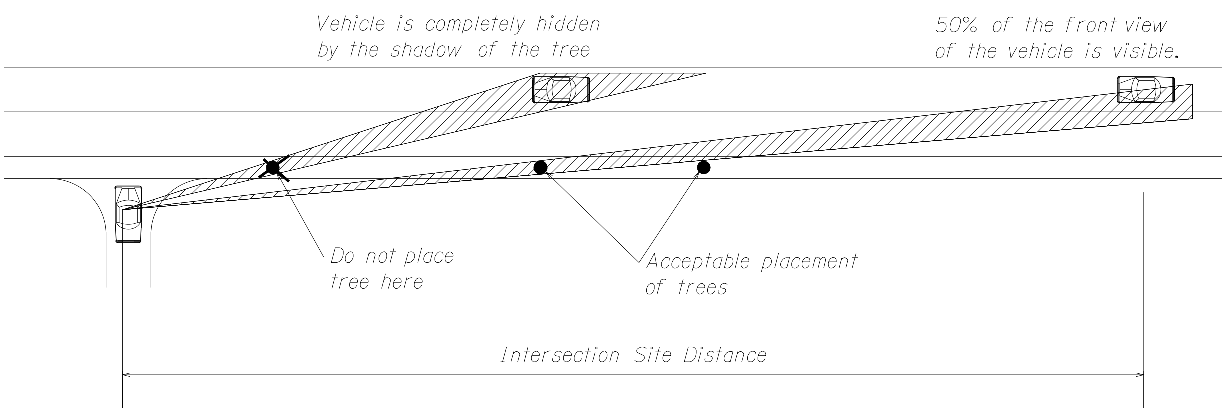



1. When the design speed is 45 mph or less and if the shoulder is nonstandard, or if there is no on-street parking, trees should be located such that there is at least 6 feet from the edge of travel to the trunk of the tree at maturity.
2. Where the posted speed is greater than 35 mph, trees should be 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 crashes or a high potential for such crashes.
- **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

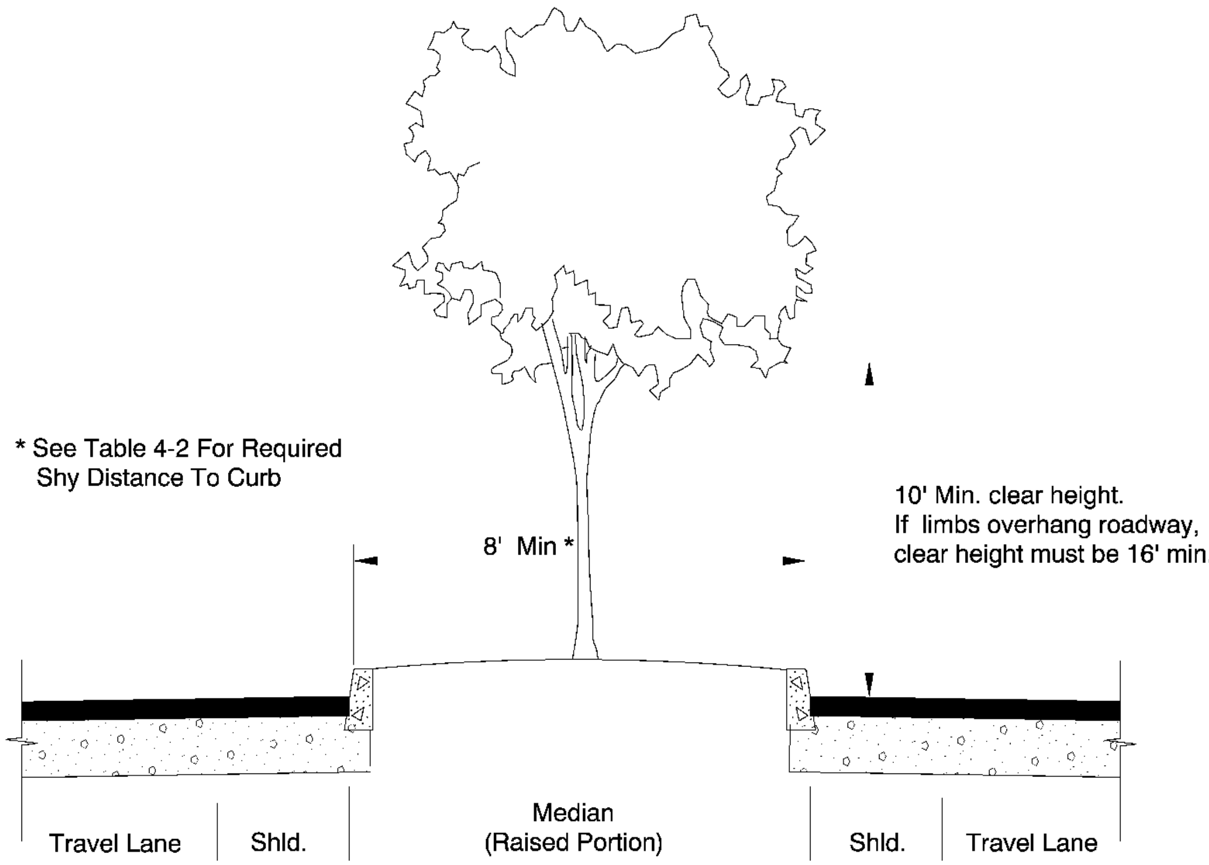
reduce visibility by planting trees. Note that ISD applies equally to all approaches & should be determined by a design professional.

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 crashes or a high potential for such crashes.
- **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.

Figure 400-5: Median Tree placement




# 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:

## 407.3.1 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.

## 407.3.2 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.

## 407.3.3 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.

## 407.3.4 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.

## 407.3.5 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. Intersection control evaluation is important to determine the appropriate intersection control option to develop for a project. Intersection control evaluation is a function of the ODOT Traffic Section. The roadway designer should work with the Region Traffic Section and the Statewide Project Delivery, Traffic Section staff concerning intersection control options.

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.

**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. It may also be referred to a sidewalk ramp or curb cut in portions of this manual.

**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.

Figure 500-1: Functional Intersection Area

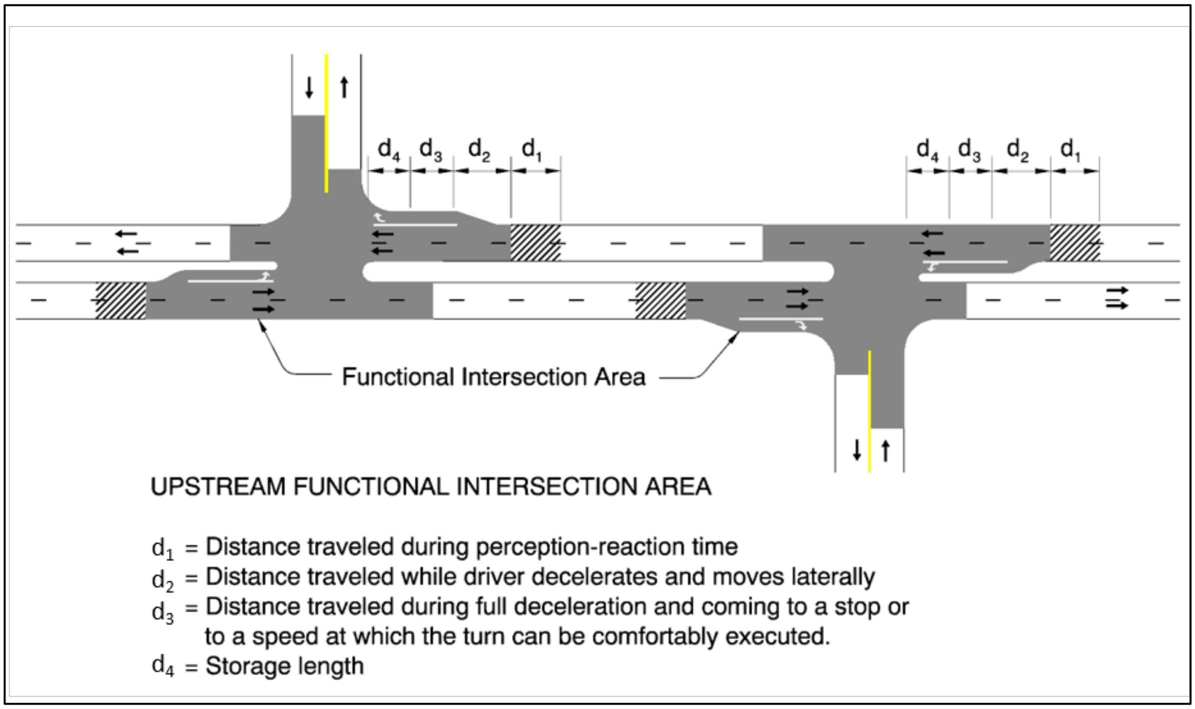



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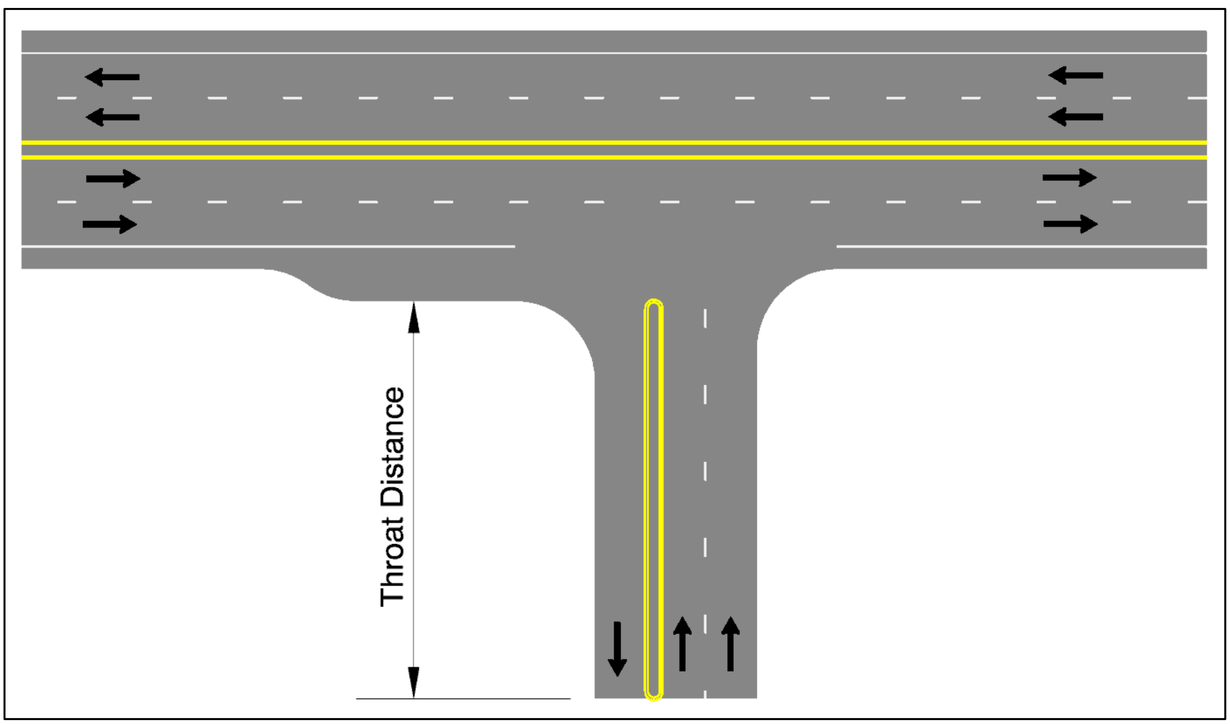
Figure 500-2: Throat Distance at Approaches



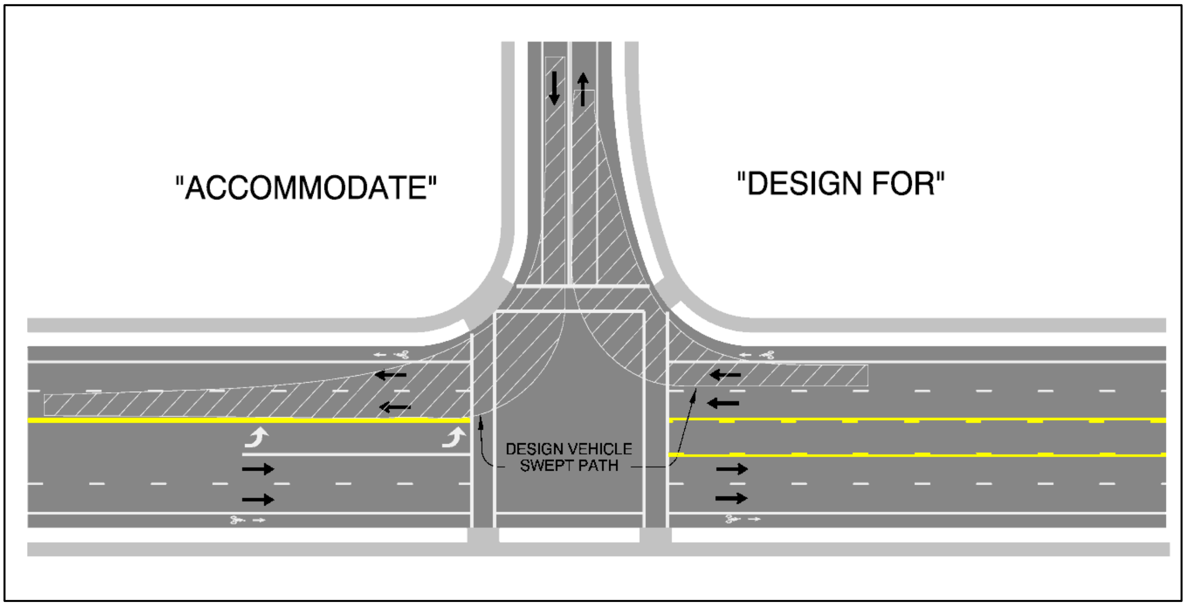
For approach connections from properties adjacent to the highway, the corresponding site circulation plan should specify the entry/exit throat distance. This throat distance is critical in order to provide an efficient and functional connection between the highway and the adjacent property. Throat lengths 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.

# 502.2 Design for or Accommodate for Design Vehicle

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.

# 502.3 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.

# 502.4 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.

Figure 500-4: Median Detail: Right-In Right-Out

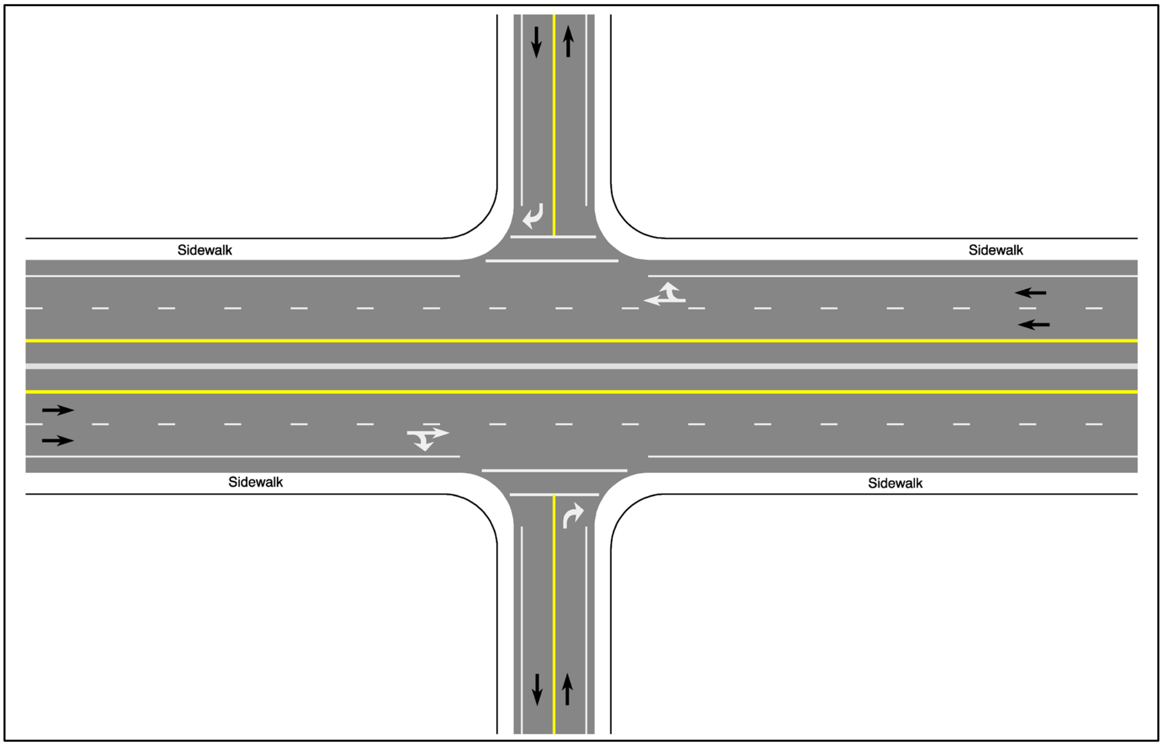



Figure 500-5: Raised Median Detail: Right-In Right-Out

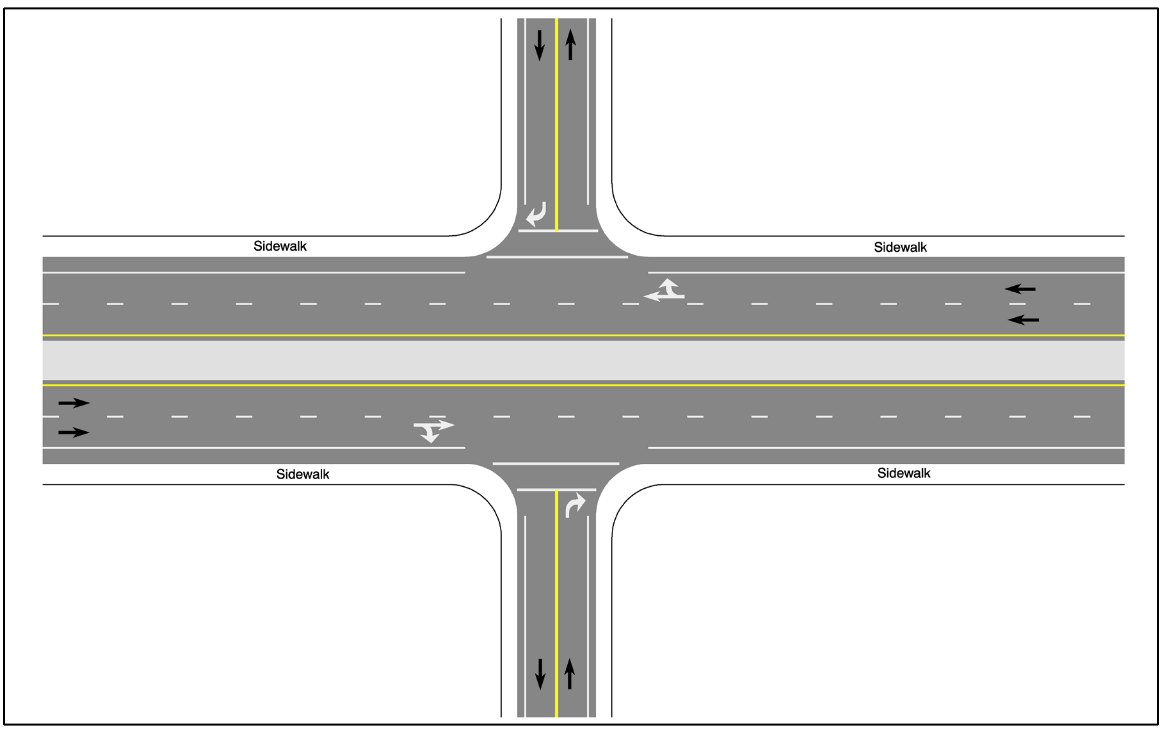


Figure 500-6: Benefits of Median Control for Pedestrians

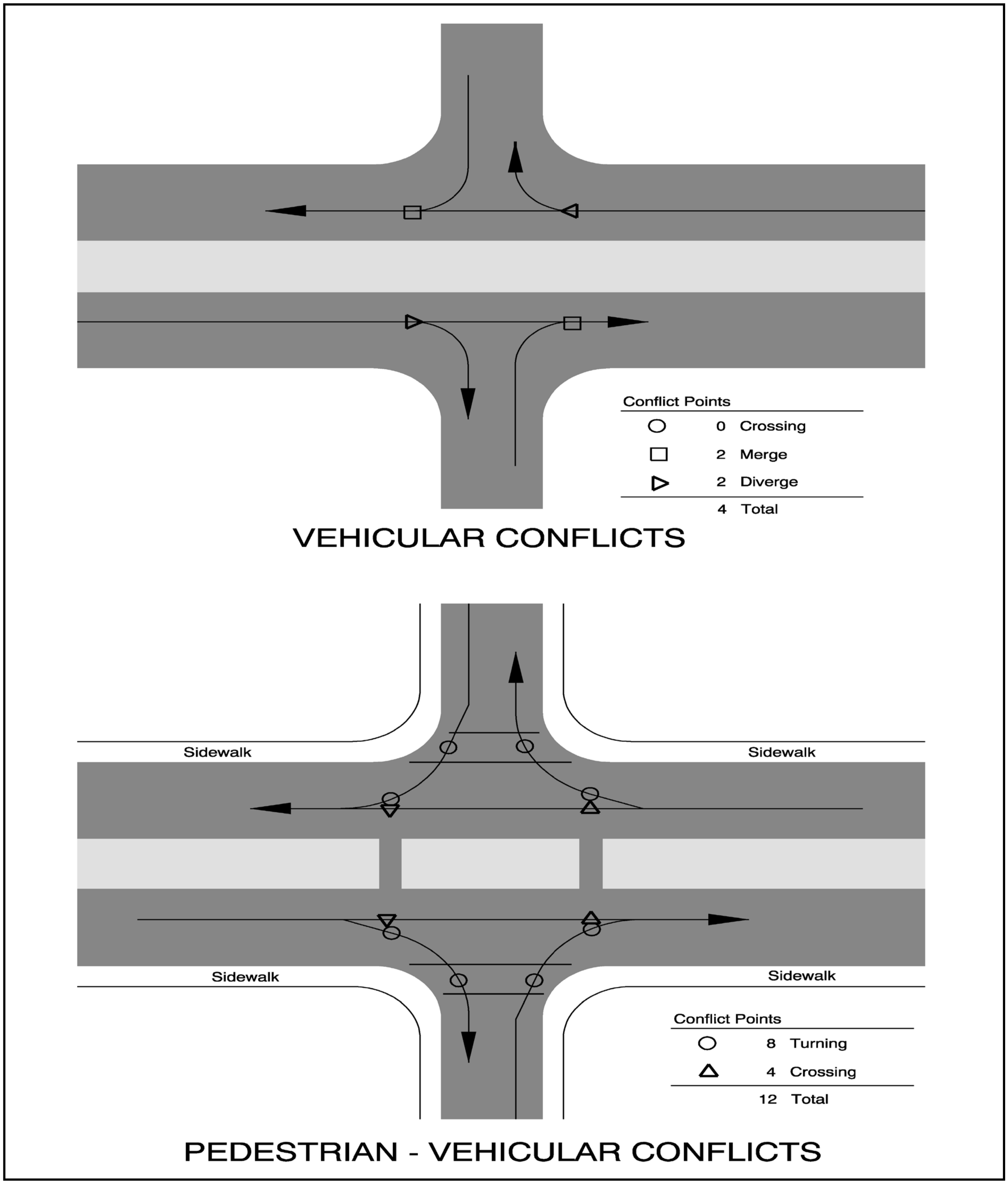
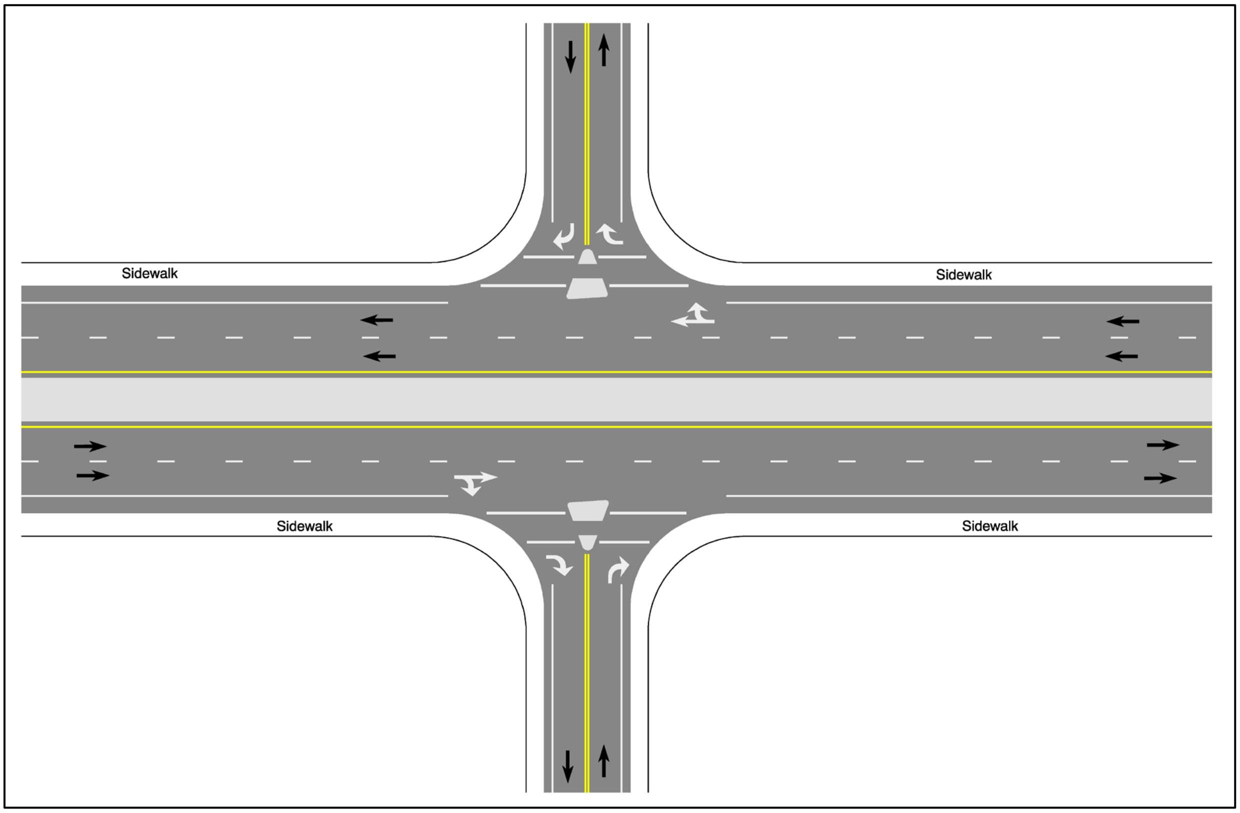


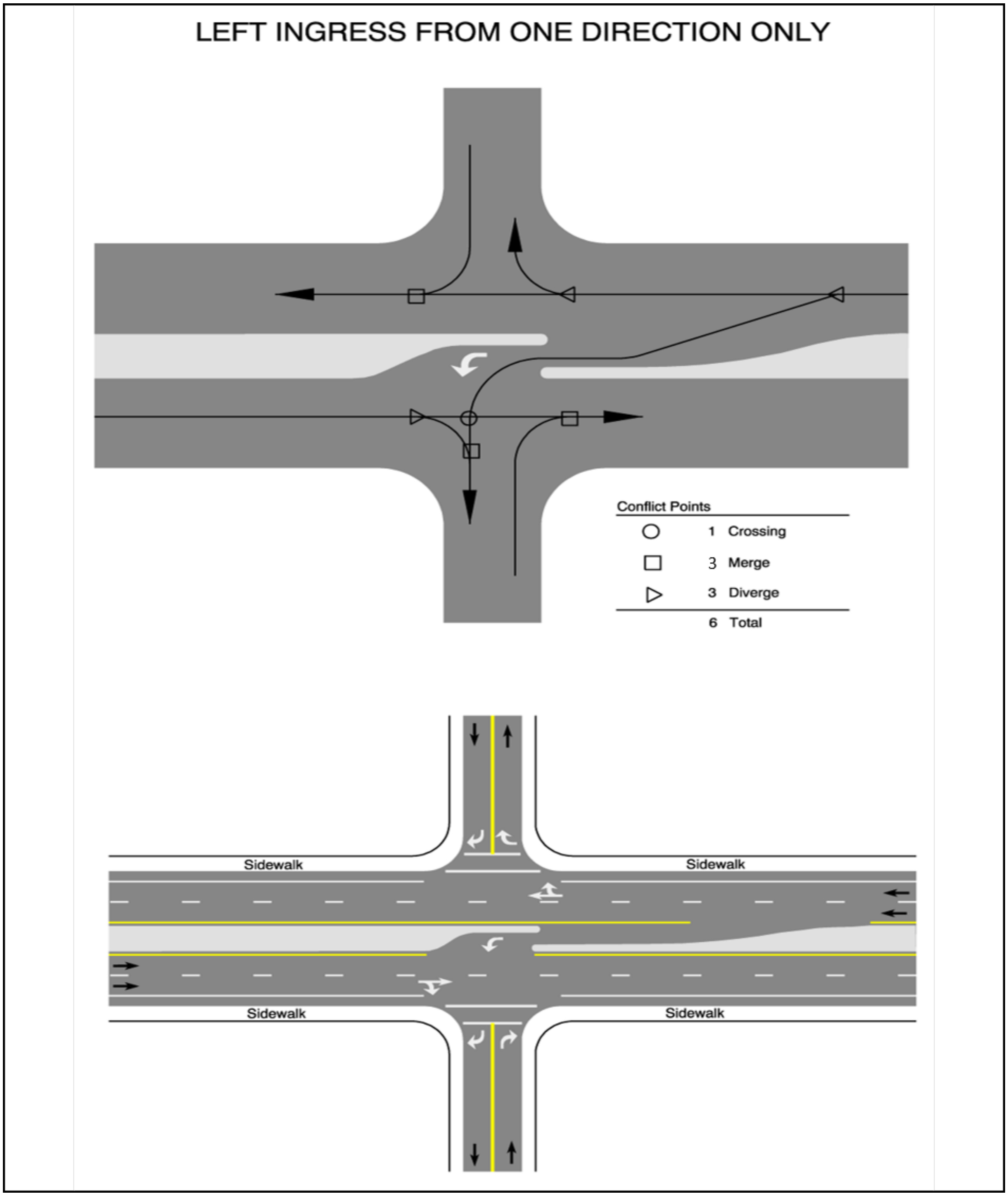
Figure 500-7: "Pork Chop" with Non-Traversable Median




## 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.

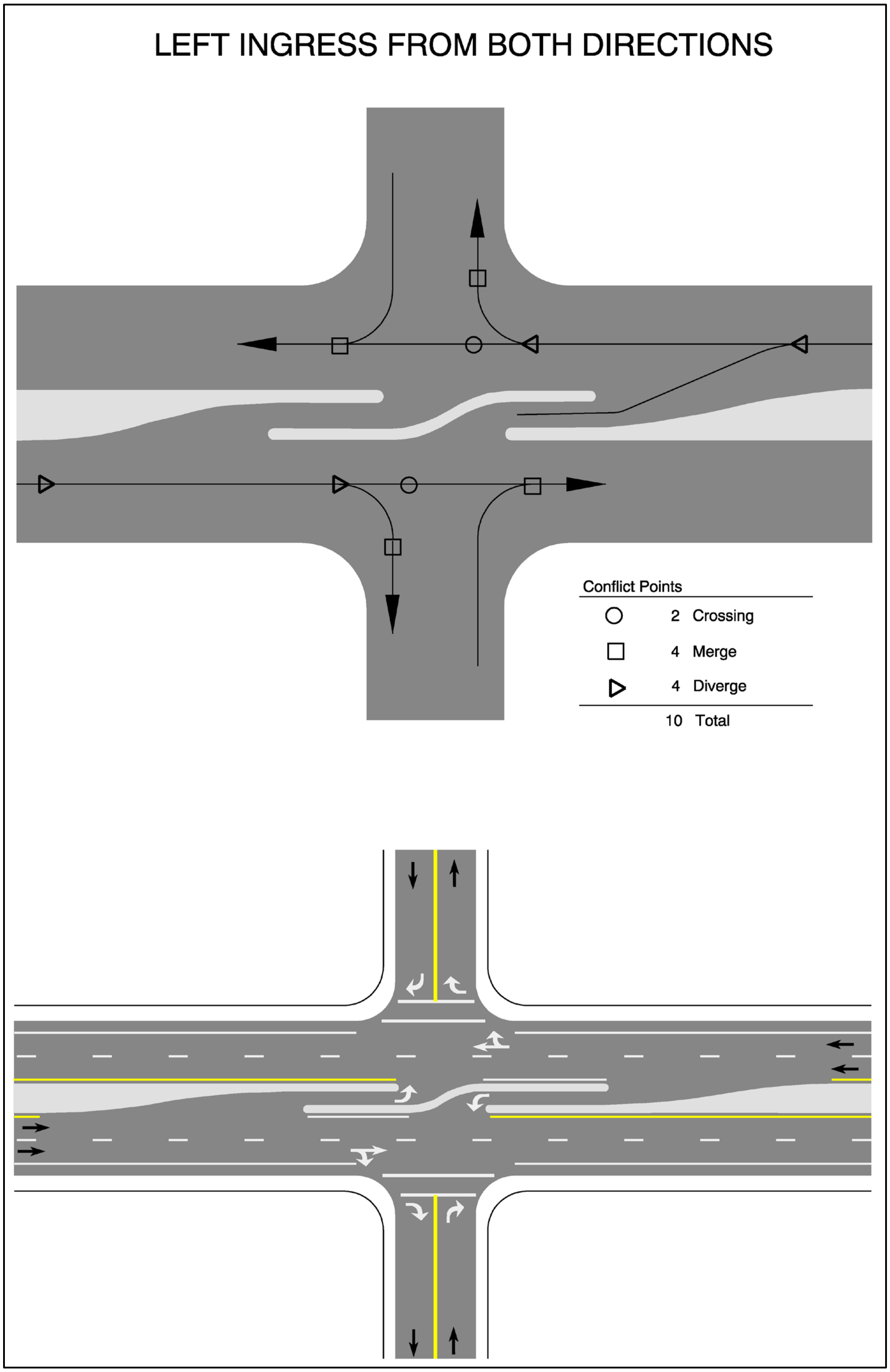
Figure 500-8: Right-In, Right-Out, Left-In (One Direction)



## 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.

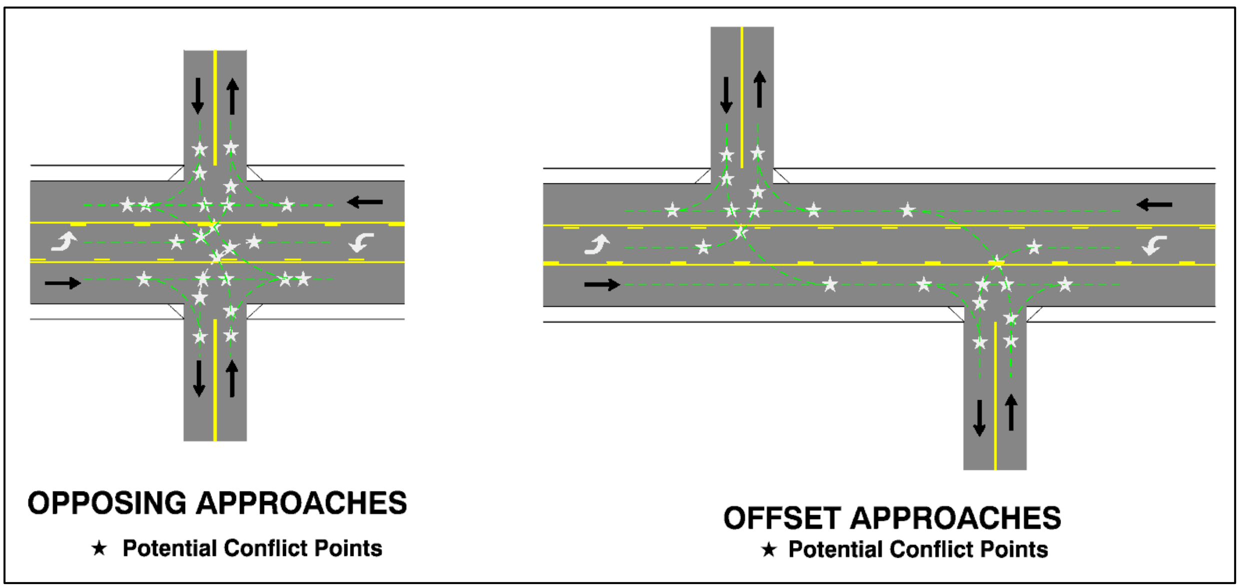
Figure 500-9: Opposing Approaches, Right-In, Right-Out, Left-In (Both Directions)



# 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

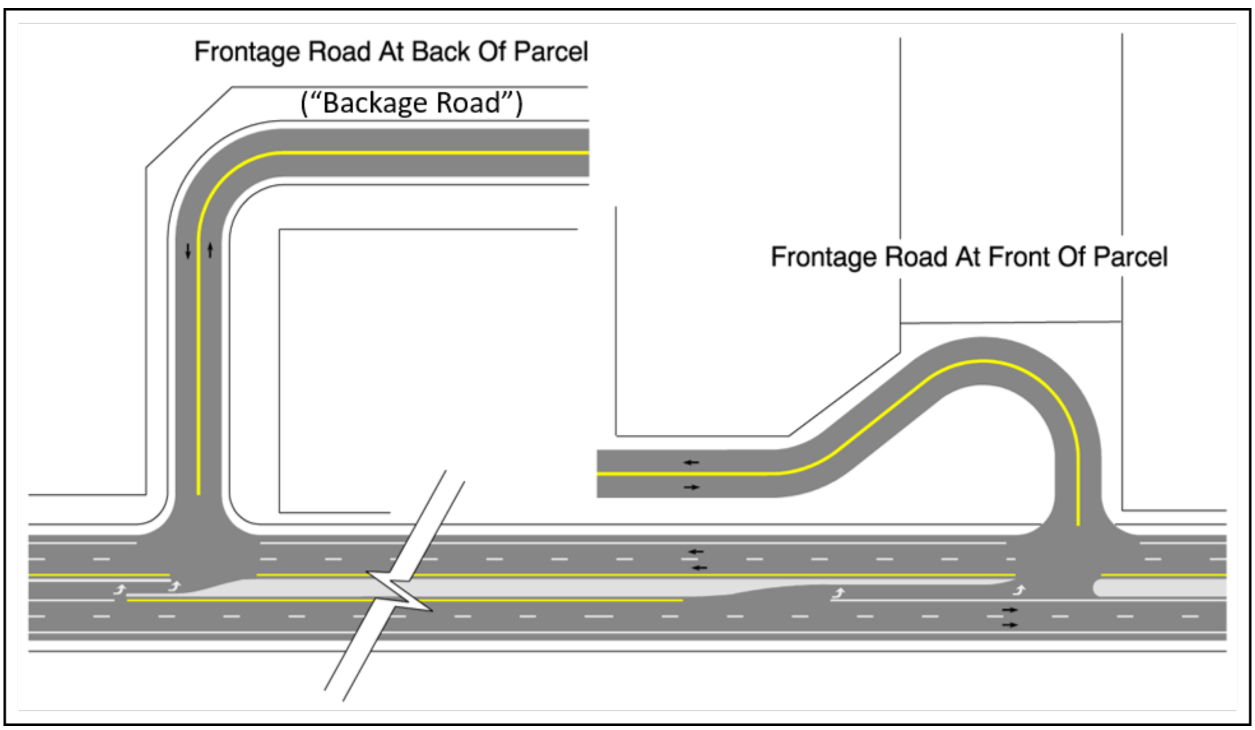



# 504.5 Frontage Roads

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.

Also, see the ODOT Traffic Manual and the ODOT Traffic Signal Policy and Guidelines for traffic related design and approvals. Consult with the region Traffic Section.

Figure 500-12: U-Turns at Intersections

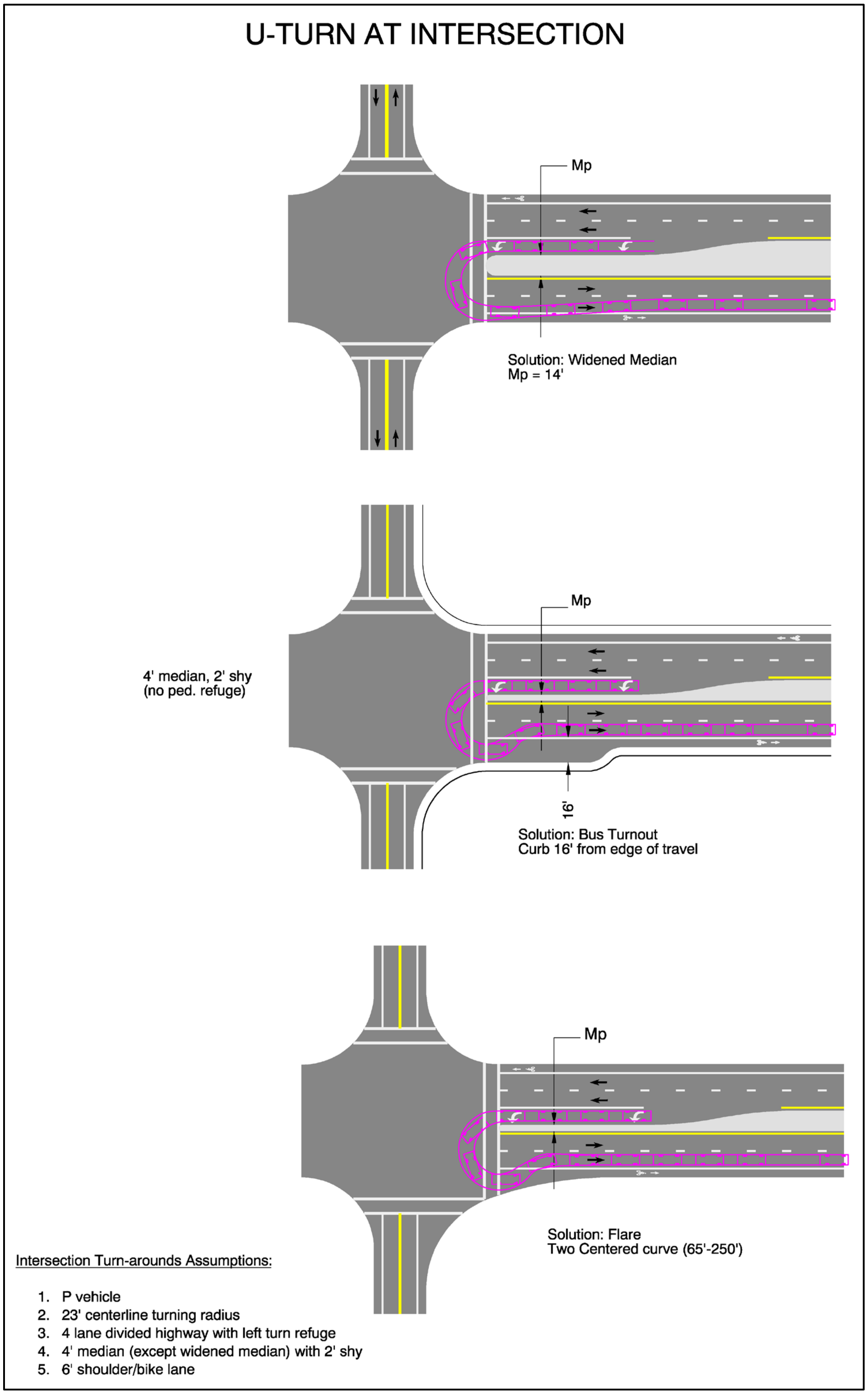
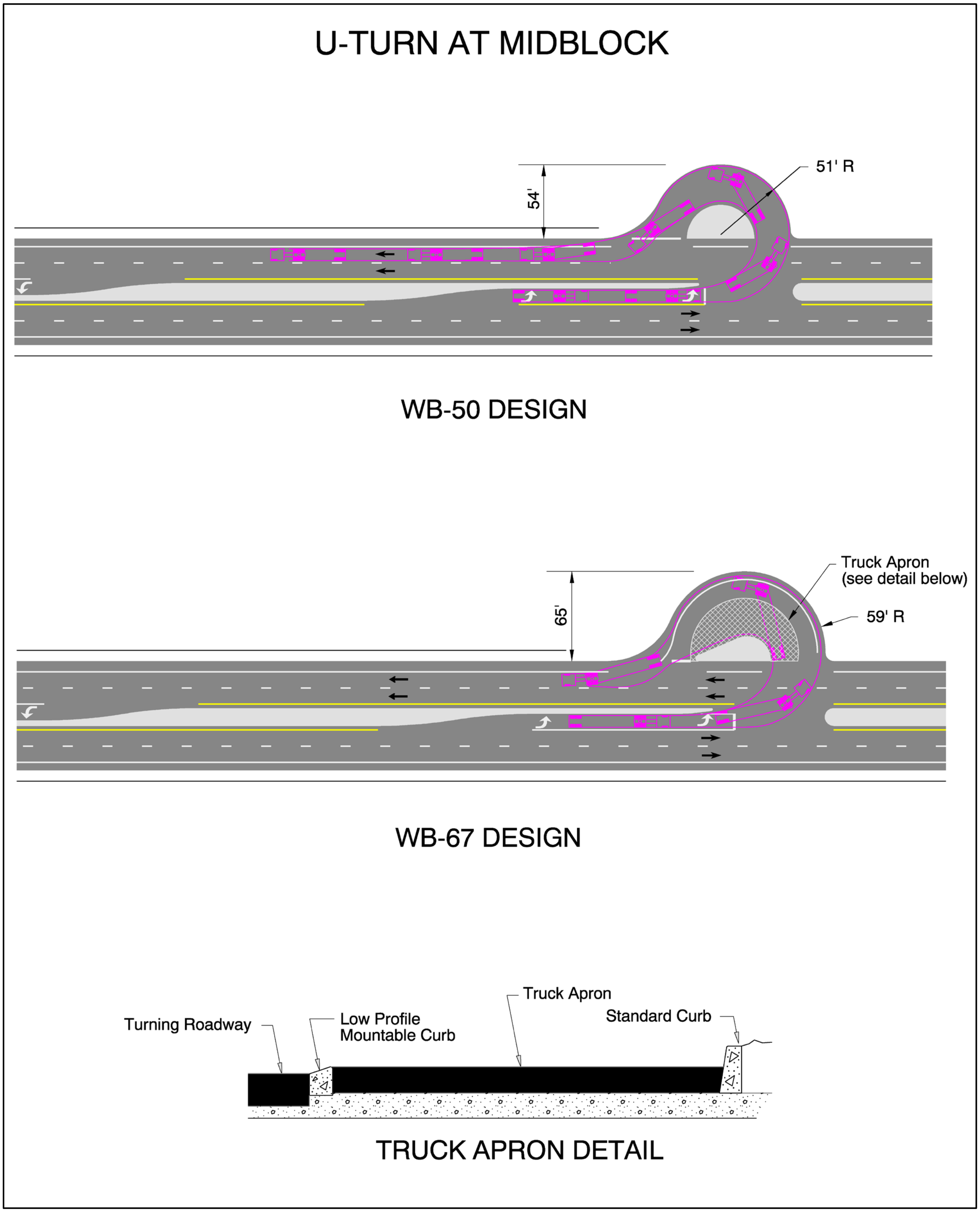


Figure 500-13: U-Turns at Mid-Block



## 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 and RD900 series provide information and various design options for curb, sidewalk, and driveway design at approaches and curb ramps.
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.

   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.

Table 500-1: Typical Private Approach Style and Width

| Land Use Type | Approach Peak Hour Volume | Approach Style | Typical Throat Width[1] |
|---|---|---|---|
| SF Residential2 | 0 – 10 | Dust Pan | 16′ |
| SF Residential2 | 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 | Radius4 | 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 Uses7 | | 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.

7 Special 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.

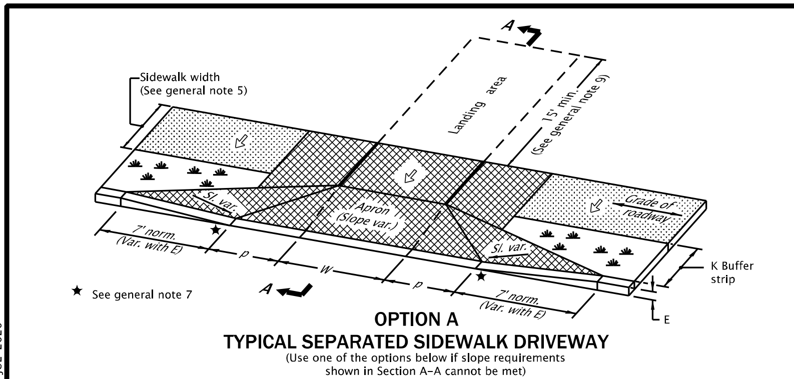
In order to effectively match intersecting roadway grades with state highway grades, vertical curve alignments should be used on all approach connections. Generally the intersecting roadway's vertical alignment should match with the cross slope of the highway as long as the cross slope is less than 3 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.

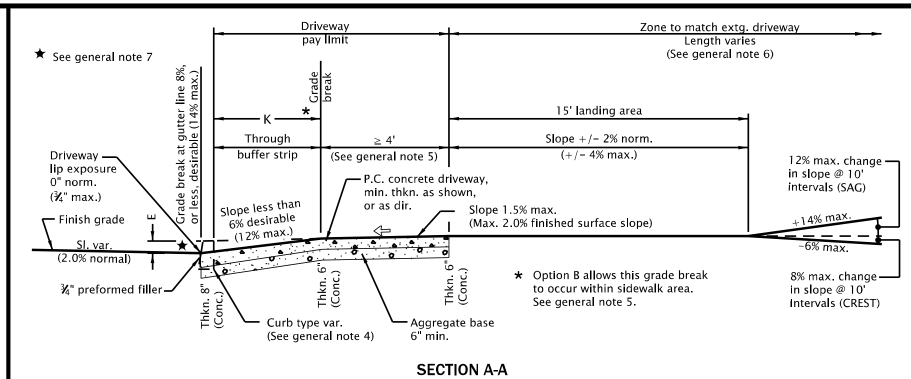
Due to typically expected operating conditions, driveway approaches to state highways can be constructed with greater differential changes in grade than public roadway connections. Figure 500-14 and Figure 500-15 provide design and layout information for an approach with sidewalk and without sidewalk. 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, RD720, RD721, RD725, RD730, RD735, RD740, RD745 and RD750.

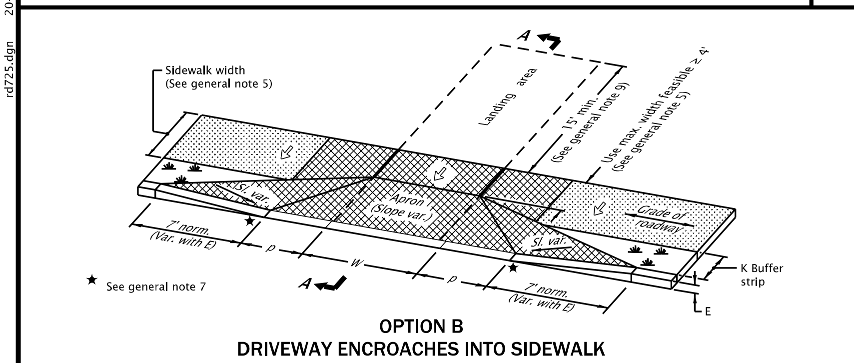
Regardless of roadway connection type, where a marked or unmarked crosswalk exists, the cross slope should be held to 2 percent or less to meet ADA requirements. Figure 500-16 and the Oregon Standard Drawing RD900 series provide information about curb ramps. In addition, adequate sight distance must be provided at all road connections.

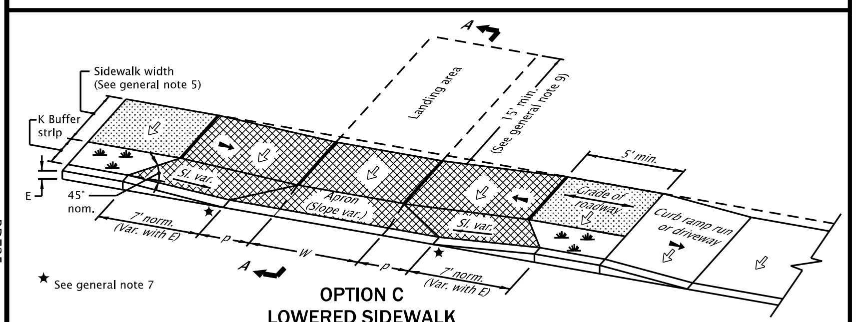
**NOTE: Crosswalks, whether marked or unmarked, exist across each approach to an intersection unless specifically closed by the road authority.**

Figure 500-14: Driveway Approaches With Sidewalks




GENERAL NOTES FOR ALL DETAILS ON THIS SHEET:

1. Details are based on applicable ODOT Standards.
2. Only use details allowed by jurisdiction.
3. The following dimensions are as shown on plans, or as directed: driveway width, driveway slope, sidewalk width, buffer strip width, curb exposure, driveway lip exposure, landing area length and width. See project plans for details not shown.
4. Curb, gutter, and sidewalk types varies, see plans.
   See Std. Dwgs. RD700 & RD701 for curb details.
   See Std. Dwg. RD721 for sidewalk details.
   See Std. Dwg. RD722 for joint details.
5. A greater than or equal to 4' unobstructed clear passage with cross slope 1.5% max. (Max. 2.0% finished surface slope) is required behind driveway apron. Sidewalk profile grade of the pedestrian accessible route shall not exceed the adjacent roadway profile grade.
6. Where existing driveway is in good condition, and meets slope requirements, construct only as much landing area as required for satisfactory connection with new work.
7. Check the gutter flow depth at driveway locations to assure that the design flood does not overtop the back of sidewalk at driveway. If overtopping occurs place an inlet at upstream side of driveway or perform other approved design mitigation.
8. Construct a full depth expansion joints with ½" (In) preformed joint filler at ends of each driveway. Tooled joints are required at all driveway slope break lines.
9. 15' min. of the driveway behind the sidewalk should be surfaced to prevent tracking of gravel onto the sidewalk.

LEGEND:

| | |
|---|---|
| (dotted pattern) | Sidewalk |
| (crosshatch pattern) | Driveway pay limit (See project plans for details not shown) |
| ⇦ | Cross slope 1.5% max. (Max. 2.0% finished surface slope) (Normal sidewalk cross slope) |
| ← | Running slope 7.5% max. (Max. 8.3% finished surface slope) |
| W | Width of driveway |
| K | Buffer strip width (5' normal, 3' min.) |
| E | Curb exposure |
| p | 7.0' in commercial land use types<br>3.5' in residential land use types |

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SEPARATED SIDEWALK DRIVEWAYS OR ALLEYS (OPTIONS A, B & C)
ODOT HIGHWAYS

HIGHWAY DESIGN MANUAL

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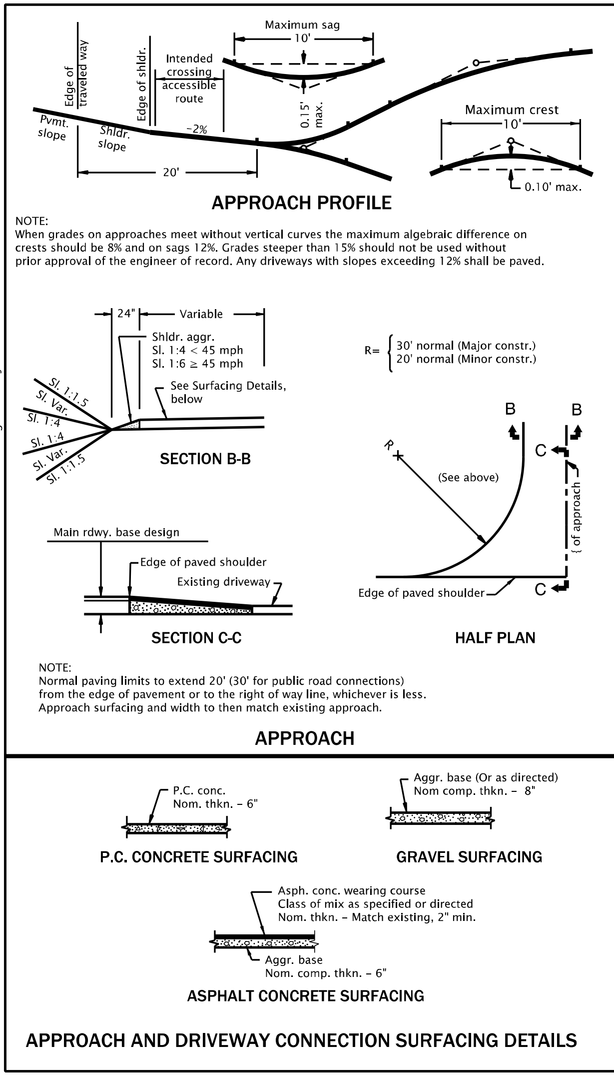
RD725

Figure 500-15: Driveway Approaches Without Sidewalks



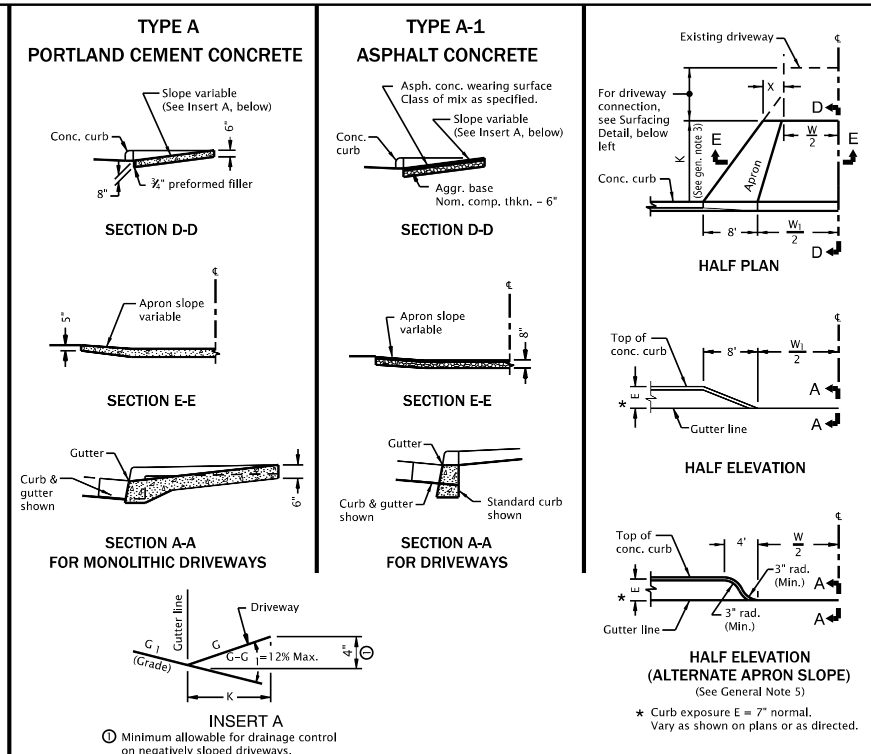




TABLE A

| W (ft) | X (ft) | K (ft) 5 | 6 | 8 | 10 |
|---|---|---|---|---|---|
| | | $W_1$ (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.

NON-SIDEWALK DRIVEWAYS

NOTE: This driveway type shall not be used along a pedestrian route. See "Table A" for dimensions not shown.

GENERAL NOTES FOR ALL DETAILS ON THIS SHEET:

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. Dwgs. RD720, RD721, 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. Dwgs. RD700 & RD701.
8. For expansion and contraction joint requirements, see applicable curb and sidewalk standard drawings.

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APPROACHES AND NON-SIDEWALK DRIVEWAYS

HIGHWAY DESIGN MANUAL

RD715

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RD715

Figure 500-16: Typical Curb Ramp Components and Legend

### CURB RAMP INDEX

| STD. DWG. NO. | STD. DWG. TITLE |
|---|---|
| RD900 | Curb Ramp Components And Legend |
| RD901 | Curb Ramp Legend And Corner Identification |
| RD902 | Detectable Warning Surface Details |
| RD904 | Detectable Warning Surface Placement For Curb Ramps |
| RD905 | Detectable Warning Surface Placement For Directional Curbs |
| RD906 | Detectable Warning Surface Placement For Accessible Route Island |
| RD908 | Detectable Warning Surface Placement |
| RD910, RD912 | Perpendicular Curb Ramp |
| RD913 | Perpendicular Curb Ramp With Closure |
| RD916 | Perpendicular Curb Ramp Single Ramp |
| RD920 | Parallel Curb Ramp |
| RD922 | Parallel Curb Ramp Single Ramp |
| RD930, RD932 & RD936 | Combination Curb Ramp |
| RD938 | Combination Curb Ramp Single Ramp |
| RD940 | Blended Transition Curb Ramp Single Ramp |
| RD950 & RD952 | End Of Walk Curb Ramp |
| RD960 | Unique Curb Ramp |

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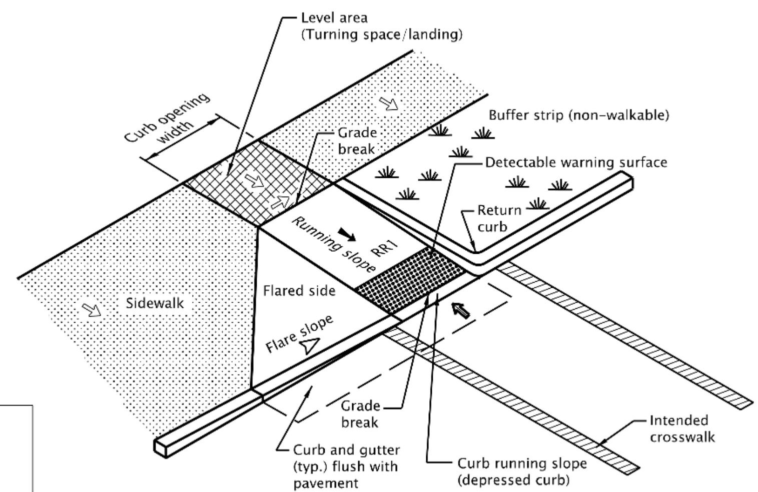


**TYPICAL CURB RAMP SYSTEM COMPONENTS**
(PERPENDICULAR TYPE SHOWN)

### LEGEND

- Crosswalk Stripe
- Sidewalk or other traversable surface
- Detectable warning surface (DWS)
- Level area (Turning space/landing)
- Cross slope 1.5% max. (Max. 2.0% finished surface slope) (Normal sidewalk cross slope)
- Running slope 4.0% max. (Max. 4.9% finished surface slope)
- Running slope 7.5% max. (Max. 8.3% finished surface slope)
- Counter slope 4.0% max. ascending or descending (Max. 5.0% finished surface slope) Slope as required for drainage
- Flare slope (Max. 10.0% finished surface slope)
- 4'x4' clear space
- RR1 Ramp Run Position 1

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CURB RAMP COMPONENTS AND LEGEND

HIGHWAY DESIGN MANUAL

RD900

# 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 500-20. 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 sections of this manual to 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.

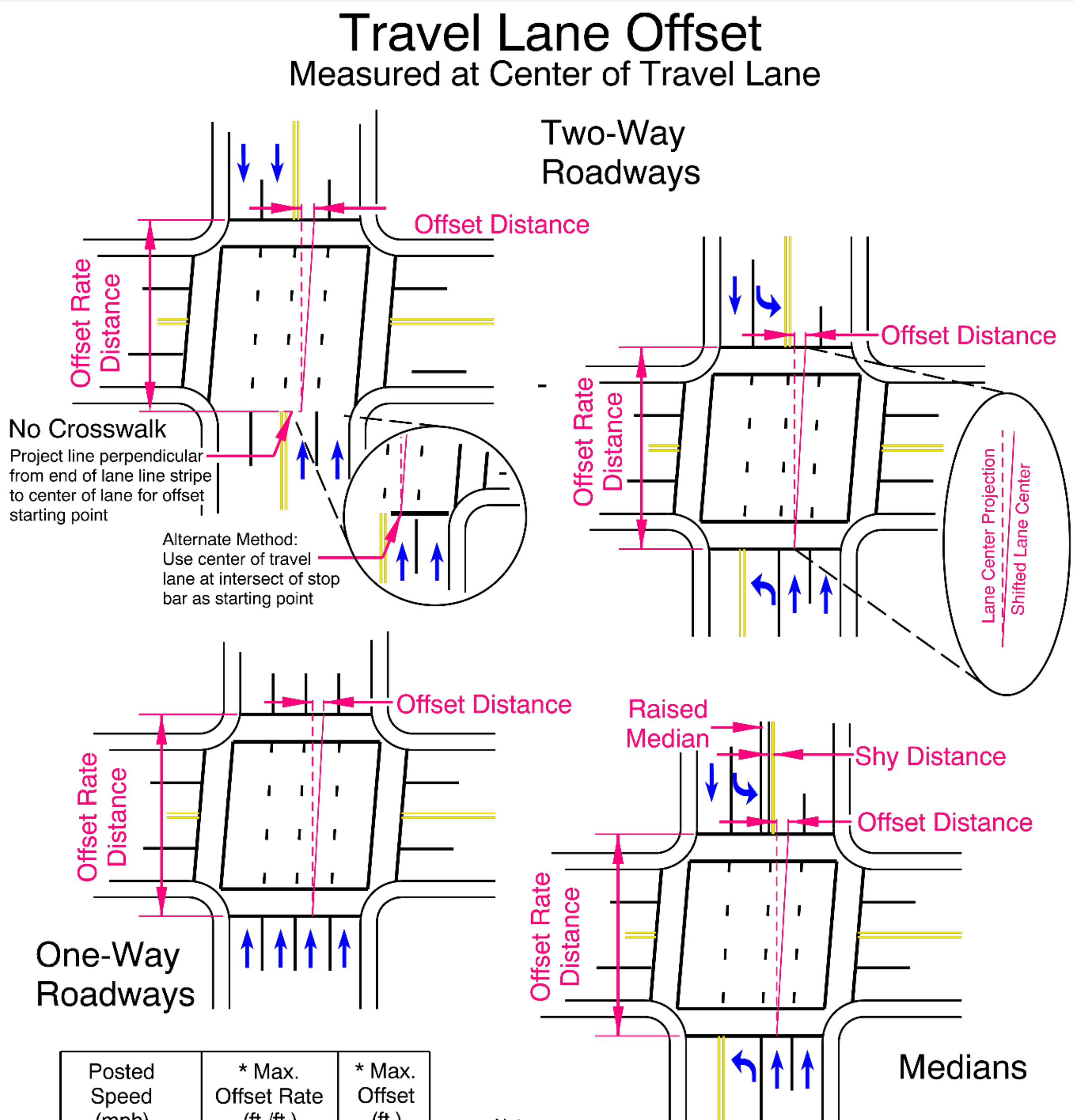
When lanes are shifted through an intersection, care must be taken to ensure that adequate space is maintained between travel lanes and roadway features like curbs; raised median islands, signs, illumination or signal poles, etc. All proposed lane shift designs must be reviewed by appropriate staff in 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.

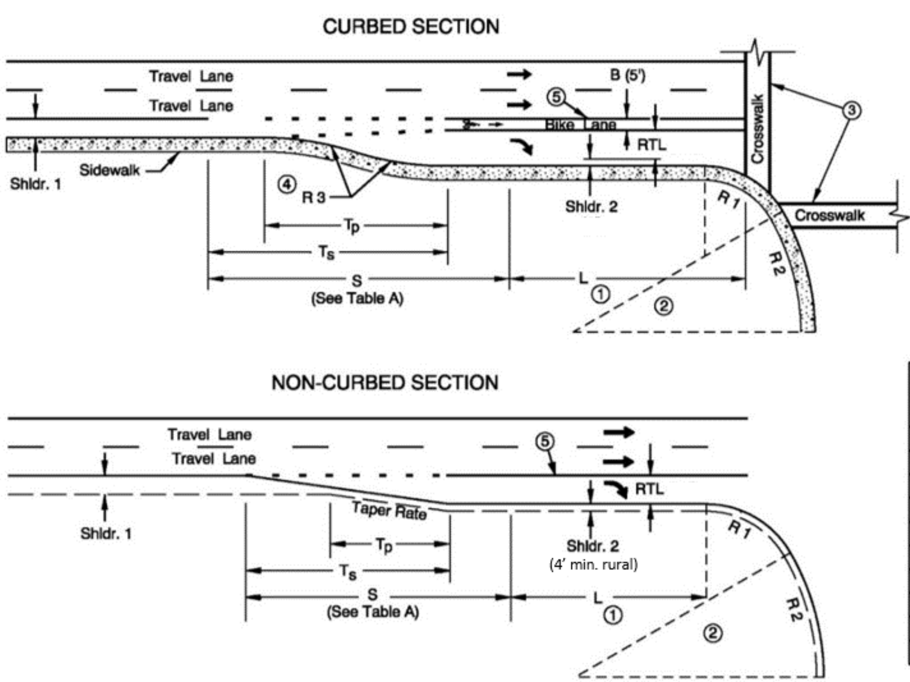
# 506.6 Shoulder Widths

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

To be used in locations where a traffic investigation has determined a right turn lane to be warranted.




① Minimum Storage Length 'L'
Unsignalized:
Provide 50' minimum beyond end of '$T_S$' distance.
Signalized:
Determined by traffic study.

② Compound radii accomodate large design vehicles, yet minimize pedestrian crossing distance. See discussion on accommodating vs designing for the design vehicle under Turning Radii in this chapter.

③ See Traffic Section for placement of crosswalk.

④ R 3 for reversing curves used only in curbed sections.

⑤ Through bike lane is generally constructed and striped in sections with a posted speed of 45 mph or less, even where there is no approaching shoulder or bike lane. See Oregon Bicycle and Pedestrian Design guide.

**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 |

DESIGN EQUATIONS AND VARIABLES

S = Deceleration distance for initial speed

$T_P$ = Pavement or Curb Taper Length = Taper Rate x [(B + RTL) + (Shldr. 2 - Shldr. 1)]

$T_S$ = Striping Taper Length = Taper Rate x (B + RTL)

R 3 = Reversing Curve Radius

$$= T_P \times \frac{\text{Taper Rate} + \frac{1}{\text{Taper Rate}}}{4}$$

B = Bicycle Lane Width (5' typ.)

RTL = Right Turn Lane Width (12' typ.)

DESIGN PROCEDURE

1. Decide on values for 'B', 'RTL', 'Shldr.1' and 'Shldr.2'
2. Determine 'S' from Table A
3. Calculate '$T_S$'
4. Determine 'L' (see note 1). For unsignalized intersections, check to see that $S - T_S \geq 50'$. If so, L = 0. If not, L = 50 - (S - $T_S$).
5. Calculate '$T_P$' for layout of curb or edge of pavement

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RIGHT TURN CHANNELIZATION

HIGHWAY DESIGN MANUAL

# 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 superelevation 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 500-28 shows an intersection with excessive skew and the intersection reconfigured to improve skew. Figure 500-29 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.

Highway speeds are low, generally 35 mph or less;

Volumes on both the highway and intersecting roadway are low (at or below left or right turn channelization warrant limits);

Large vehicle turning movements are minimal;

Intersecting roadway has a functional classification of minor collector or below, and

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, Chapter 9 for possible alignment solutions to skewed intersections. Chapter 9, Figure 9-18, page 9-59 provides information on sight triangles as 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. When designing with tighter radii, it is important to evaluate the impacts of large vehicle off-tracking. Off-tracking should not occur over pedestrian ramps or sidewalks or impact signal or utility pole installations.

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.

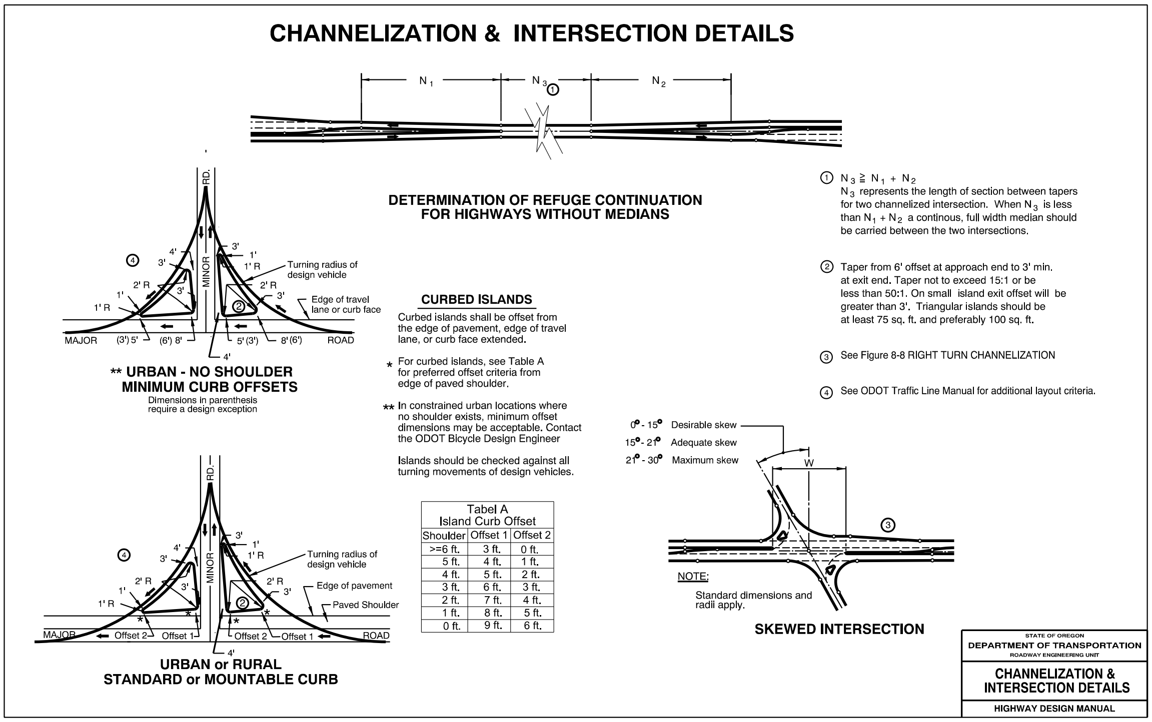
Designers are encouraged to keep the size of intersections to a minimum. Often when accommodating large trucks, the intersection radii become very large. This can substantially increase the size of the intersection. Larger intersections generally have greater accident potential, are difficult to delineate, 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 section, 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. Figure 500-19 provides an equation to avoid an hour glass.

Figure 500-19: Channelization and Intersection Details




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 in 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 500-20. 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 500-20 depicts the standard left turn channelization design. Figure 500-21 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;

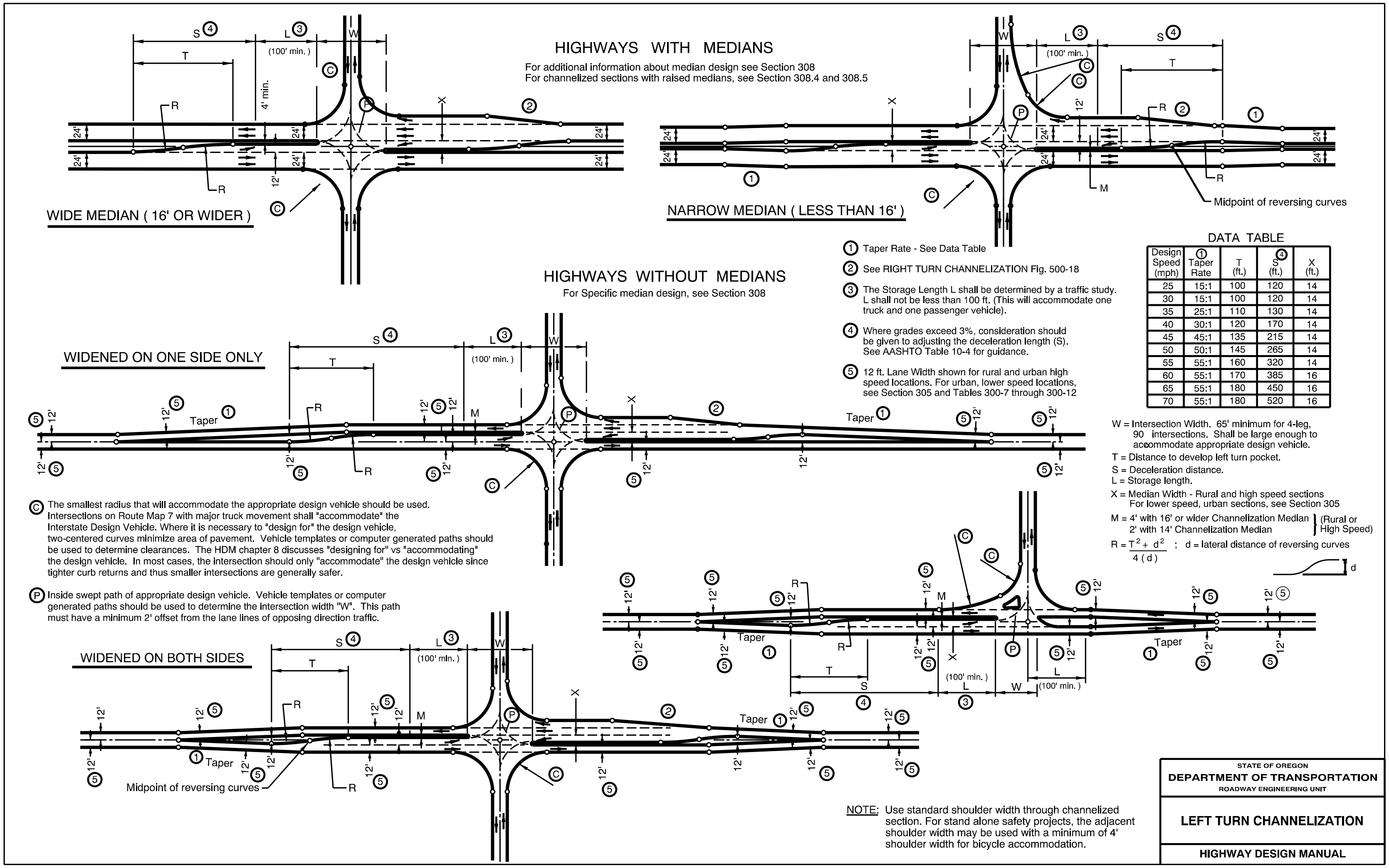
All left turn lanes developed from sections without medians or with narrow medians, and

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.

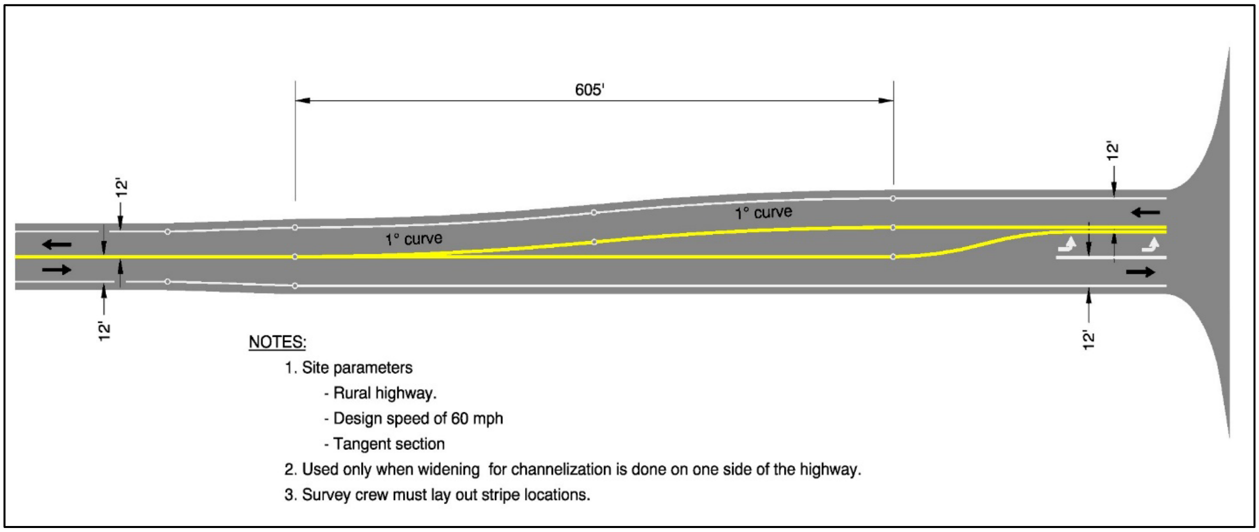
In some instances, dual left turn lanes may need to be considered. When designing dual left turn lanes, there must be dual receiving lanes on the connecting roadway with adequate length downstream prior to any merge points. The designer must determine the appropriate design vehicles to use for side-by-side 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 500-20: Left-Turn Channelization




| Design Speed (mph) | ① Taper Rate | T (ft.) | ④ S (ft.) | X (ft.) |
|---|---|---|---|---|
| 25 | 15:1 | 100 | 120 | 14 |
| 30 | 15:1 | 100 | 120 | 14 |
| 35 | 25:1 | 110 | 130 | 14 |
| 40 | 30:1 | 120 | 170 | 14 |
| 45 | 45:1 | 135 | 215 | 14 |
| 50 | 50:1 | 145 | 265 | 14 |
| 55 | 55:1 | 160 | 320 | 14 |
| 60 | 55:1 | 170 | 385 | 16 |
| 65 | 55:1 | 180 | 450 | 16 |
| 70 | 55:1 | 180 | 520 | 16 |

Figure 500-21: Reversing Curve Option for Left-Turn Channelization – Rural Highway




# 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. For urban locations, the dimensions in Figure 500-18 may be modified. 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 may be available.

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. In urban locations, narrower than preferred right turn lanes may be appropriate. 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 at interchanges. 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 500-22 “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 500-22: Right Turn Acceleration Lane from at Grade Intersection

## RIGHT TURN ACCELERATION LANE FROM AT GRADE INTERSECTION

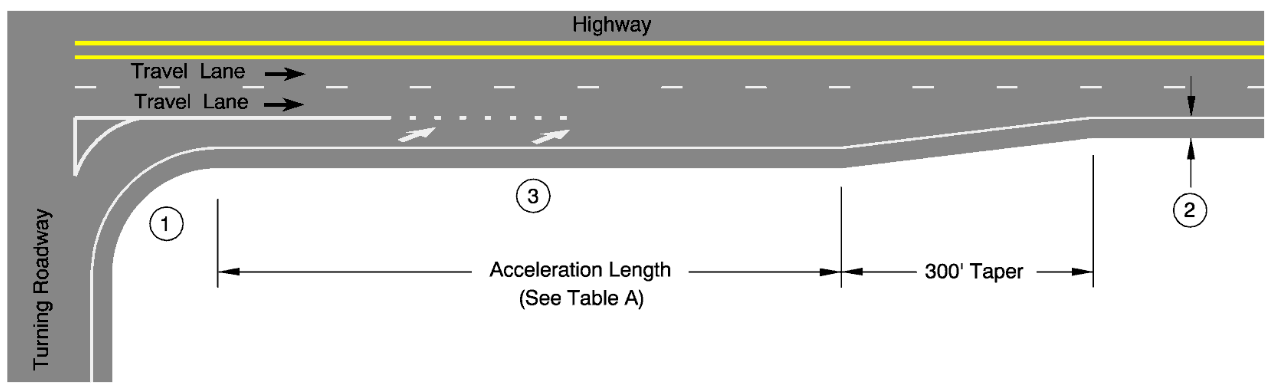



**TABLE A**
**MINIMUM ACCELERATION LENGTH**

| Design Speed of Highway (mph) | Design Speed of Turning Roadway | |
|---|---|---|
| | Stop Condition | 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.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

RIGHT TURN ACCELERATION LANE FROM AT GRADE INTERSECTION

HIGHWAY DESIGN MANUAL

# 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 500-23 and Figure 500-24 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 500-23 and Figure 500-24
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 |

Note: 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.

$$V_f^2 = V_i^2 + 2AS$$

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 500-23: Median Acceleration Lane - Narrow Median

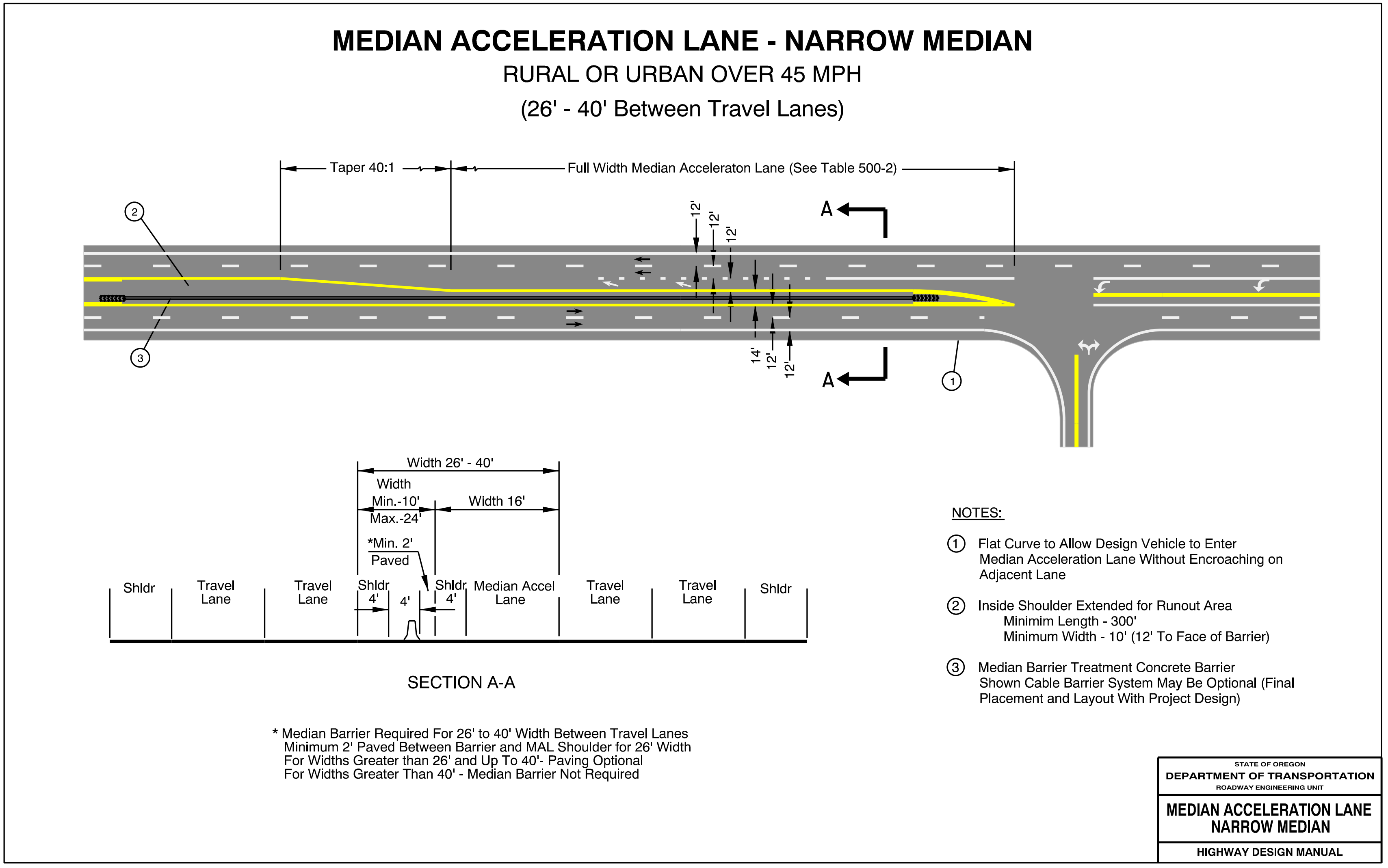
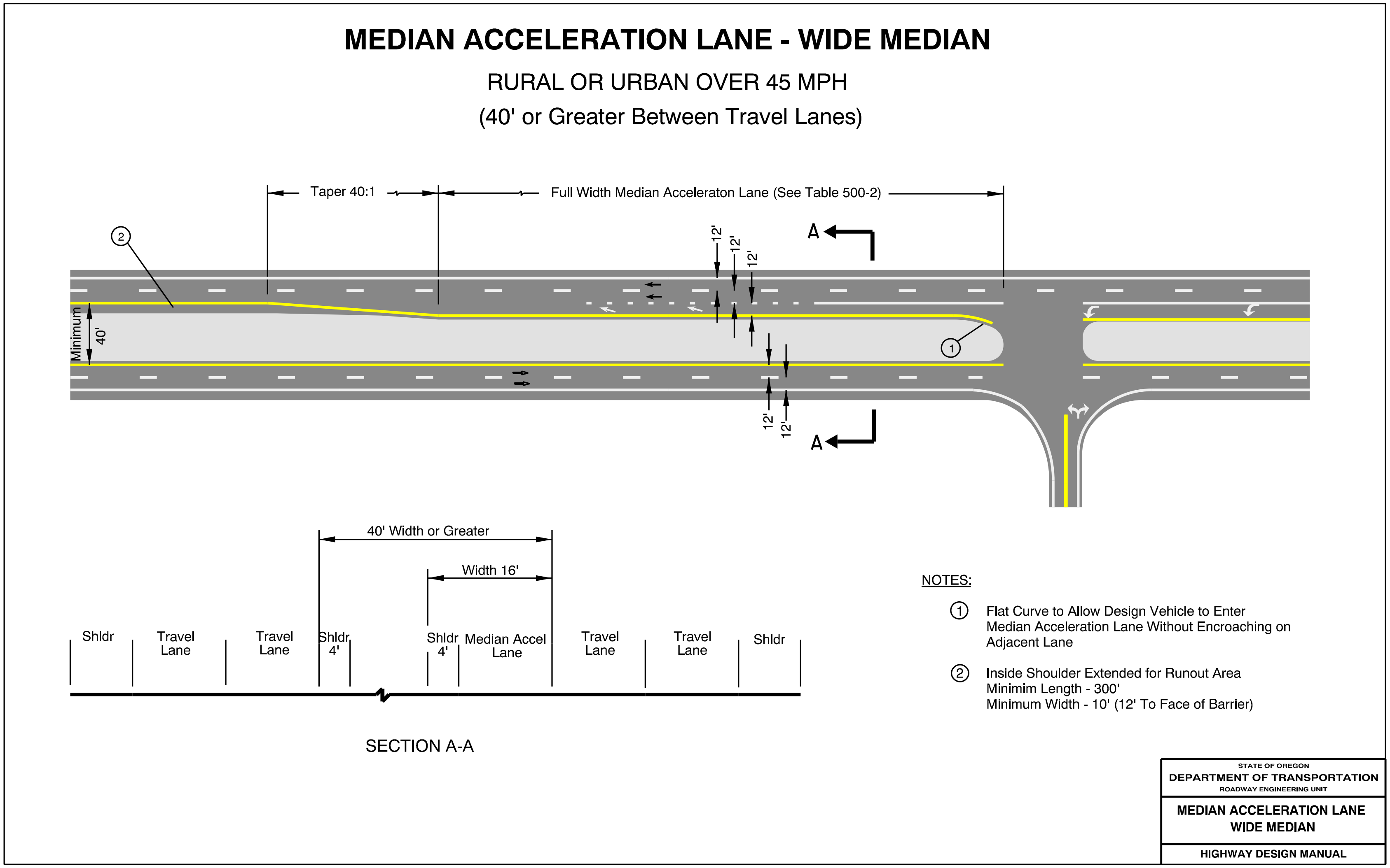


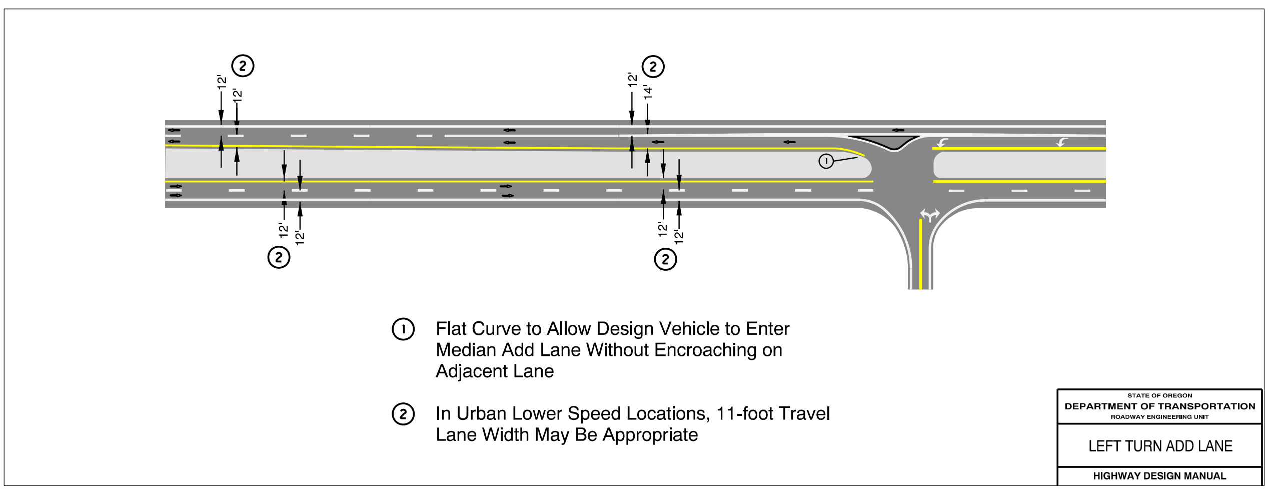
Figure 500-24: Median Acceleration Lane - Wide Median



# 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 500-25 illustrates a left turn add lane configuration.

Figure 500-25: Left Turn Add Lane



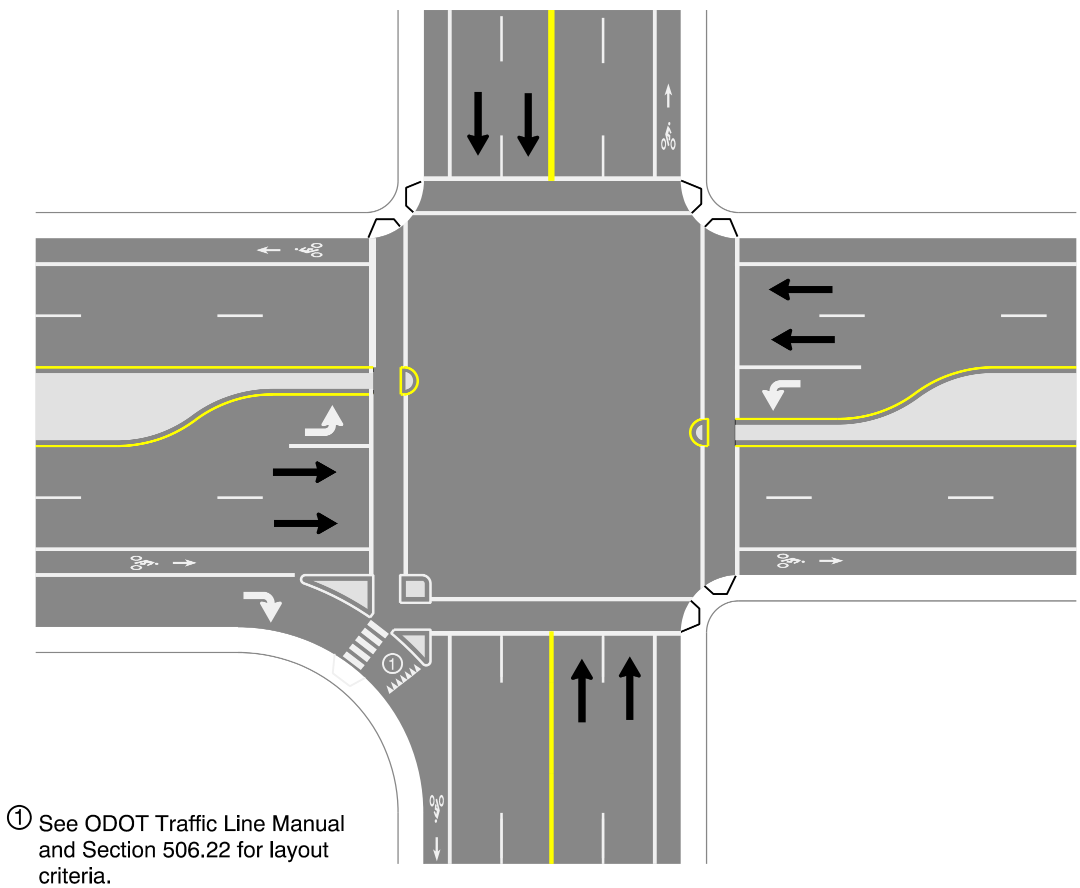

# 506.16 Channelization Islands

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 this section (Section 506.16) provides additional guidance on channelization islands for bicyclists and pedestrians). Channelization islands should be designed in conformance with Figure 500-26 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 500-33 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 500-26: 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.

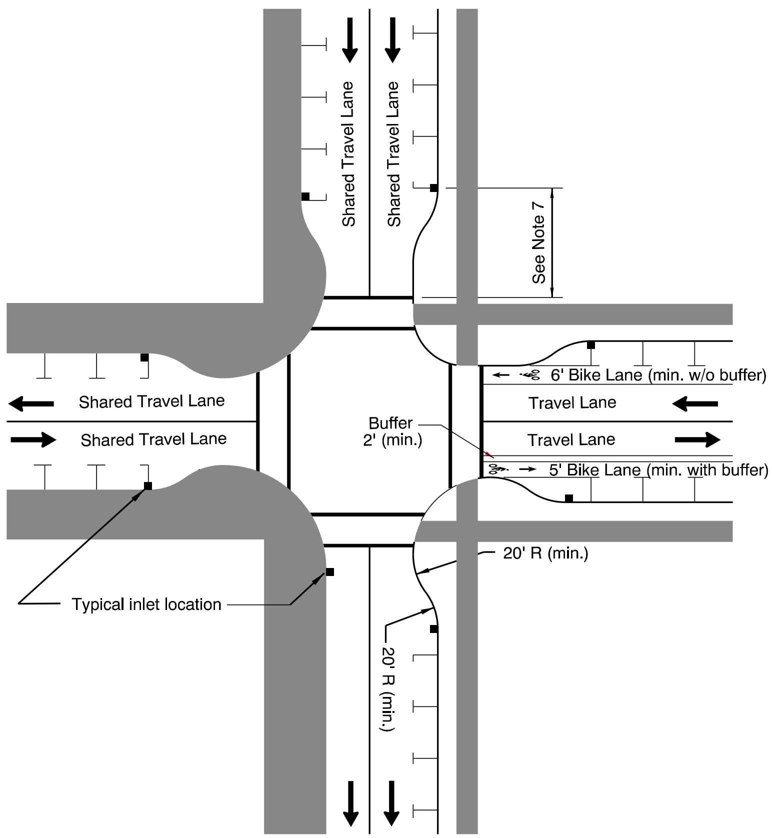
The curb extensions still must be designed to accommodate the appropriate design vehicle. However, due to the speed, traffic characteristics, and importance of alternative modes in these areas, the level of accommodation of large vehicles is expected to be minimal. Curb extension design at proposed locations 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 500-27 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 curb 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 500-27: 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
8. For bicycle facility selection, see Part 800
9. For lane width options, see Part 300

| |
|---|
| STATE OF OREGON<br>DEPARTMENT OF TRANSPORTATION<br>ROADWAY ENGINEERING UNIT |
| CURB EXTENSIONS |
| HIGHWAY DESIGN MANUAL |

# 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. While some of these area addressed in the sections of this Part, Part 500, see Part

800 for greater information about pedestrian design for intersections. The ODOT Traffic Manual is another available resource to roadway designers. Traffic control options for intersections are covered by the ODOT Traffic Section. Coordinate with the Region Traffic Section and the Statewide Project Delivery, Traffic Section staff.

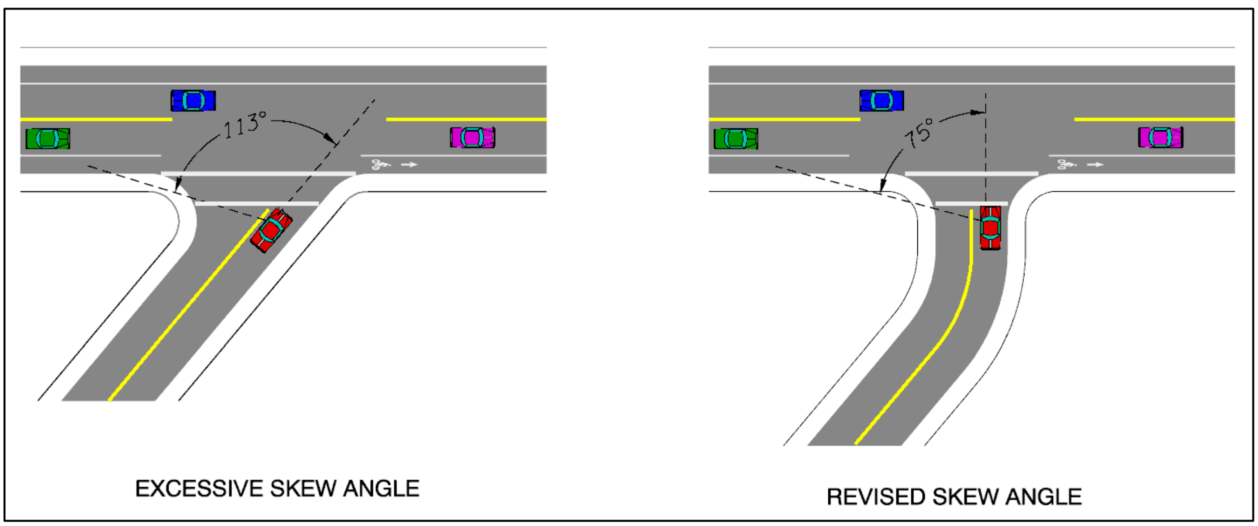
# 506.20 Excessive Skews

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 500-28 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 500-28: 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:

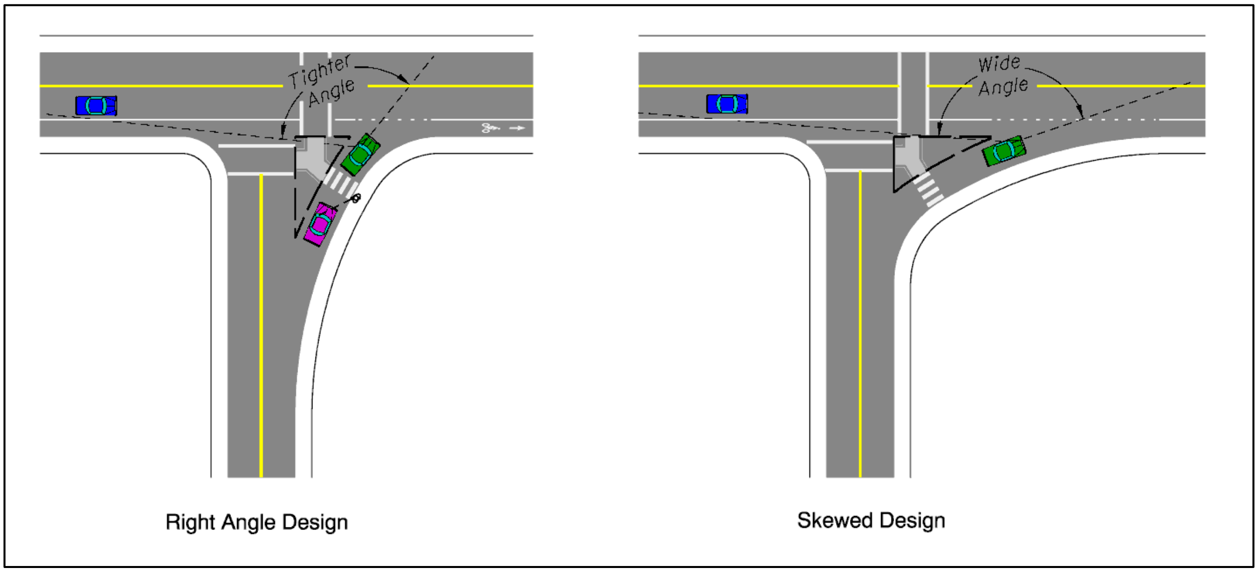
1. Narrow the cross-section;
2. Provide curb-extensions on streets with parking;
3. Reduce the skew of the intersecting street, and
4. Minimize curb radius.

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 500-29 shows an example of a reconfigured right angle design and a 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 500-29: Island Geometry (Right Turn Bypass)




# 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 a potentially higher speed, and
3. They make it very difficult to line up the sidewalks, crosswalks and curb ramps.

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, minimizing impacts to pedestrians and bicyclists.

# 506.24 Crosswalk and Ramp Placement

Crosswalk and curb 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 pedestrian zone.

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.

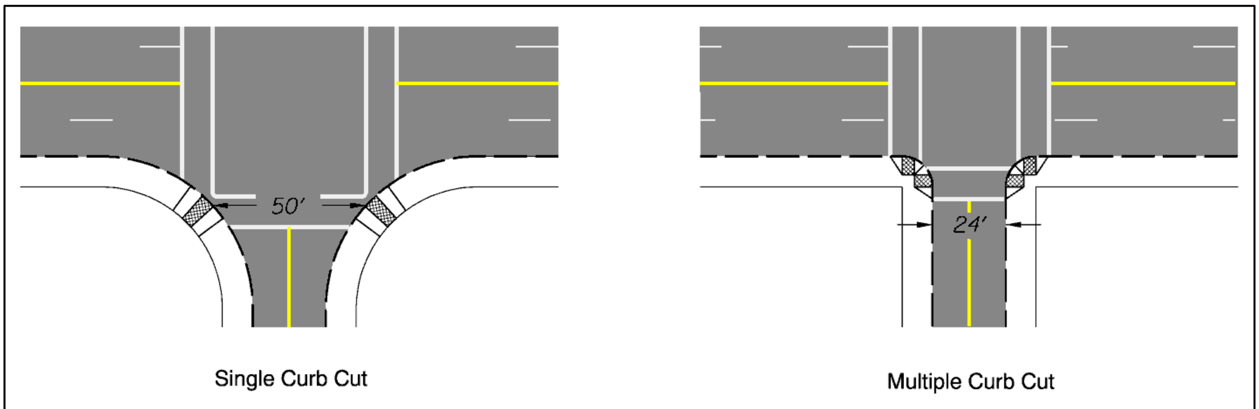
Another consideration is trying to ensure that sidewalks are separated with a buffer strip. This has two advantages: the extra separation will place the sidewalks between the offset crosswalk and the curb-tight crosswalk described above, and a curb ramp traced through the buffer strip will more effectively 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 curb 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 500-30 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 500-30 are for illustrative purposes for discussion about curb ramp number and placement. Actual curb 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 curb 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 500-30: Crosswalk Ramp Placement




# 506.26 Signal Pole Placement

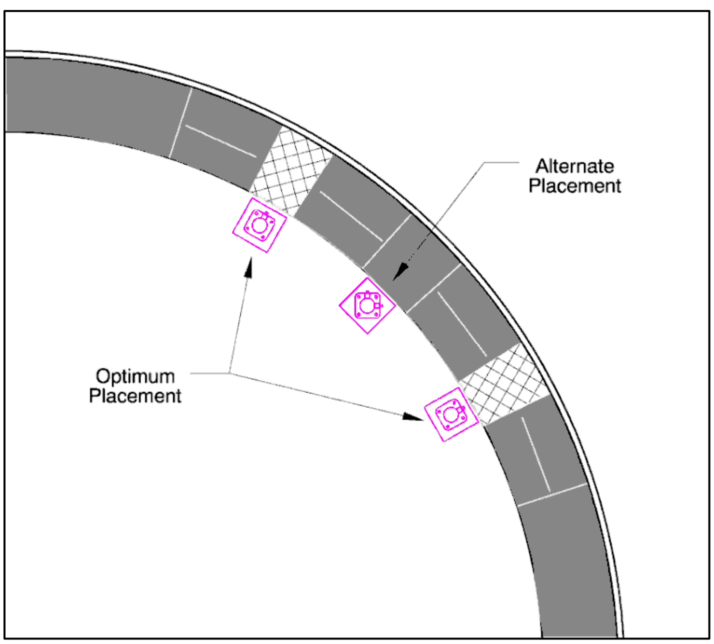
Signal poles must be placed in a location where they do not interfere with pedestrians' path of travel. But, they must be placed in a manner that all pedestrians are able to conveniently reach the signal control push-buttons. There are special placement criteria for accessibility that must be followed 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 4.5 foot by 5.5 foot long level area between the pole and the back of sidewalk. Under no circumstances shall poles be placed in a curb ramp run for new construction. Figure 500-31 provides a general example of signal pole placement with parallel style curb 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 500-31: 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

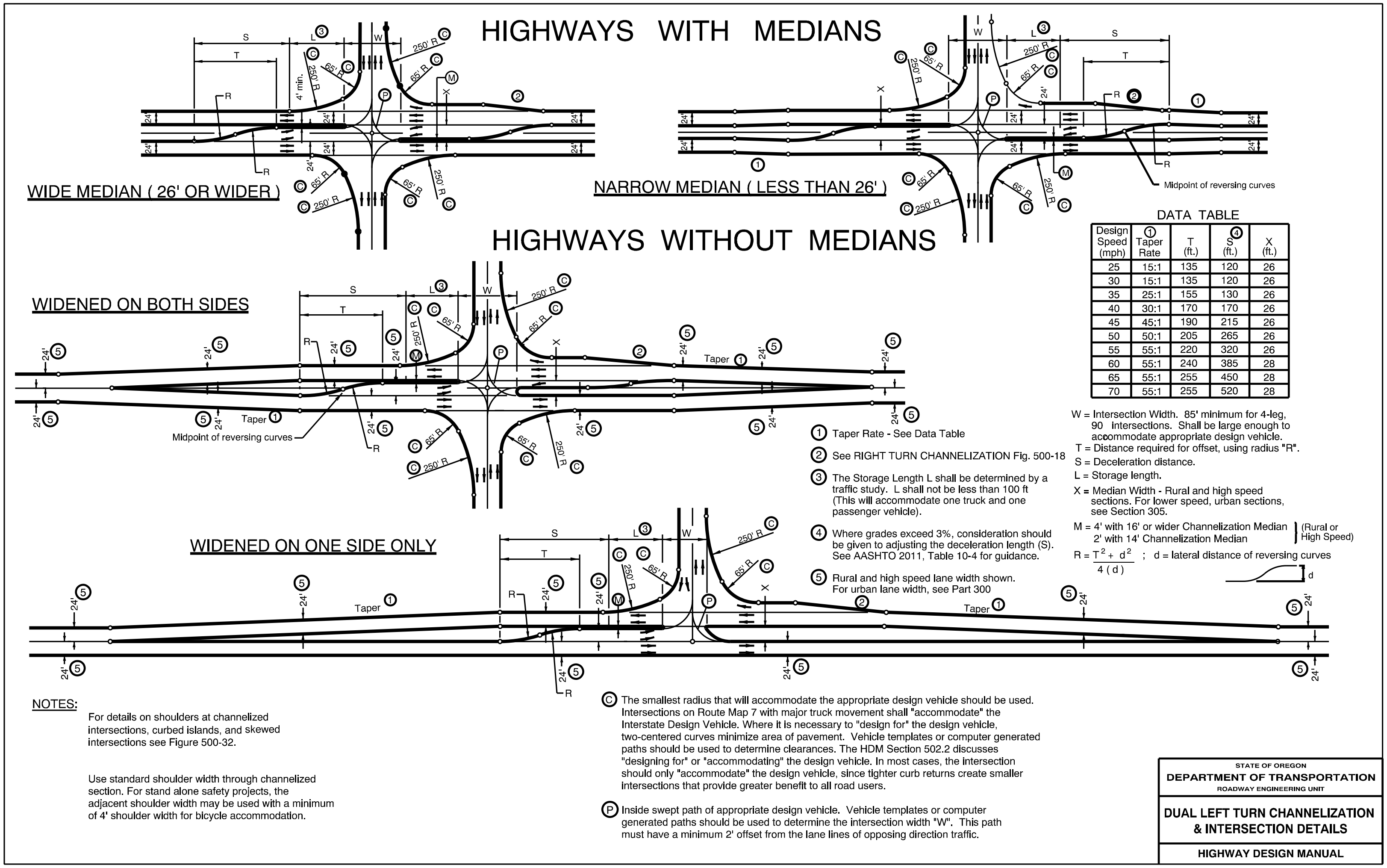
Signalized intersection design will need to consider the following issues in addition to the design standards for general intersection design that were discussed in Section 506. Specific roadway design items of interest at signalized intersections include left turn lanes, right turn lanes, bicycle accommodation 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 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, 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 500-32. Consult the Region Traffic Section when considering the design of a dual left turn lane as well. Figure 500-33 illustrates channelization, island and intersection details.

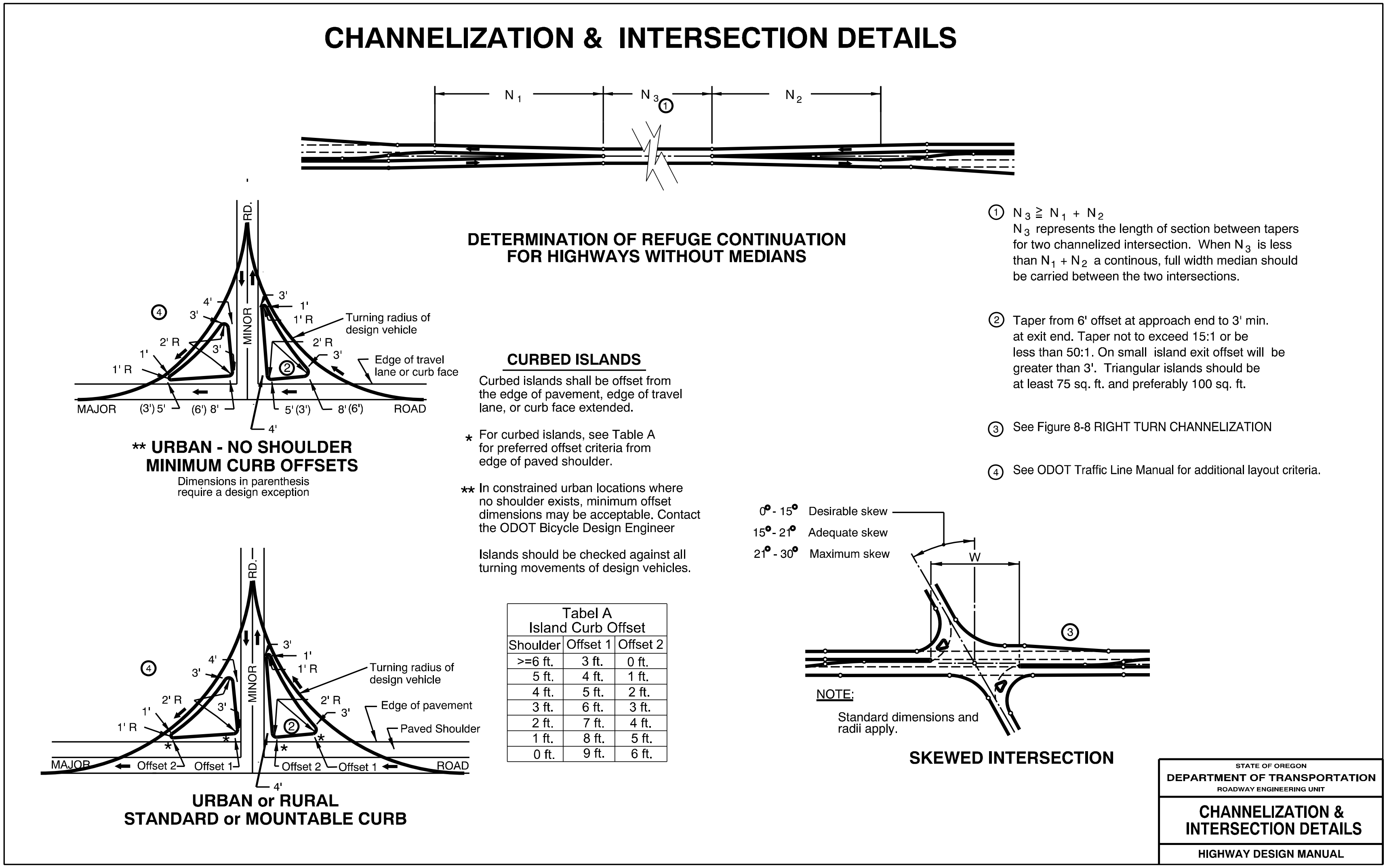
Figure 500-32: Dual Left Turn Channelization




DATA TABLE

| 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 |

Figure 500-33: Channelization Island & Intersection Details




Tabel A
Island Curb Offset

| Shoulder | Offset 1 | Offset 2 |
|---|---|---|
| >=6 ft. | 3 ft. | 0 ft. |
| 5 ft. | 4 ft. | 1 ft. |
| 4 ft. | 5 ft. | 2 ft. |
| 3 ft. | 6 ft. | 3 ft. |
| 2 ft. | 7 ft. | 4 ft. |
| 1 ft. | 8 ft. | 5 ft. |
| 0 ft. | 9 ft. | 6 ft. |

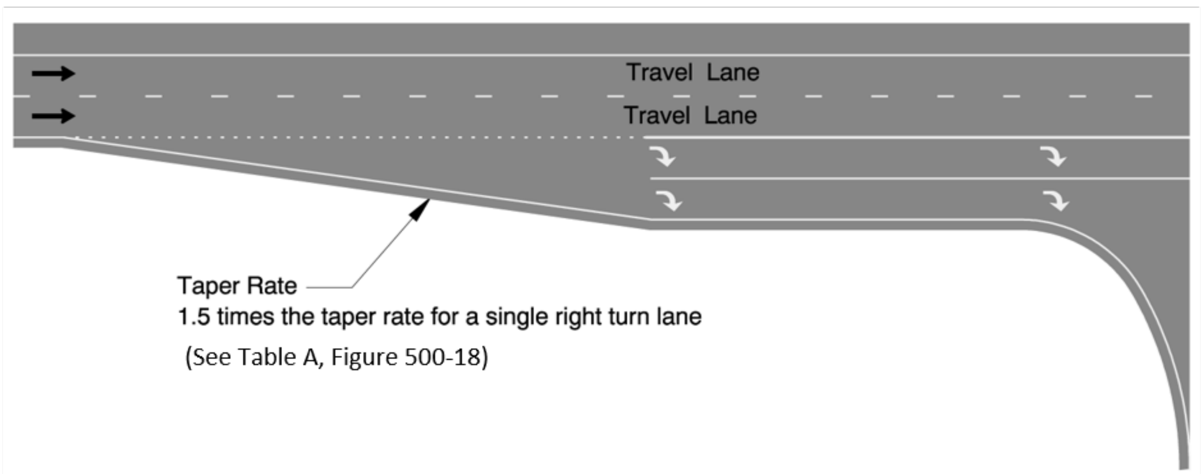
# 507.2 Right Turn Lanes

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 500-34. 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 500-34: 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

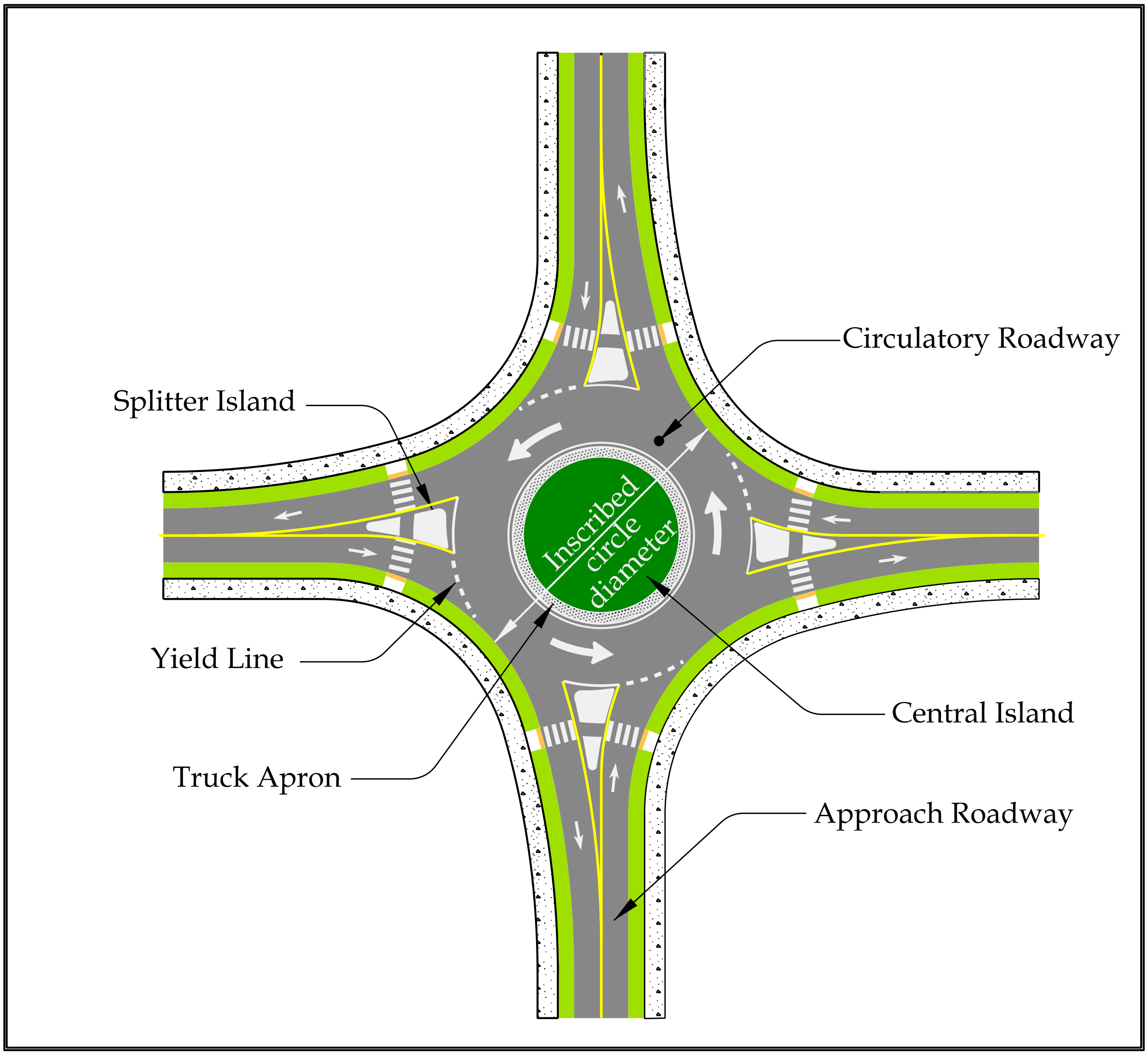
## 509.1 General

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 500-35 details several major roundabout elements.

Figure 500-35: Elements of a Modern Roundabout




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.

## 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 500-35 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 pavement markings 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
        i. how the requirements of Highway Division Directive DES 02 have been net, or
        ii. How the OAR 731-012 process (Reduction of Vehicle Carrying Capacity) has been met.
    c. Identified deviations from design standards where design exceptions might be needed.
    d. Roundabout geometric data, including:
        - Approach, 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 (AutoTurn) paths showing design vehicle and largest oversize vehicle movements (The Highway Division Directive DES 02 process 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.

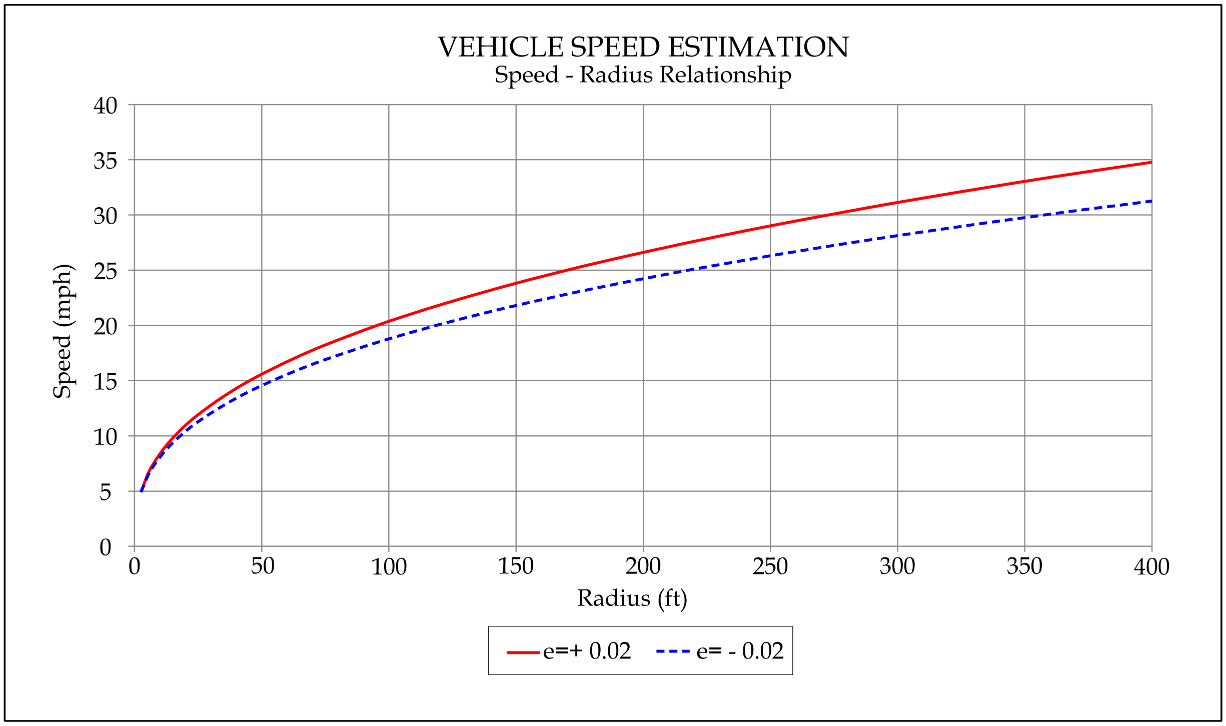
When designing a roundabout on the state highway system, the designer:

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 and 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 500-36: 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 500-36 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 500-36 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;

$$V = \sqrt{15R(e + f}$$

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 500-36 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 to 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: Speed Radius Relationship

$$V = 3.4415R^{0.3861} \quad \text{For e= 2\%} \quad \text{(NCHRP Report 672)}$$

Equation 500-2: Speed Radius Relationship

$$V = 3.4614R^{0.3673} \quad \text{For e= -2\%} \quad \text{(NCHRP Report 672)}$$

Equation 500-3: Speed Radius Relationship

$$V = \sqrt{15R(e+f)} \quad \text{(AASHTO Minimum Radius)}$$

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 500-37 denotes the five critical radii that determine fastest path calculations for a roundabout. Figure 500-38 and Figure 500-39 demonstrate the method and assumptions used to calculate a fastest path through a single lane roundabout and a multi-lane roundabout respectively. 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 500-37: Five Critical Path Radii for Fastest Path Analysis

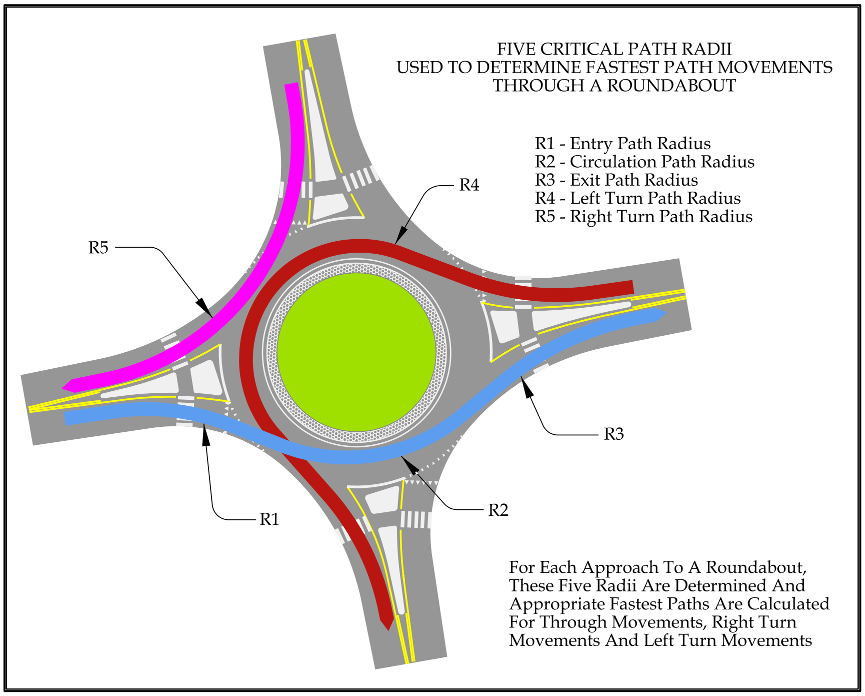



Figure 500-38: Fastest Vehicle Path through a Single Lane Roundabout

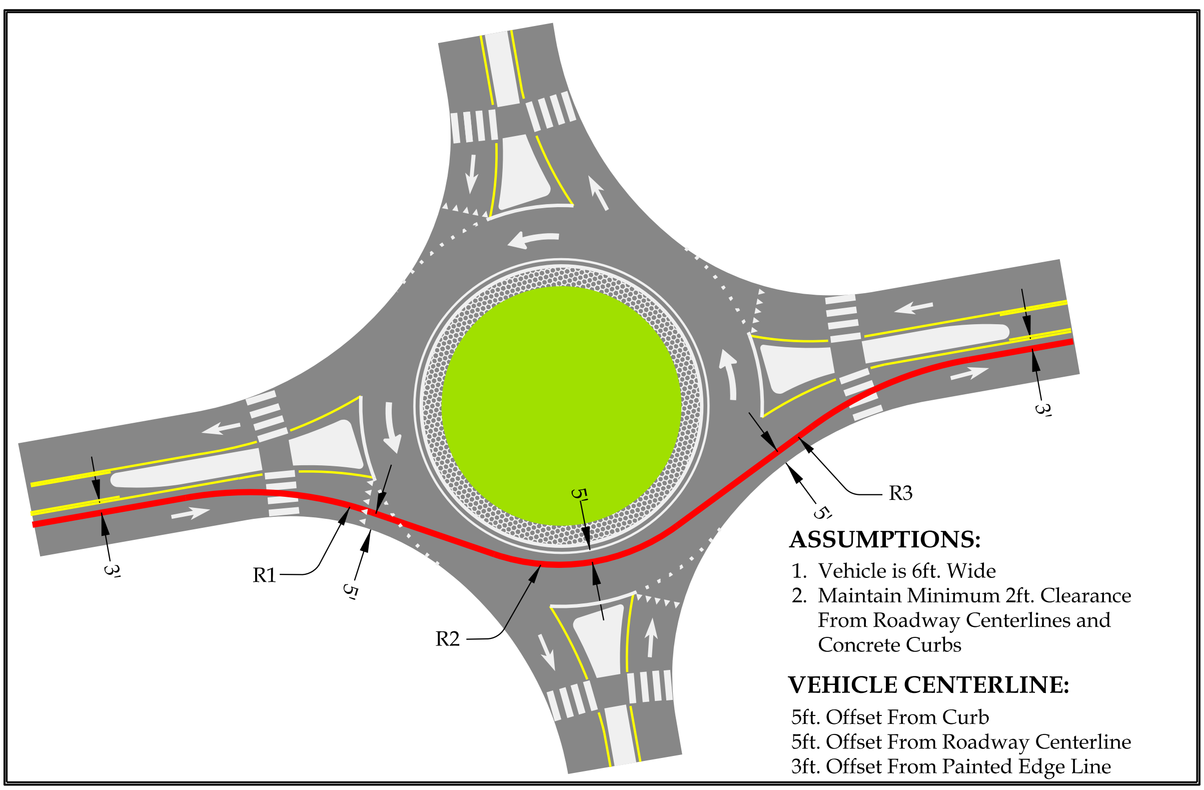
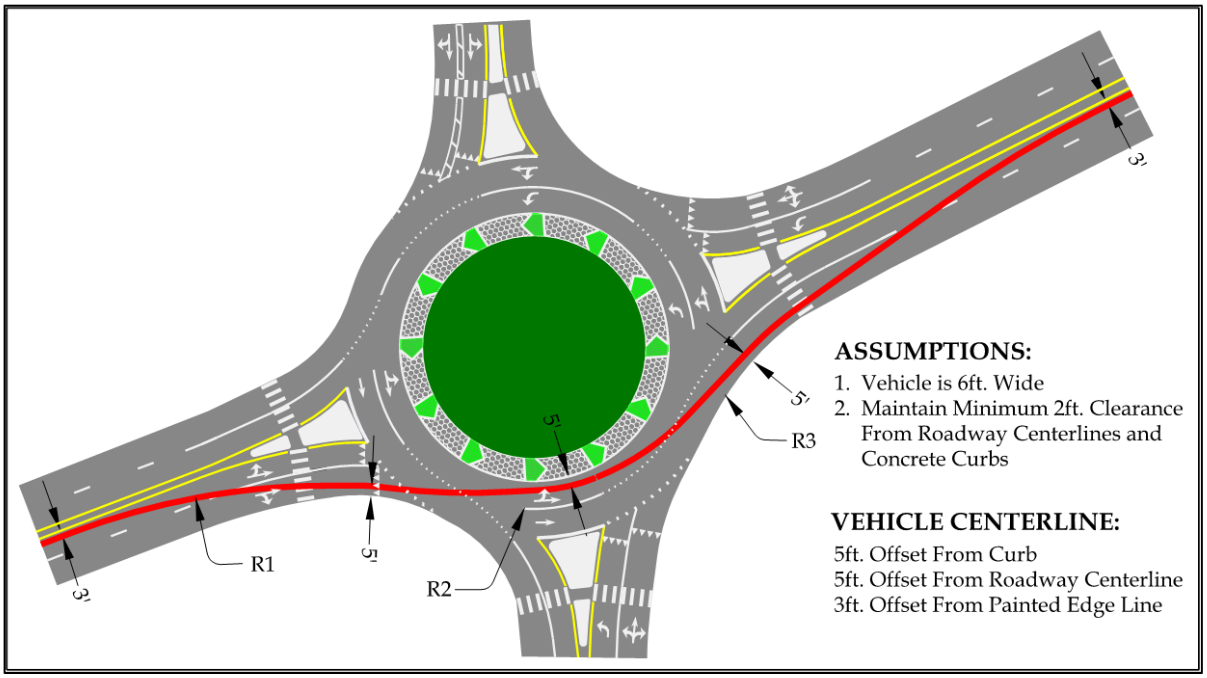


Figure 500-39: Fastest Vehicle Path through a Multi-Lane Roundabout

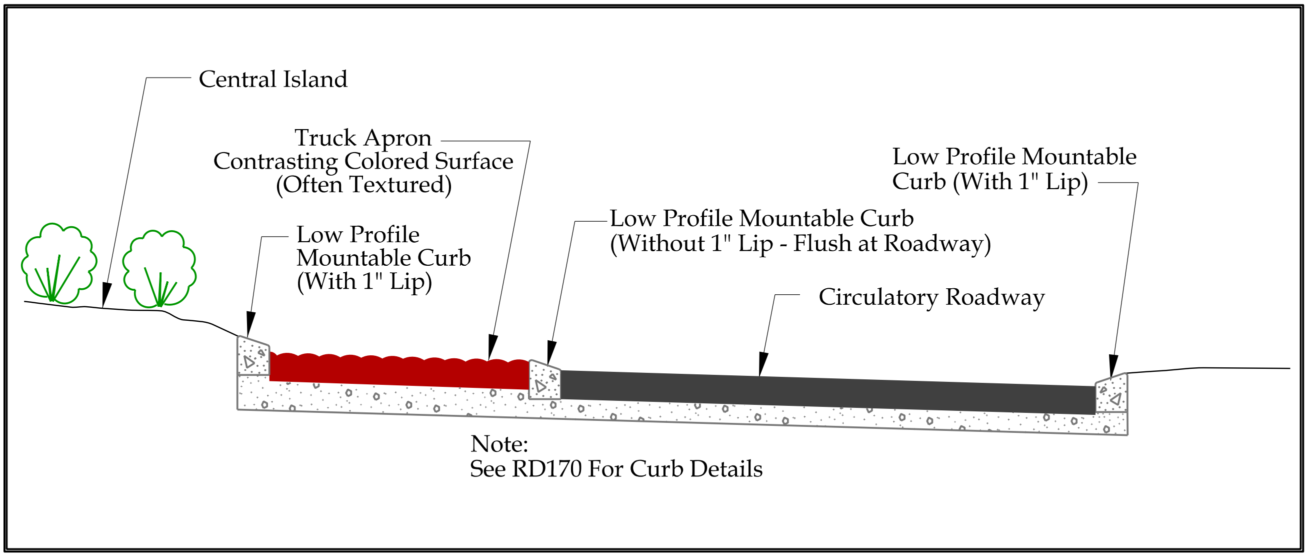



# 509.7 Inscribed Circle and Central Island

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 500-40 shows a typical cross-section of a roundabout including the basic elements of the truck apron, circulating roadway and central island.

Low profile mountable curbing is used for roundabouts on the state highway system. For truck aprons or where it is anticipated that trucks will need to mount the curb to maneuver through a roundabout, the low profile curb is installed without the 1-inch lip at the roadway finish surface. On splitter islands approaching the roundabout, the low profile curb is generally installed with the 1-inch lip at the roadway finish surface. However, if there are locations along the splitter island where it is intended for large or over-sized vehicles to mount the curb in order to traverse the roundabout, the curb can be installed without the lip and flush with the roadway finish surface. See RD170 for curb details at roundabouts on the state highway system.

Figure 500-40: Typical Roundabout Cross-Section Elements




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 good design practice to minimize the circulatory roadway width and provide a more comfortable ride for passengers. However, design each roundabout to fit the location needs and to provide the most appropriate design elements for the traffic stream expected to use it. In the case of mini-roundabouts or compact roundabouts, the central island may need to be mounted by all larger vehicles. 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 with wider circulating lane width would be the exception as a special case 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. For general design parameters on the state highway system, the inscribed circle diameter for a single lane and multi-lane roundabouts accommodating the Interstate Design Vehicle generally follows the inscribed circle diameter of the NCHRP 672. However, for Oregon state highways, ORS 366.215 and OAR 731-012 must be considered and appropriate procedures followed when determining the design inscribed diameter of a roundabout. For roundabouts proposed on a reduction review route, the OAR 731-012 process leads to a record of support and documents collaboration with stakeholders. On non-reduction review routes, the DES-02 process provides agreement of the roundabout being “properly sized”.

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 require design concurrence and/or design exceptions. Contact the Technical Services, Traffic-Roadway Section for guidance.

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 lower speed, urban locations, this may not be a substantial consideration.

Table 500-4: Roundabout Inscribed Diameters

| ROUNDABOUT INSCRIBED DIAMETER | | | | | |
|---|---|---|---|---|---|
| | NCHRP Report 672 | | | ODOT Range | |
| Design Vehicle | **Single Lane | Multi-Lane | | **Single lane | Multi-Lane |
| | | 2-Lane | 3-Lane | | |
| WB-67 | 130 ft. - 180 ft. | 165 ft. – 220 ft. | 220 ft. - 300 ft. | *130 ft. -180 ft. | *175 ft. – 220 ft. |
| WB40/ WB-50 | 90 ft. - 130 ft. | 150 ft. – 220 ft. | 200 ft. - 250 ft. | *95 ft. -130 ft. | *165 ft. – 220 ft. |

* Design Exception Required For Smaller Inscribed Diameters

** Mini-roundabouts are a special case of Single Lane designs and have a general diameter from 45ft. – 90ft.

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. The safety benefits afforded by roundabouts, even small diameter ones, are well documented. Roundabouts should be considered whenever intersection safety improvements are considered. 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.

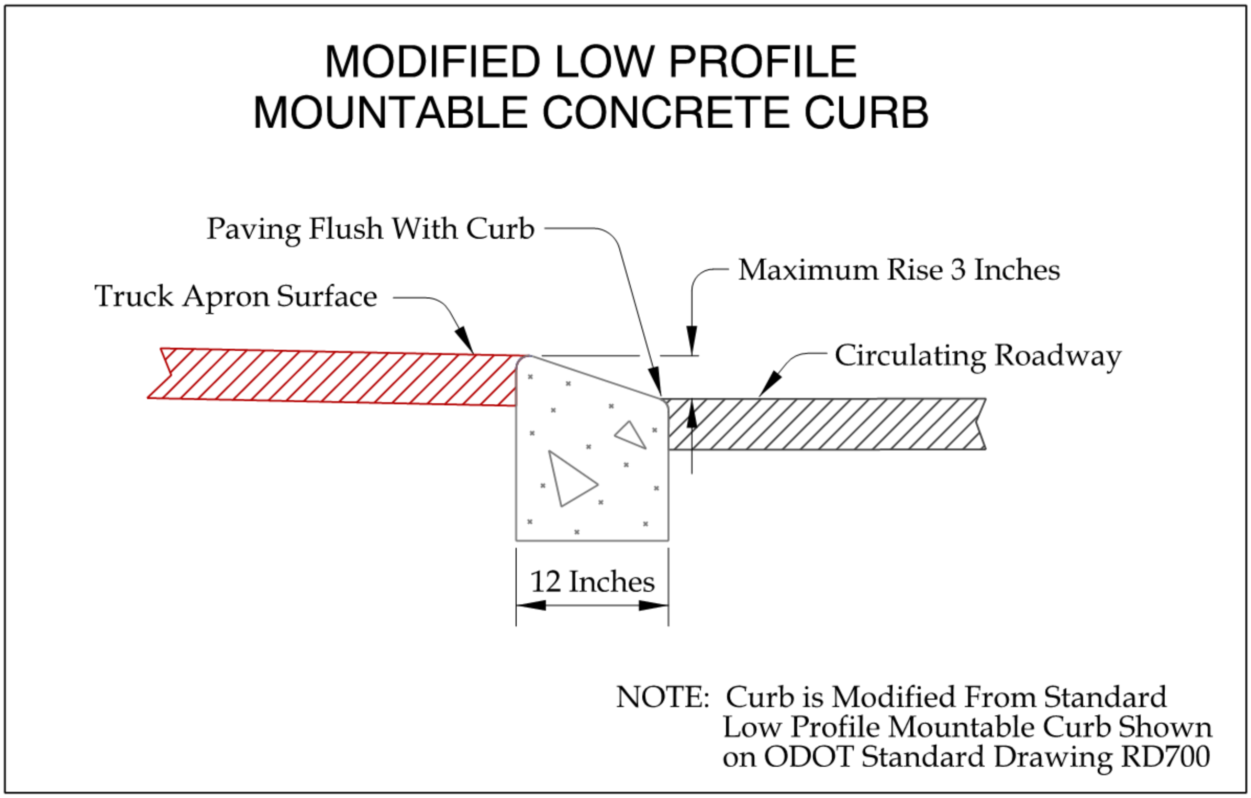
# 509.8 Roundabout Cross Section

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 500-41. For full curb design at roundabouts. (See Standard Drawing RD170.)

Figure 500-41: Truck Apron Modified Low Profile Mountable Concrete Curb



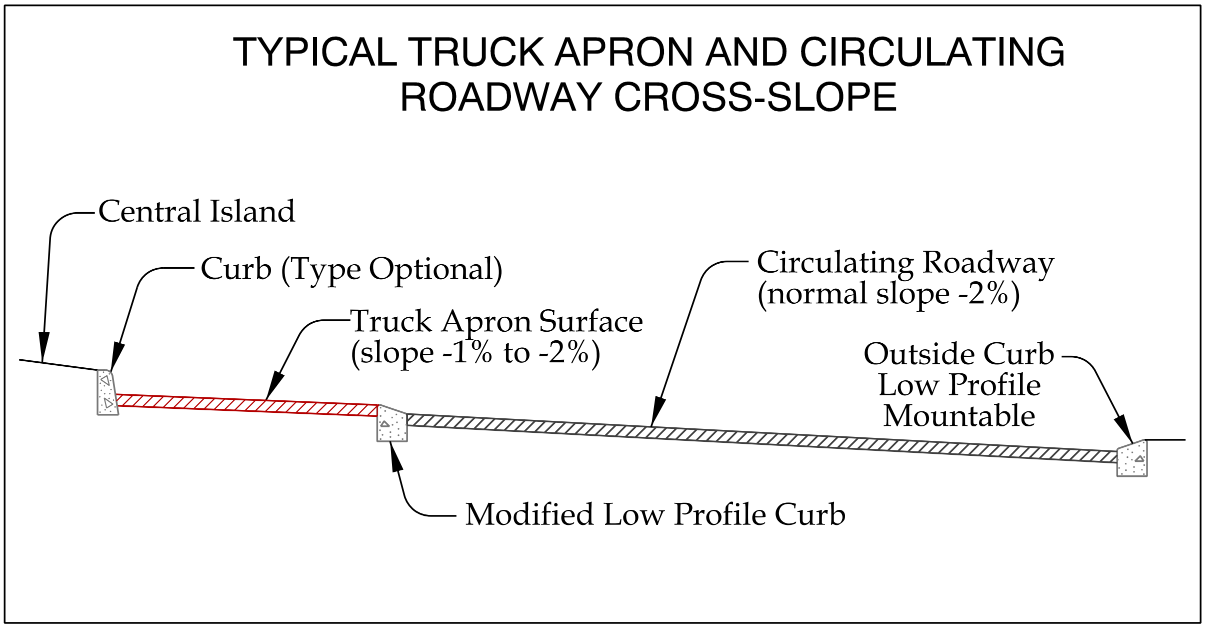

Truck apron width is determined by turning requirements of the design vehicle and other large vehicles being accommodated through the roundabout. Vehicle paths can be simulated using computer software to determine off-tracking needs.

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 500-42 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.

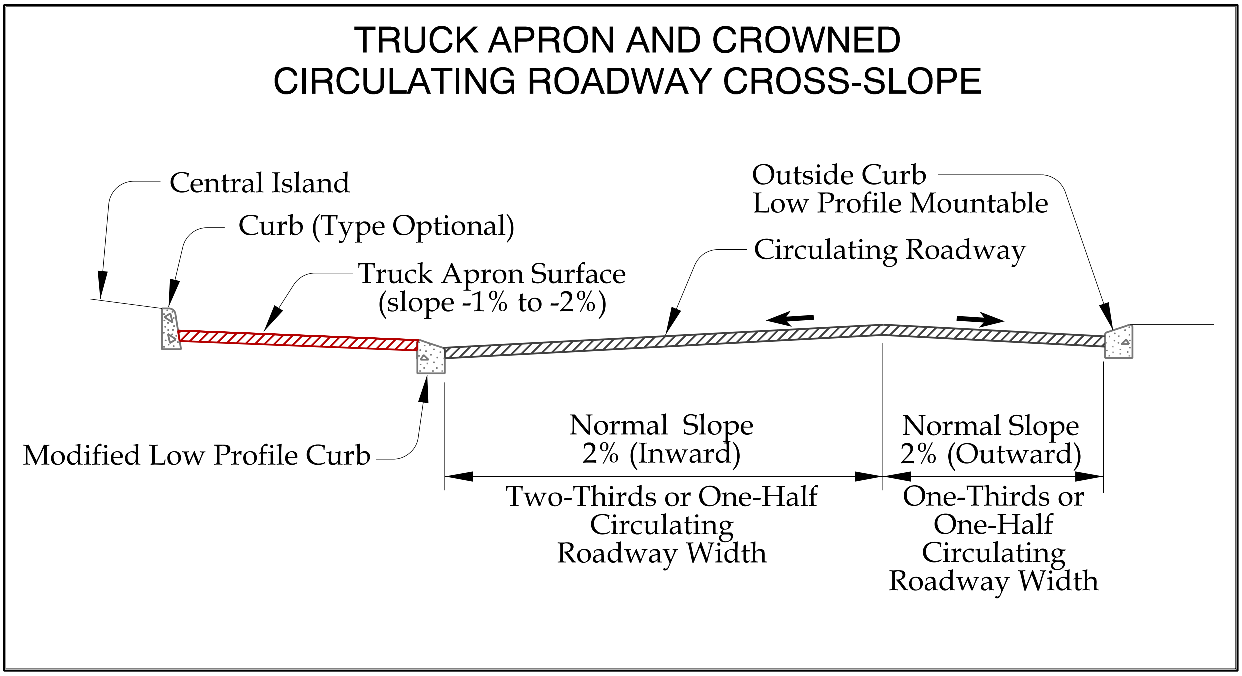
Figure 500-42: Typical Truck Apron and Circulating Roadway Cross-Slope




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 500-43 illustrates the crowned circulating roadway concept.

Figure 500-43: 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:

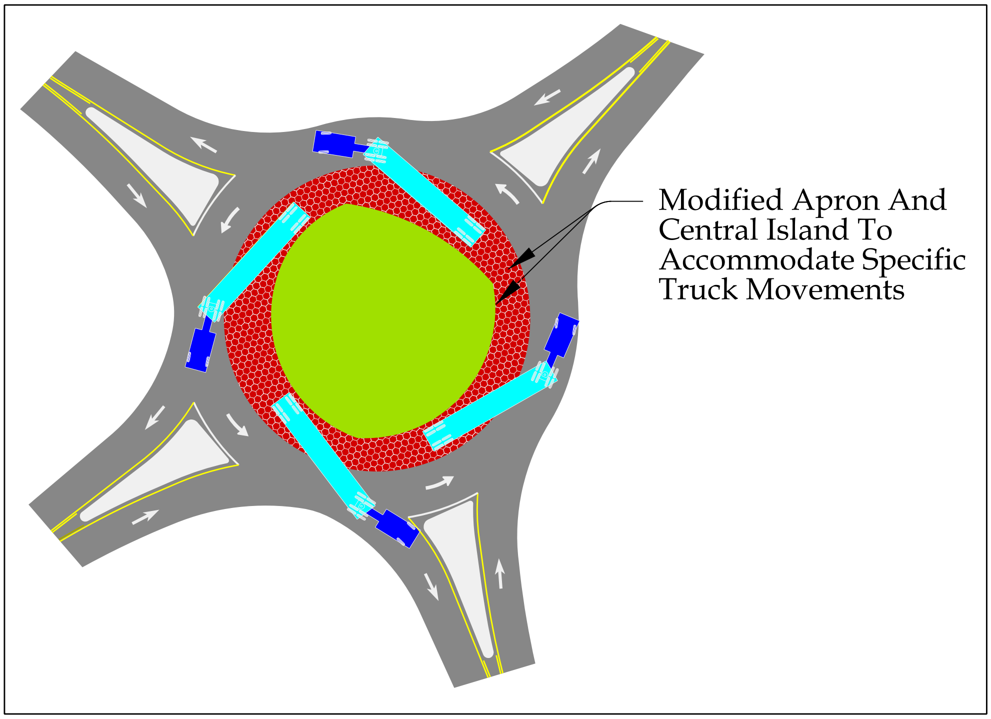
1. More inlets are required to handle the drainage and the drainage system is more complex with the potential for increased maintenance.
2. The crown section introduces a break point in the vehicle path at entrances and exits that must be adequately blended for both comfort and vertical clearance problems
3. Sloping the circulating roadway inward reduces or eliminates the adverse superelevation of the fastest path through the roundabout. This can increase some 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 500-44 illustrates modifying the truck apron and central island to accommodate truck movements.

Figure 500-44: 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.

## 509.9.1 Approach Alignment

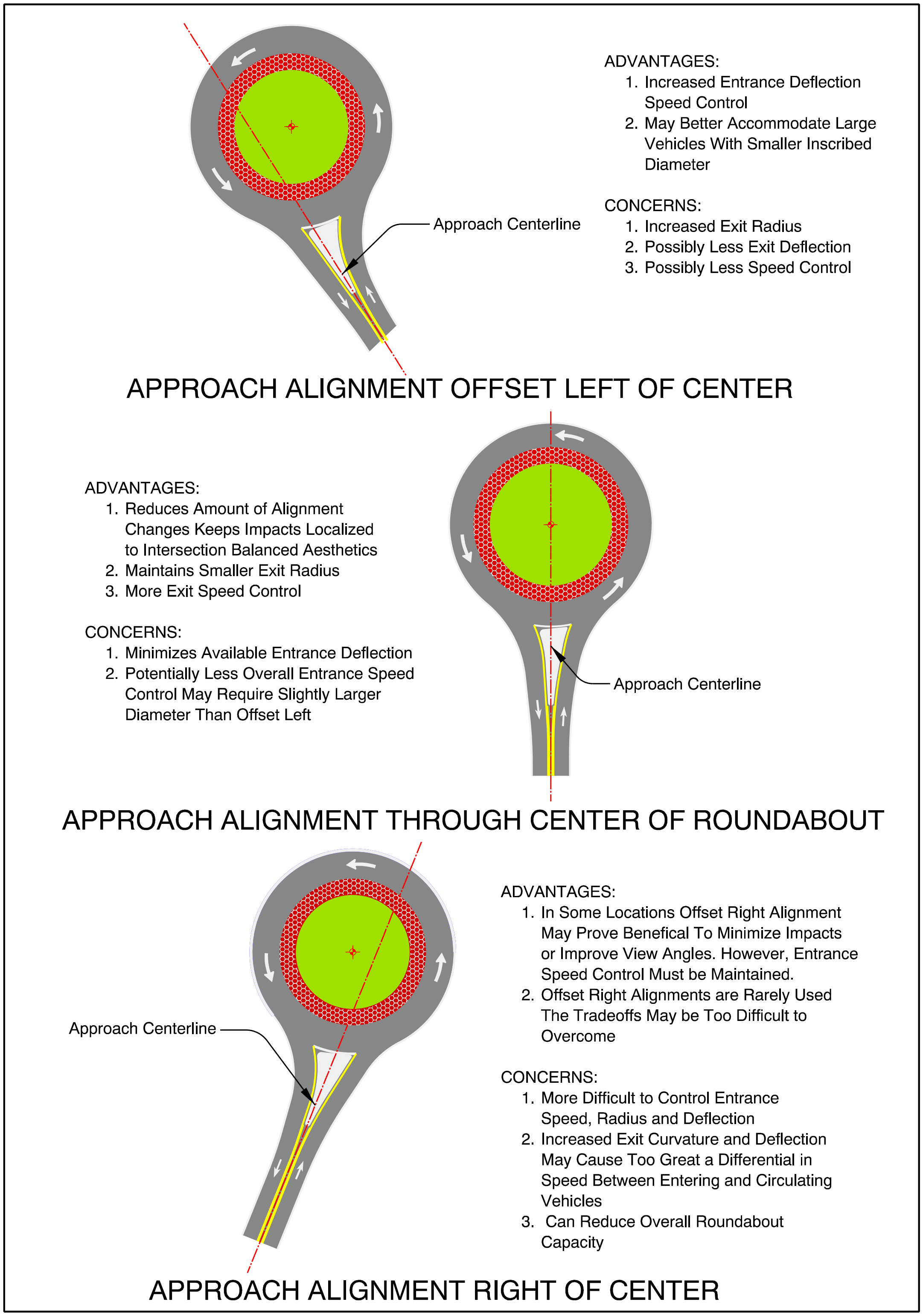
There are three general types of approach alignment. They include:

1. Alignment offset left of center;
2. Alignment with center, and;
3. Alignment offset right of center.

Figure 500-45 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

Figure 500-45: Approach Alignment



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 generally should not be used. The major concern with offset right alignments is speed control on entry. However, there may be a rare location where an offset right alignment might be appropriate. Offset right alignments will require design concurrence through the ODOT Technical Services, Traffic-Roadway Section and the state Traffic-Roadway Engineer.

## 509.9.2 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 500-46 demonstrates difficulties with approach angles too great or too small.

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 500-47 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 500-45 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 500-48 depicts three legged roundabout approach alignment.

Figure 500-46: Angle Between Approaches

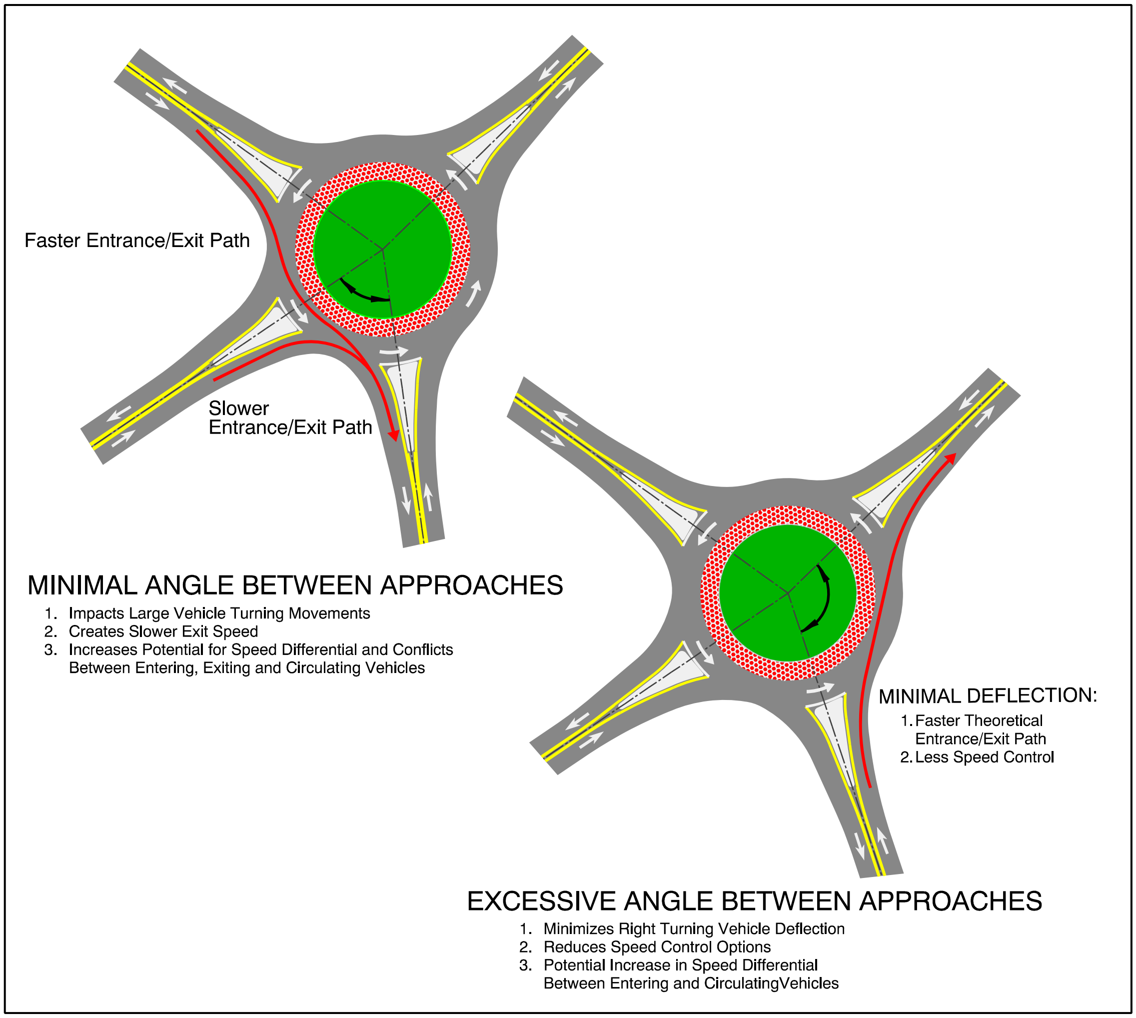


Figure 500-47: Skewed Alignments

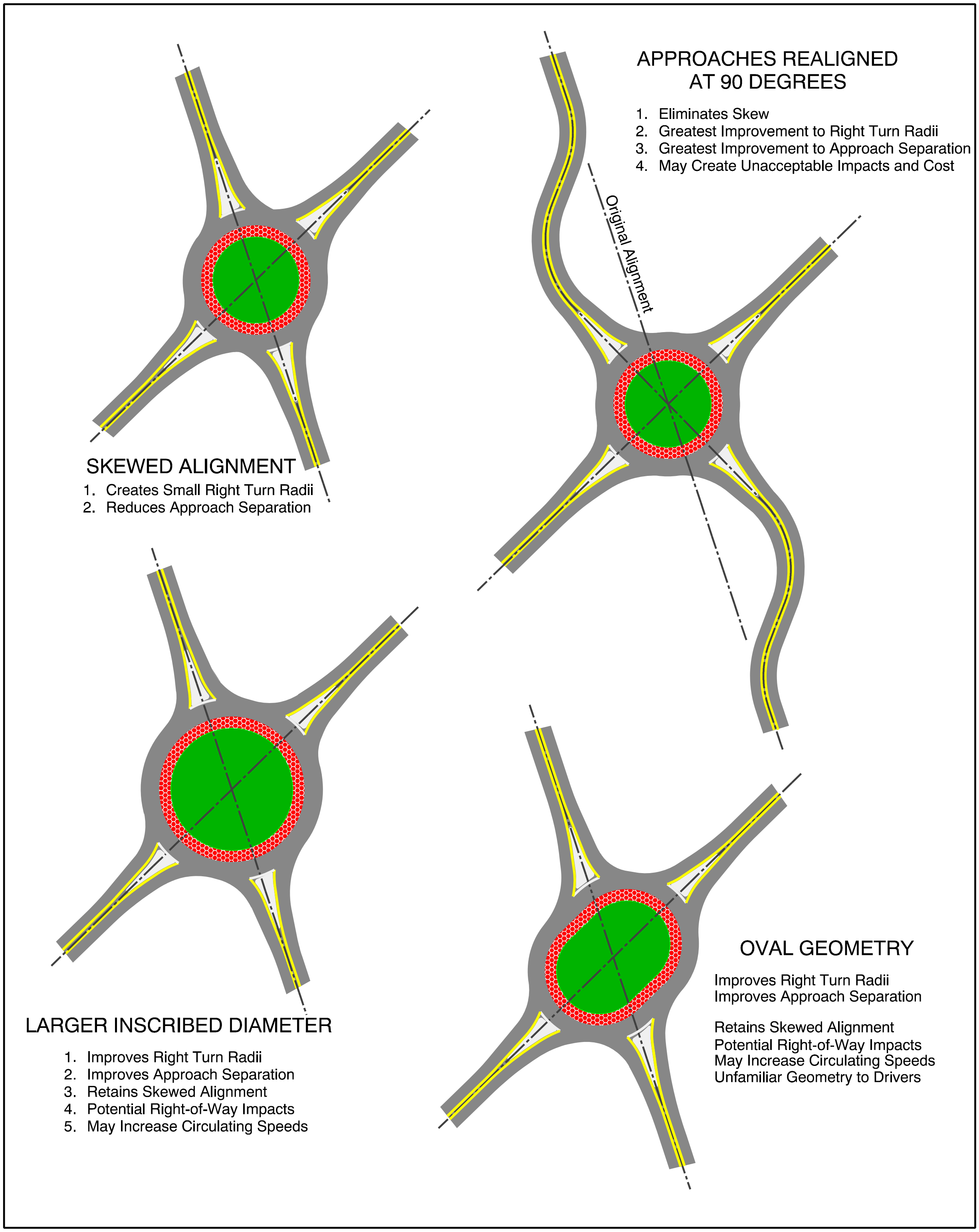


Figure 500-48: Roundabout With Three Approaches

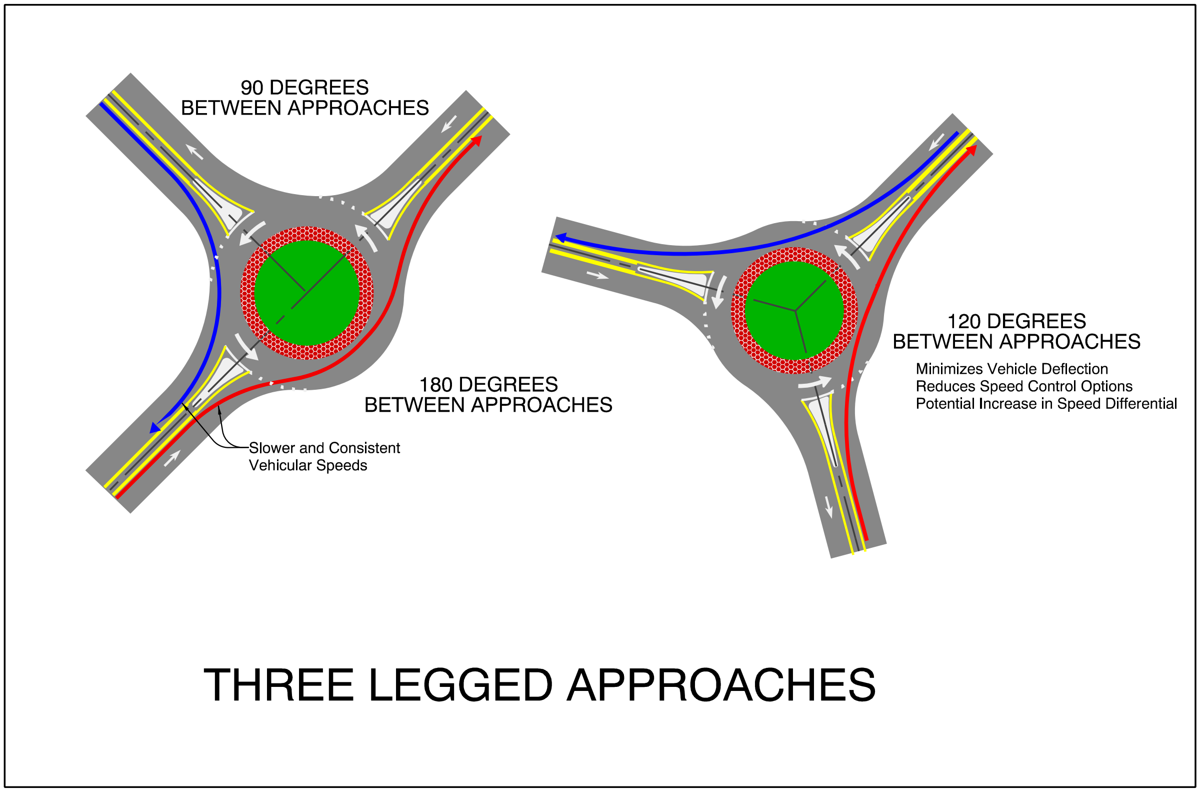
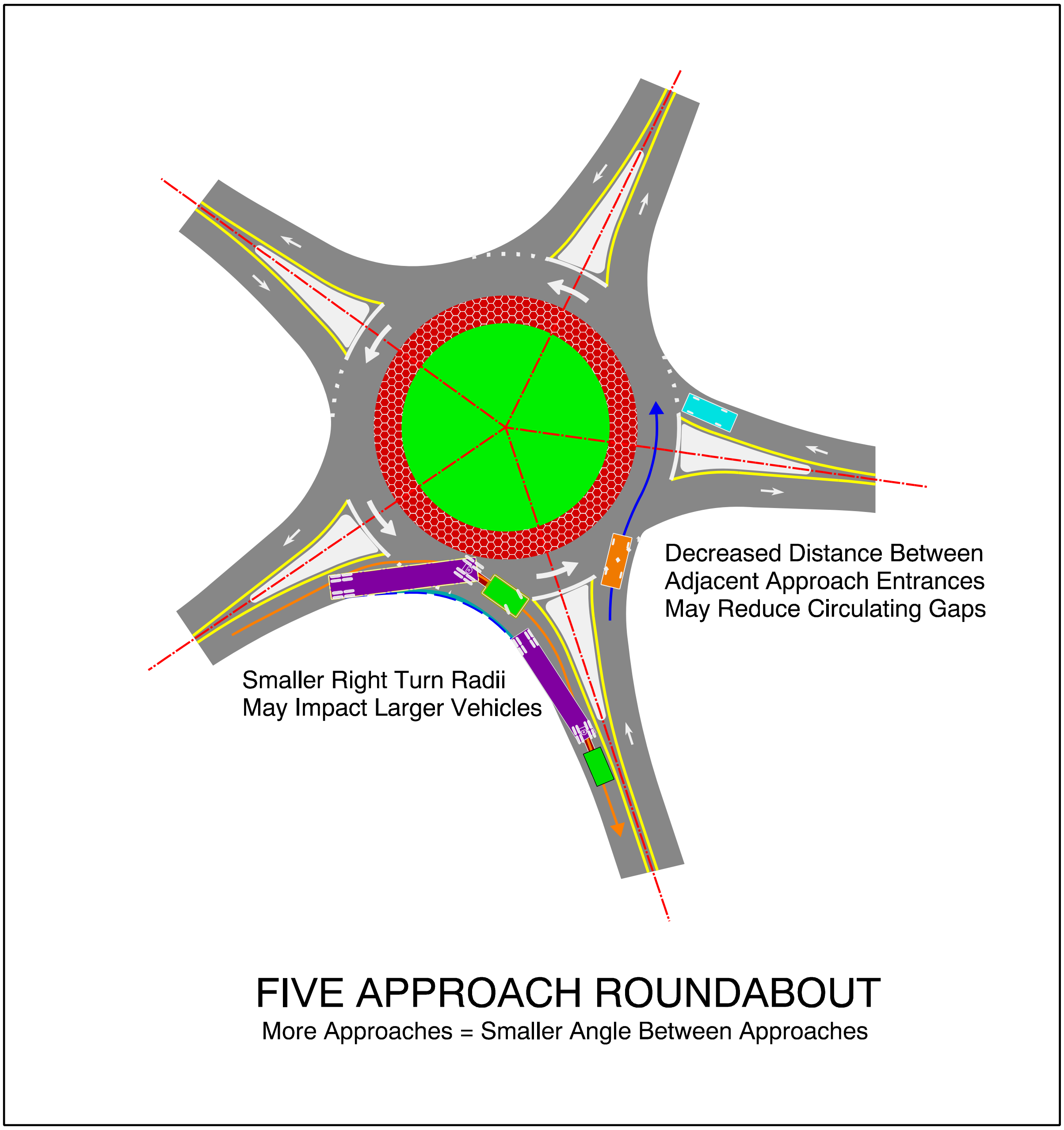



Figure 500-49 portrays a roundabout with five approaches and some of the inherent problems with roundabouts comprised of more than four legs. Roundabouts with more than four approaches present challenges with approach angles and with entry and exit parameters. In general, the more approaches there are, the smaller the angle between the approaches. These roundabouts will need special design considerations to achieve an effective design. Contact the Technical Services Roadway Unit to discuss options when laying out a roundabout with more than four approach legs.

Figure 500-49: Roundabout with Five Approaches




# 509.10 Entry and Exit Width

Entry width and exit width are also important factors in creating effective roundabout design. These widths are dictated by the needs of the traffic stream based principally on the design vehicle. However, vehicle needs must be balanced against necessary speed management and pedestrian crossing needs. Single lane roundabouts generally employ widths between 14 ft. for smaller diameter or mini-roundabouts and 18 ft. for more standard size roundabouts. Although, in some locations, these widths may be increased if deemed appropriate 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. Widths should only be as wide as necessary. Increasing width can affect fastest path speeds and may compromise overall safety goals.

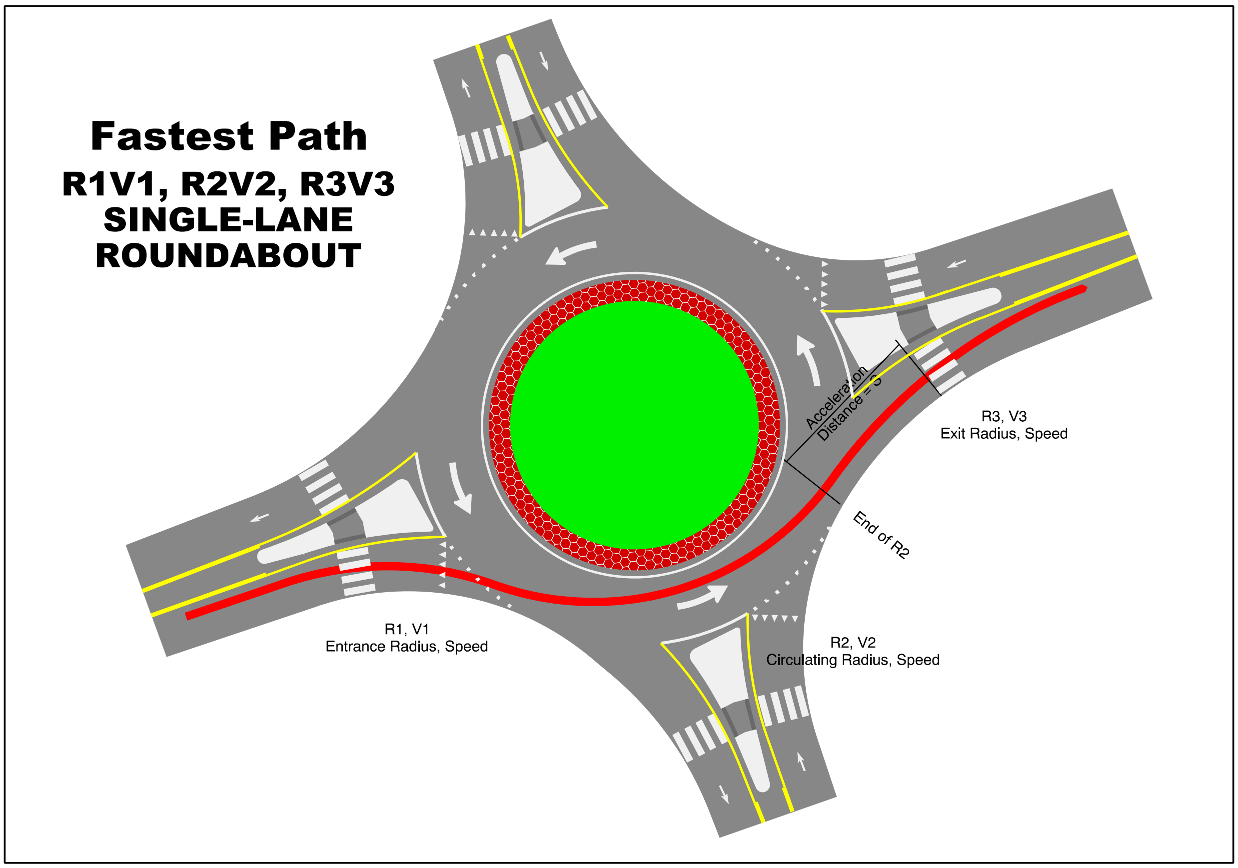
# 509.11 Entry and Exit Geometry

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 500-50: Exit Geometry – Alternate Speed Prediction Method




Equation 500-4: Newtonian Equation for Uniform Acceleration to Predict Roundabout Exit Speed

$$V_f^2 = V_i^2 + 2as \qquad \text{(Figure 500-50)}$$

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 on page 500-88, Figure 500-36, 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 500-51 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 500-41). 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 500-52 demonstrates an oversize vehicle swept path through a single lane roundabout utilizing an entrance apron.

Figure 500-51: Oversize Vehicle and Entrance Apron

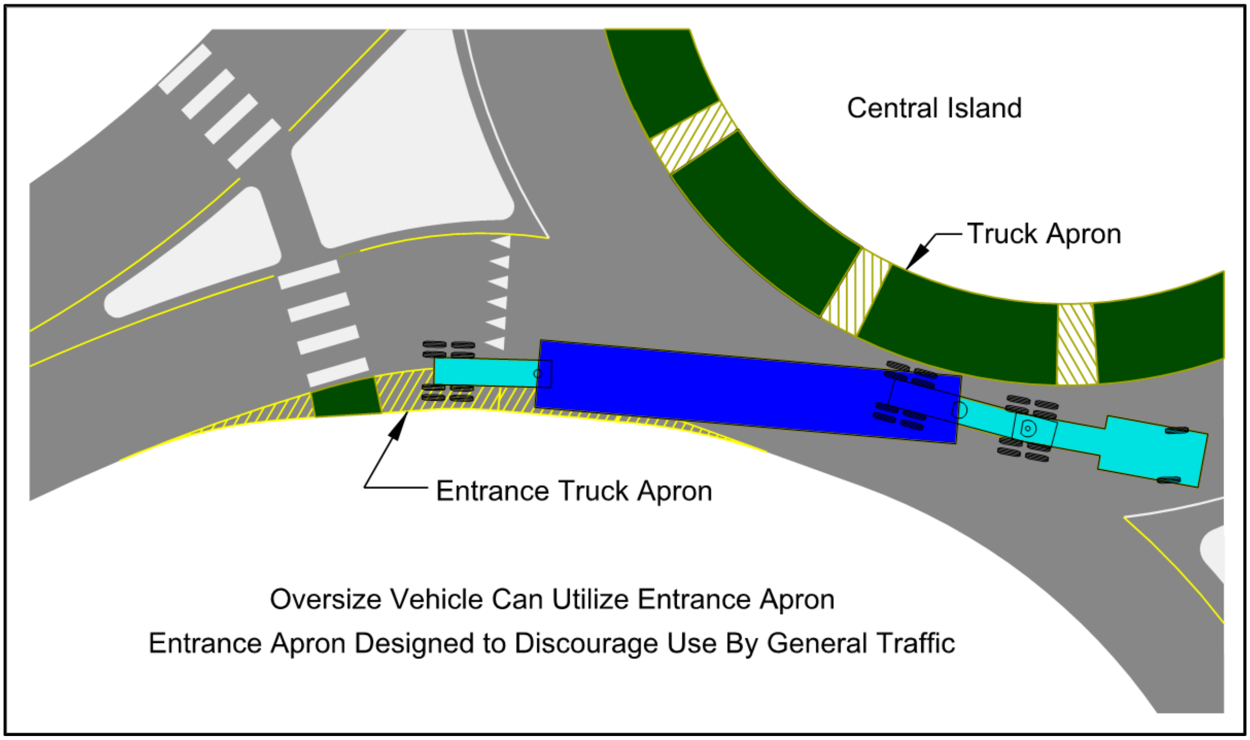
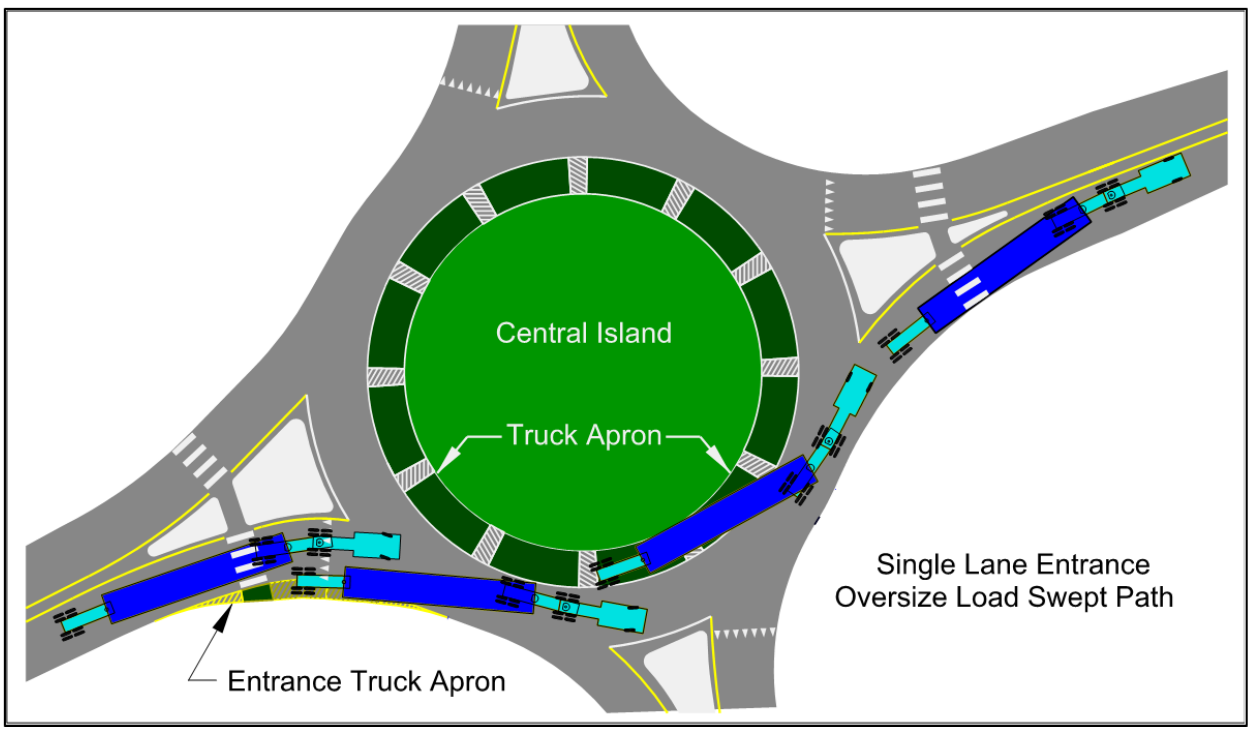



Figure 500-52: Swept Path of Oversize Vehicle Using an Entrance Apron



# 509.13 Splitter Island

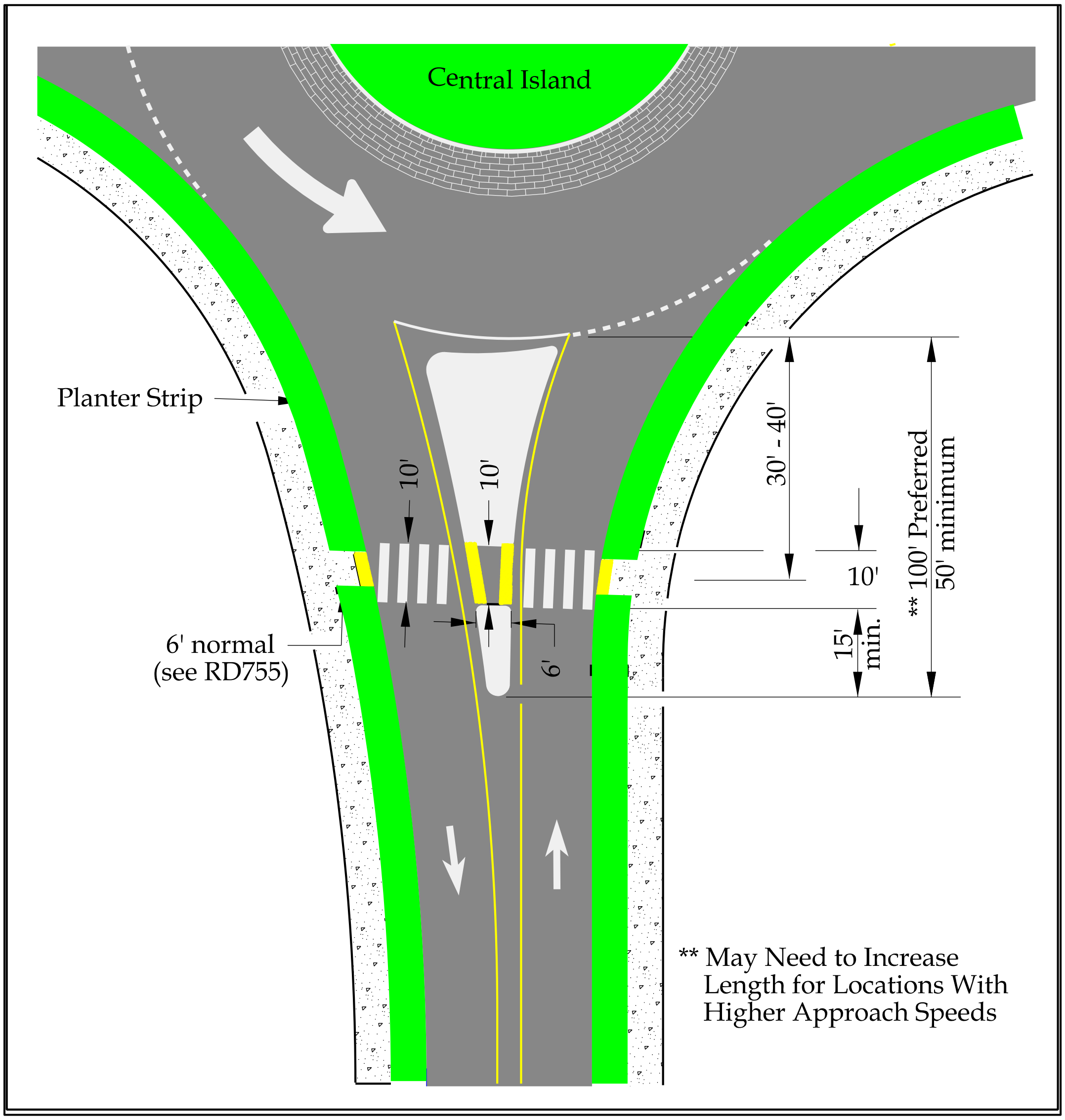
The purposes of splitter islands are to:

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 500-53 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 500-53: 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 shall 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

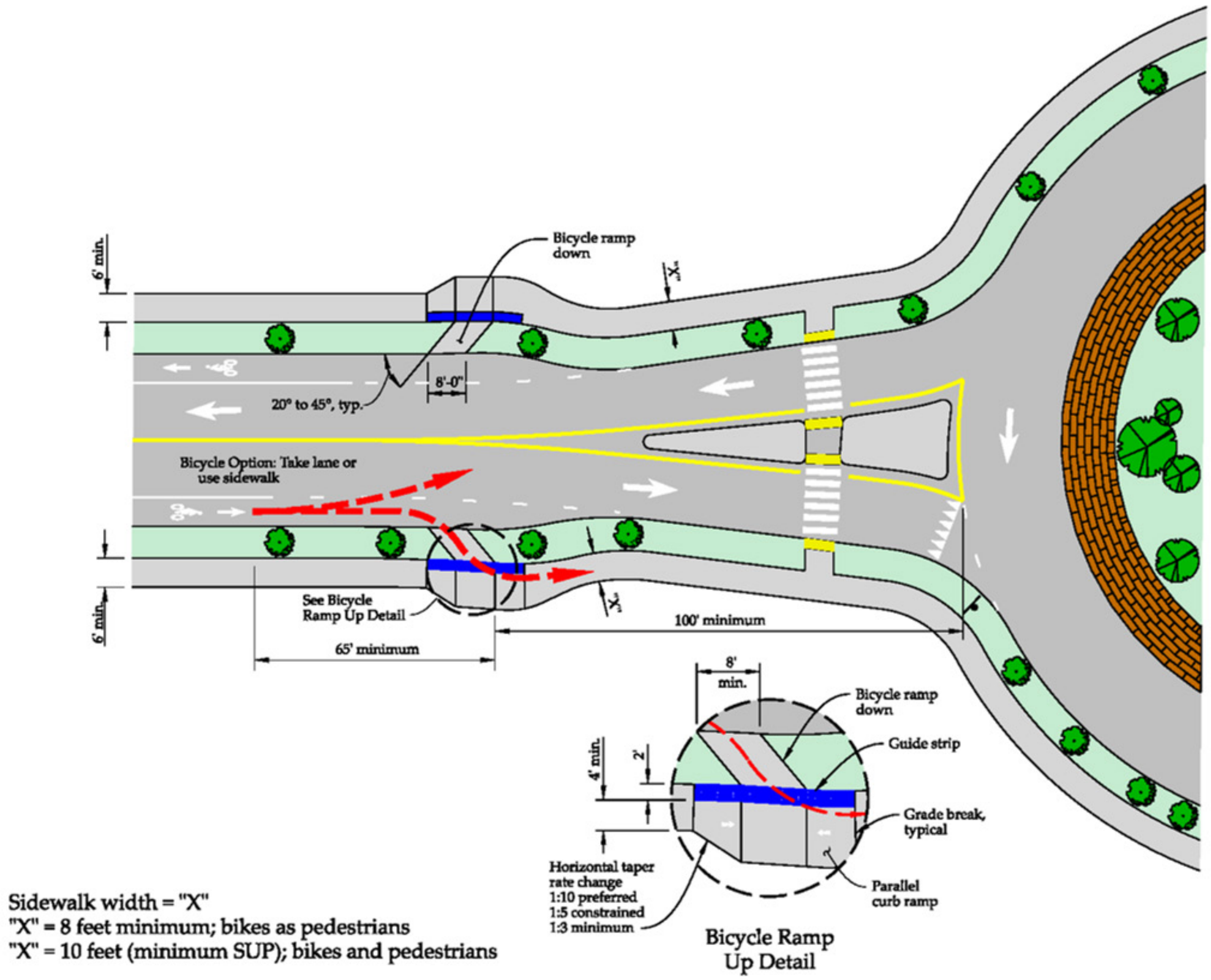
As in general roadway design for bicyclists, greater emphasis is being placed on separated bicycle facilities at roundabouts and that is the preferred method to accommodate cyclists and all efforts should be made to achieve separated facilities. However, not all locations will have the ability it include 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 500-54 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 500-54: 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 if a detectable warning surface is used, 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. However, a second option that is gaining popularity is to use Tactile Wayfinding Tiles also called Tactile Walking Surface Indicators across the top of the bicycle ramp and sidewalk. This option is relatively new and is ODOT's preferred method (See Part 981, Figure 900-19). 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 for installing Tactile Walking Surface Indicators at roundabouts.

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 to accommodate bicycles and pedestrians. 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.

Exhibit 500-1: 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 Roundabout Metering

When one approach to a roundabout may be creating operational issues for the roundabout as a whole or 1is impacting access to the roundabout at another approach, a metering device installed on the higher volume approach can improve overall operations of the roundabout. Metering devices have been used successfully in many locations. However, metering devices should not be indiscriminately installed at roundabouts. Their use should be limited to when it is necessary for operations for them to be installed. Metering can be an effective method of providing operational improvements, but their use must be evaluated and determined to be appropriate.

# 509.20 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.

Figure 500-55: Various Multi-Lane Roundabout Entrance and Exit Configurations

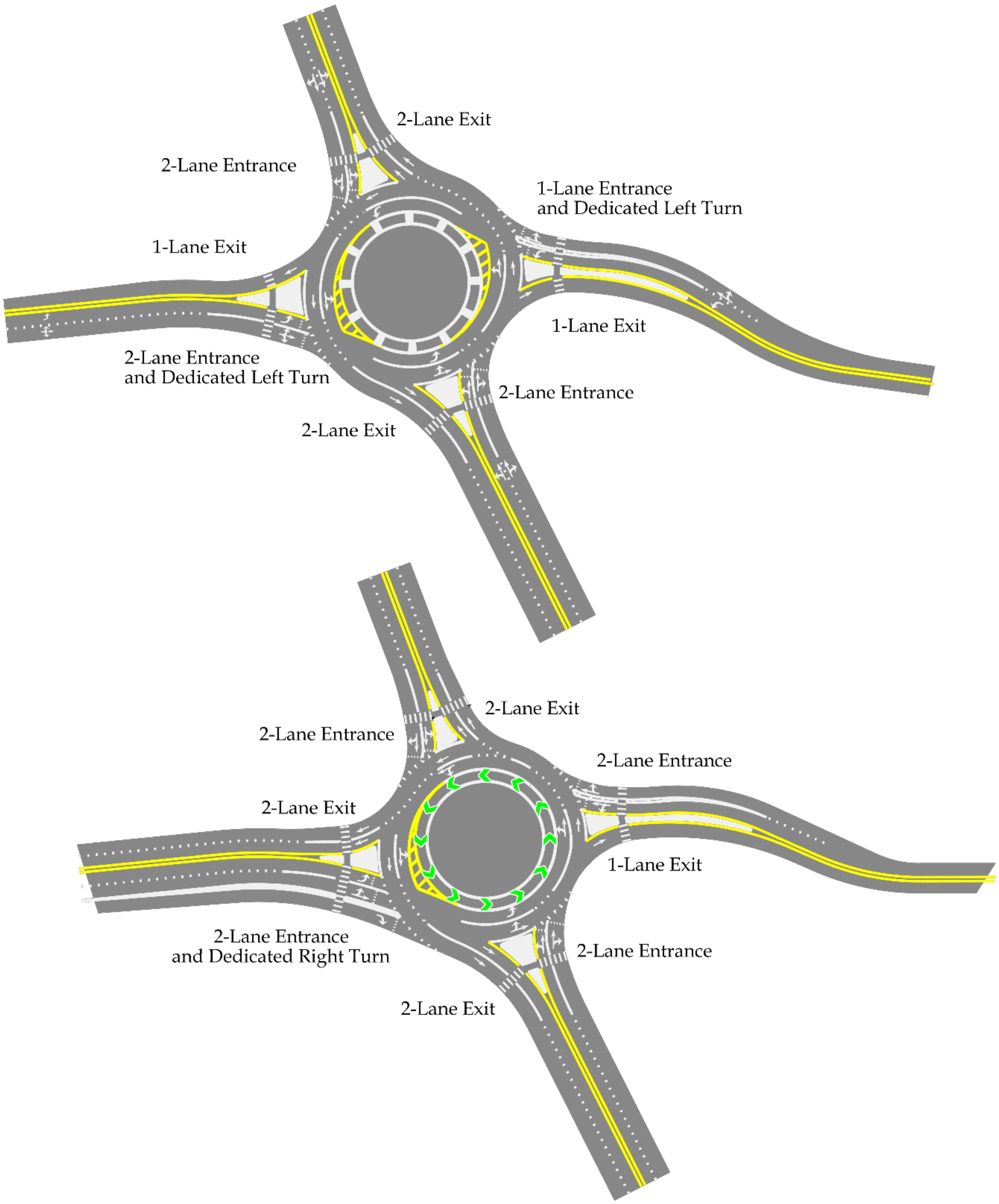
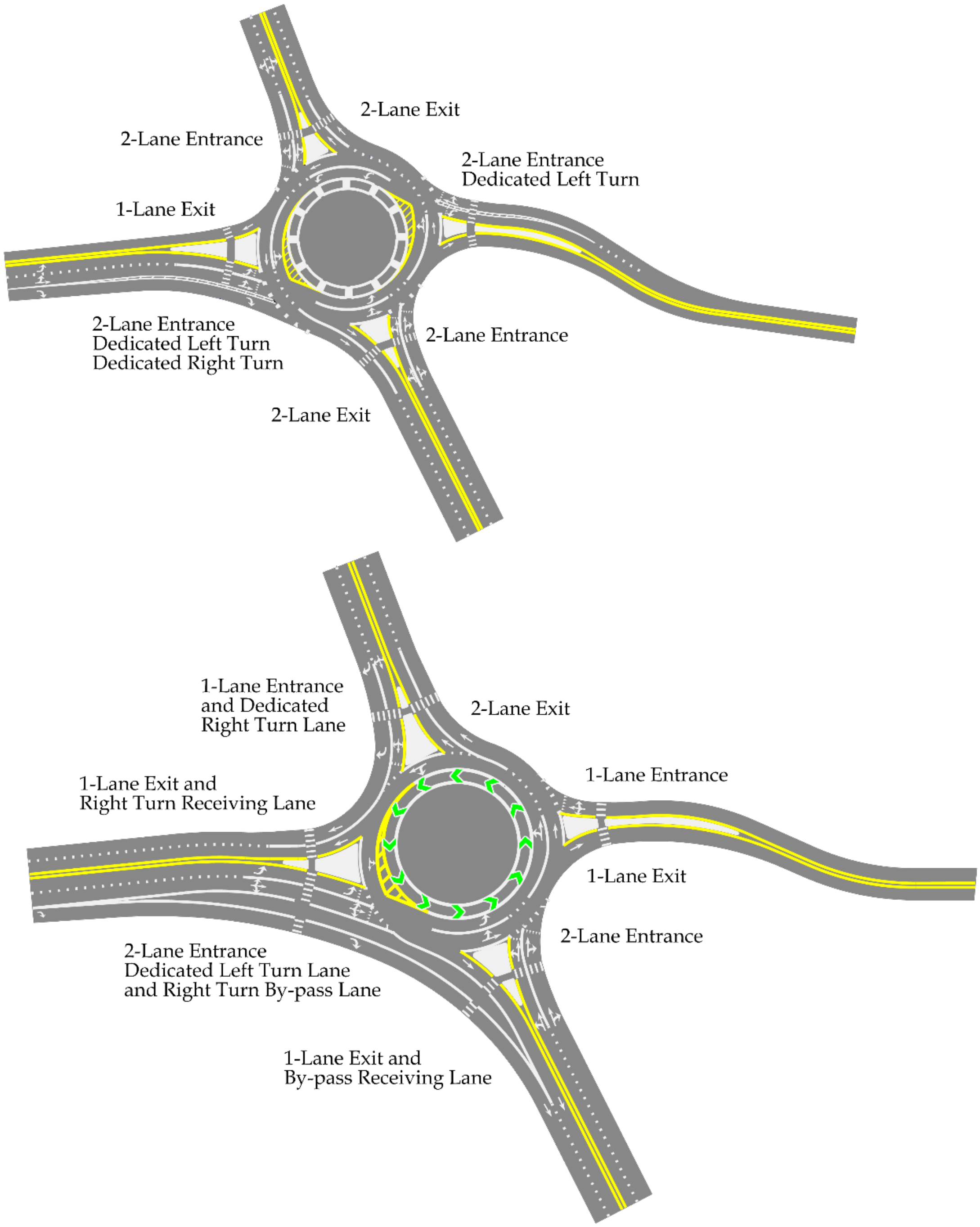
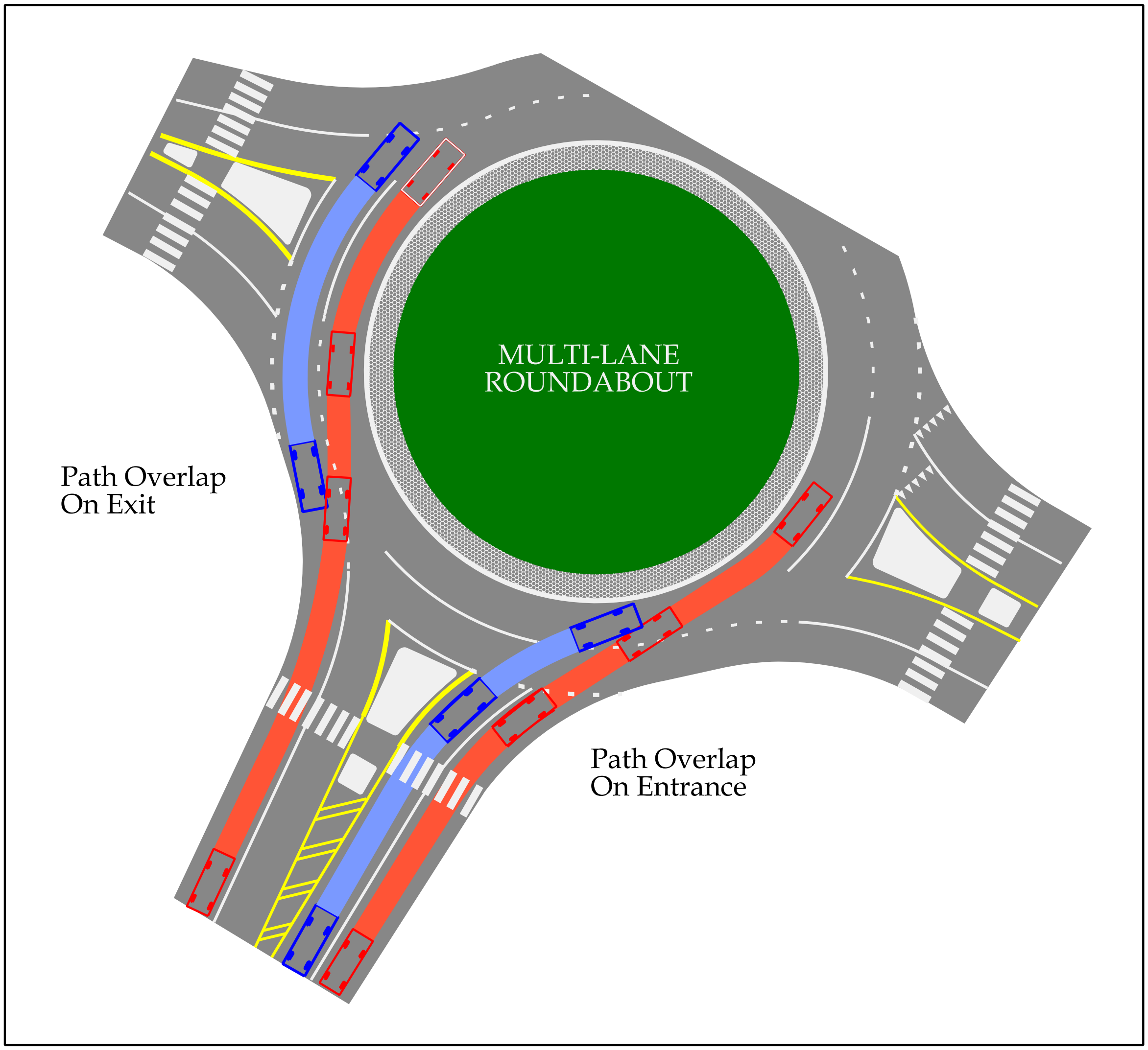


Figure 500-56: Additional Multi-Lane Roundabout Entrance and Exit Configurations



# 509.21 Path Overlap (Multi-Lane Roundabouts)

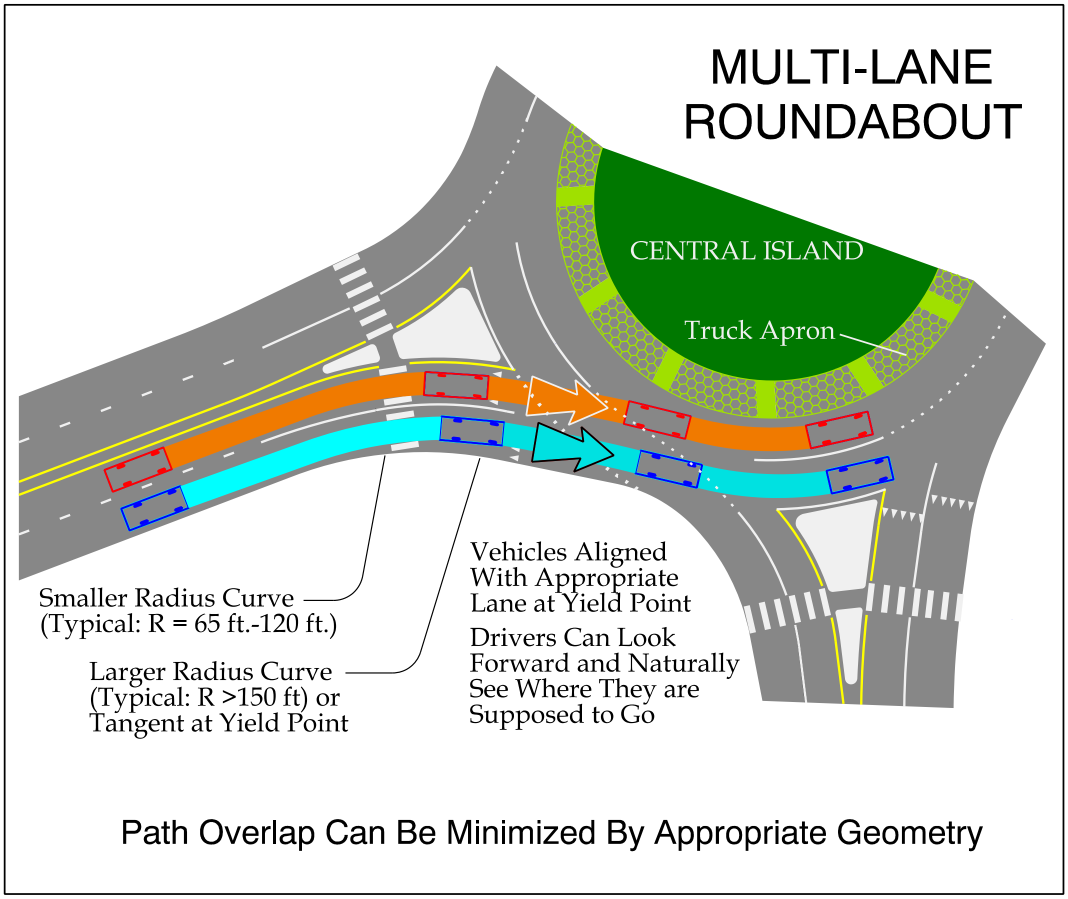
Figure 500-57: Path Overlap - Multi-Lane Roundabout




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




# 509.22 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 Outside Lane, Using Gore Striping – Two-Lane Entrance

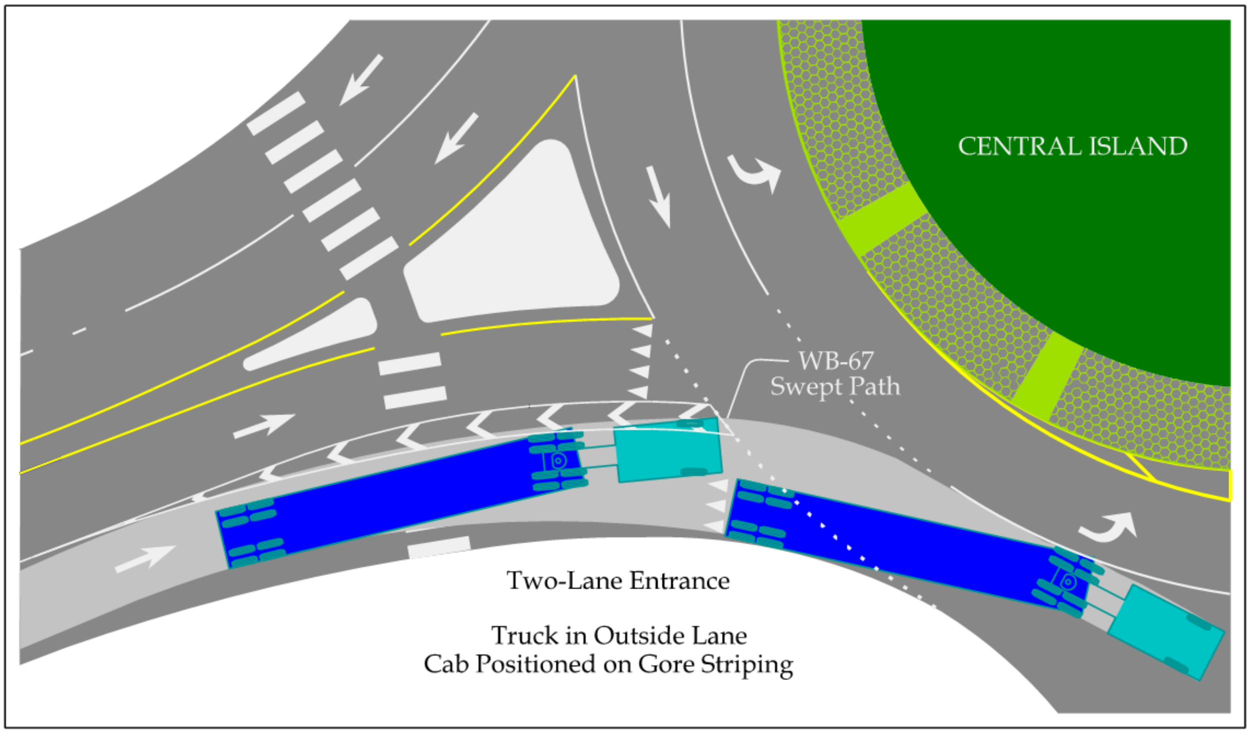
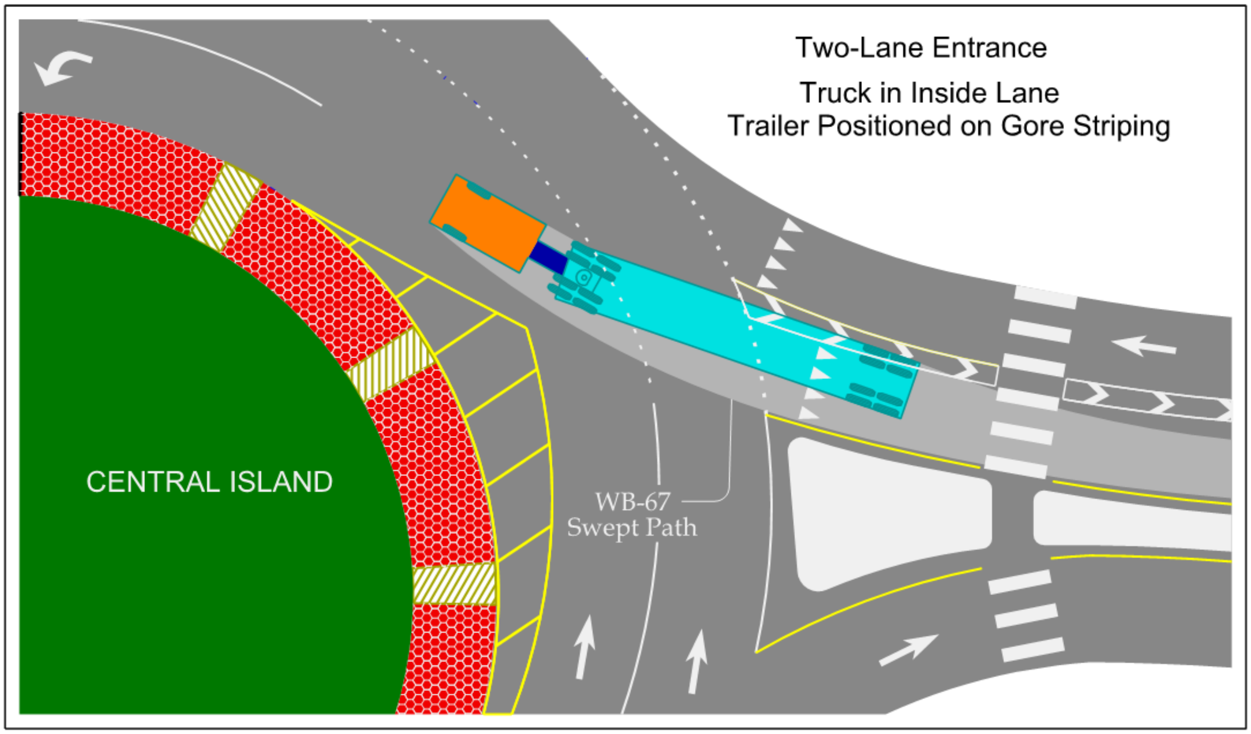


Figure 500-60: WB-67 Entering in the Inside Lane, Using Gore Striping – Two–Lane Entrance




# 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; $V = \sqrt{15R(+f)}$, 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

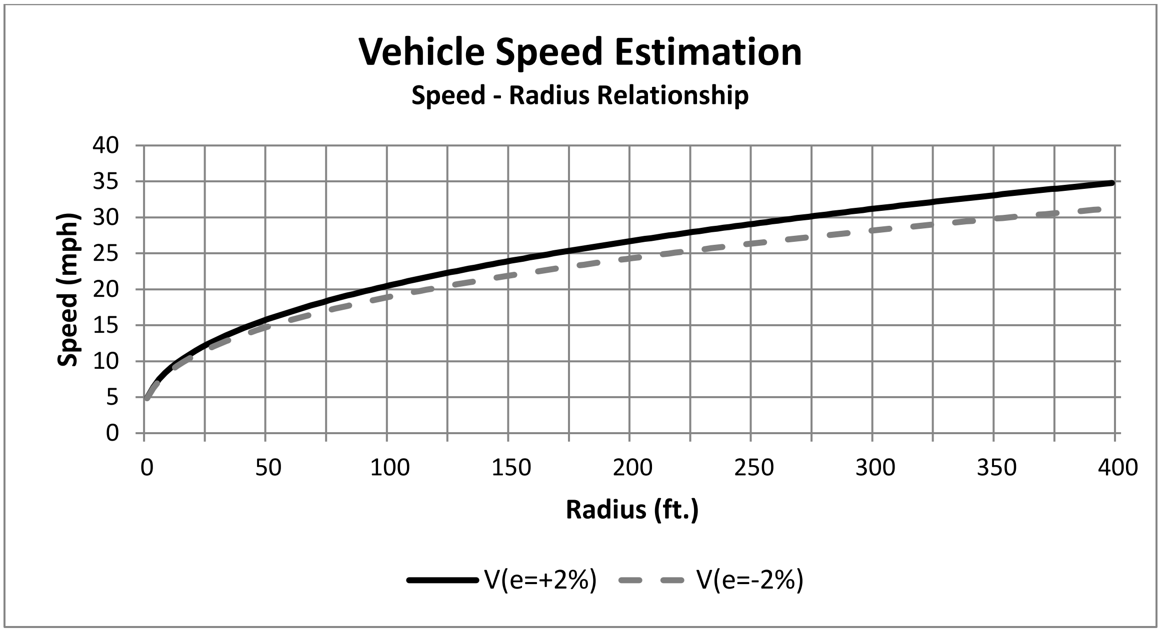



Table 500-5: Speed, Radius Relationship

| 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 |

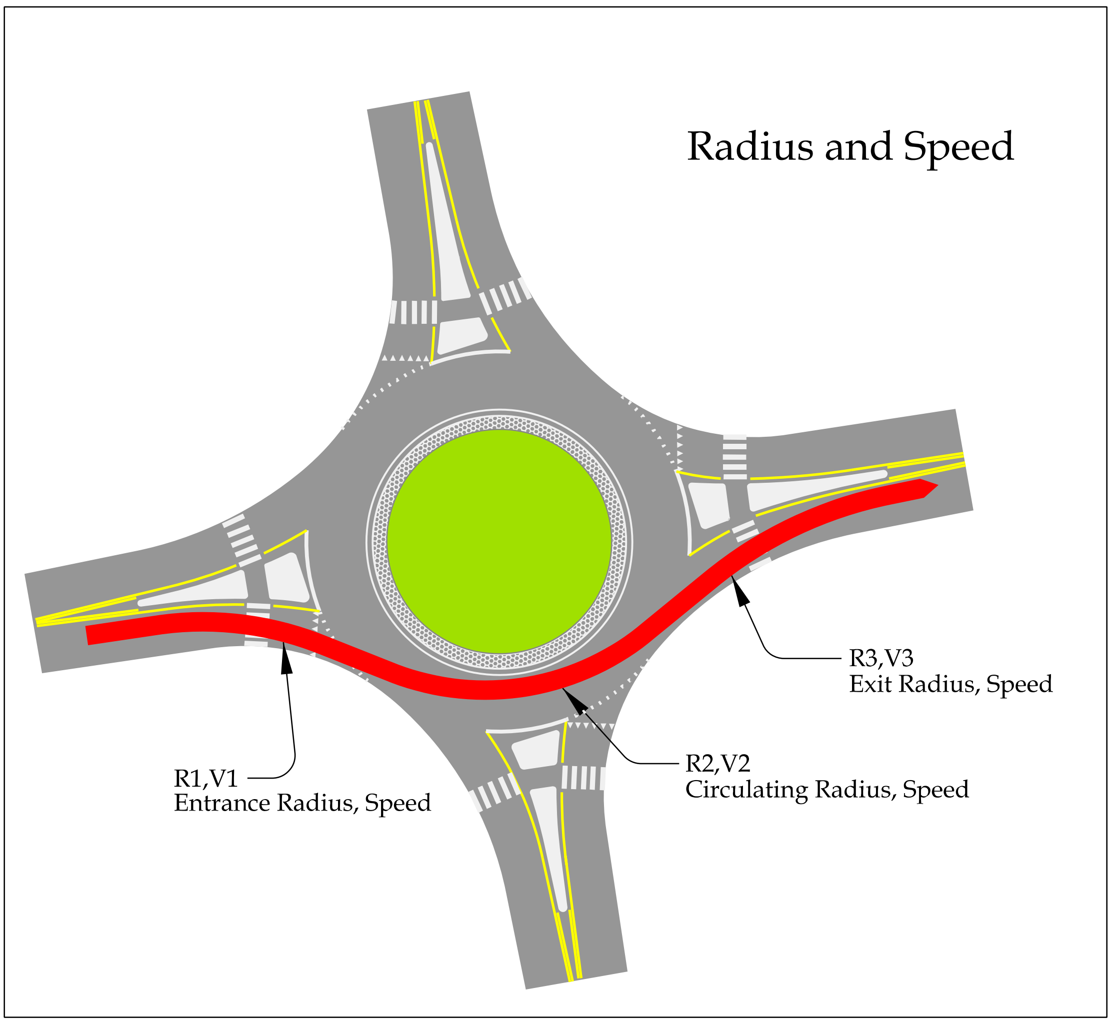
Speed (V), Radius (R) Relationship Equations:

| | | | |
|---|---|---|---|
| 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) | |

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.

Figure 500-62 illustrates the vehicle path through a roundabout depicting the R1,V1; R2,V2; and R3,V3 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?

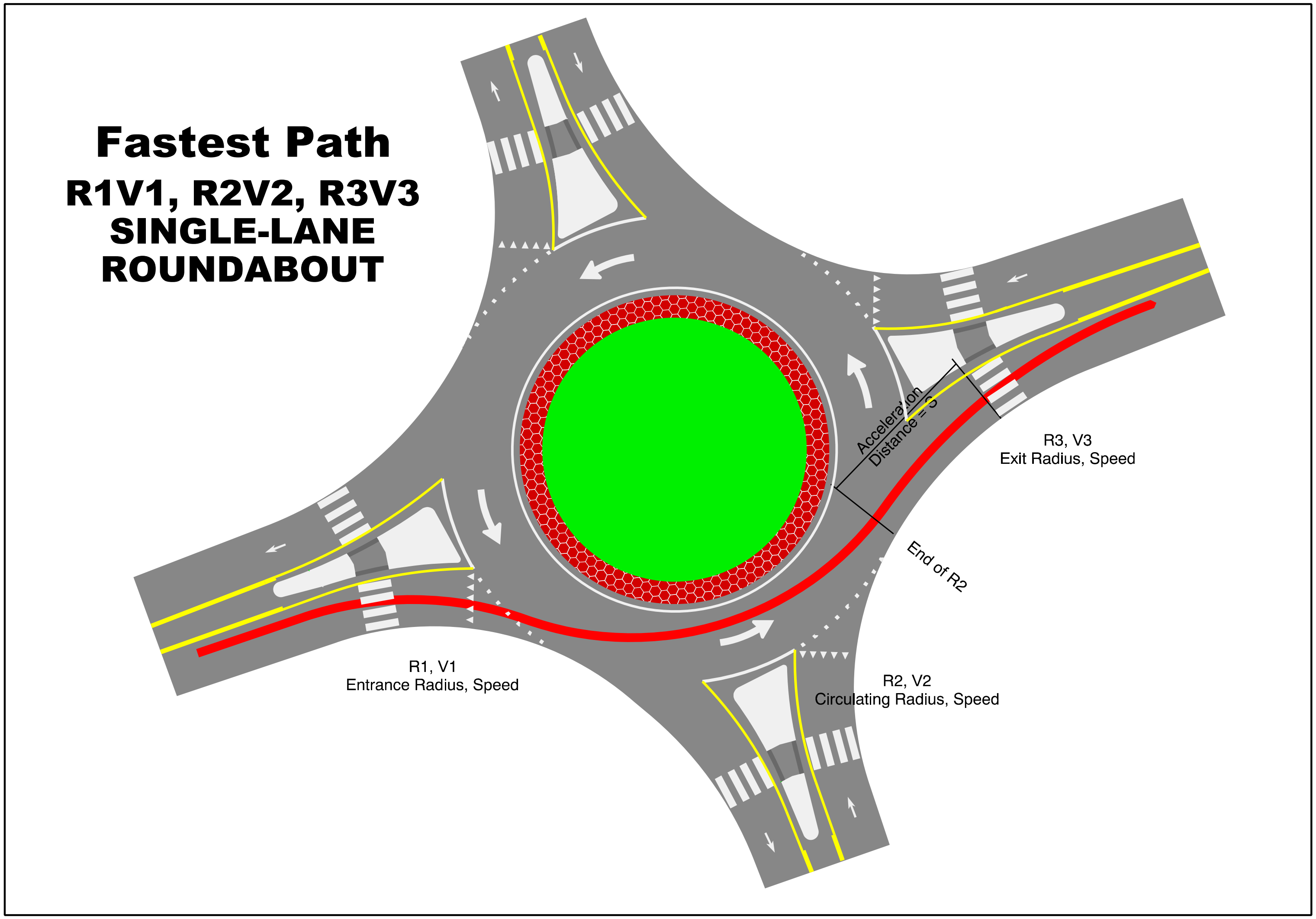
# 510.1 Research for Alternate Calculation Method

## 510.1.1 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.

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.

Figure 500-63: Vehicle Path through a Roundabout Speed, Radius, Acceleration Distance



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.

# 510.1.2 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, $V_1$

$$\boldsymbol{V_1 = \frac{1}{1.47}\sqrt{(1.47V_2)^2 + 2a_{1,2}d_{1,2}}}$$

$V_1$ = 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/s² 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/s²

$d_{2,3}$ = 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.

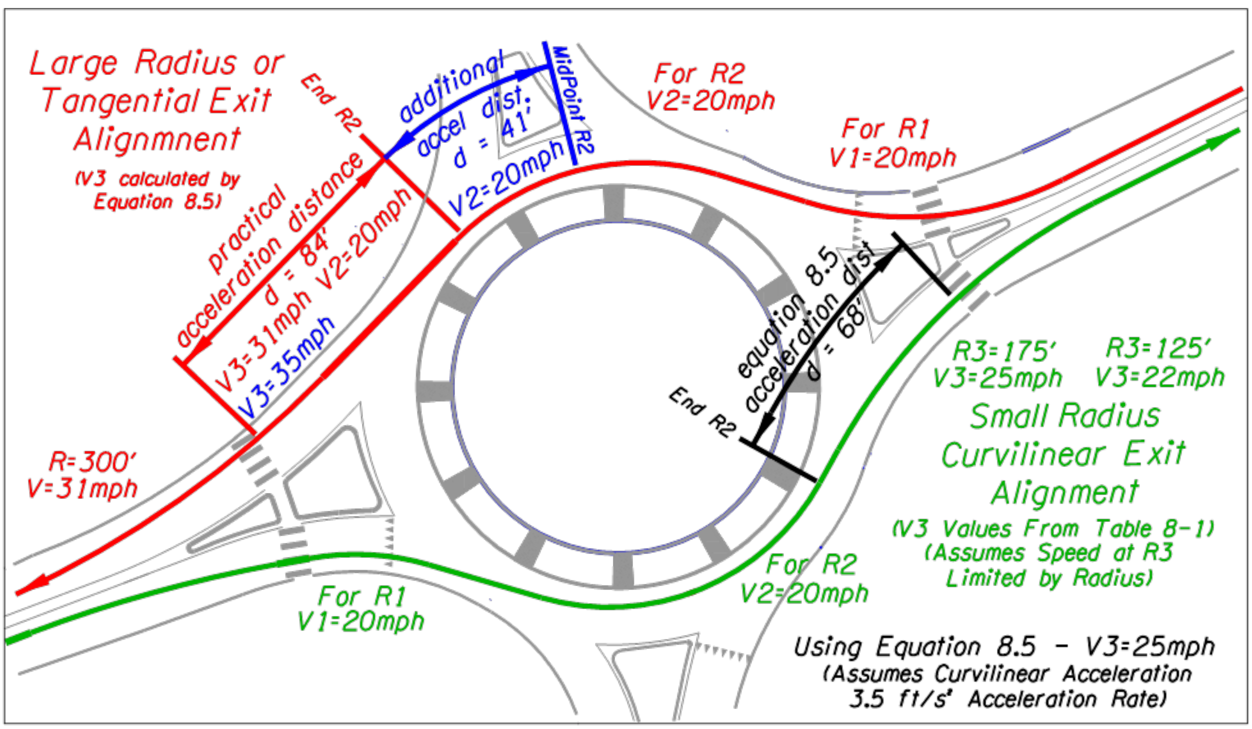
# 510.2 Evaluation of Large Radius or Tangential Exits and Small Radius Exits

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

| Vehicle Data | 0-60 (sec) | 1/4 Mile (sec) | 60 MPH Distance (ft) | 60 MPH Acceleration (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 |
| | | | | Average, 12.89 ft/s$^2$ |

Note: Data From AutoRooster (autorooster.com/0-60-times)

# 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 | State Traffic-Roadway Engineer (STRE) and, for some projects, 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 | Not Applicable | Not Applicable |

See Part 100, Section 101 for additional information.

# 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. The strongly preferred approach for system planning is to use consistent control features and not mix at-grade intersections with grade separated interchanges. Grade separations without ramps are sometimes necessary on at-grade facilities due to terrain, development patterns, or the need to maintain appropriate spacing of adjacent intersections. When this approach is considered, the completeness of the supporting local road network (local roads or frontage roads for example) must also be considered; strong consideration must be given to including those elements that are missing or incomplete as part of the roadway work.

In some very unusual situations, intersections at-grade and interchanges can be used together, with appropriate spacing and other criteria being applied. However, this needs to be very carefully evaluated regarding safety and operations, and implemented with exceptional care. Mixing of controls create uncertainty and confusion for roadway users (driver expectations). If users are accustomed to seeing a facility that is accessed by way of interchanges, an at-grade intersection is out of context.

An example of this is the incremental development of OR 217 (Beaverton-Tigard Highway). Although interchanges were planned at several locations, they were not built during initial construction in the mid 1960s - they had interim at-grade intersections with signals. Shortly after the facility was opened, the operational and safety issues became very apparent. Access was eventually handled by completing the remaining interchanges in the late 1970s; close interchange spacing and some confusing connections created ongoing additional issues. The highway is also affected by inadequate supporting facilities.

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<br>Interstate and Non-Interstate | Urban<br>Rural | 3 miles<br>6 miles |
| Non-Freeways<br>Expressways, Statewide, Regional, and District Highways | Urban<br>Rural | 1.9 miles<br>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.*

# 602.6.1 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:

(www.oregon.gov/odot/engineering/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

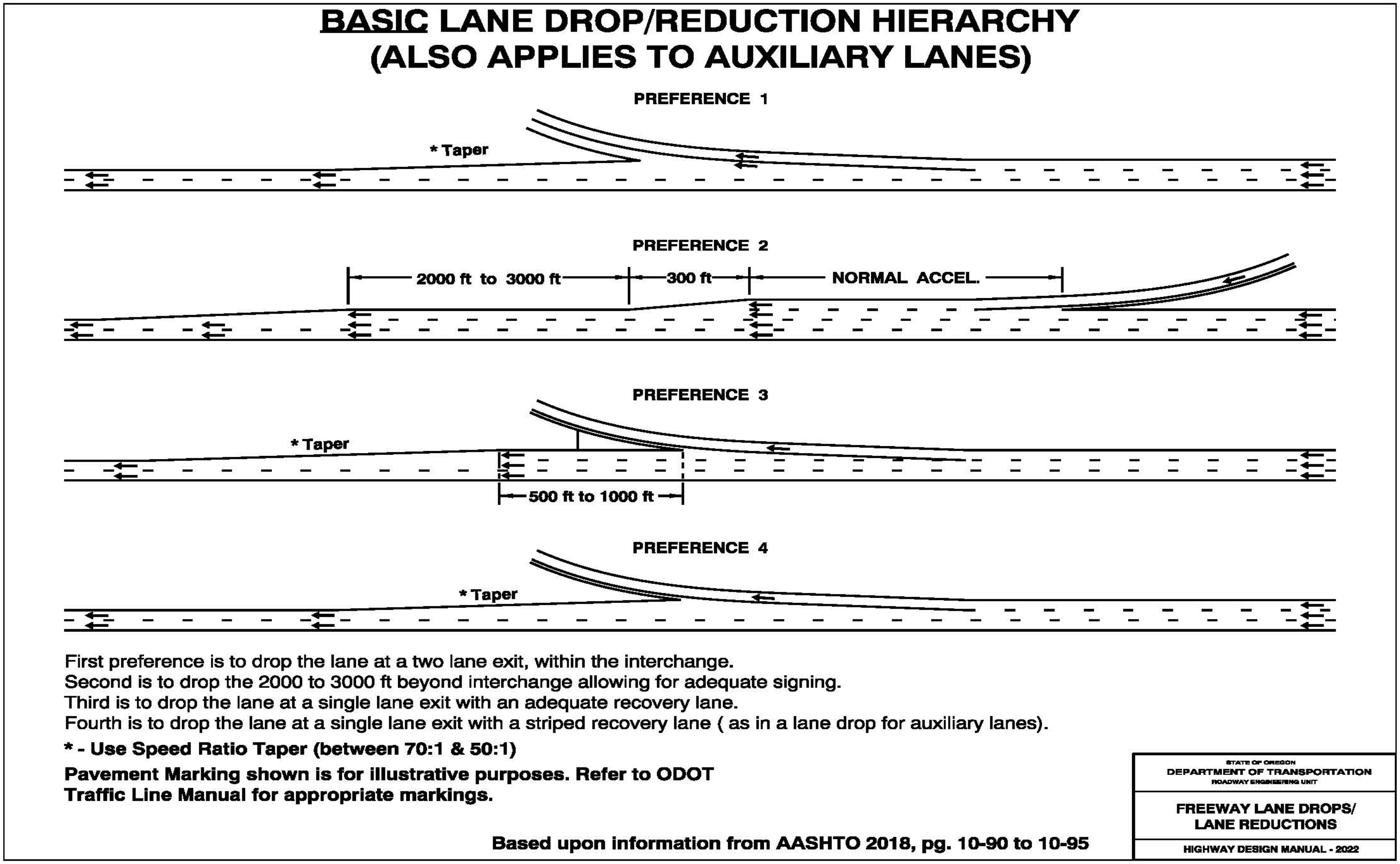
A basic lane is simply a through travel lane that continues for a specified distance along a highway route. For example, an **Interstate route has a minimum of four basic lanes (two in each direction) over its entire length.** The basic number of lanes is maintained over a significant length of the route 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.*

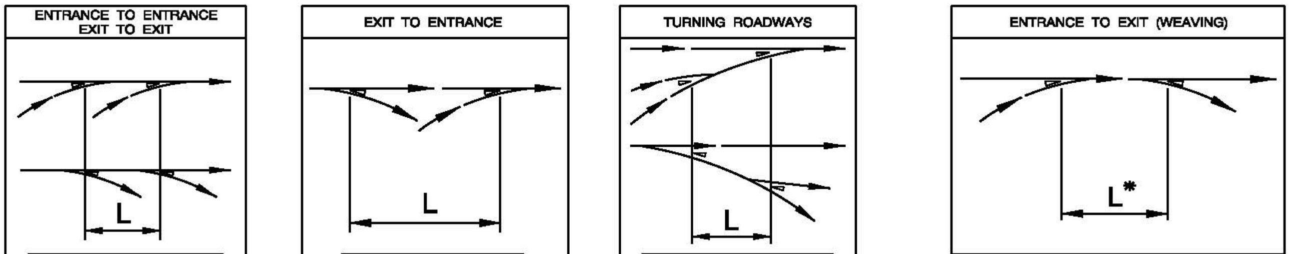
Collector-Distributor roads can also be used to reduce traffic friction from multiple entrance and exit connections on the same side of the freeway, thereby permitting more uniform speeds and smoother operations on the through traffic lanes. More guidance on C_D roads is provided in 603.6.

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**

| GUIDELINES | FULL FREEWAY | C-D ROAD OR FWY. DIST. |
|---|---|---|
| DESIRABLE | 1500 | 1200 |
| ADEQUATE | 1200 | 1000 |
| MINIMUM | 1000 | 800 |

**EXIT TO ENTRANCE**

| GUIDELINES | FULL FREEWAY | C-D ROAD OR FWY. DIST. |
|---|---|---|
| DESIRABLE | 750 | 600 |
| ADEQUATE | 600 | 500 |
| MINIMUM | 500 | 400 |

**TURNING ROADWAYS**

| GUIDELINES | SYSTEM INTCHG. | SERVICE INTCHG. |
|---|---|---|
| DESIRABLE | 1200 | 1000 |
| ADEQUATE | 1000 | 800 |
| MINIMUM | 800 | 600 |

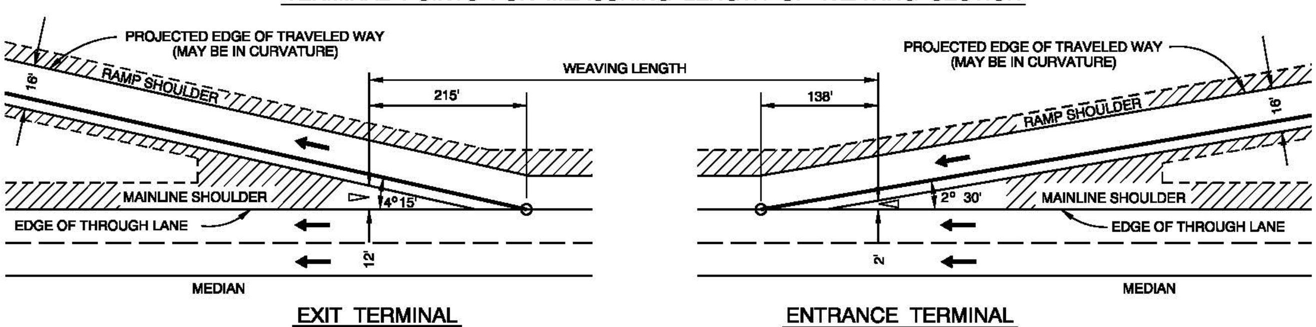
**ENTRANCE TO EXIT (WEAVING)**

| GUIDELINES | SYSTEM TO SERVICE INTERCHANGE | | SERVICE TO SERVICE INTERCHANGE | | GUIDELINES |
|---|---|---|---|---|---|
| | FULL FREEWAY | C-D RD. OR FWY. DIST. | FULL FREEWAY. | C-D RD. OR FWY. DIST. | |
| DESIRABLE | 3000 | 2000 | 2000 | 1500 | DESIRABLE |
| ADEQUATE | 2500 | 1800 | 1800 | 1200 | ADEQUATE |
| MINIMUM | 2000 | 1600 | 1600 | 1000 | MINIMUM |

* RECOMMENDED: SHOULD BE CHECKED IN ACCORDANCE WITH PROCEDURE OUTLINED IN THE HIGHWAY CAPACITY MANUAL. (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.

### TERMINAL POINTS FOR MEASURING LENGTH OF WEAVING SECTION




STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

RAMP TERMINAL SPACING

HIGHWAY DESIGN MANUAL - 2022

# 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.**

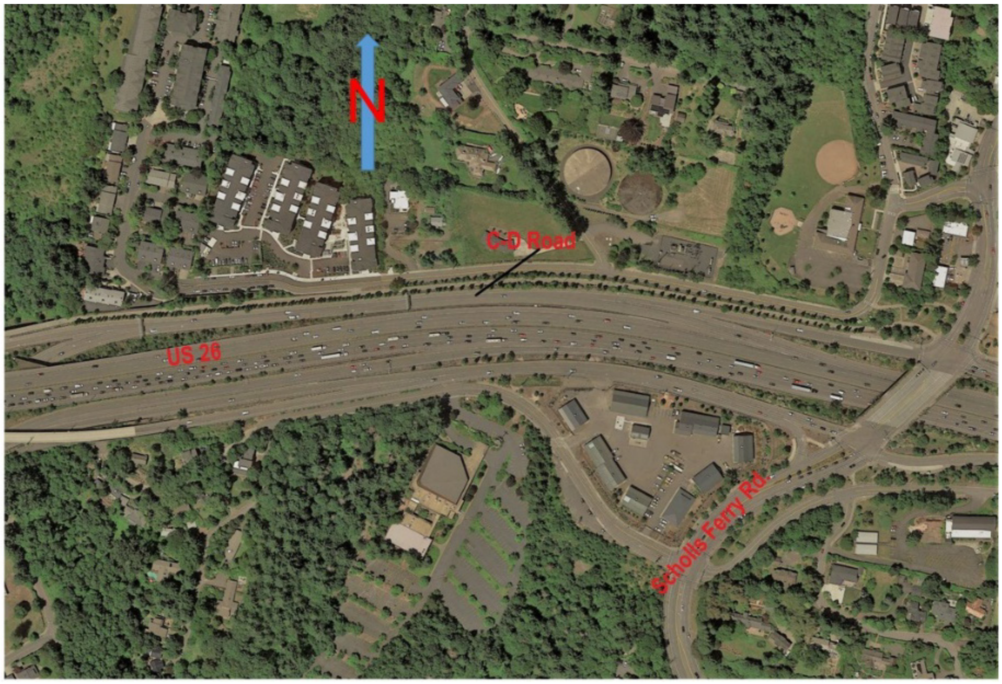
# 603.6 Collector-Distributor (C-D) Roads

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)




# 603.7 Grade Separation Structure Considerations

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

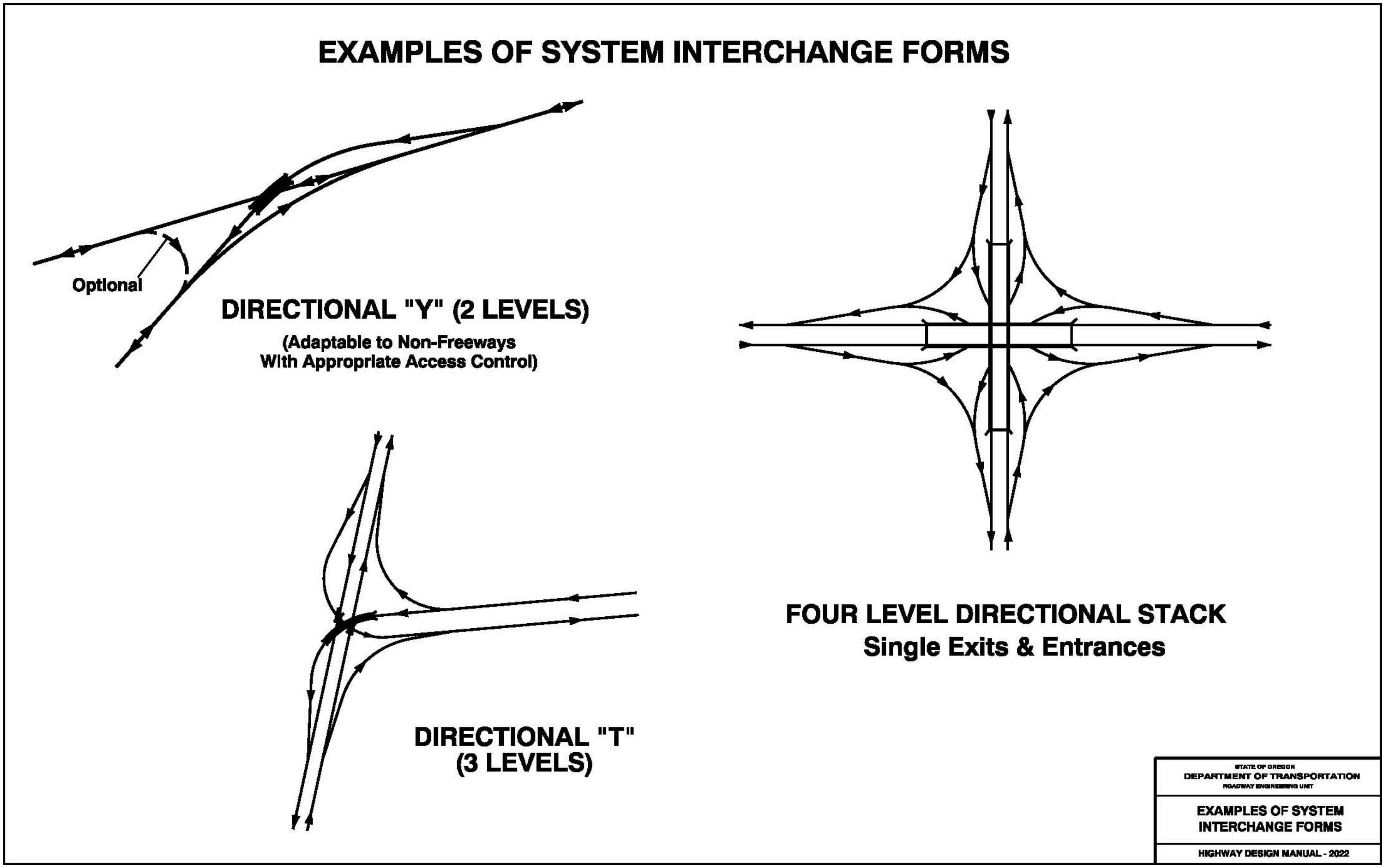


Figure 600-5: Common Service Interchange Forms

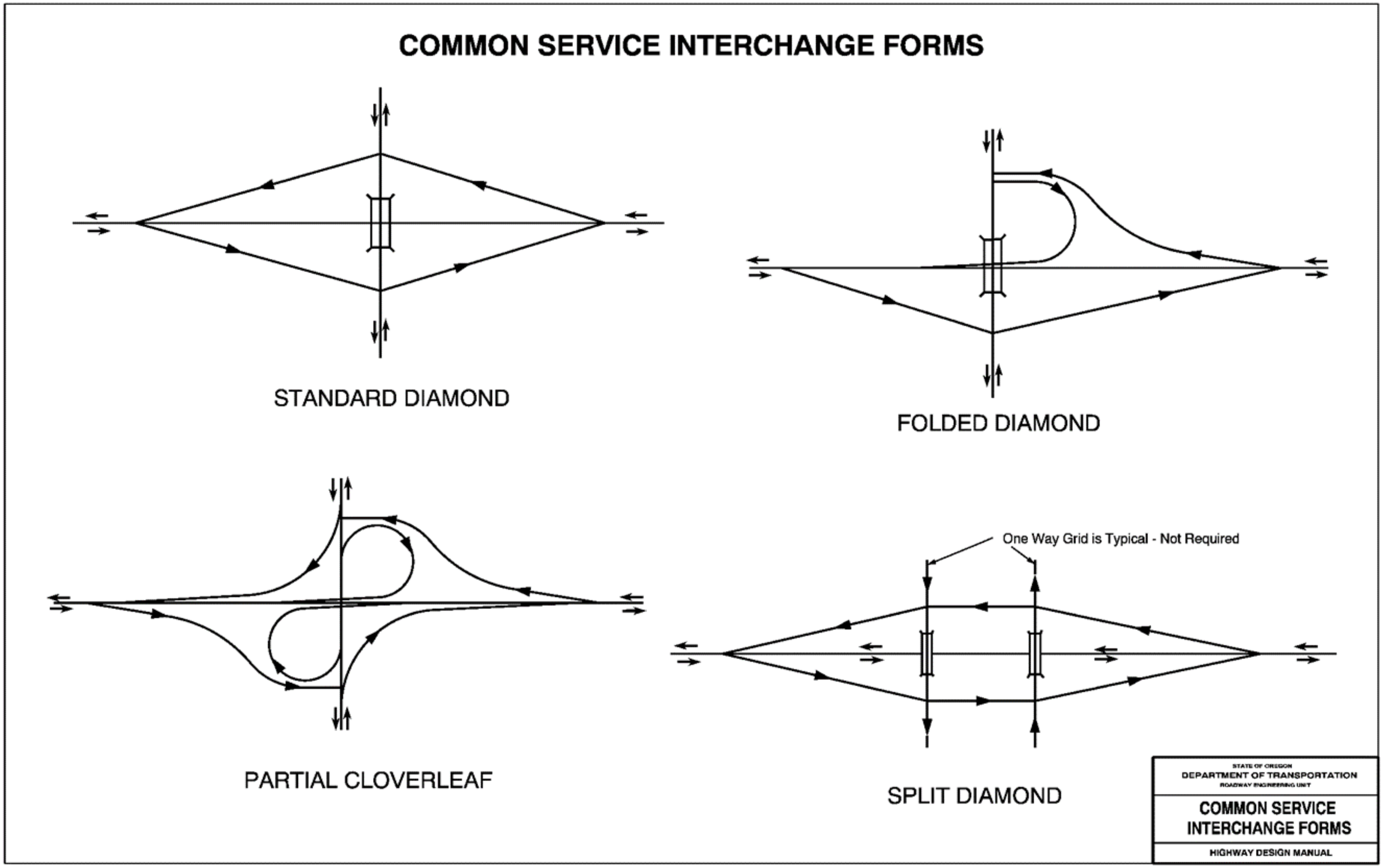


Figure 600-6: Examples of Compact Diamond Interchange Forms

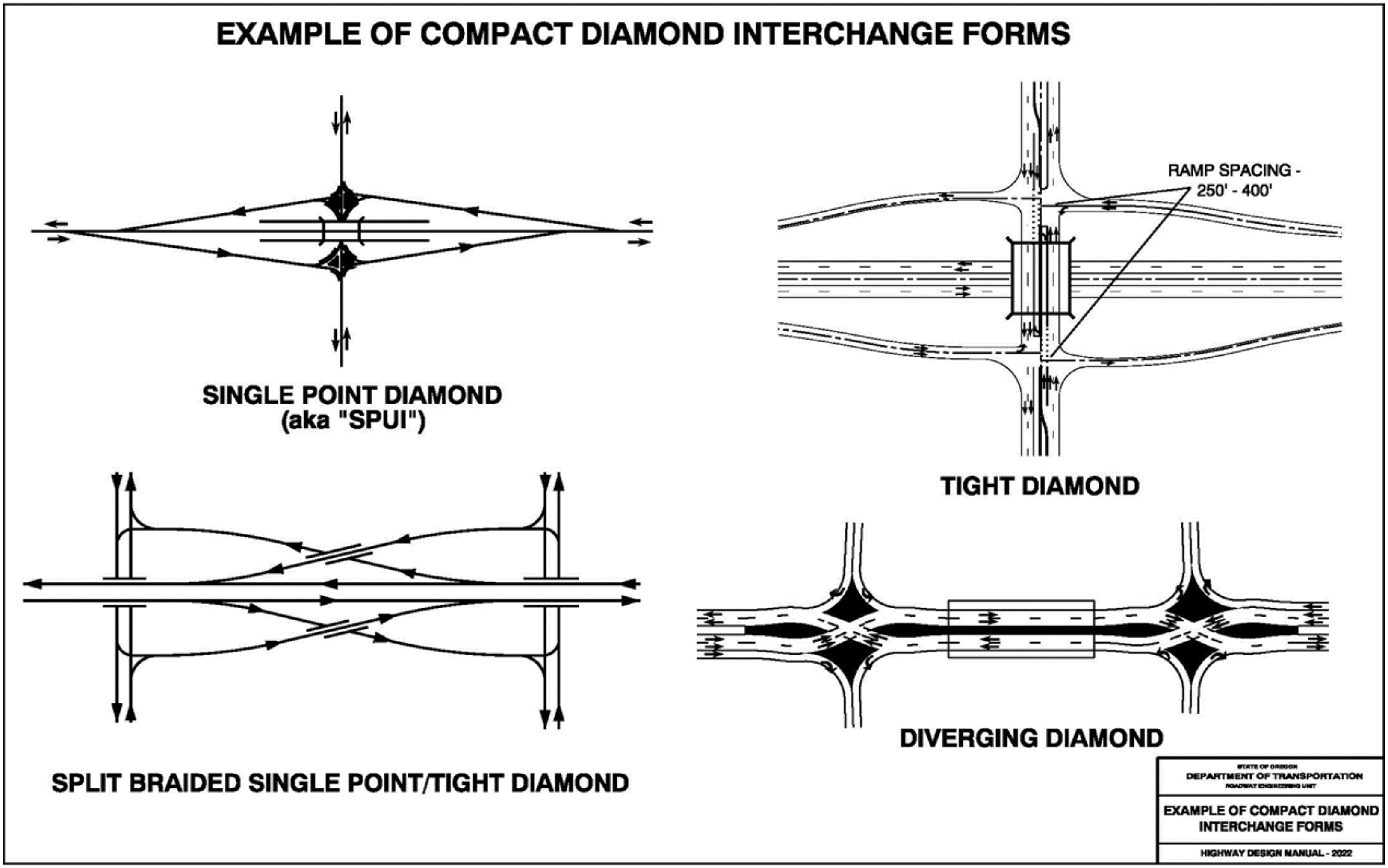


Figure 600-7: Superimposed Interchange in Keizer, OR (I-5 Exit 260)

Figure 600-8: Non-Freeway Interchange Forms

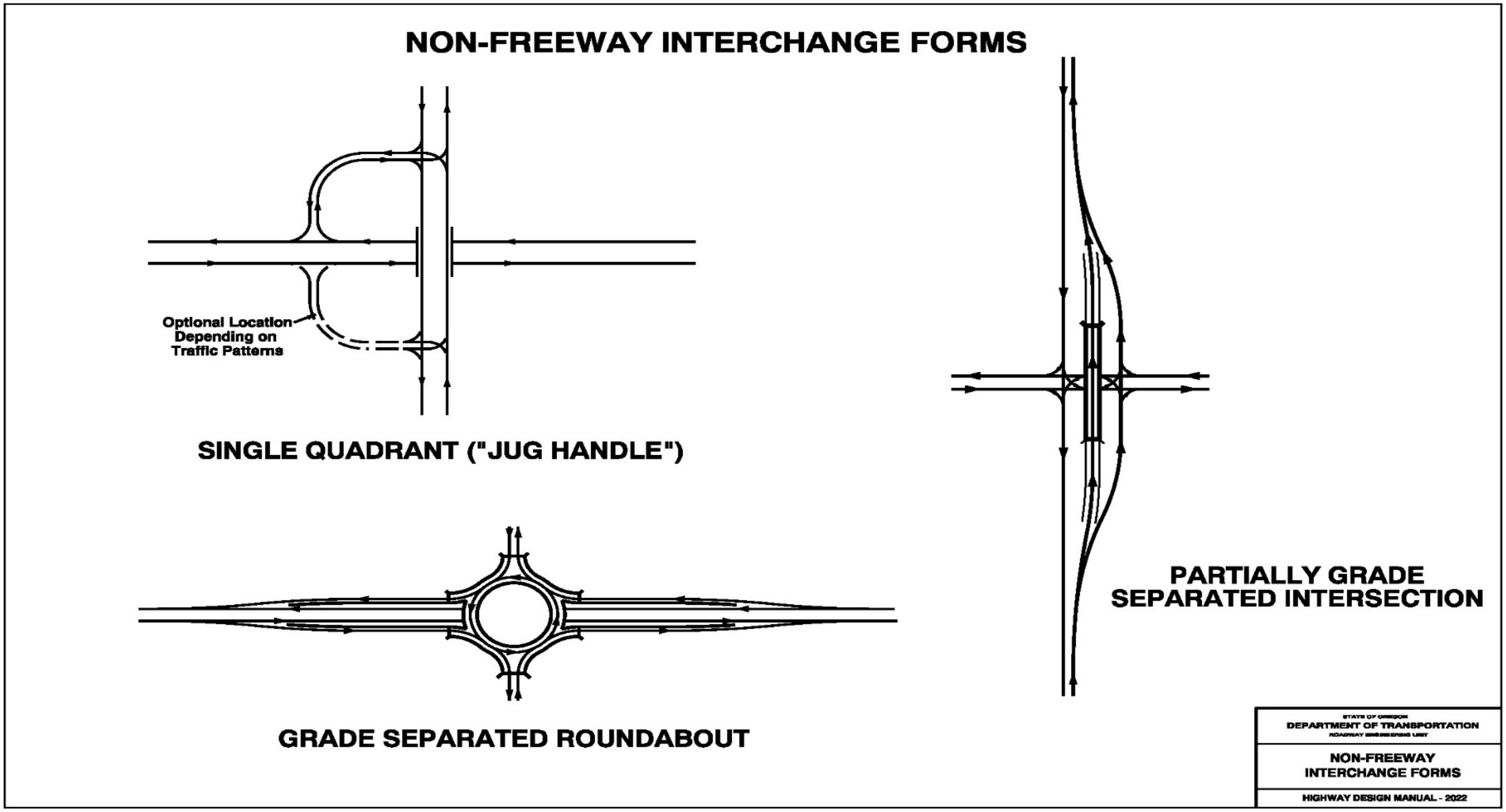


Figure 600-9: Examples of Specialized Interchange Forms

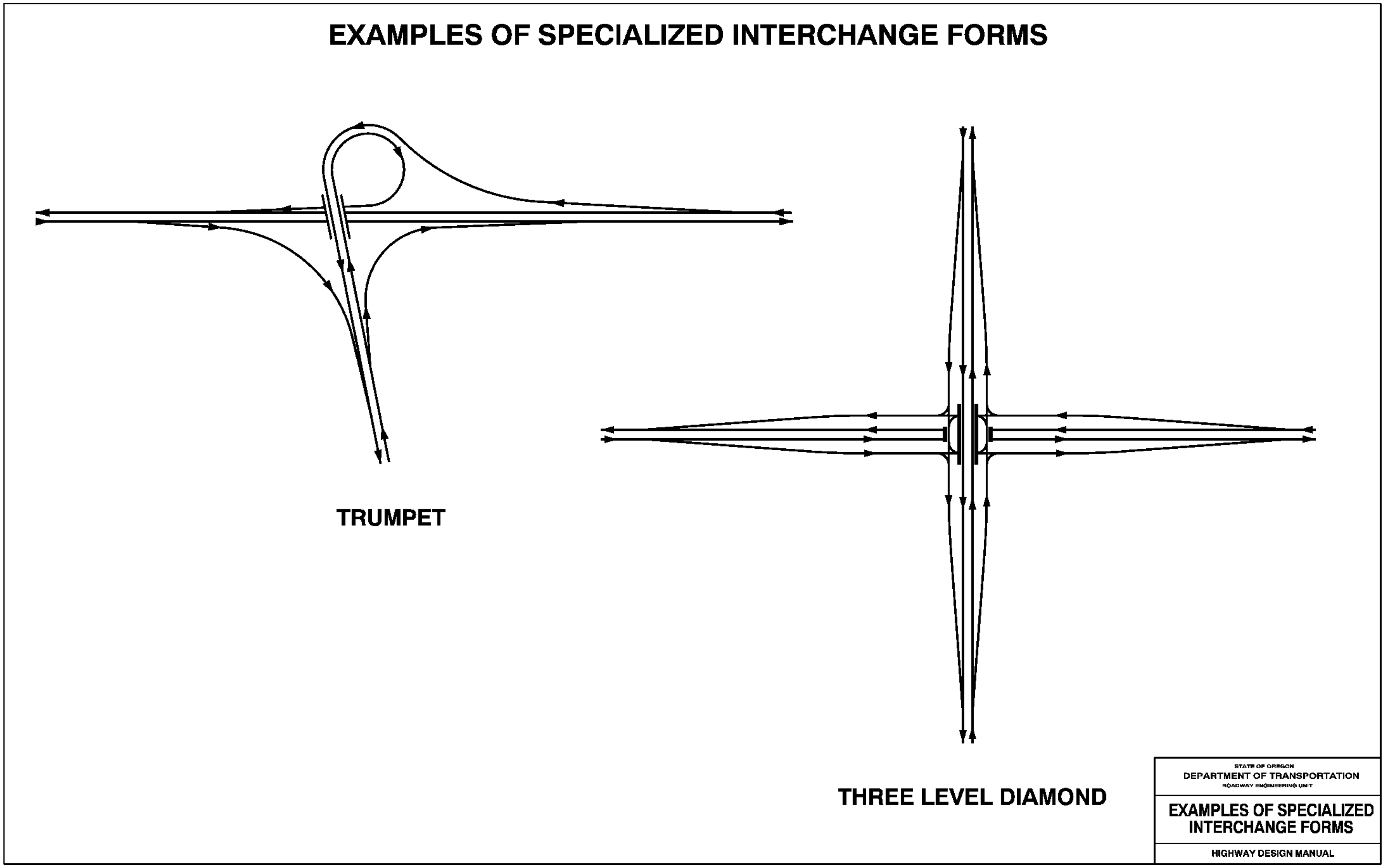


Figure 600-10: I-84 Exit 261 in La Grande

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. Adaptability/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. This approach provides for a smooth and logical transition from freeway speeds and conditions to the situation where drivers are dealing with an at grade intersection. Stepping speeds down makes sense to users and is relatively easy to negotiate. Although stopping sight distance is the minimum criteria, every effort should be made to improve on this – decision sight distance being the goal.***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.*** (See Figure 600-11.)

Terminal Areas should continue the “stepped down” approach for design speed (between 50 and 85% of the main transition curve). Refer to Figure 600-11, Figure 600-13, and Figure 600-14. 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 600-16.

**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

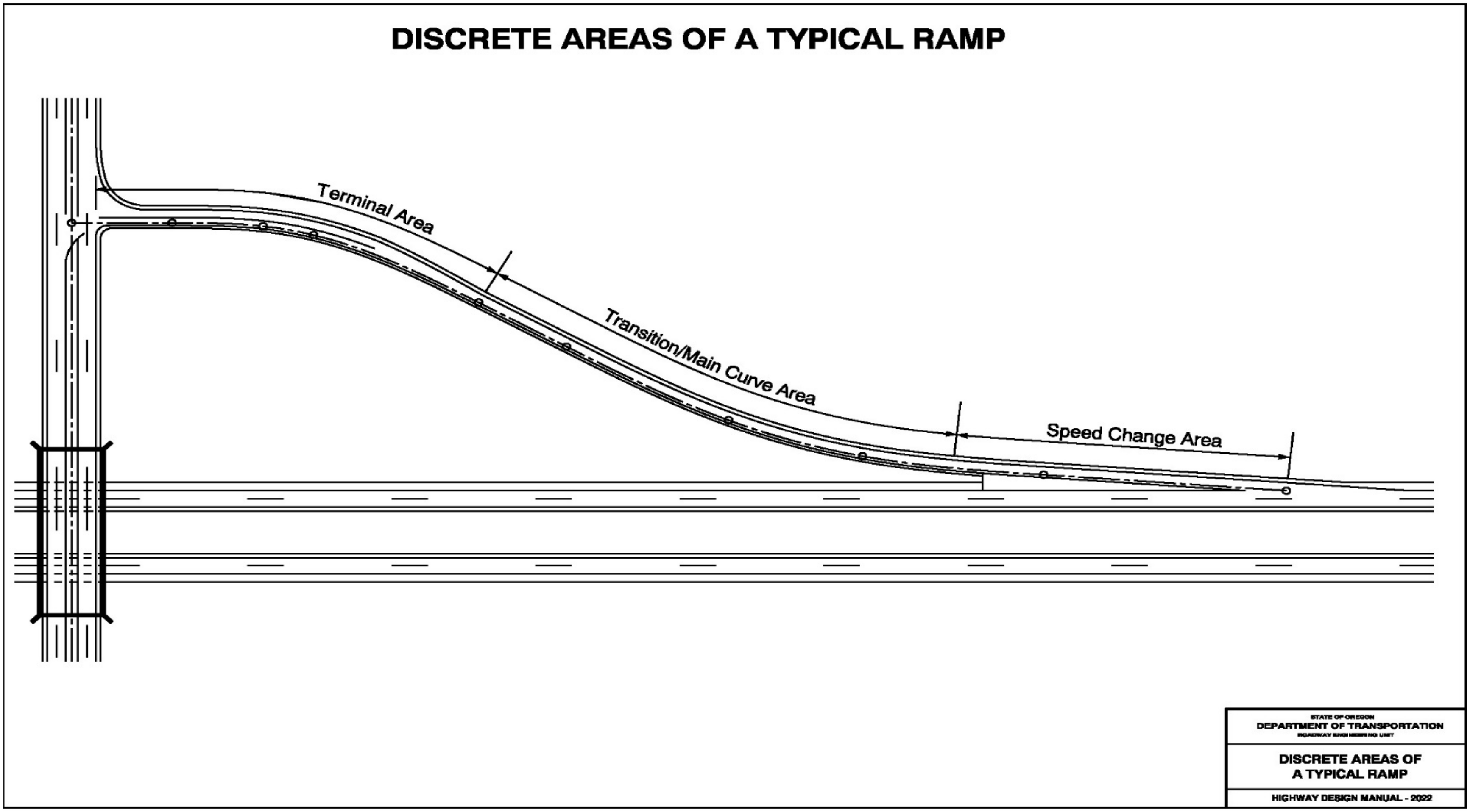


Figure 600-12 illustrates examples of different types of interchange ramps. Some types are only appropriate for non-freeway applications. Assuming adequate access control is in place, the other types can be adapted for non-freeway use as well.

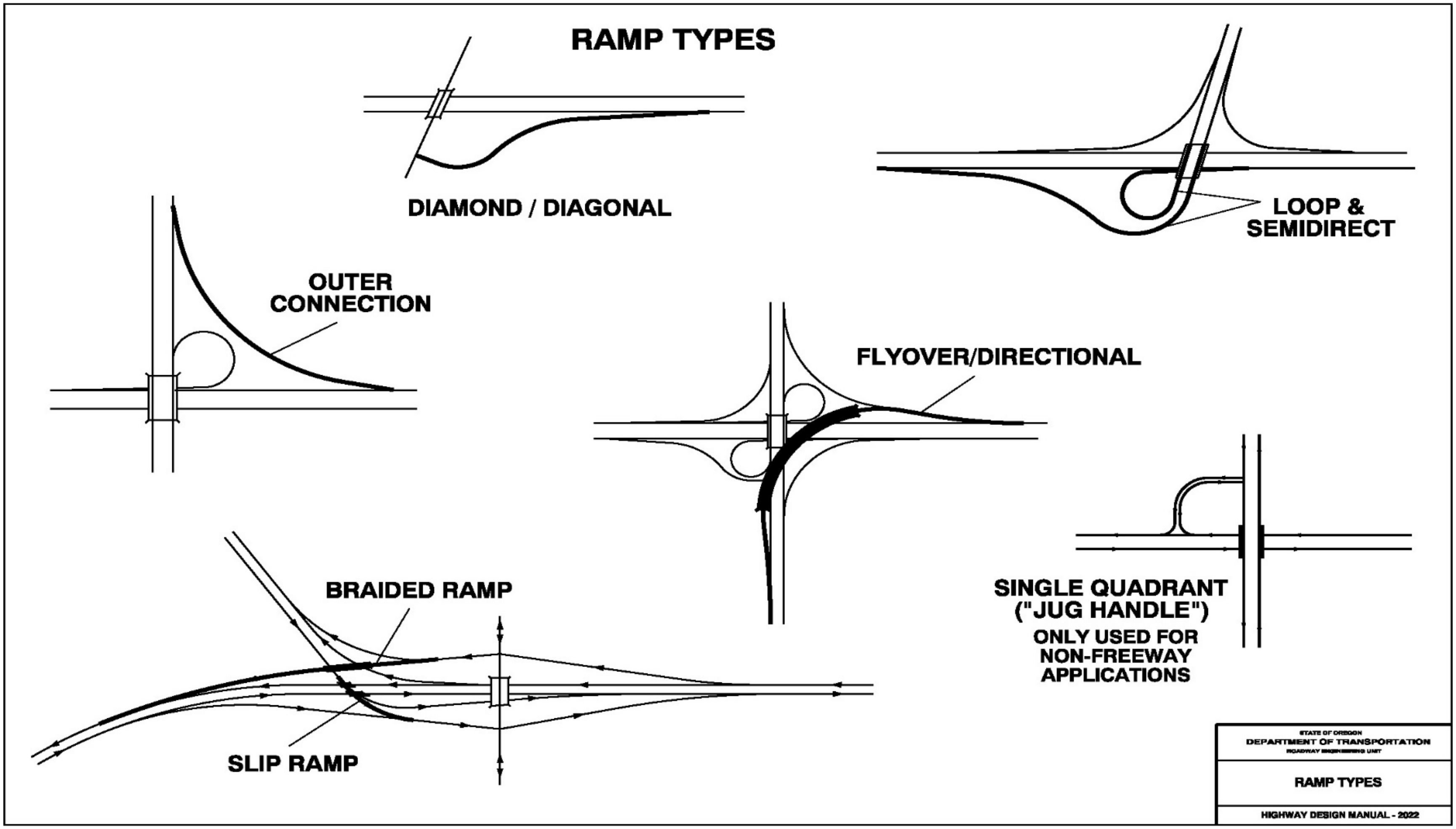
Interchange ramp designs need to provide flexibility for the future. This doesn't mean over-designing, just making sure that there is flexibility to deal with changing needs. **Providing additional deceleration length and at least 100' of tangent on the horizontal alignment between the main curve and 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

| Highway Design Speed (mph) | Desirable Ramp Design Speed (mph) | Minimum Ramp Design Speed (mph) |
|---|---|---|
| 50 | 45 | 25 |
| 55 | 45 | *30 |
| 60 | 50 | *30 |
| 65 | 55 | *35 |
| 70 | 60 | *35 |

NOTE:

* 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.***

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 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.

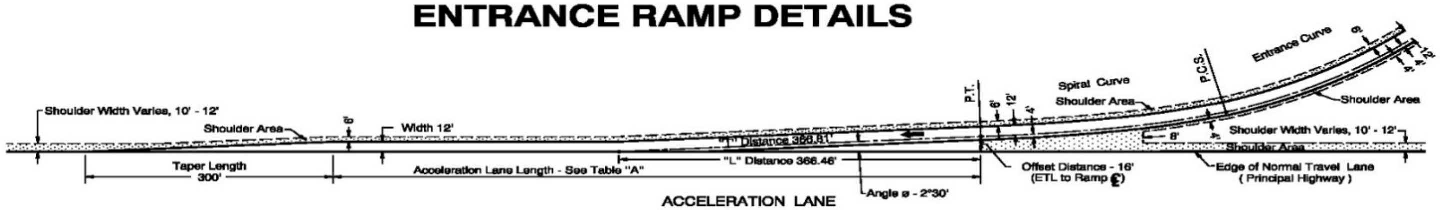
The deceleration and acceleration characteristics of trucks are quite different from the normal passenger vehicle. When there is significant truck traffic (over 20 trucks with 4 or more axles per hour), the minimum deceleration design lengths for trucks should be consistent with Figure 600-13. Due to 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




## TABLE "A"
## MINIMUM ACCELERATION LANE LENGTHS

| Design Speed of Turning 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.

## 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.

## 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 |

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

ENTRANCE RAMP DETAILS

HIGHWAY DESIGN MANUAL - 2022

Figure 600-14: Exit Ramp Details

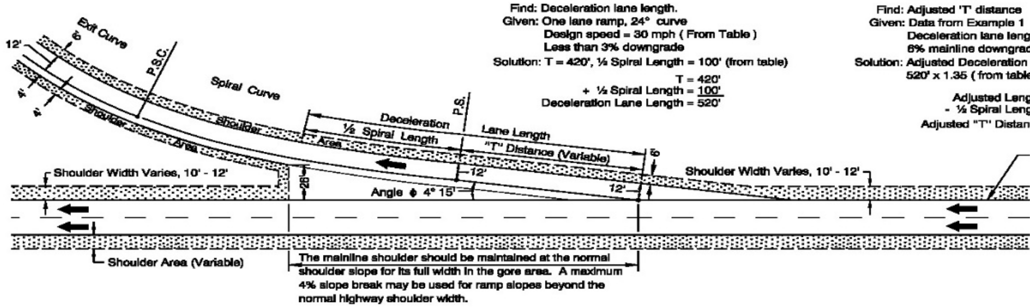
# EXIT RAMP DETAILS

**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'



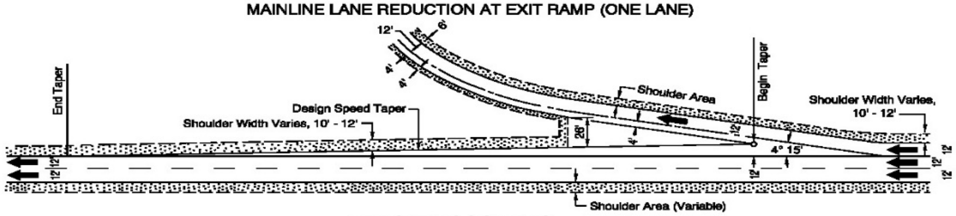

## MINIMUM DECELERATION LANE LENGTHS (1 LANE)

| 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 |

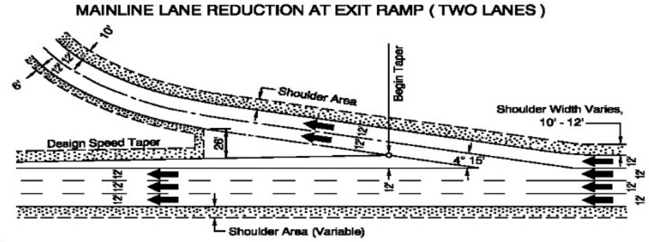
| Ratio of Length of Deceleration Lanes on Mainline Grade to Length on Level | | |
|---|---|---|
| Grade | Down | Up |
| 3% to 5% | 1 .20 | 0.9 |
| 5% and over | 1 .35 | 0.8 |

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 | "S" Value | "T"* Distance (ft.) | "T" TRUCK Distance (ft.) | 2 LANE (Highway Design Speed 70 mph) Spiral Length (ft.) | Spiral Parts "a" Value | "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

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Figure 600-15: Consecutive Entrance Ramps

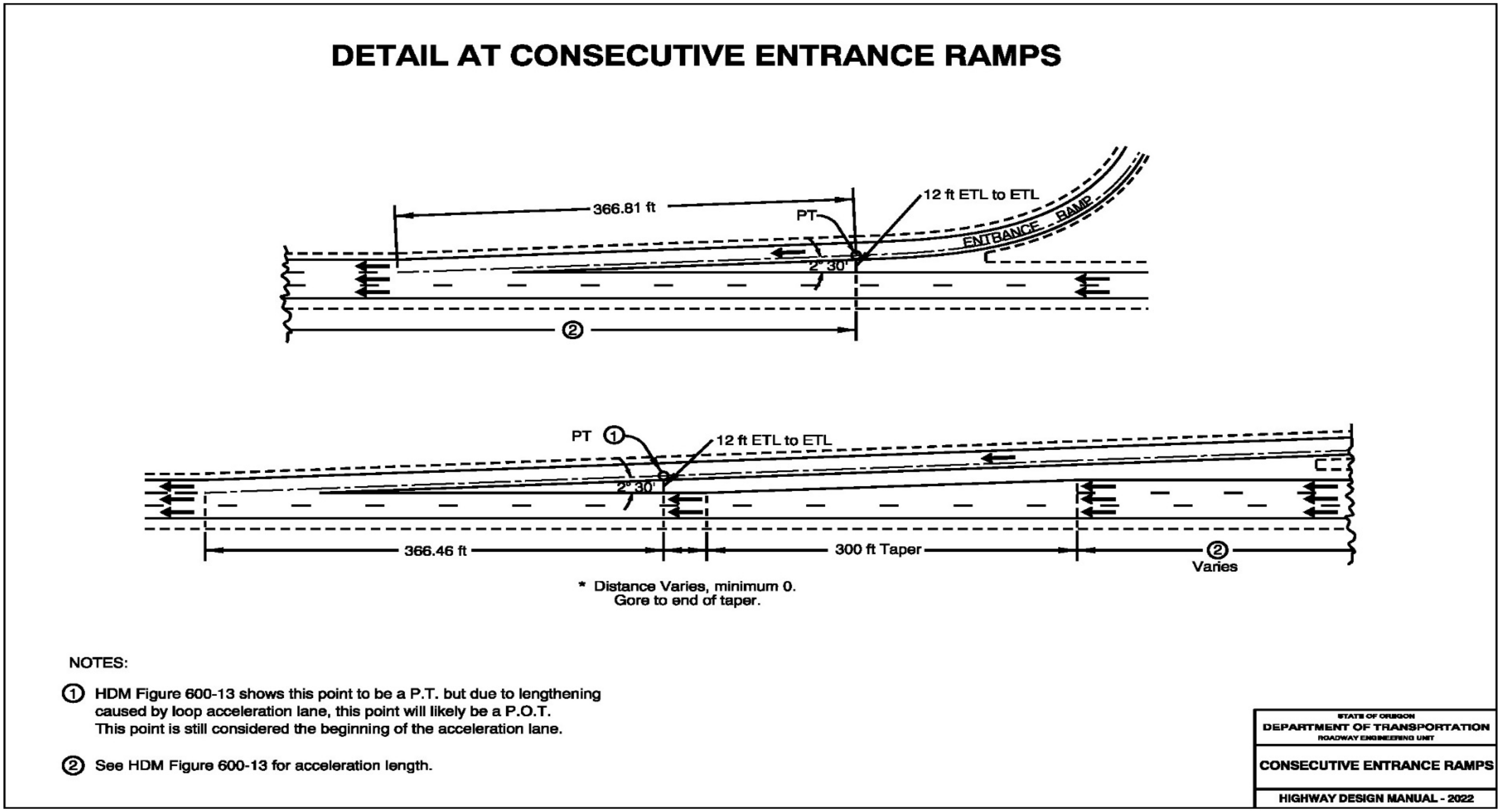
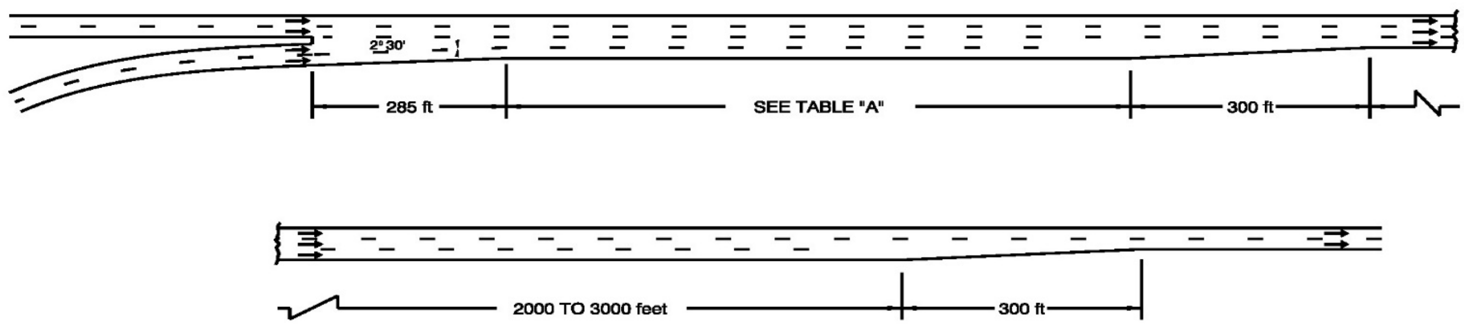


Figure 600-16: Two-Lane Parallel Entrance Ramp

## 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 feet ; this allows additional decision time for picking gaps.

NOTE: This is the standard two lane ramp configuration.

Two-Lane Tapered Entrances are NOT Considered Acceptable Configurations.

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TWO-LANE PARALLEL ENTRANCE RAMP

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# 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 Table 600-5. 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.

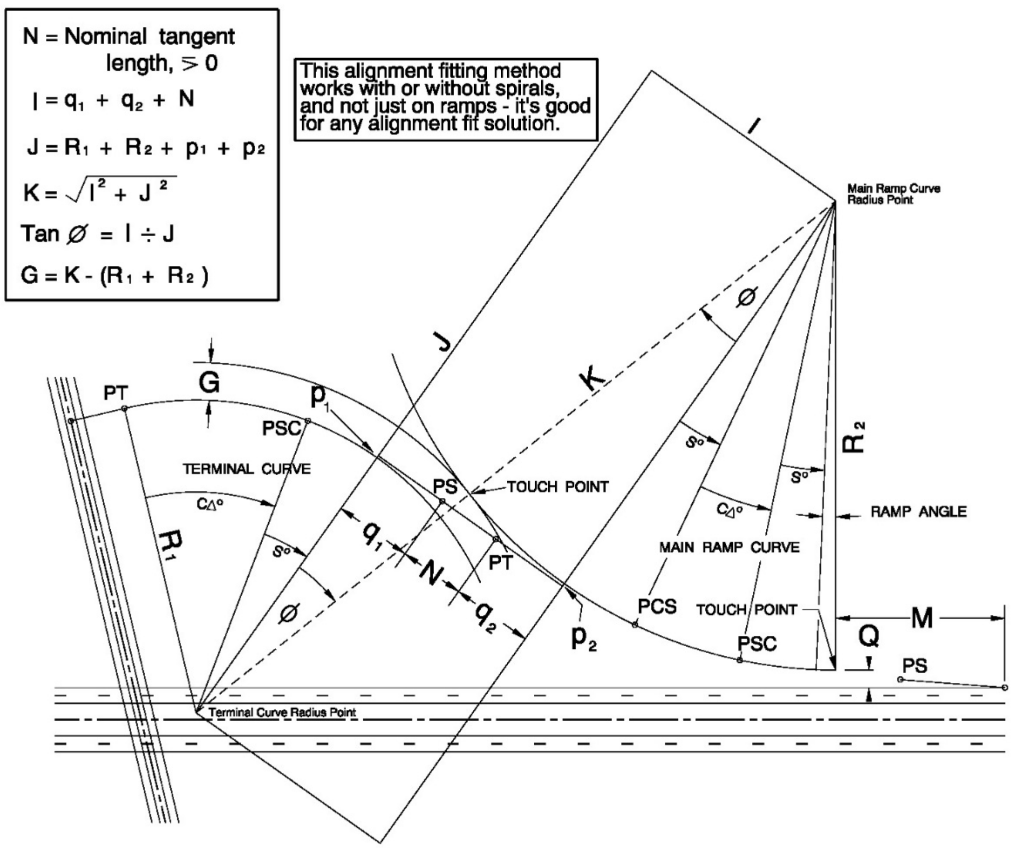
When one way, one-lane ramps exceed 1500 feet in length, consider adding a second lane to relieve congestion caused by slow moving or stalled vehicles. Steep grades and/or a high percentage of trucks may require an added lane on shorter ramps.

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 tools.

Figure 600-17: Ramp Alignment Fitting

## RAMP CURVE FITTING DETAIL




A.) Establish the location of the ramp terminal intersection with the crossroad. Refer to HDM Figure 600-23 (Diamond Interchange - Terminal Ramp Spread) and HDM Figure 600-24 (Detail at Ramp & Crossroad Intersection). When Loop Ramps are present refer to HDM Figures 600-36 & 600-37 (Loop Fitting Data), HDM Figure 600-34 (Partial Cloverleaf Intersection Detail) and Figure 600-35 (Folded Diamond Terminal Detail) to fix terminal location.

B.) Choose curves and tangency between them appropriate for the individual situation. Normally the Terminal Curve is designed to between 50 and 75% of the Main Curve design speed. The Main Curve design speed should be between 70 and 85% of the Thru Roadway design speed. The tangent length between curves is variable - strive for 100'.

C.) Having established the ramp terminal, and appropriate ramp curves, the next steps are:

1.) Establish radius point of terminal curve.

2.) Look up values for $p_1$ & $q_1$ from HDM Fig. 600-25 (for the Terminal Curve) and $p_2$ & $q_2$ from HDM Figure 600-18/600-19 (For the Main Ramp Curve). Q & M are also found in Figure 600-18/600-19.

3.) Compute value of "K".

4a.) Establish touch points for main ramp curve from the formula "K - R = distance from radius point of terminal curve" and "Q = distance from edge of travel lane".

4b.) Establish radius point of main ramp curve "K" distance from radius point of terminal curve and "Q + $R_2$" from edge of travel lane.

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**RAMP CURVE FITTING DETAIL**

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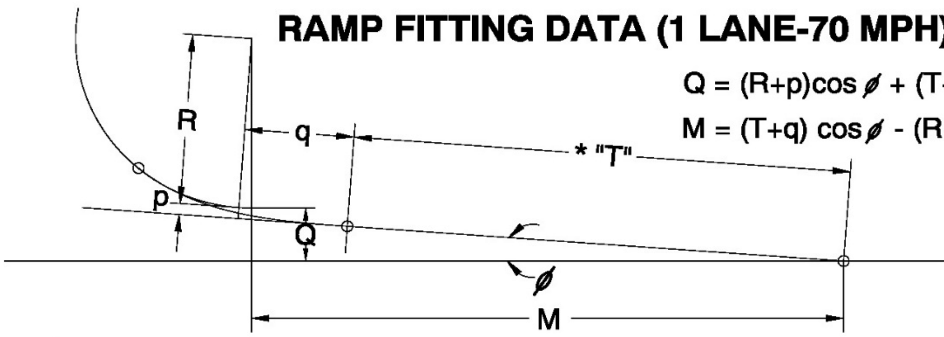
Figure 600-18: Alignment Fitting Data 70 MPH

## RAMP FITTING DATA (1 LANE-70 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 70 MPH | | | | | | | | | EXIT ø = 4°15' | | | ENTRANCE ø = 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 | 441.2085 | 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 | 99.8286 | 340 | 35.1473 | 405.6771 | 23.7060 | 446.8046 | 1000 |
| 40 | 14 | 409.26 | 200 | 11.5 | 7.00 | 14.00 | 4.0638 | 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 |

* NOTE: Where exit ramp "T" distances are variable for grades in excess of 3% see HDM Figure 600-14 to calculate "T" distance.

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**RAMP FITTING DATA (1 LANE - 70 MPH)**

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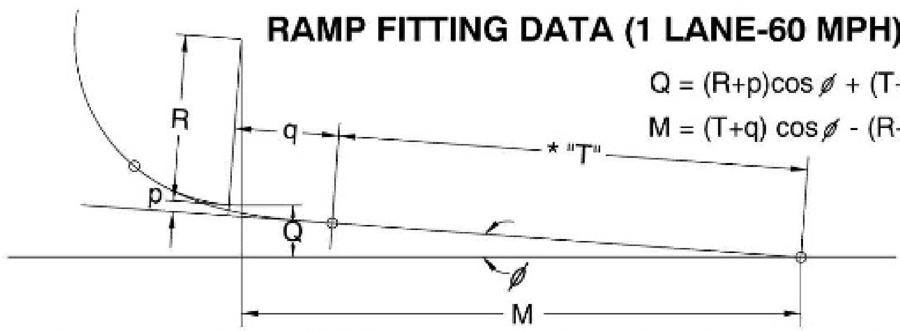
Figure 600-19: Alignment Fitting Data 60 MPH

## 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 ∅ = 4° 15' | | | ENTRANCE ∅ = 2°30', T= 366.61 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 99.9959 | 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 | 2.4985 | 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

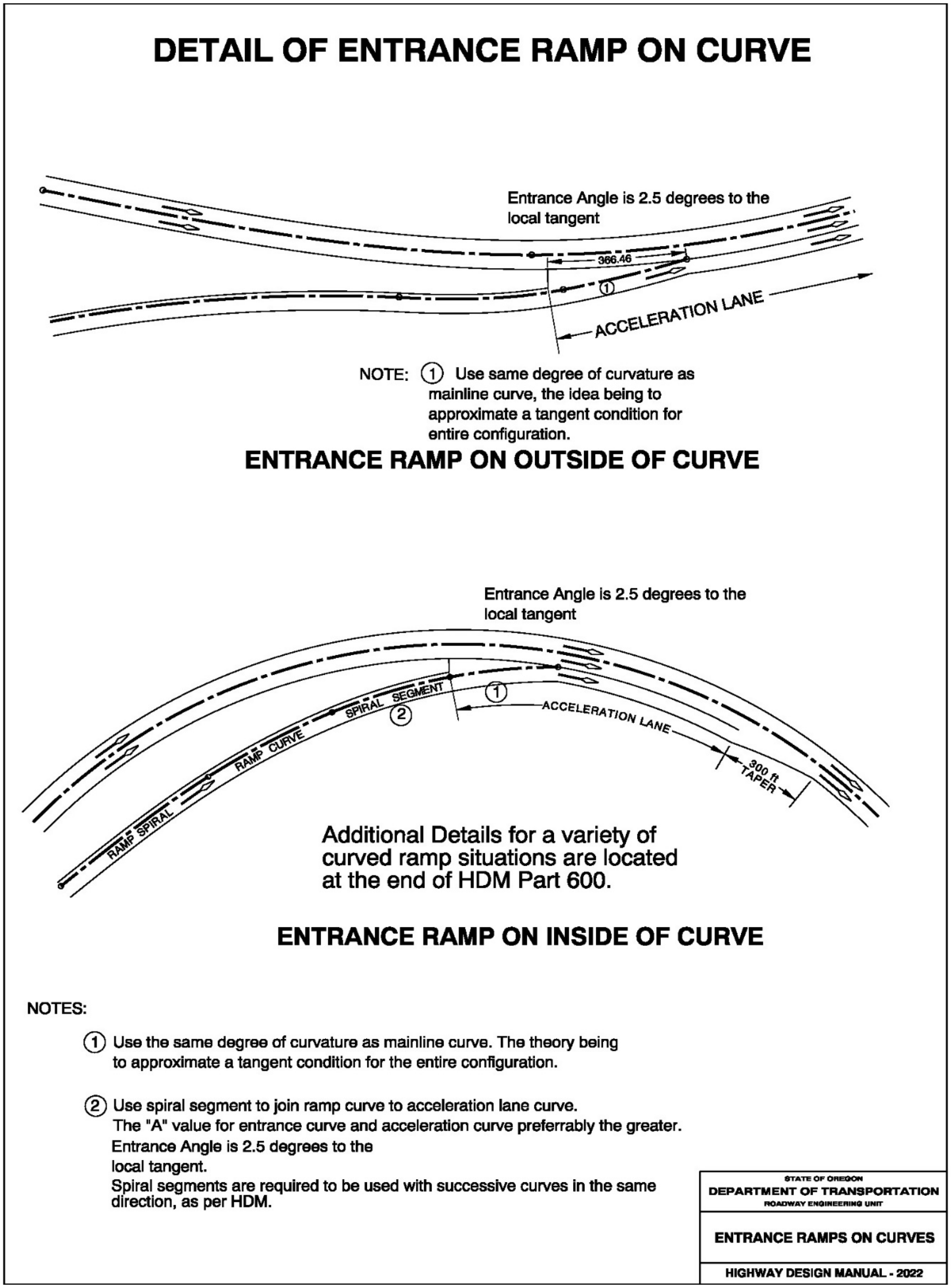
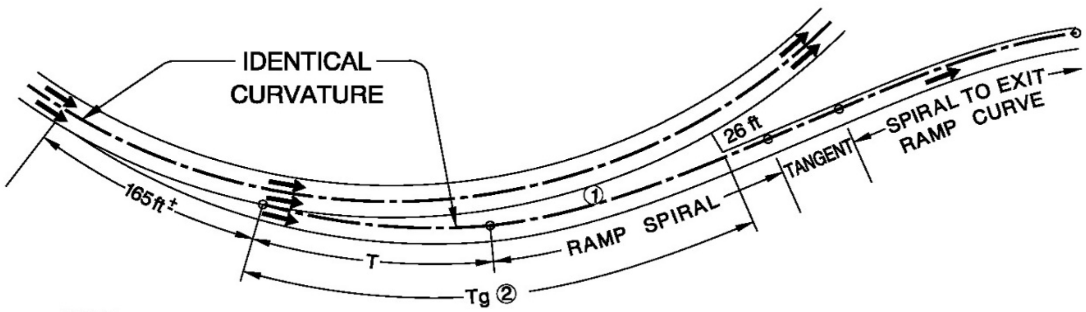


Figure 600-21: Exit Ramps on Curves

## DETAIL OF EXIT RAMP ON CURVE

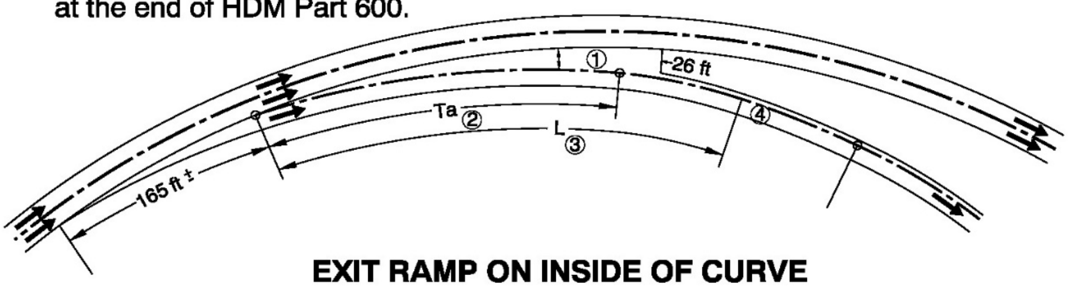



**NOTE:**
**The theory behind this is to emulate a tangent condition for the entire configuration.**

1. This angle is to be 4° 15' to local tangent.
2. 'Tg' should approximate distance from takeoff to gore on tangent section (approximately 405 ft)

**EXIT RAMP ON OUTSIDE OF CURVE**

Additional Details for a variety of curved ramp situations are located at the end of HDM Part 600.




**EXIT RAMP ON INSIDE OF CURVE**

NOTES:

① This angle is to be 4° 15' to local tangent.

② 'Ta' distance will be the 'T' distance from table for exit curve plus the difference between the length of spiral specified for the exit curve and the length of the spiral segment.

EXAMPLE:

Given: 3° mainline curve, 12° exit curve
with 240 ft Sp. A = 5.0, & T = 320 ft
'Ta' = 320 ft + 240 ft (Sp.) - 150 (Sp. Seg.) = 410 ft

③ "L" deceleration lane length is the "T" distance from the table for exit curve plus ½ length of spiral normally used. To adjust "Ta" for grade correction using above data see example.

EXAMPLE:

Given: T = 320 ft, Ta = 410 ft, ½ Sp. = 120 ft
grade = 4%, factor = 1.2
320 ft (T) + 120 ft (½ Sp.) = 440 ft x 1.2 = 528 ft (round to 530)
"Ta" = 530 ft - 440 ft + 410ft = 500 ft

④ Use spiral segment to join exit curve to curve of deceleration lane, which is the same as the mainline curve. The "a" value may vary between designated "a" values for exit curve and deceleration curve, preferably the greater.

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EXIT RAMPS ON CURVES

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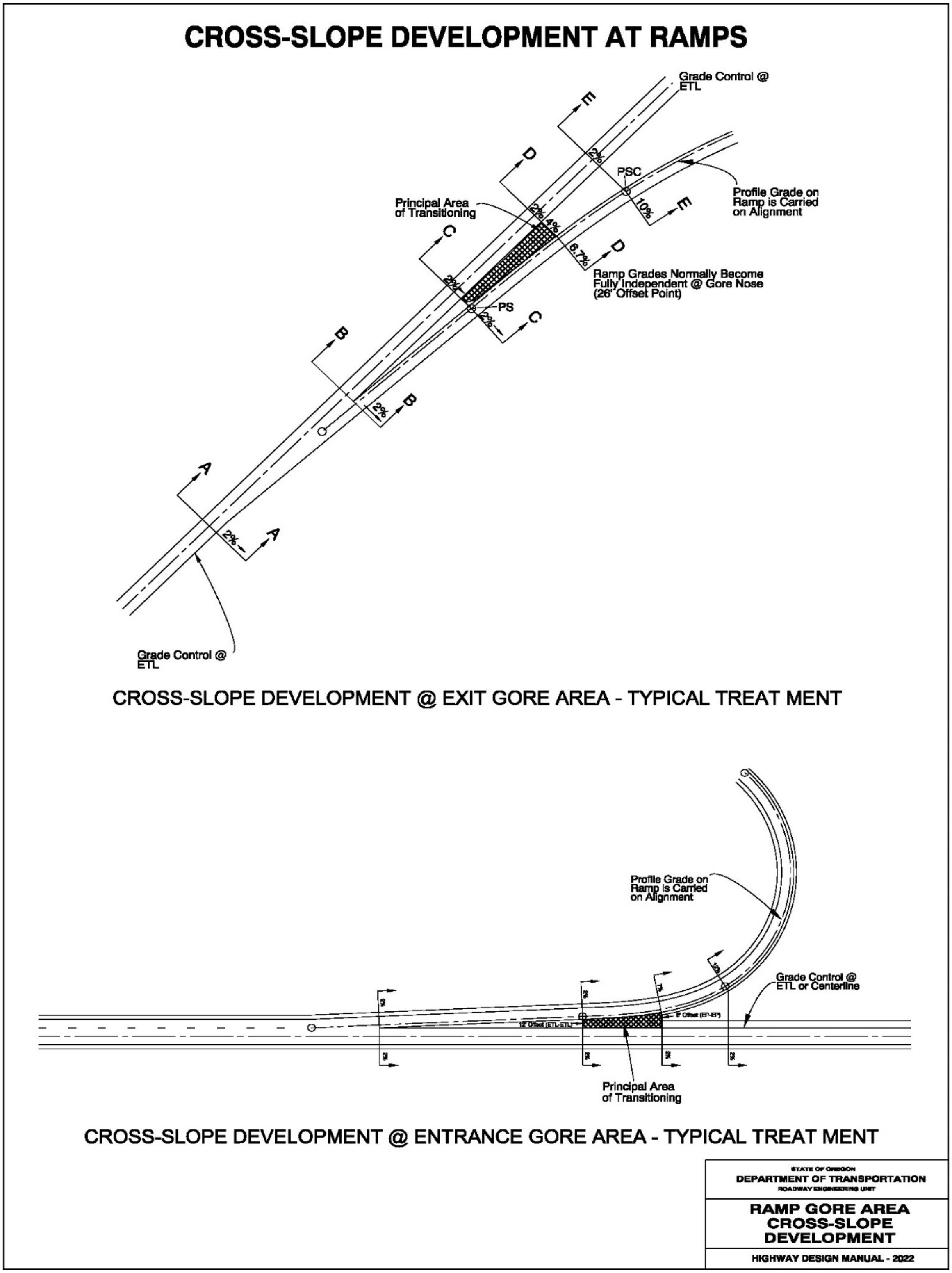
Figure 600-22: Cross Slope Development at Gore Areas



# 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 10-98 to

10-102, 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 | X-X MIN 5-Lane |
|---|---|---|---|---|---|---|
| 25 | 195 | 100 | 155 | 100 | 610 | 510 |
| 30 | 195 | 100 | 155 | 100 | 610 | 510 |
| 35 | 250 | 110 | 155 | 100 | 600 | 520 |
| 40 | 305 | 120 | 200 | 100 | 680 | 590 |
| 45 | 370 | 135 | 250 | 100 | 765 | 675 |
| 50 | 435 | 145 | 305 | 150 | 965 | 875 |
| 55 | 510 | 160 | 360 | 150 | 1060 | 970 |
| 60 | 595 | 170 | 425 | 150 | 1180 | 1090 |
| 65 | 680 | 180 | 495 | 150 | 1310 | 1220 |
| 70 | 680 | 180 | 570 | 150 | 1460 | 1370 |

## 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. (Based on 2018 AASHTO, Table 3-1)

L = Length of storage determined by storage analysis - Minimums shown.

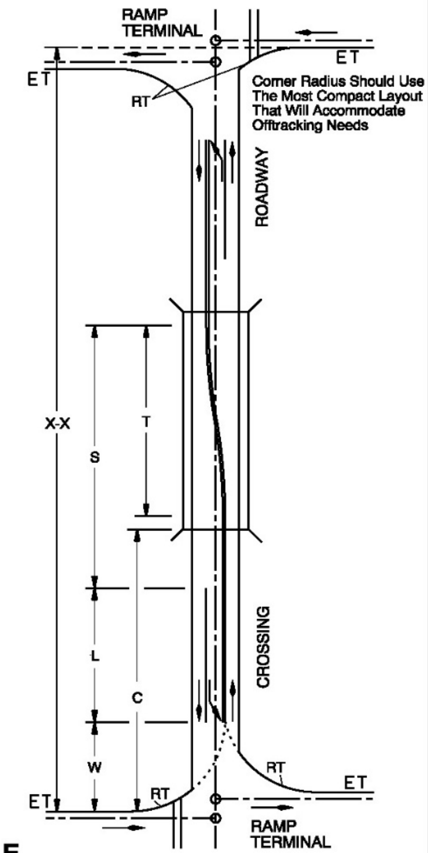
W = 100' for 3-lane @ 90° in tangent section. 55' for 5-lane @ 90° in tangent section. W determined by where turning vehicle's off-track crosses edge of left-turn lane (See figure right). This is where stop bar should be placed.

X-X = Minimum distance between the left edges of travel of the ramp terminals (see diagram right). X-X = 2(W+L+S)-T ; where S ≥ T. Else X-X = 2(W+L)+T.

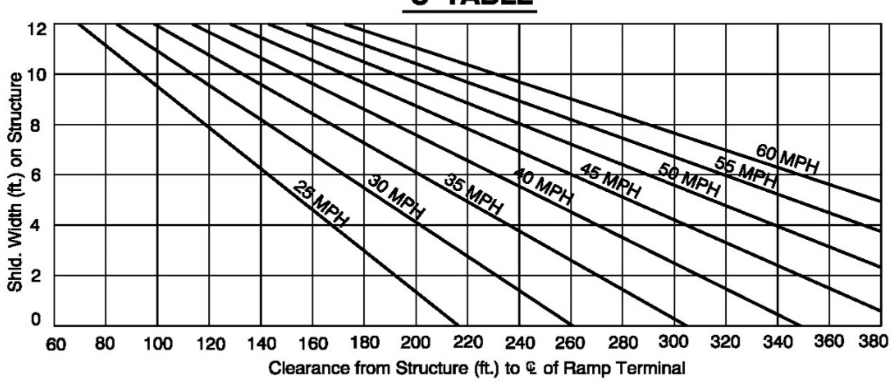
C = Combined horizontal and vertical sight distance clearance from the structure. Typically 200 feet or more.

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 horizontal stopping sight distance values for the design speed in a tangent section.
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.

ORIGINAL SOURCE: ODOT PRELIMINARY DESIGN

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INTERCHANGE RAMP SPREAD

HIGHWAY DESIGN MANUAL - 2022

Figure 600-24: Detail at Ramp/Crossroad Intersection

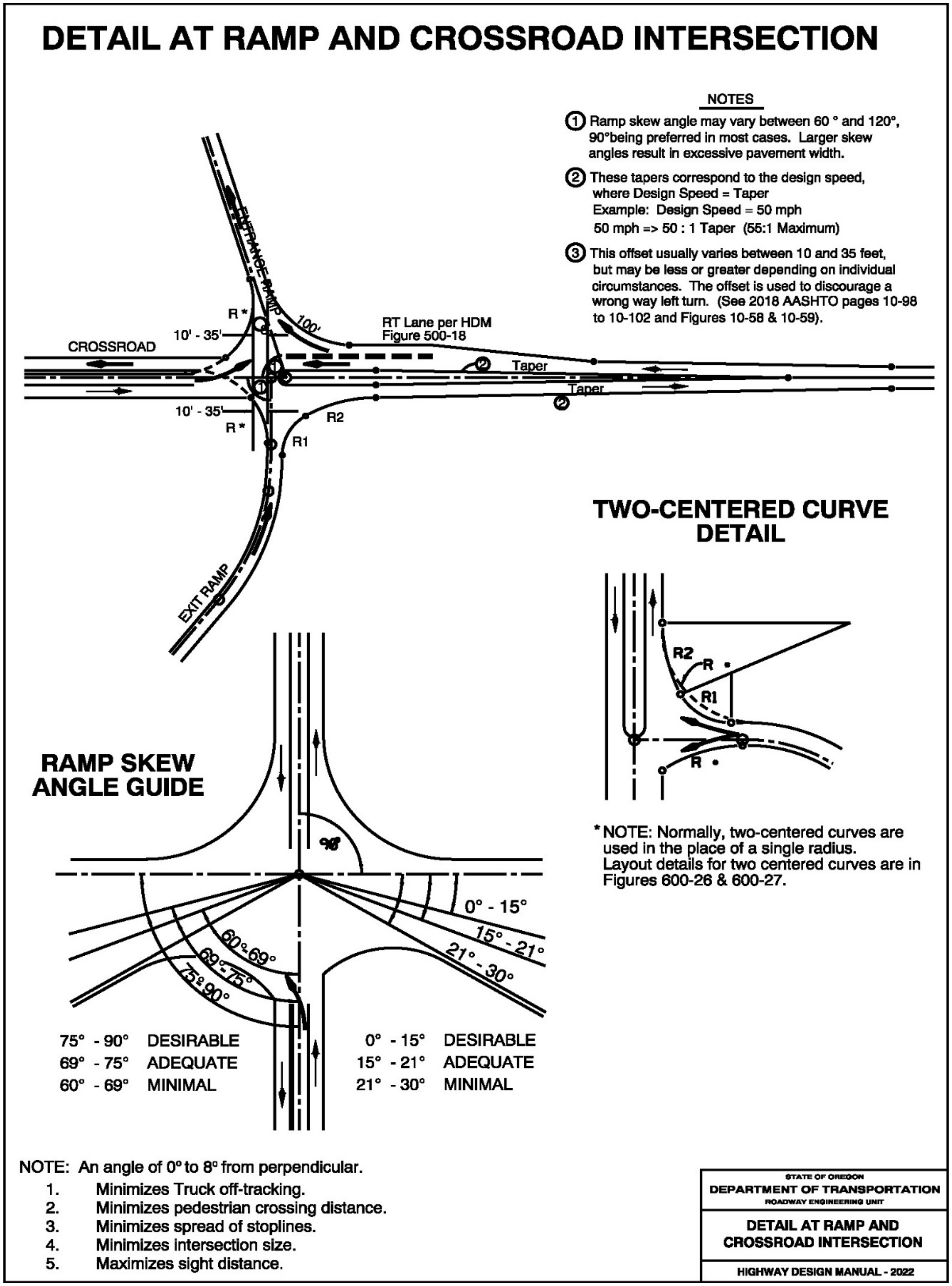
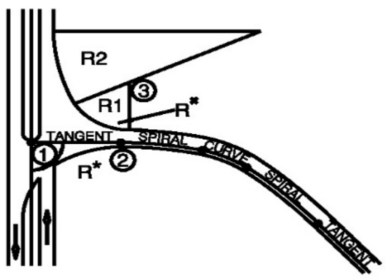
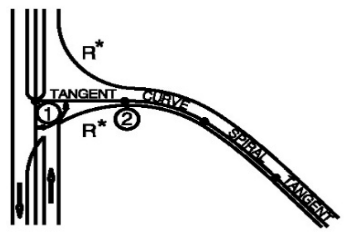


Figure 600-25: Terminal Curve Design Option

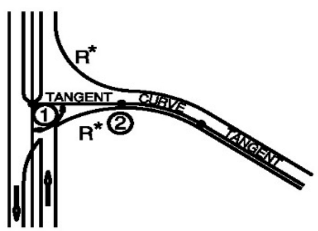
## ACCEPTABLE TERMINAL CURVE DESIGNS
### in descending order of preferrence



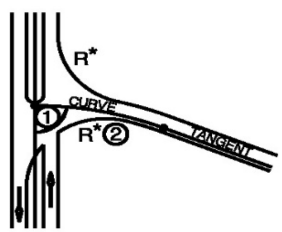

OPTION 1




OPTION 2




OPTION 3

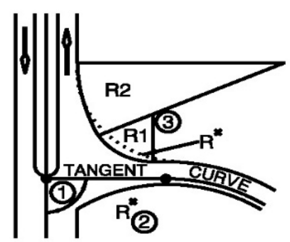



OPTION 4

### 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 HDM Figures 600-26 & 600-27 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.

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|---|
| RAMP TERMINAL CURVE DESIGN |
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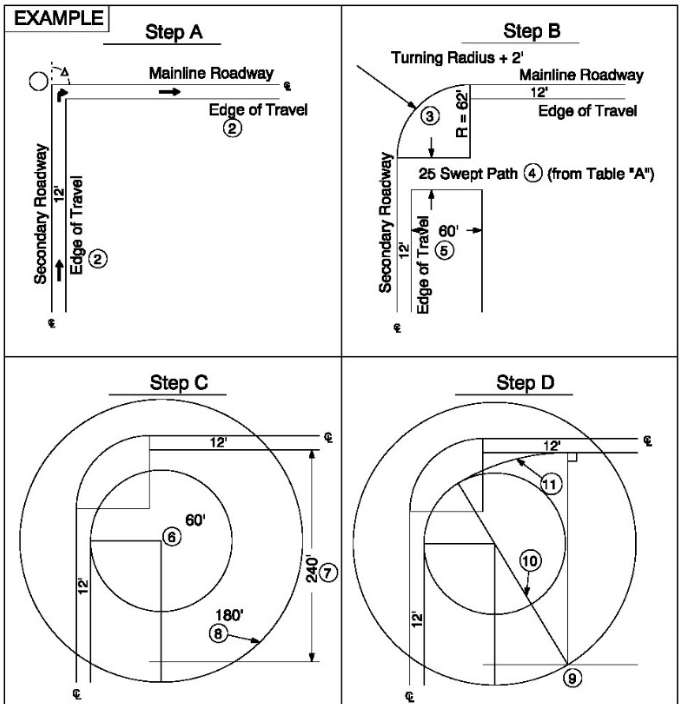
**Freeway ramp terminals, and intersections pre-approved for interstate trucks shown on Route Map 7 (Route Map 7 can be found at:** [http://www.odot.state.or.us/forms/motcarr/od/8104.pdf](http://www.odot.state.or.us/forms/motcarr/od/8104.pdf)**) at major truck use locations, shall accommodate the current 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.

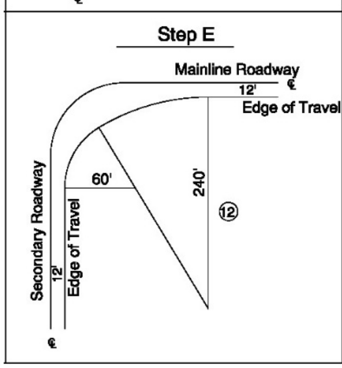
TABLE "A"

| 60' Turning Radius | |
|---|---|
| Delta | Swept Path Distance + 2' |
| $60^{\circ}$ | 25.0 |
| $75^{\circ}$ | 27.3 |
| $90^{\circ}$ | 29.3 |
| $105^{\circ}$ | 31.0 |
| $120^{\circ}$ | 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.

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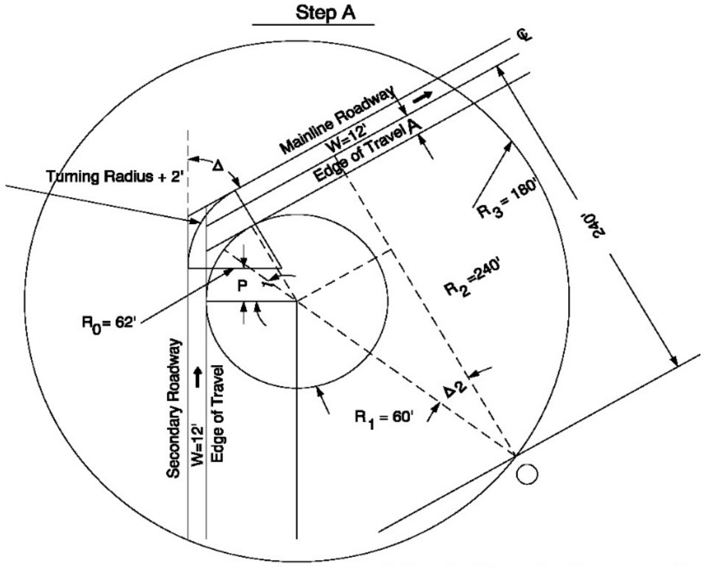
GRAPHICAL SOLUTION
TWO-CENTERED
CORNER RADII

HIGHWAY DESIGN MANUAL - 2022

Figure 600-27: Two Centered Corner Mathematical Layout

# TWO CENTERED CURVE LAYOUT

Step A



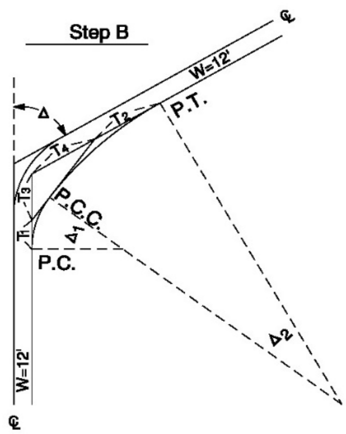

This method uses a 60', 240' radius compound curvature, assuming a 60' turning radius.

The 60', 240' radius curve combination will work in most situtations.

If the turning area or turning radius needs to be changed, then use truck turning software 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.

Step B




Follow the illustration for the graphic method for layout of the two centered curves. Step A will be done using these equations below to calculate point ⑨.

A = distance at right angle parallel from edge of travel to 60' radius curve.

P = Swept Path + 2'

W = Lane width

R = Radius

R = R - R

Step A

1) $$A = \left(P + \left[(R_0 - R_1)\ \text{Tan}\ \frac{\Delta}{2}\right] - \frac{}{\text{Tan}\Delta}\right) \text{Sin}\ \Delta = 14.9186'$$

2) $$\Delta_2 = \text{arc Cos}\ \frac{R - (R + A)}{} = 23\ 29'\ 30''$$

$$\Delta_1 = \Delta - \Delta$$

Step B

1) $$T_1 = R_1 \tan \frac{\Delta_1}{2}$$

2) $$T_2 = R_2 \tan \frac{\Delta_2}{2}$$

3) $$T_3 = (T_1 + T_2)\ \frac{\text{Sin}\ \Delta_2}{\text{Sin}\ (180 - \Delta)}$$

4) $$T = T_3\ \frac{\text{Sin}\ \Delta_1}{\text{Sin}\ \Delta_2}$$

$T_1 + T_3$ = distance from intersection of edge of travel to P.C. of initial two centered curve.

$T_2 + T_4$ = distance from intersection of edge of travel to P.T. of final two centered curve.

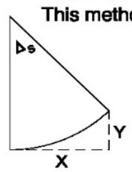
Note: Table "A" based on Interstate Design Vehicle 3S2, C-75, WB-67.

TABLE "A"

| 60' Turning Radius | |
|---|---|
| Delta | Swept Path Distance + 2' |
| Δ | P |
| 60° | 25.0 |
| 75° | 27.3 |
| 90° | 29.3 |
| 105° | 31.0 |
| 120° | 32.3 |

TANGENT LAYOUT OF CURVE

This method will allow to layout curves, if obstructions prevent setting radius points.




$$Y = R - \sqrt{R^2 - X^2}\ ,\quad R - R\ \text{COS}\ \Delta_s$$

$$X = \sqrt{2RY - Y^2}\ ,\quad R\ \text{SIN}\ \Delta_s$$

$$R = (X^2 + Y^2) - 2Y$$

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MATHEMATICAL SOLUTION TWO-CENTERED CORNER RADII

HIGHWAY DESIGN MANUAL - 2022

Ramp intersection design simultaneously needs to provide for design vehicle movements, pedestrian and bike crossings, good lines of sight, and appropriate traffic control devices. Transit stops are also a consideration, primarily in urban contexts.

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, but other geometric design and lower cost measures are available to help minimize wrong way potential. Studies have consistently shown that impaired and older drivers are overrepresented in wrong way type incidents. Measures to reduce risk need to account for this. Although it's often not possible to determine precisely where drivers make mistakes, certain interchange forms, such as partial service interchanges, non-freeway directional interchanges, and cloverleafs/folded diamonds with exit loops, may create driver confusion and increase wrong way risks. Reconfiguring interchanges is often costly and sometimes infeasible. Lower cost measures, such as increased lighting, lane extension markings (providing more positive guidance), oversize and low mounted "Do Not Enter" and "Wrong Way" signs, and the use of raised traffic separators are demonstrated effective countermeasures. Providing decision sight distance and appropriate signing in advance of the maneuver area can help reduce risks as well. The use of roundabout intersection control when appropriate is also a proven wrong way movement countermeasure. Refer to "*AASHTO 2018 - Pages 10-98 thru 10-102*" for examples and more detailed discussion of how geometric design can help reduce wrong way movement issues. When designing partial cloverleaf and folded diamond intersections with crossroads, these ideas are especially helpful.

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 600-29 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 600-28: Maximum I.D.V. Swept Path

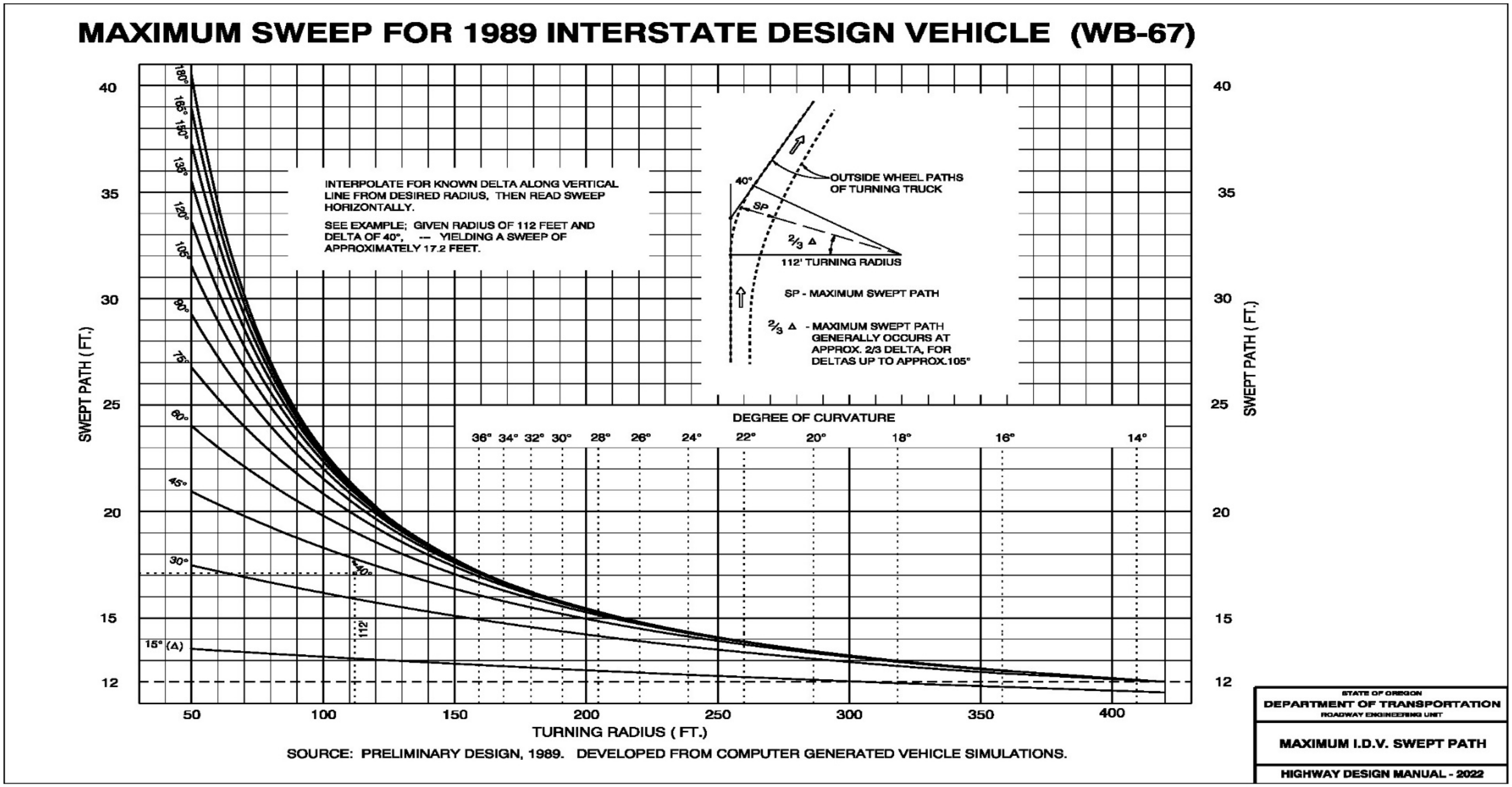
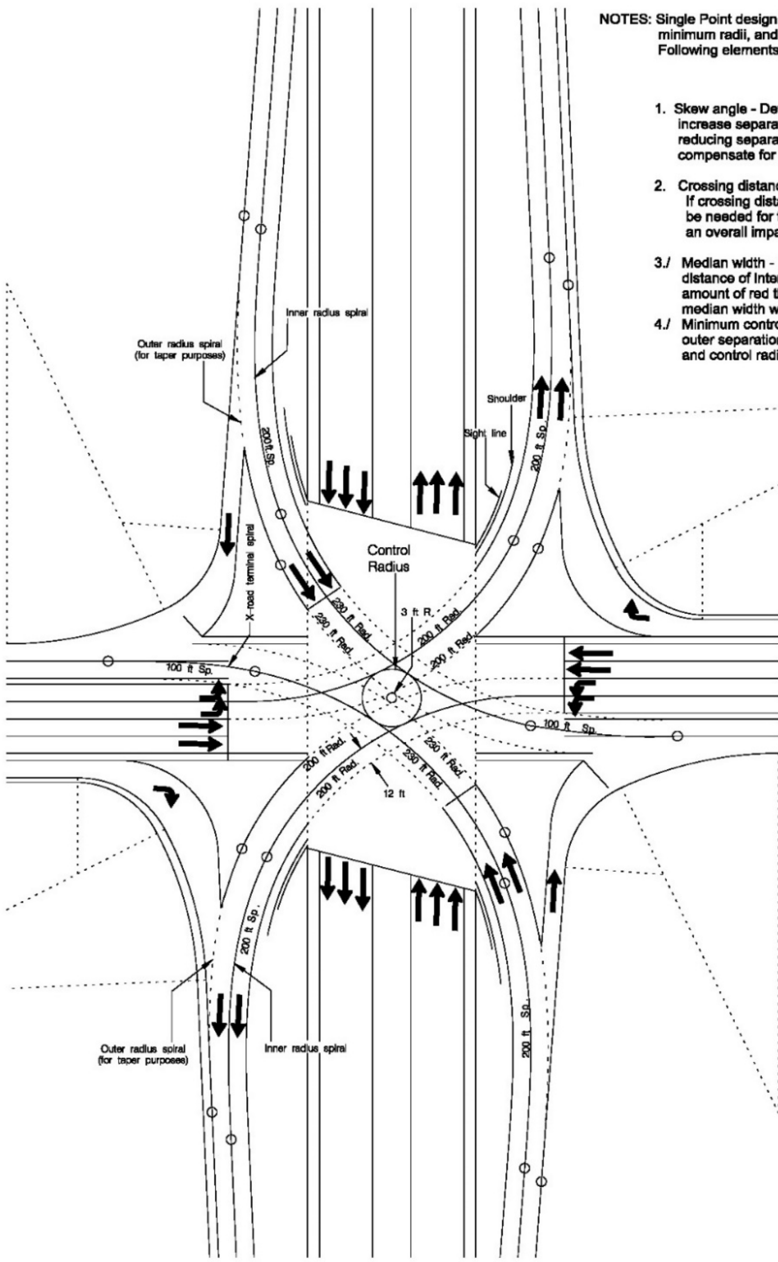


Figure 600-29: Minimal Single Point Intersection Details

## MINIMUM DESIGN VALUES FOR SINGLE POINT INTERSECTION

NOTES: Single Point design based on 90 degree intersection angle, minimum radii, and no superelevation.
Following elements are critical to proper design:

1. Skew angle - Deviation from 90 degree skew angle will increase separation between some ramps and mainline while reducing separation on other ramps(Radii must change to compensate for separation).
2. Crossing distance - Critical to coordinate with traffic analysis. If crossing distance is too great, additional red time may be needed for traffic to clear intersection. This may have an overall impact on the effectiveness of the design.
3./ Median width - Increased median width will allow crossing distance of intersection to be reduced. This will assist in amount of red time needed to clear intersection. Minimum median width will cause maximum crossing distance.
4./ Minimum control radii (15 ft -12 ft lane width, 3 ft outer separation) - Ramp curvature will affect swept path and control radii.




### MINIMUM VALUES FOR DESIGN

| Design Speed | Stopping Sight Distance | Inner X-road Radius | Inner X-road Terminal Spiral | Outer X-road Radius | Inner Ramp Radius | Outer Ramp Radius | Truck Sweep | Control Radius |
|---|---|---|---|---|---|---|---|---|
| 25 mph | 150 ft | 200 ft | 100 ft | 200 ft | 230 ft | 230 ft | 15.5 ft | 20 ft |

Length of inner radius spirals on outside terminals are 200 ft.
Length of outer radius spirals on outside terminals are determined by measured "p" distance.
Inside lanes are all 12 ft.

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MINIMUM DESIGN VALUES FOR SINGLE POINT INTERSECTION

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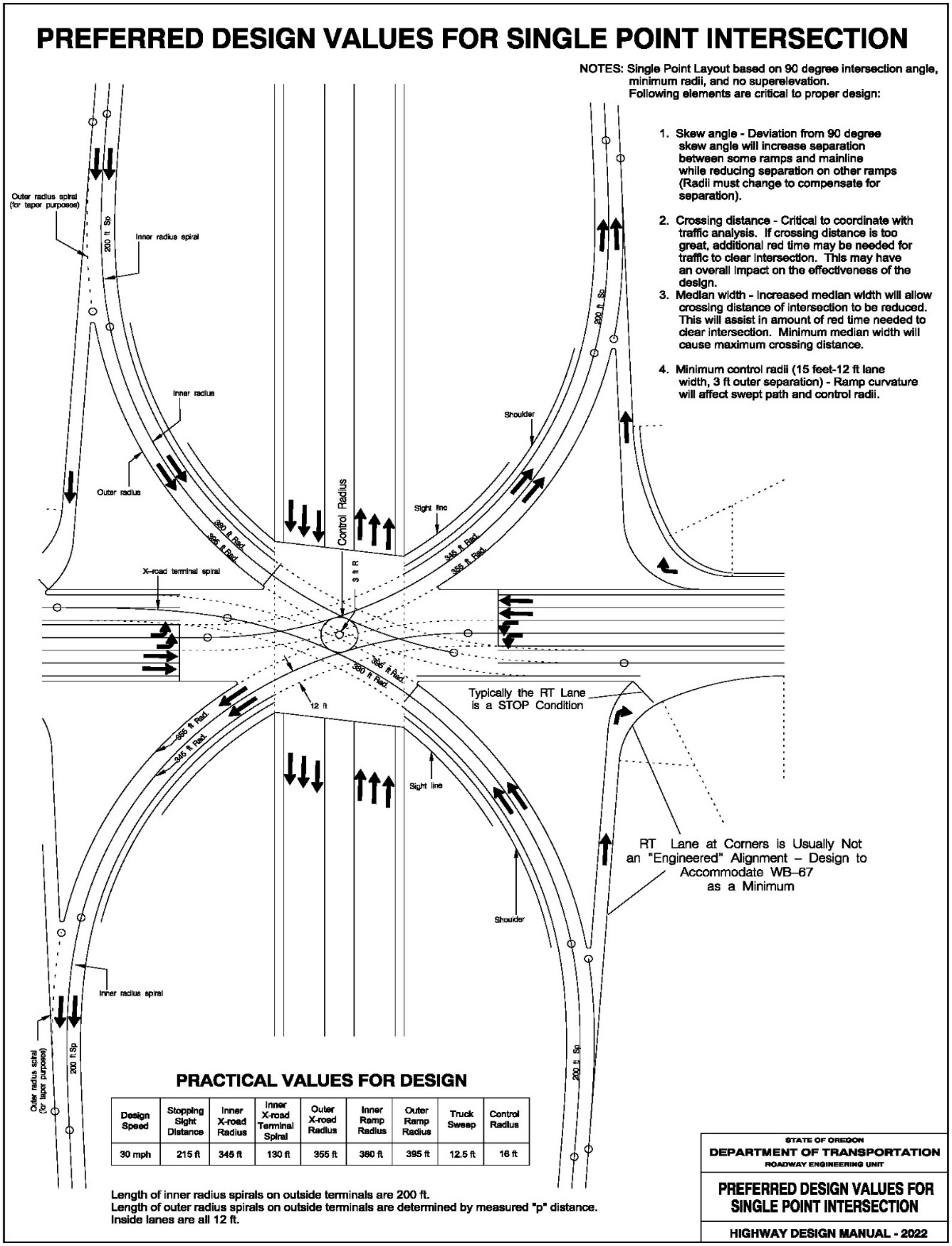
Figure 600-30: Preferred Single Point Intersection Details




| Design Speed | Stopping Sight Distance | Inner X-road Radius | Inner X-road Terminal Spiral | Outer X-road Radius | Inner Ramp Radius | Outer Ramp Radius | Truck Sweep | Control Radius |
|---|---|---|---|---|---|---|---|---|
| 30 mph | 215 ft | 345 ft | 130 ft | 355 ft | 380 ft | 395 ft | 12.5 ft | 16 ft |

# 605.8 Ramp Meters

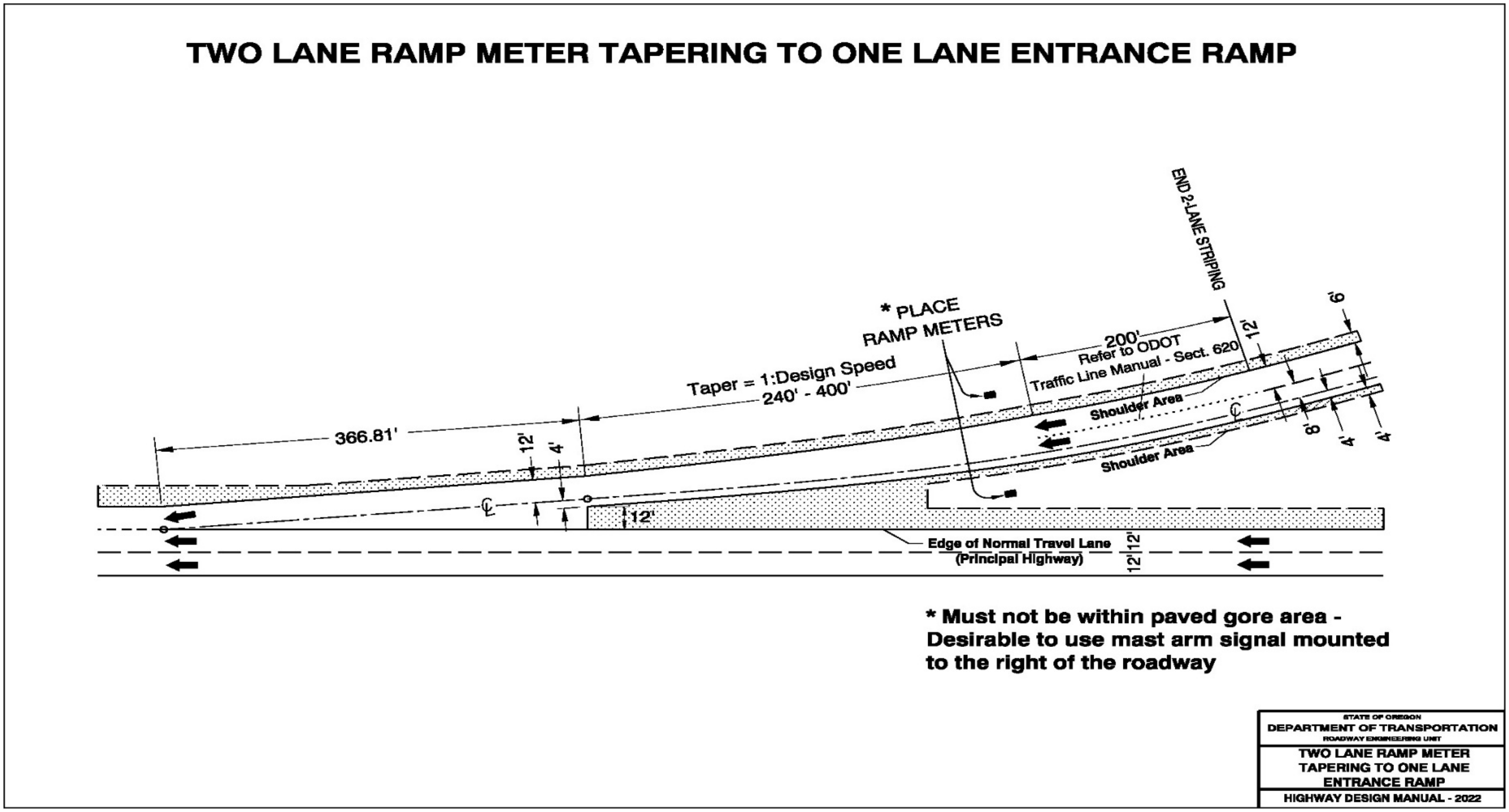
In highly congested areas, typically urban, the use of ramp meters may be beneficial to freeway traffic operations. Ramp meters reduce merge area turbulence and regulate total freeway flow through downstream bottlenecks. **The Traffic-Roadway Section should be contacted when ramp meters are being considered 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.

Figure 600-31: Two-Lane Ramp Meter with Tapering to One-lane Entrance Ramp



# 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

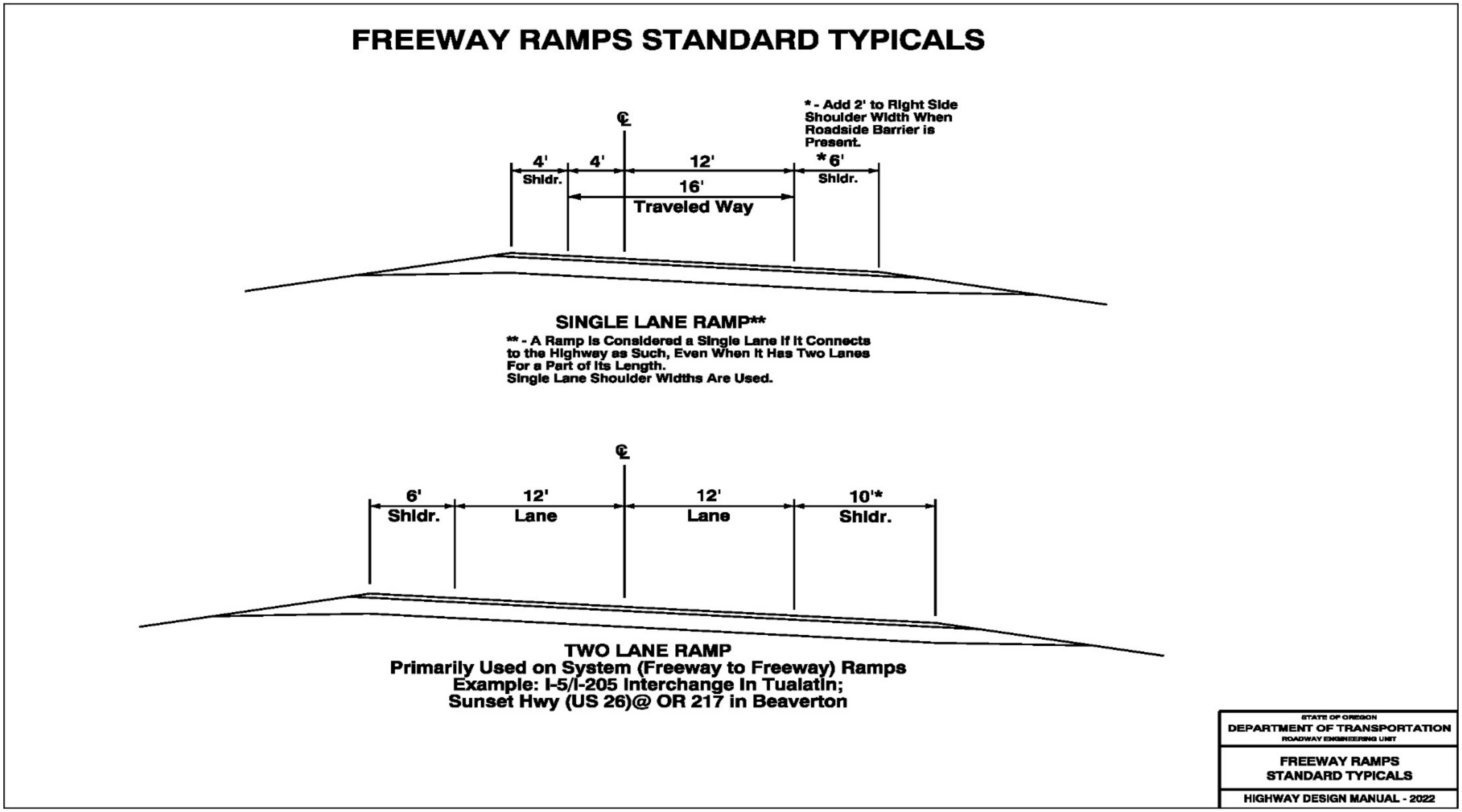
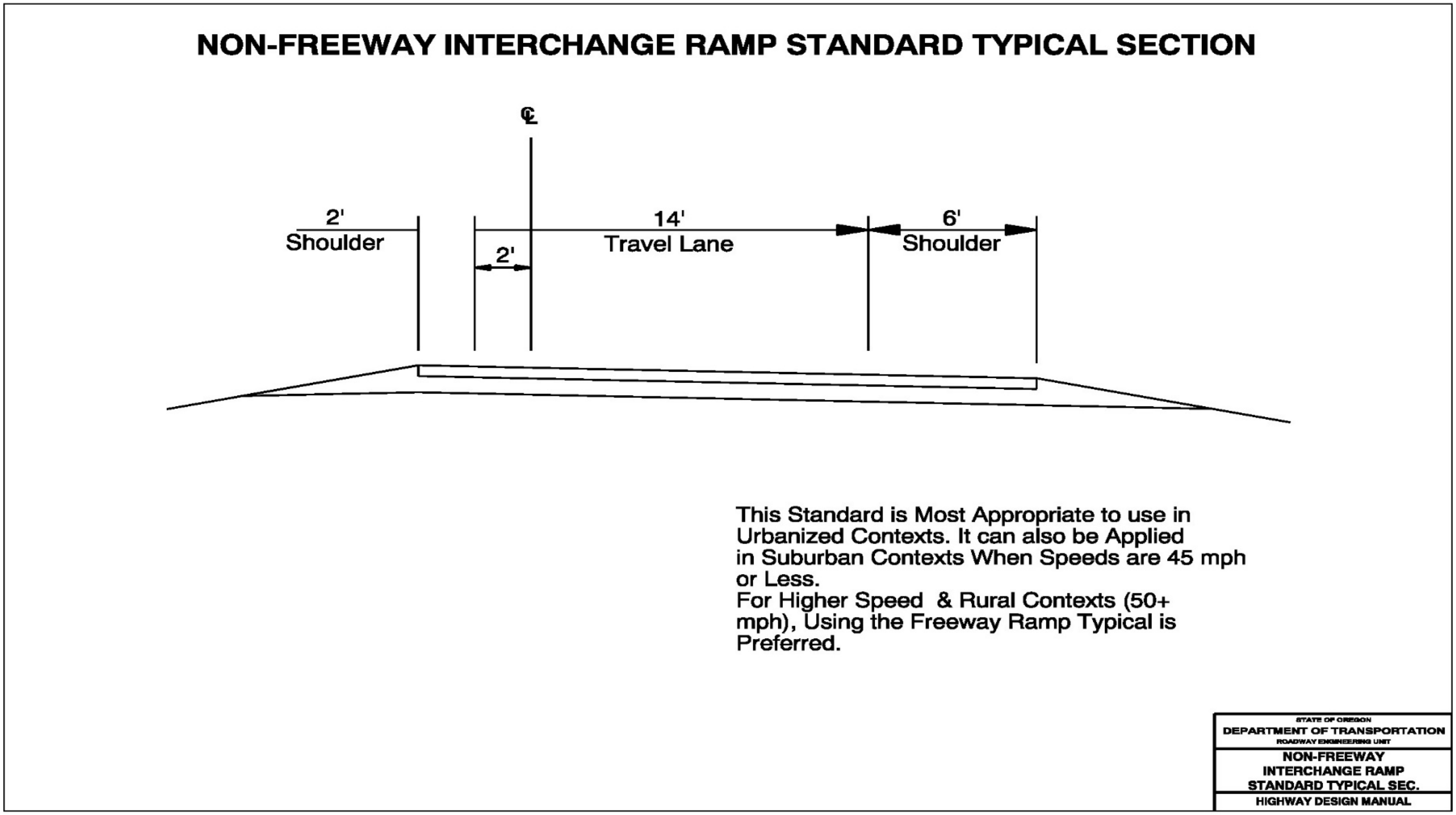


Figure 600-33: Non-Freeway Interchange Ramp Typical Section



# 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.

**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

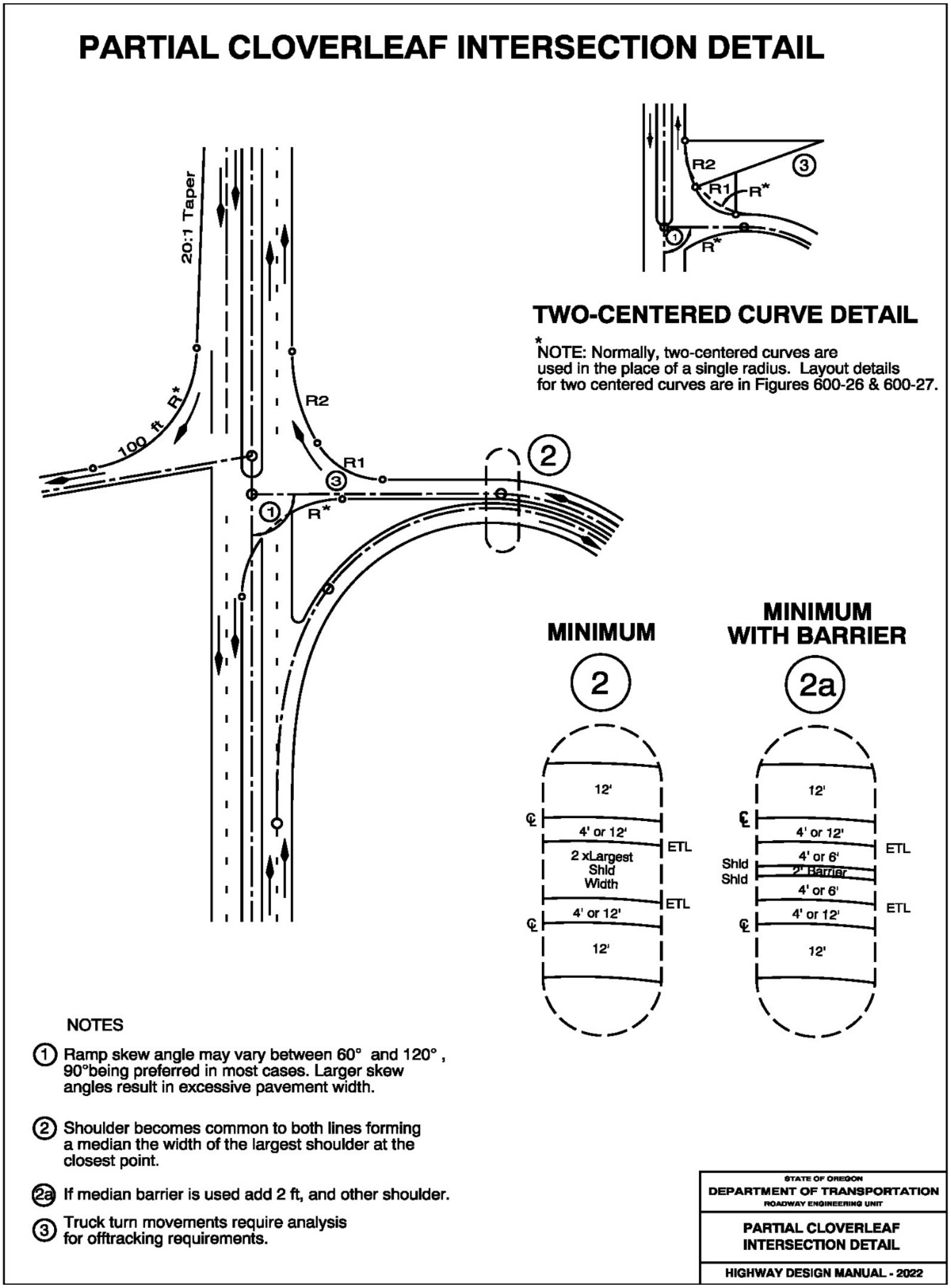


Figure 600-35: Folded Diamond Terminal Detail

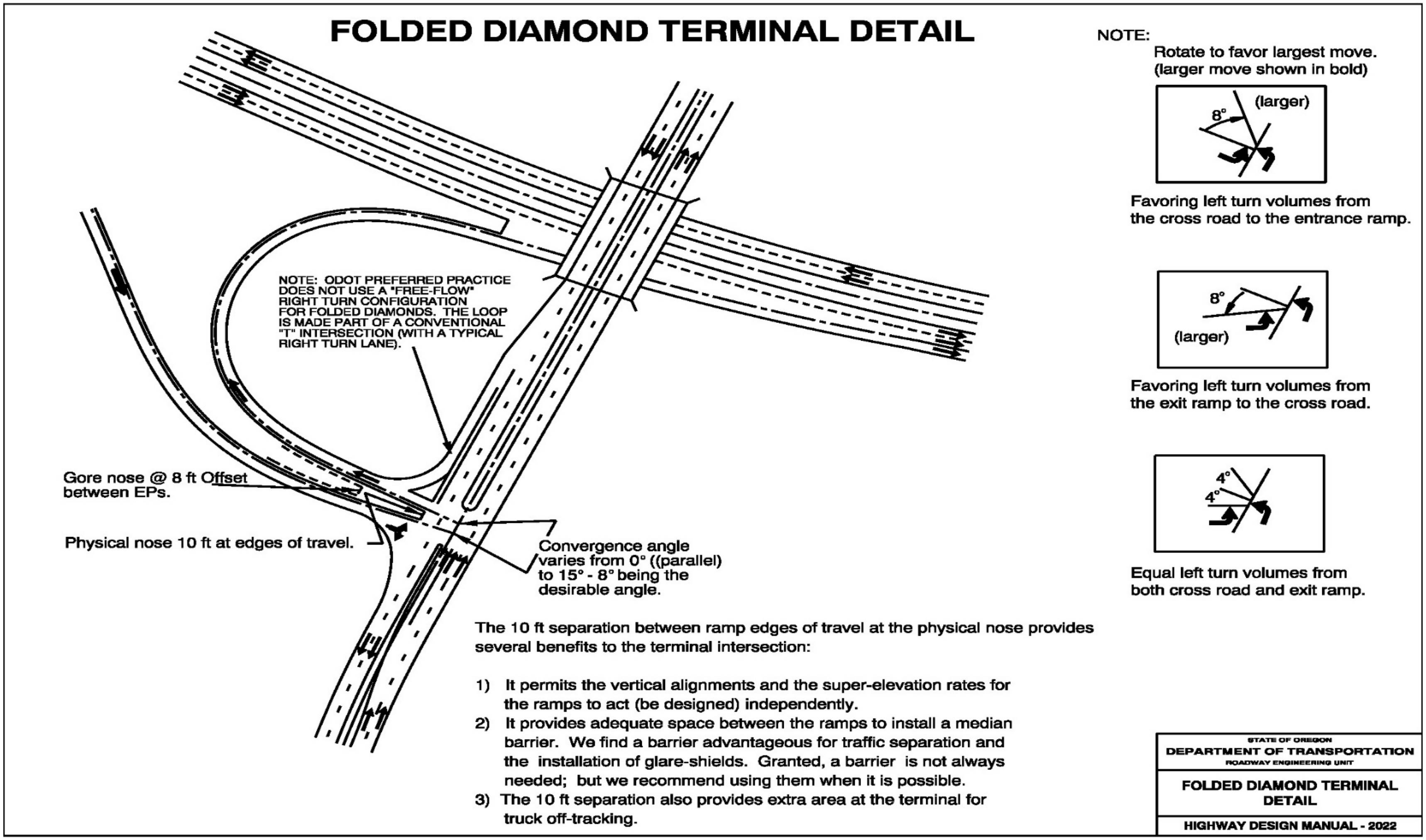
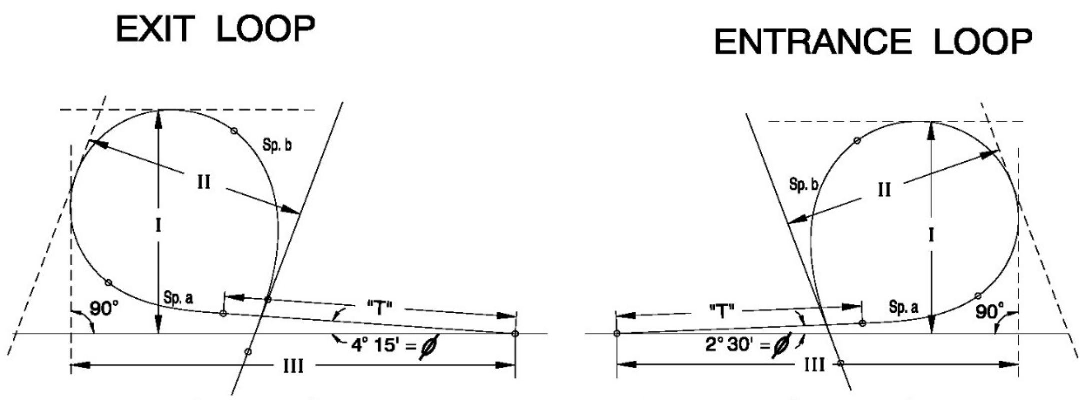


Figure 600-36: Loop Fitting Data (Single Lane)

# LOOP FITTING DATA (1 LANE)




I = (R+p)cos ∅ + (T+q)sin ∅ + R

II = 2R + $p_b$

III = (T+q)cos ∅ - (R+p)sin ∅ + 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 | 200 | 6.9377 | 99.4180 | 700 | 542.9707 | 504.7005 | 1017.7459 |
| 25 | 220.37 | 200 | 7.5077 | 99.3175 | 745 | 510.1890 | 470.1146 | 1045.4766 |
| 25 | 204.63 | 200 | 8.0758 | 99.2092 | 745 | 479.3095 | 440.7458 | 1030.7524 |
| 25 | 190.99 | 200 | 8.6417 | 99.0931 | 745 | 452.6191 | 415.5427 | 1017.9638 |
| 25 | 179.05 | 200 | 9.2054 | 98.9692 | 745 | 429.3316 | 393.7163 | 1006.7465 |
| 25 | 168.52 | 200 | 9.7667 | 98.8376 | 745 | 408.8460 | 374.6631 | 996.8219 |
| 25 | 159.15 | 200 | 10.3256 | 98.6984 | 745 | 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. A 30°curve (or flatter) is required on exit loops on a downgrade.

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LOOP FITTING DATA (1 LANE)

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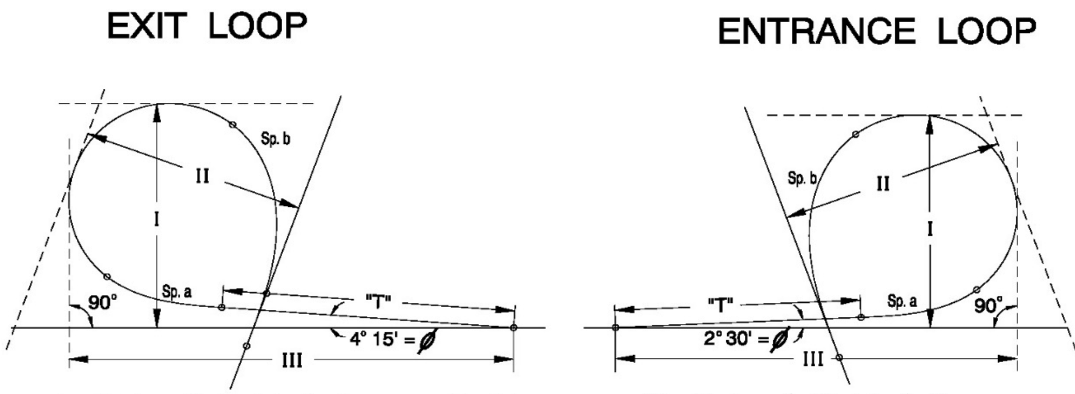
Figure 600-37: Loop Fitting Data (Two Lane)

# LOOP FITTING DATA (2 LANE)




$I = (R+p)\cos\phi + (T+q)\sin\phi + R$ $\quad II = 2R + p_b$ $\quad III = (T+q)\cos\phi - (R+p)\sin\phi + R$

| 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 | 179.05 | 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 | 240 | 9.9629 | 118.9964 | 790 | 554.1082 | 504.7005 | 1126.7988 |
| 25 | 220.37 | 240 | 10.7762 | 118.8236 | 835 | 521.5638 | 470.1146 | 1154.4394 |
| 25 | 204.63 | 240 | 11.5856 | 118.6375 | 835 | 490.9193 | 440.7458 | 1139.6197 |
| 25 | 190.99 | 240 | 12.3907 | 118.4381 | 835 | 464.4612 | 415.5427 | 1126.7303 |
| 25 | 179.05 | 240 | 13.1911 | 118.2255 | 835 | 441.4032 | 393.7163 | 1115.4070 |
| 25 | 168.52 | 240 | 13.9867 | 118.0000 | 835 | 421.1442 | 374.6631 | 1105.3714 |
| 25 | 159.15 | 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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**LOOP FITTING DATA (2 LANE)**

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# 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 not be below 25 mph. In certain fully urbanized contexts, a lower design speed might be considered, but a design exception is required.**

# 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 typical section shown in Figure 600-33 when using "jug handle' style designs.* This configuration is most appropriate in urban and suburban context, where speeds are 45 mph or less. Facilities that are grade separated in those contexts can consider using the non-freeway section as well; operational analysis need to be done to verify that using this section is appropriate.  Large volumes of freight vehicles (e.g.) may indicate that the non-freeway section is not adequate. **If the interchange is a more typical open road type design or in a rural context, or the speeds are 50+ mph, use the regular freeway ramp typical section.**

# 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

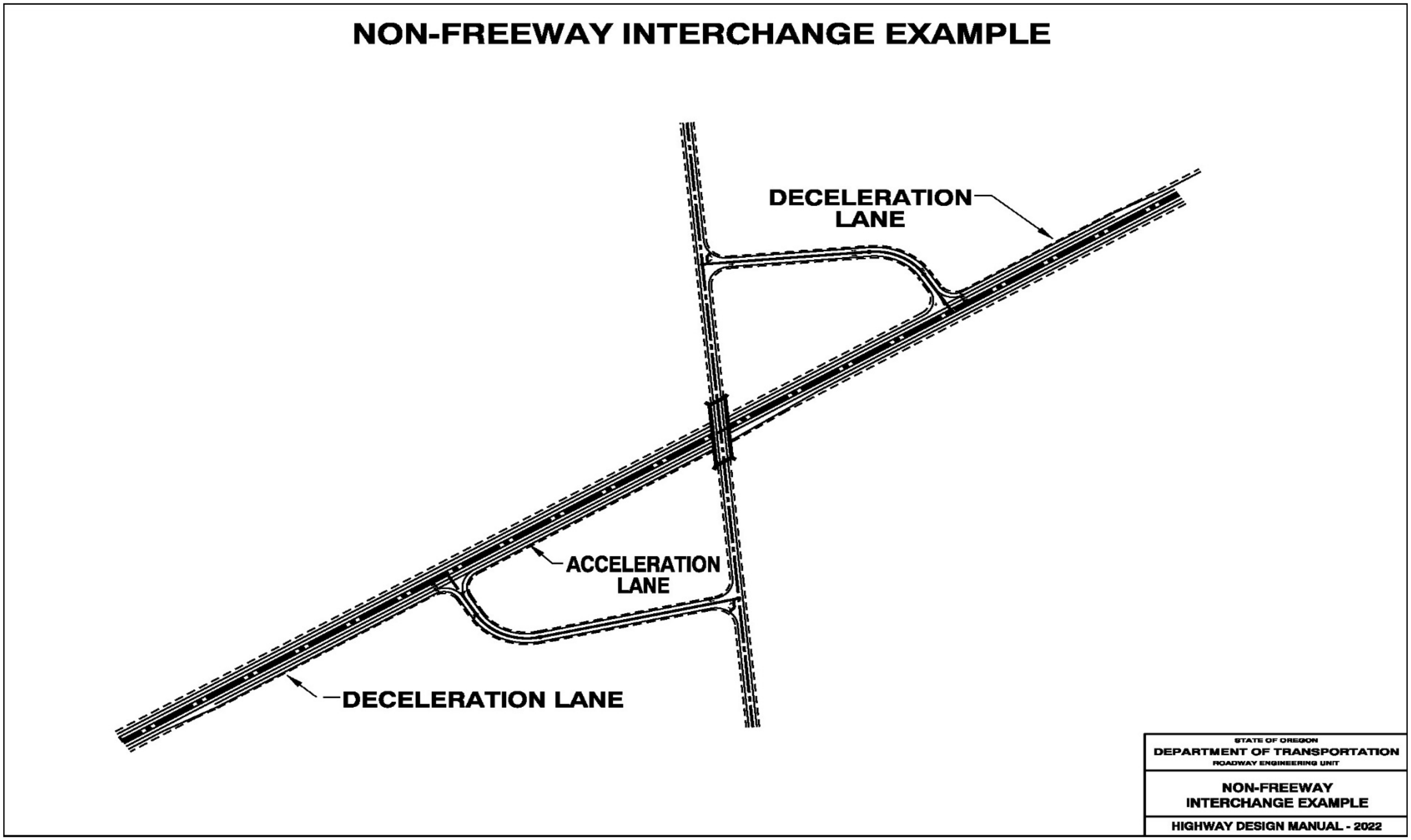
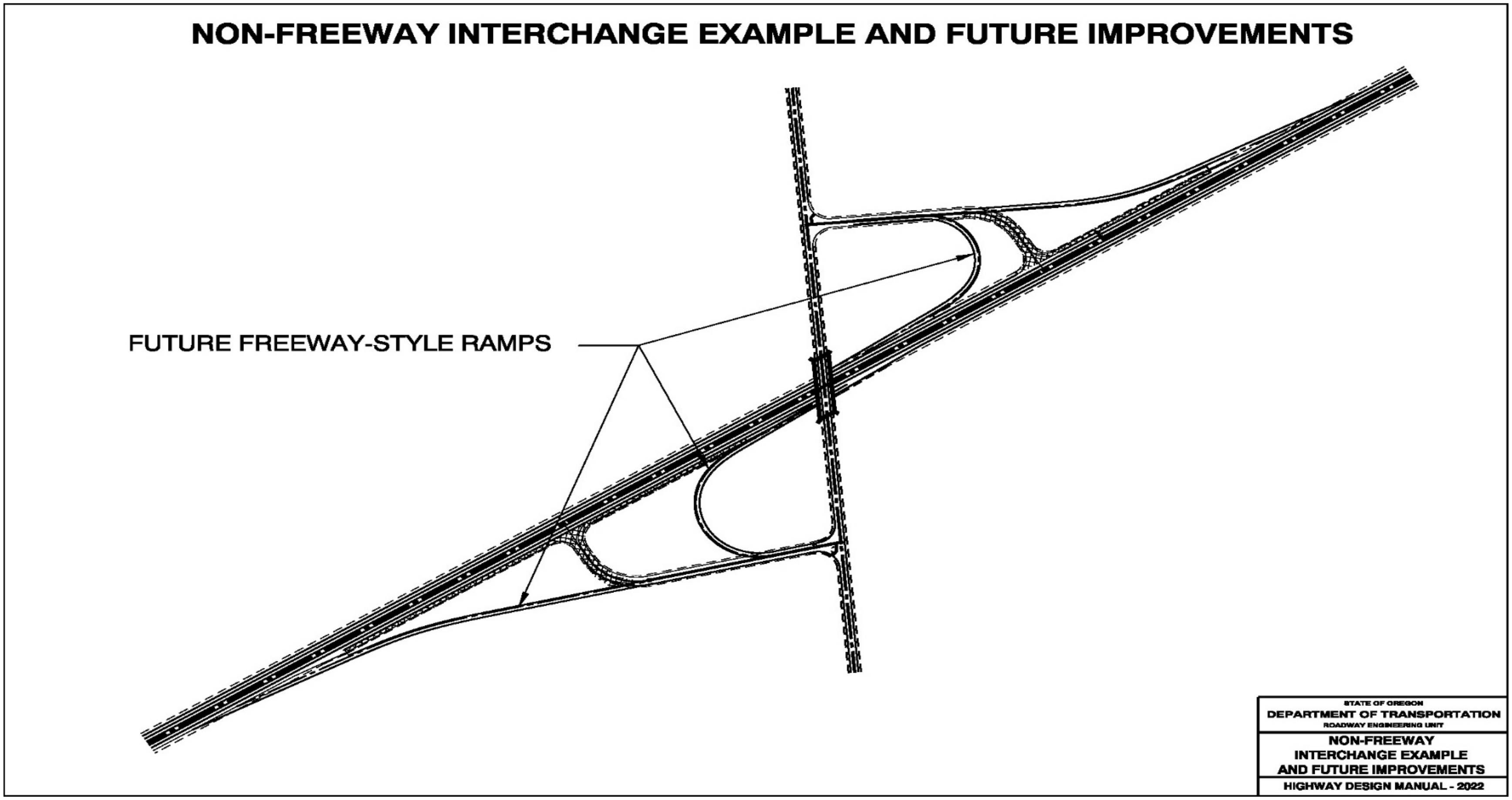


Figure 600-39: Non-Freeway Interchange Example and Future Improvements



# 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 pedestrians 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 (bicycles-pedestrians-ADA) of this manual for detailed guidance on how to treat these areas.

For all interchange projects, designers should coordinate with the ODOT Bicycle and Pedestrian 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

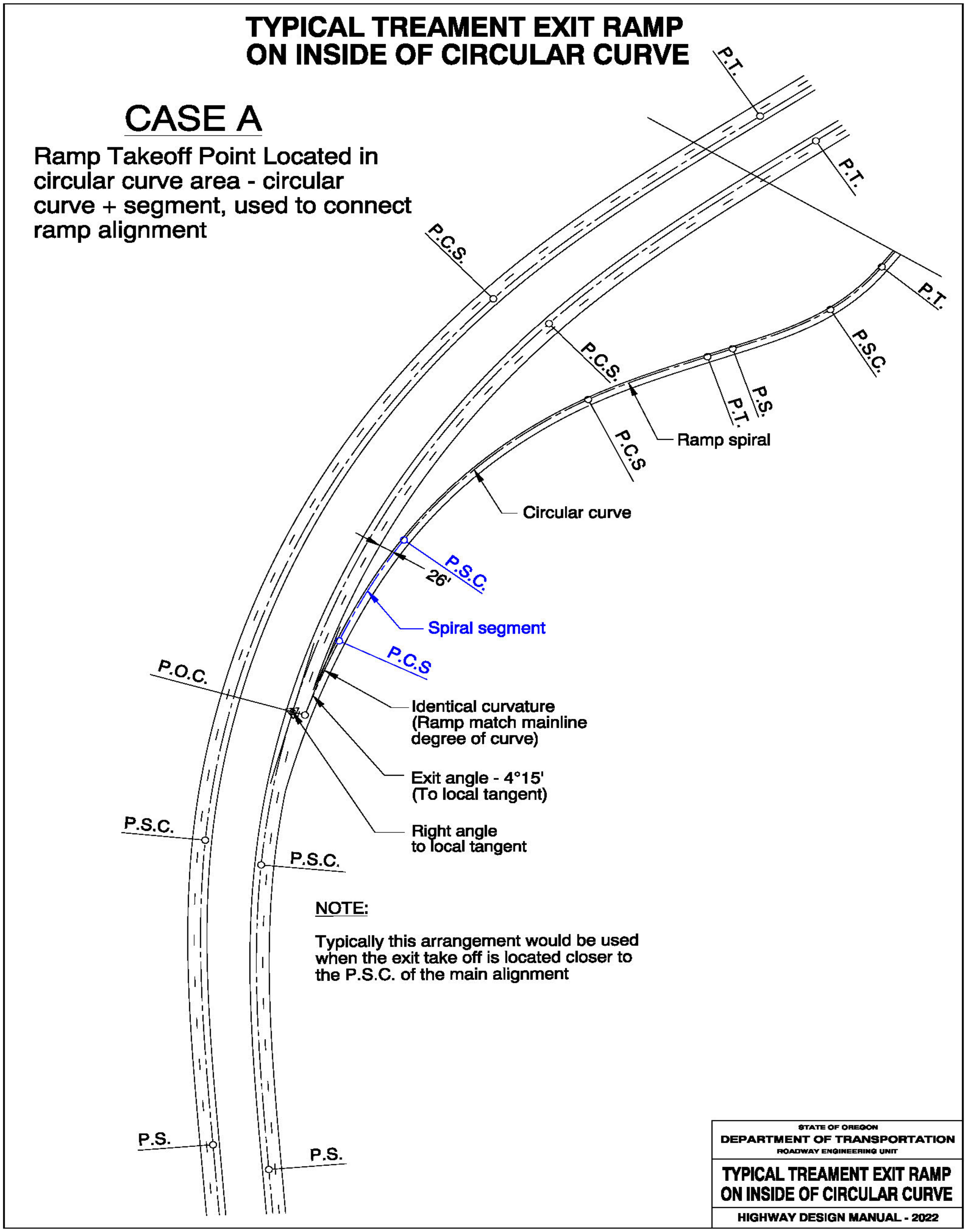


Figure 600-41: Design Aid 600-2 – Exit on Inside of Curve Case B

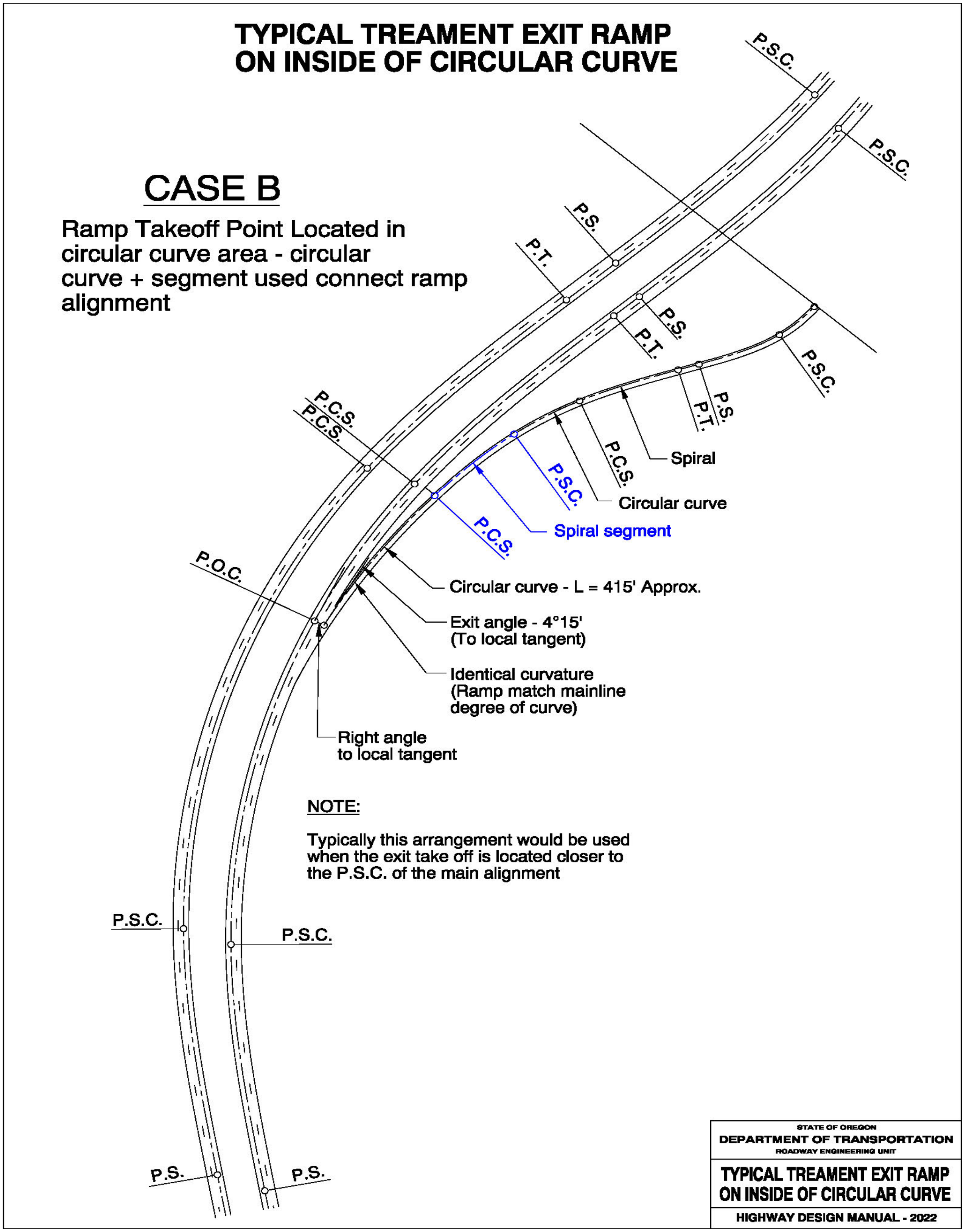


Figure 600-42: Design Aid 600-3 - Exit From Inside of Curve in Leading Spiral Area

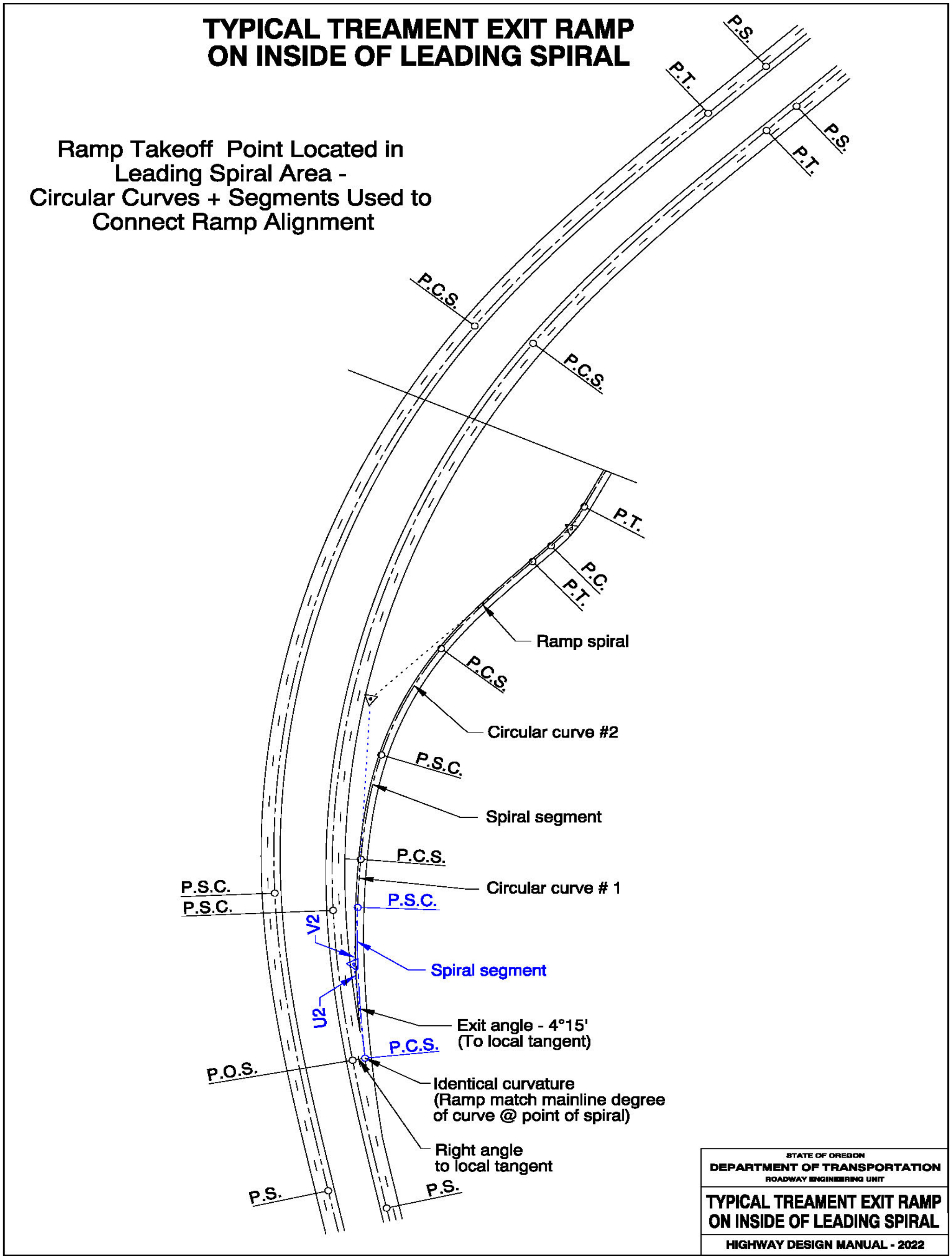


Figure 600-43: Design Aid 600-4 -Exit From Inside of Curve in Trailing Spiral Area

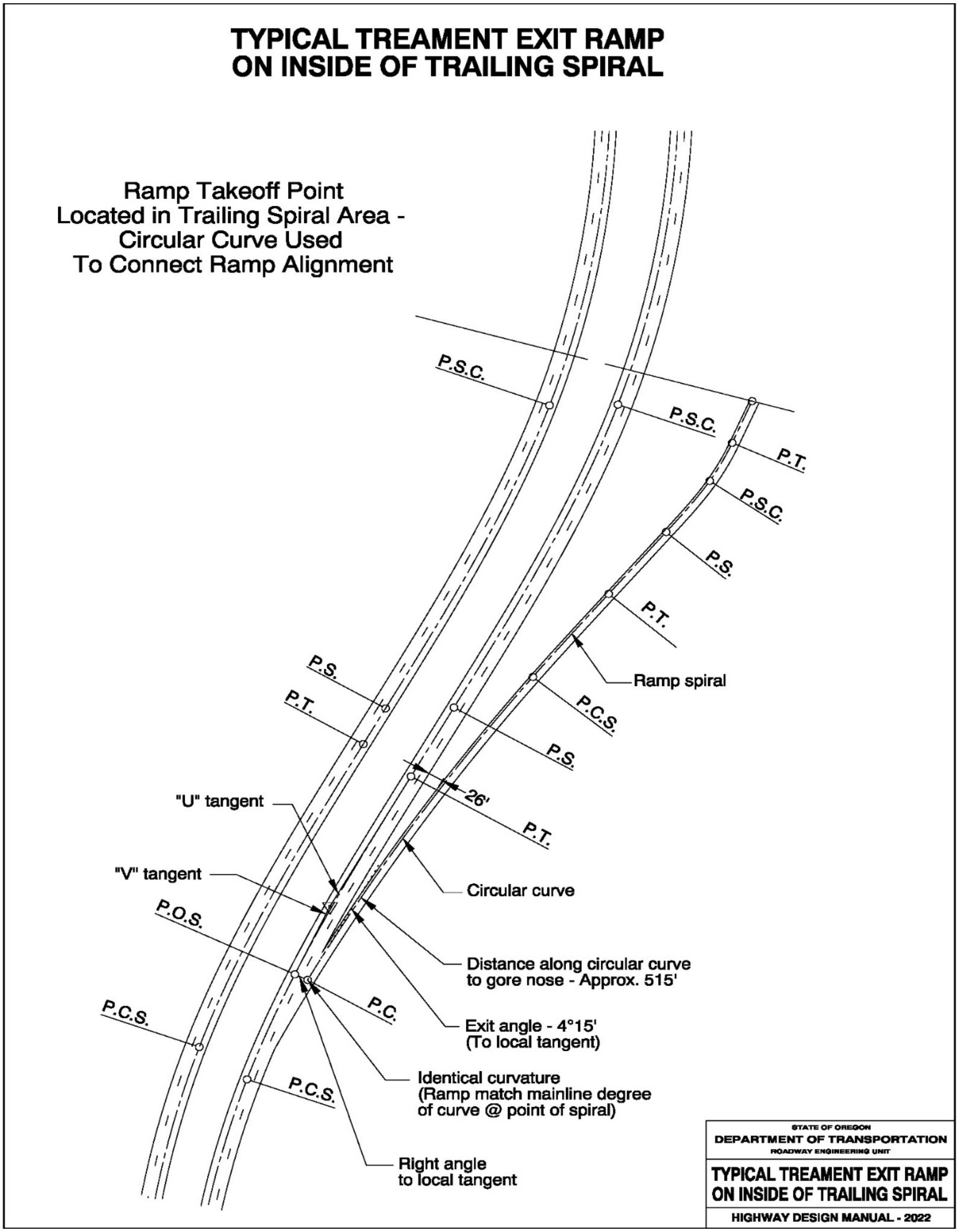


Figure 600-44: Design Aid 600-5 -Exit From Outside of Circular Curve

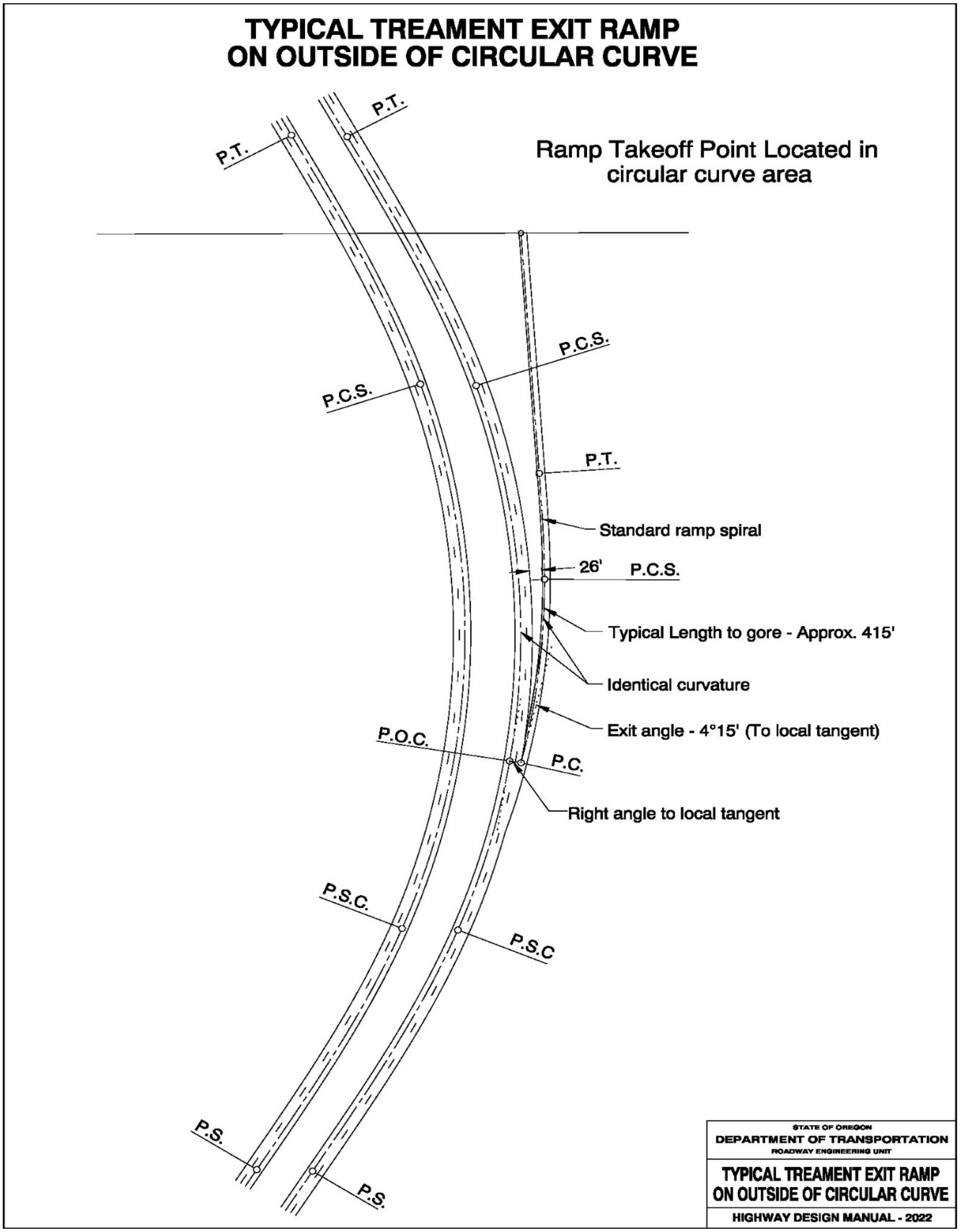


Figure 600-45: Design Aid 600-6 Exit on Outside of Curve in Leading Spiral Area

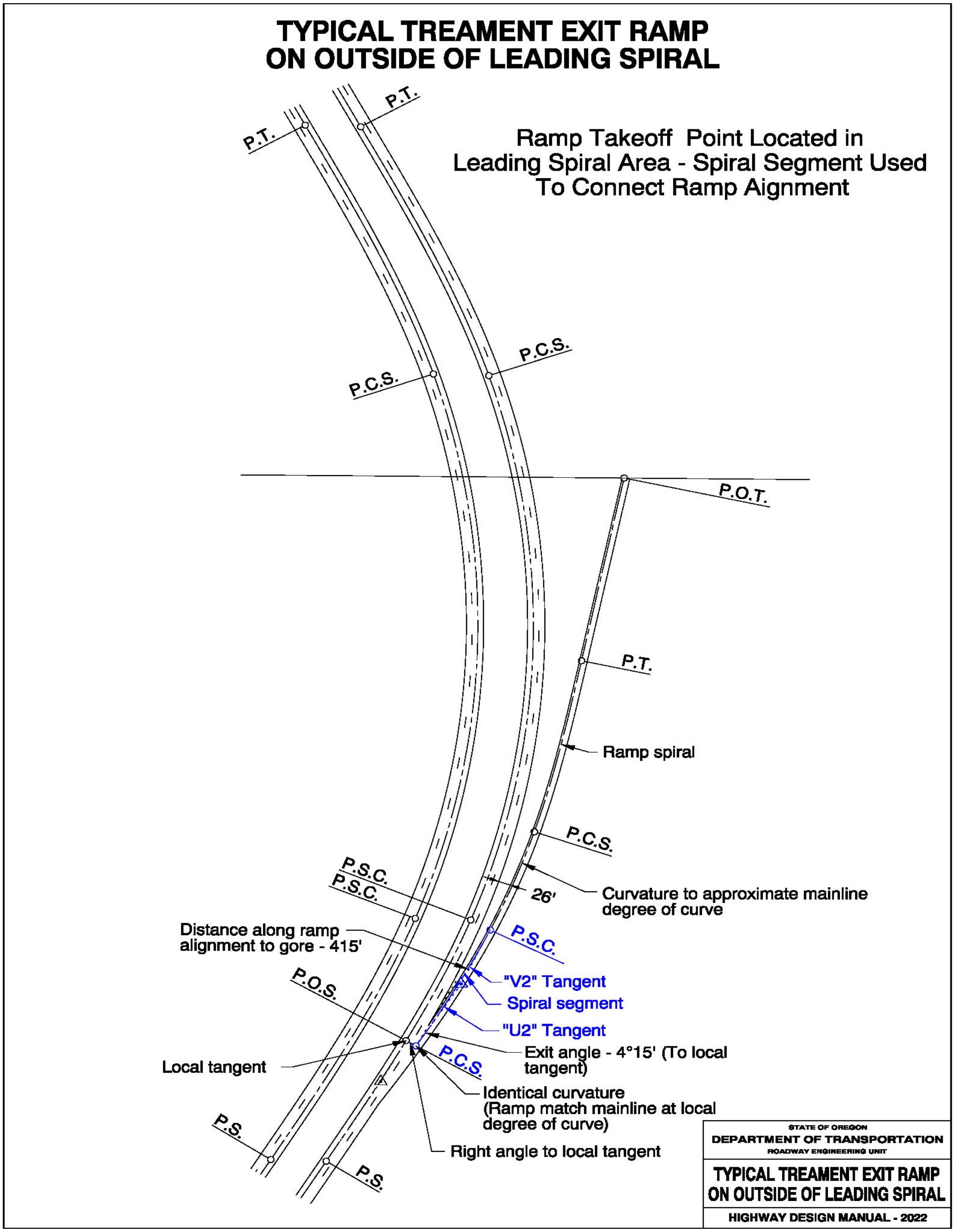


Figure 600-46: Design Aid 600-7 -Exit From Outside of Curve in Trailing Spiral Area

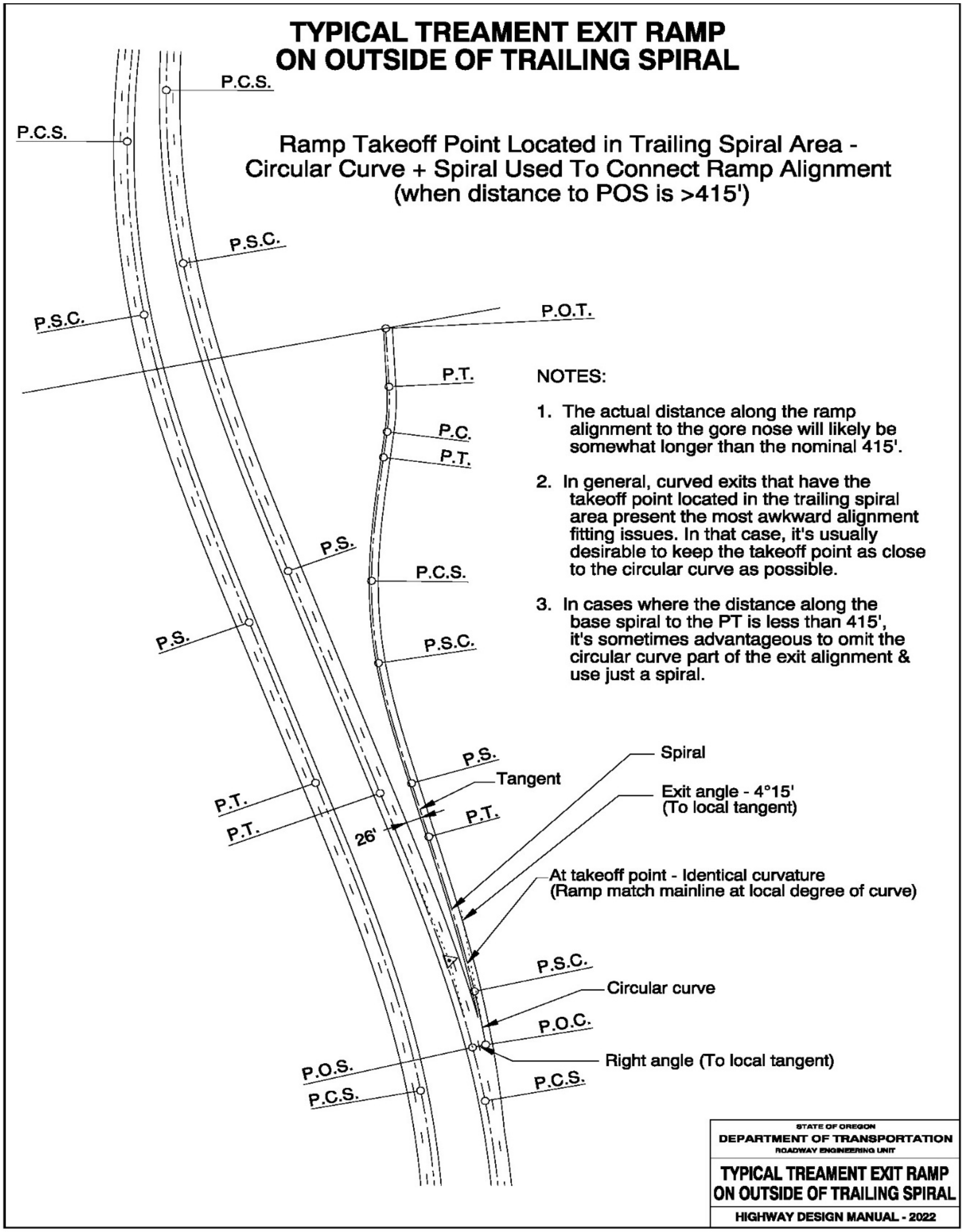


Figure 600-47: Design Aid 600-8 – Entrance on the Inside of a Circular Curve Area

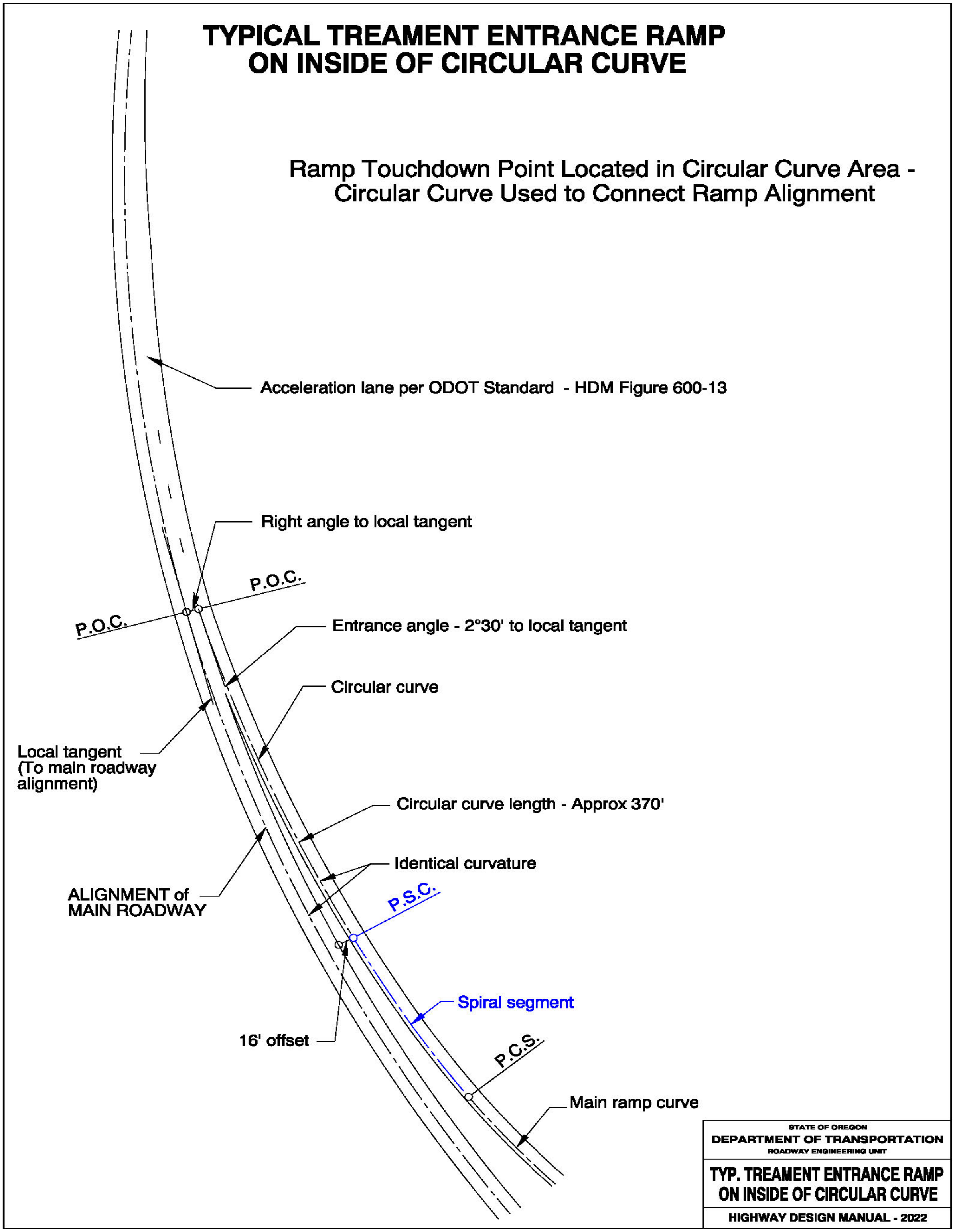
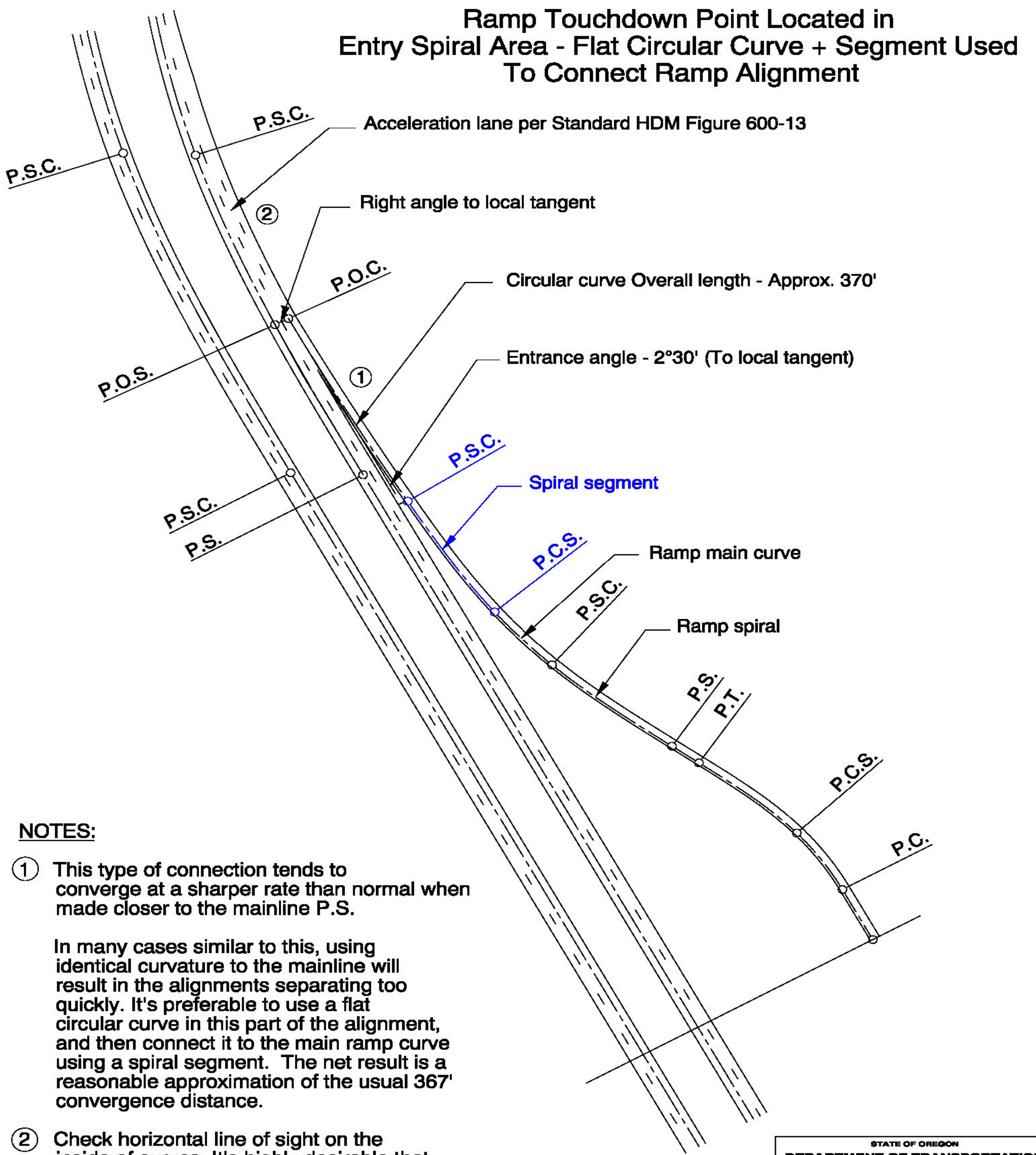


Figure 600-48: Design Aid 600-9 –Entrance on the Inside of the Leading Spiral Area

## TYPICAL TREAMENT ENTRANCE RAMP ON INSIDE OF LEADING SPIRAL




NOTES:

① This type of connection tends to converge at a sharper rate than normal when made closer to the mainline P.S.

In many cases similar to this, using identical curvature to the mainline will result in the alignments separating too quickly. It's preferable to use a flat circular curve in this part of the alignment, and then connect it to the main ramp curve using a spiral segment. The net result is a reasonable approximation of the usual 367' convergence distance.

② Check horizontal line of sight on the inside of curves. It's highly desirable that entering traffic have a view of the entire accel and merging area.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

TYPICAL TREAMENT ENTRANCE RAMP ON INSIDE OF LEADING SPIRAL

HIGHWAY DESIGN MANUAL - 2022

Figure 600-49: Design Aid 600-10 – Entrance on Inside in the Trailing Curve Area

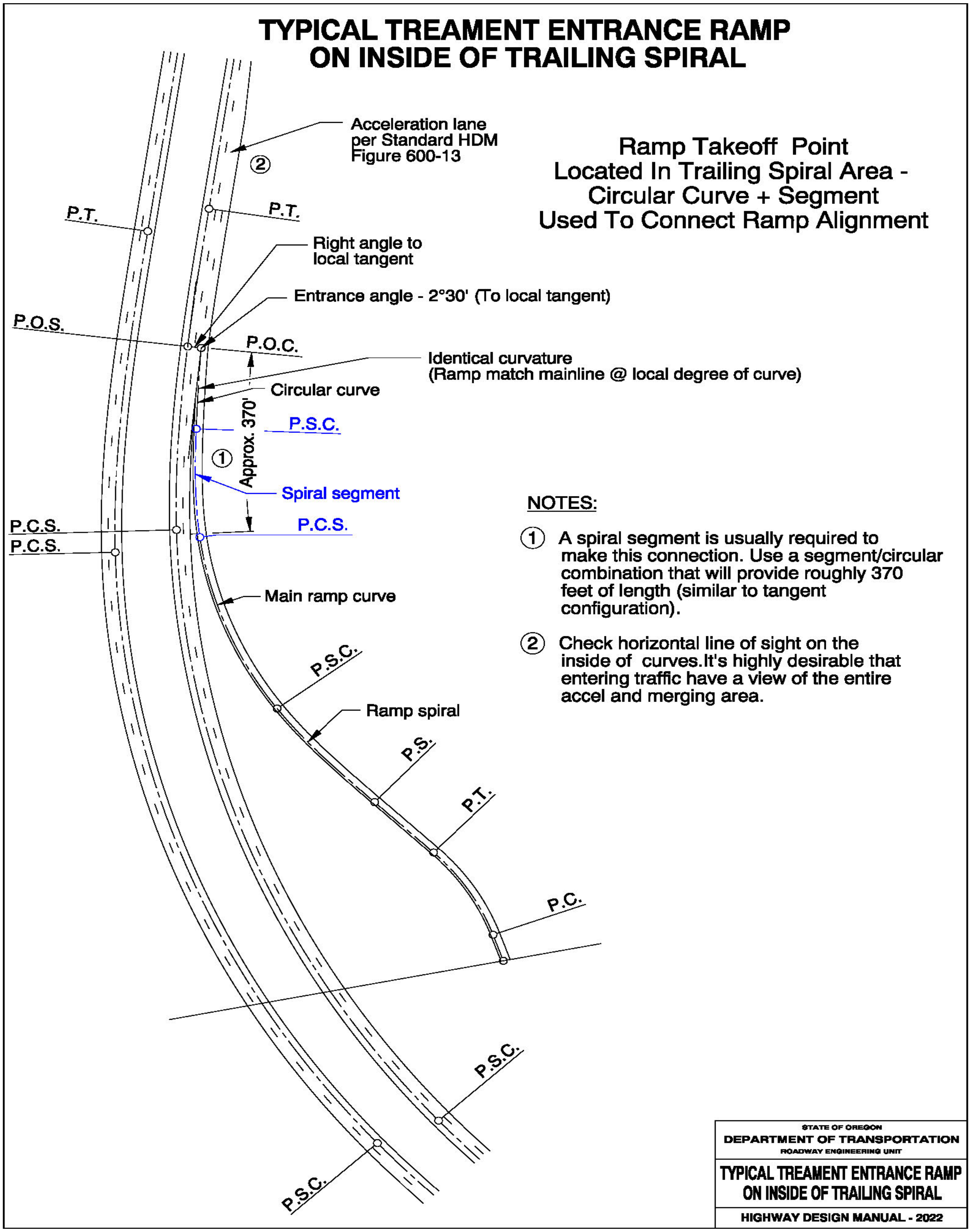


Figure 600-50: Design Aid 600-11 –Entrance on the Outside in Circular Curve Area

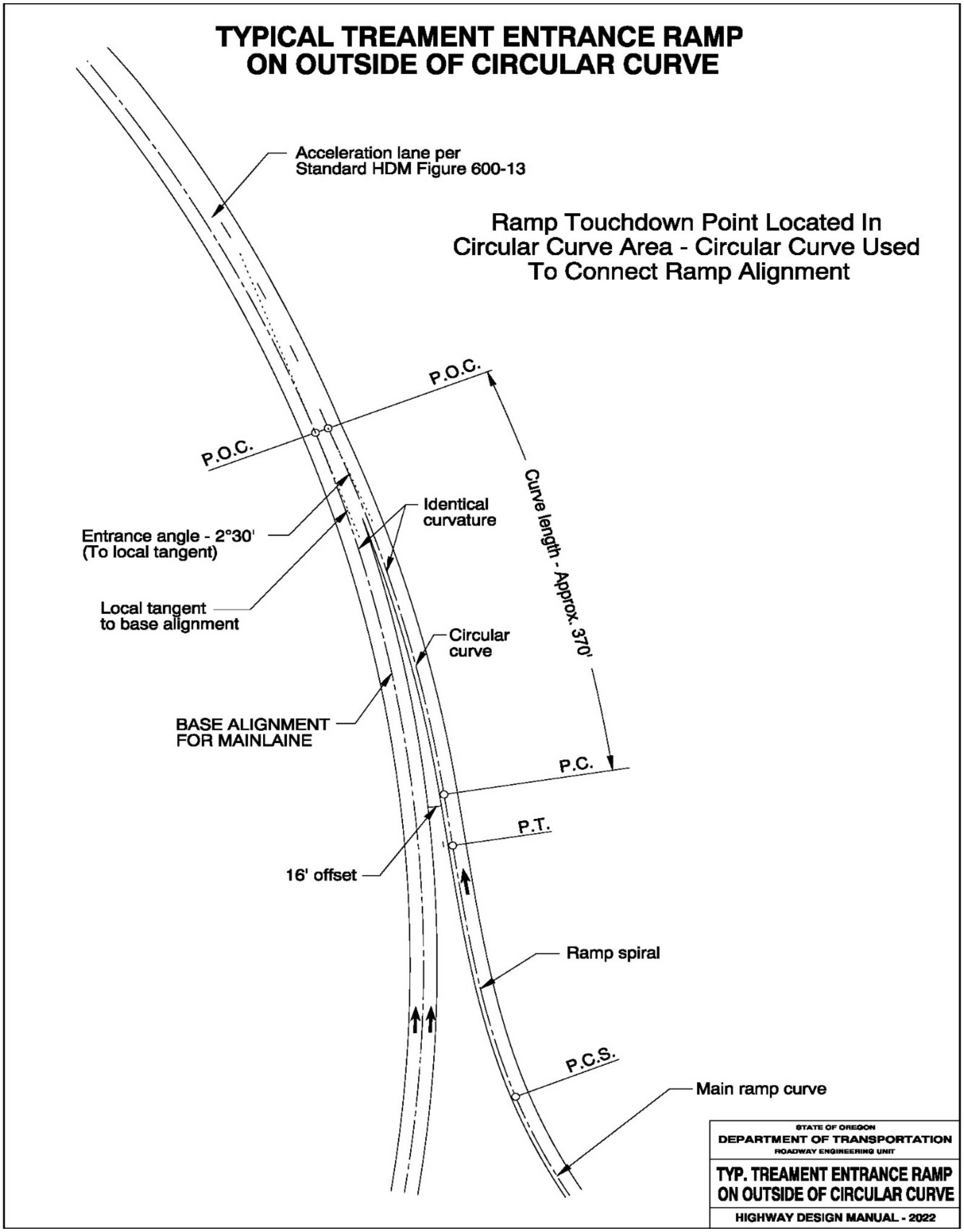


Figure 600-51: Design Aid 600-12 Entrance on Outside in Leading Spiral Area

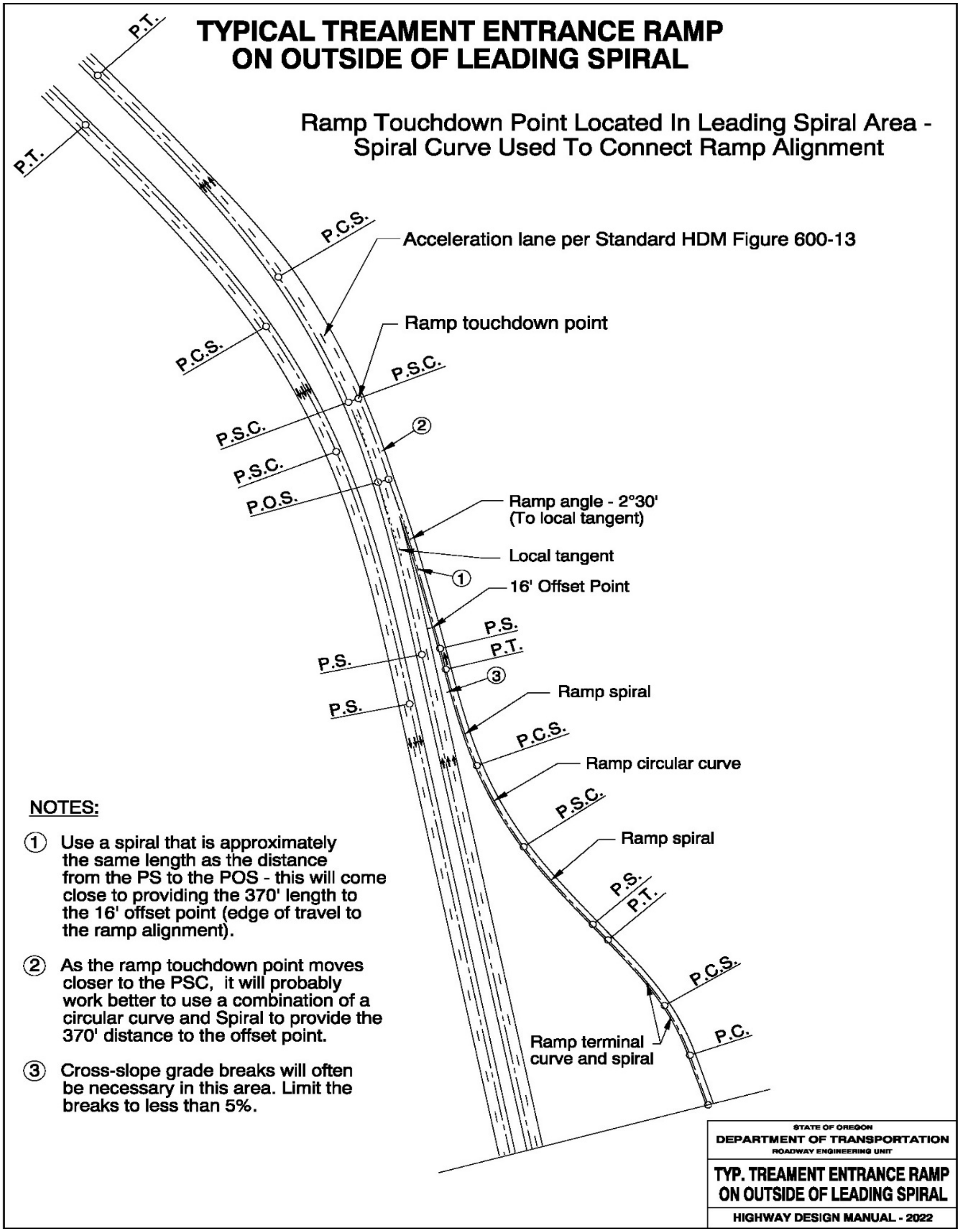
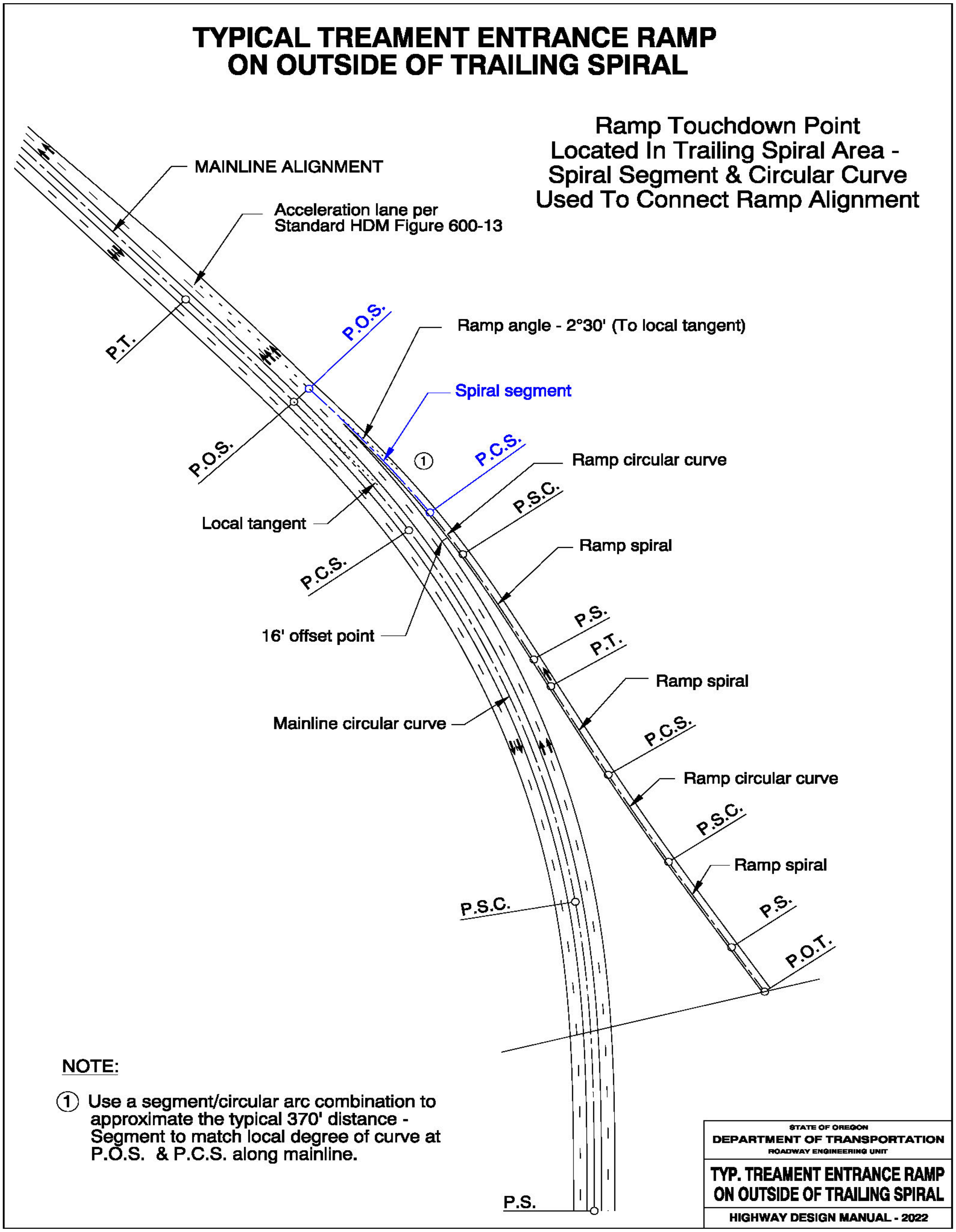


Figure 600-52: Design Aid 600-13 Entrance on Outside in Trailing Spiral Area



# 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 184.619 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 https://www.access-board.gov/prowag/. 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: https://www.access-board.gov/files/prowag/planning-and-design-for-alterations.pdf See Part 800 for additional requirements.

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 spacing that would be expected based on highway segment designations. These spacing distances are not intended to be suggested spacing. 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)

[2] 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 and/or at major transfer points;
   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 bus lane changes and bus 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<br>• Minimizes sight distance problems on approaches to the intersection<br>• Encourages pedestrians to cross behind the bus<br>• Minimizes area needed for curbside bus zone<br>• If placed just beyond a signalized intersection in a bus pullout, buses may more easily reenter the traffic stream<br>• 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)<br>• If bus stops in travel lane, could result in a high rate of rear-end accidents as motorists fail to anticipate stopped traffic<br>• May cause passengers to access buses further from crosswalk<br>• 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<br>• Allows passengers to access buses close to crosswalk<br>• Driver may use the width of the intersection to pull away from the curb<br>• Allows passengers to board and alight when the bus is stopped for a red light<br>• 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<br>• May cause sight distance problem for cross-street traffic and pedestrians<br>• 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<br>• At single lane, signalized intersections with no pullout, prohibits through traffic movement with green light, similar to far-side stop without a bus pullout<br>• 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<br>• May result in passenger waiting areas experiencing less pedestrian congestion<br>• May be closer to passenger origins or destinations on long blocks<br>• May result in less interference with traffic flow | • Requires additional distance for no-parking restrictions<br>• 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

## 703.4.1 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<br>• Assists in maximizing the vehicle capacity of the roadway<br>• Defines bus stop<br>• Passenger loading and unloading may be conducted in a more relaxed manner<br>• Less potential for rear-end accidents | • More difficult to reenter traffic, increasing bus delay and slower average travel time for bus<br>• Bus may need to cross bike lane<br>• Uses additional space, may require additional right of way<br>• May increase rates of sideswipe accidents<br>• Cost<br>• 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:

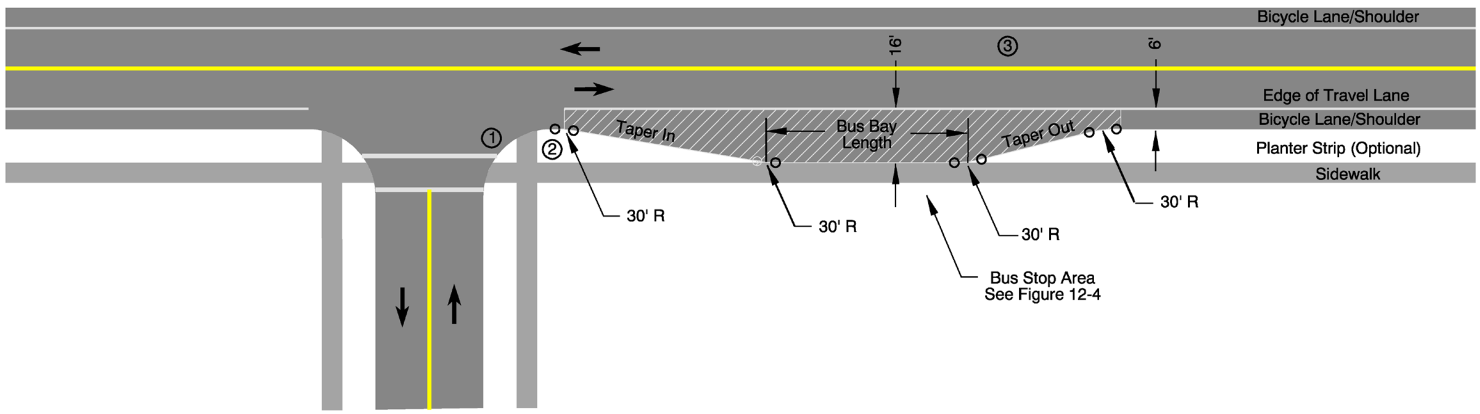
1. Average vehicle speed exceeds 40 mph;
2. Traffic in the curb lane exceeds 250 vehicles during the peak hour;
3. History of a high rate of accidents, particularly rear-end accidents;
4. More than 5 bus stops per hour;
5. Passenger boardings exceed 30 boardings per hour; or
6. Transit agency desires 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 700-1. The bay length should be increased by 50 feet for each additional single unit bus expected to concurrently use the pullout. Figure 700-1 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: Typical 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.

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ROADWAY ENGINEERING UNIT

**BUS PULLOUT DETAILS**

HIGHWAY DESIGN MANUAL

(Consult Local Transit Agency for Project Specific Details Required)

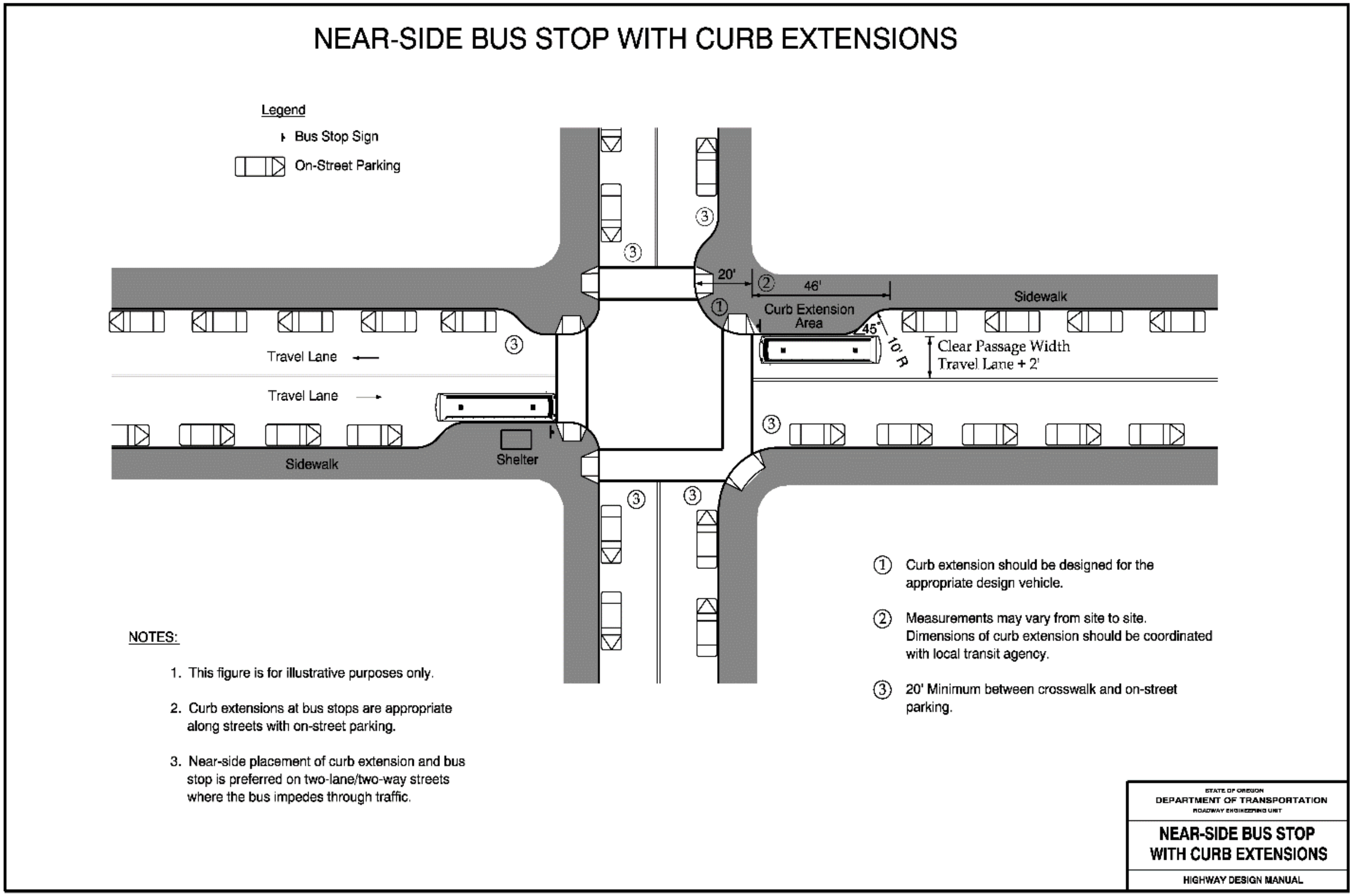
# 703.4.2 Curb Extensions

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 700-2. 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 700-3. 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



### 703.4.3 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 7 feet of vertical clearance. A minimum allowable passage of 4 feet wide may be acceptable in constrained areas. See Part 800 for pedestrian access route requirements.

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 700-4). 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.

# 704.3.1 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. See Part 800 for additional bus shelter site design guidance.

# 704.3.2 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.

# 704.3.3 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. Evaluate space for ADA companion seating and clear space requirements when benches are provided.

# 704.3.4 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.

# 704.3.5 Trash Receptacles and Other Amenities

These improvements can make waiting more pleasant, increasing the likelihood that people will use transit as a mode choice. Ensure a pedestrian access route is available and free of obstructions to all public amenities.

## 704.3.6 Bicycle Parking

Bike racks or storage lockers should be considered at bus stops in urban fringe areas and park-and-ride facilities.

## 704.3.7 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.

## 704.3.8 Future Amenities

Work 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.

Figure 700-3: Far-Side Bus Stop with Curb

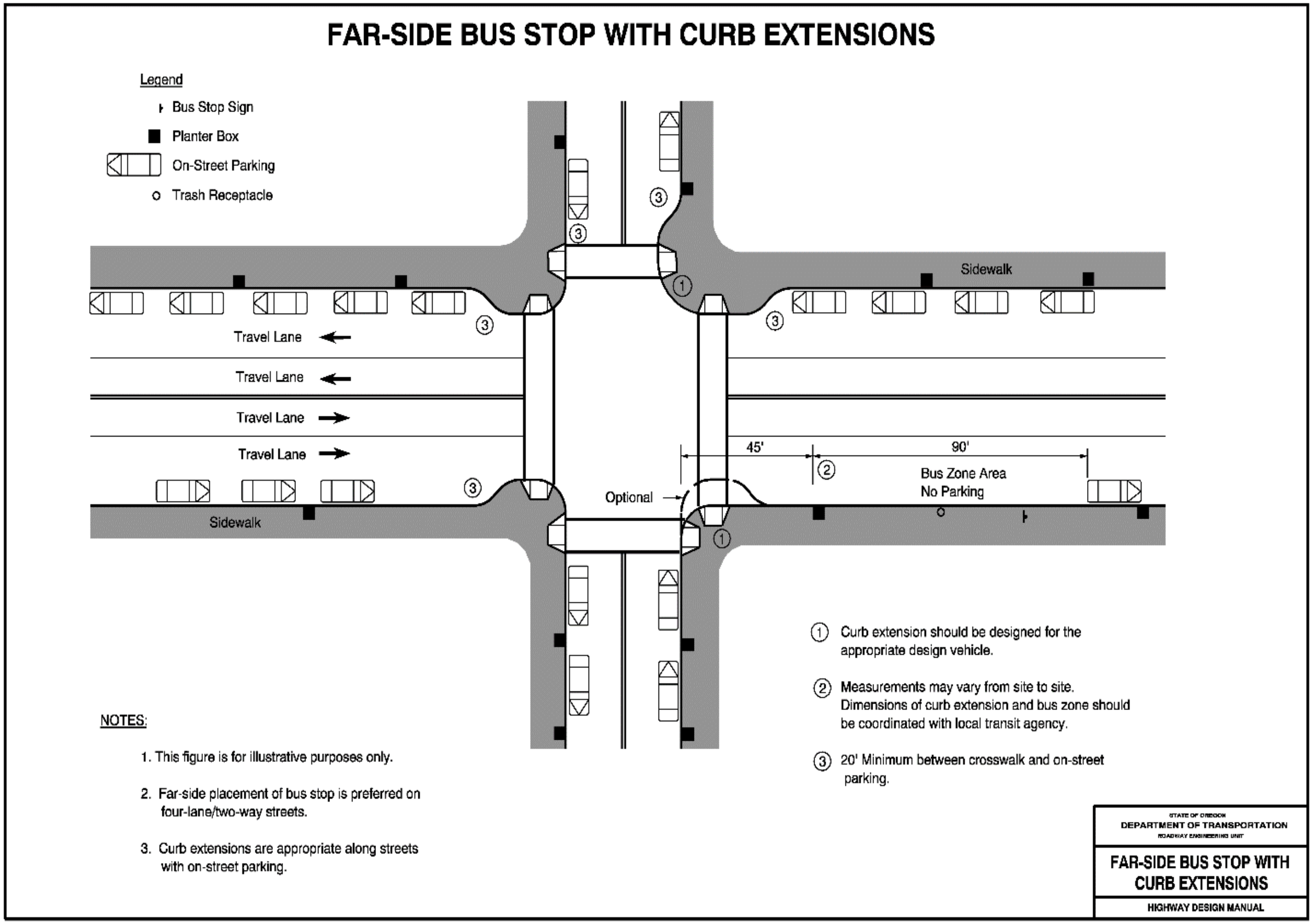
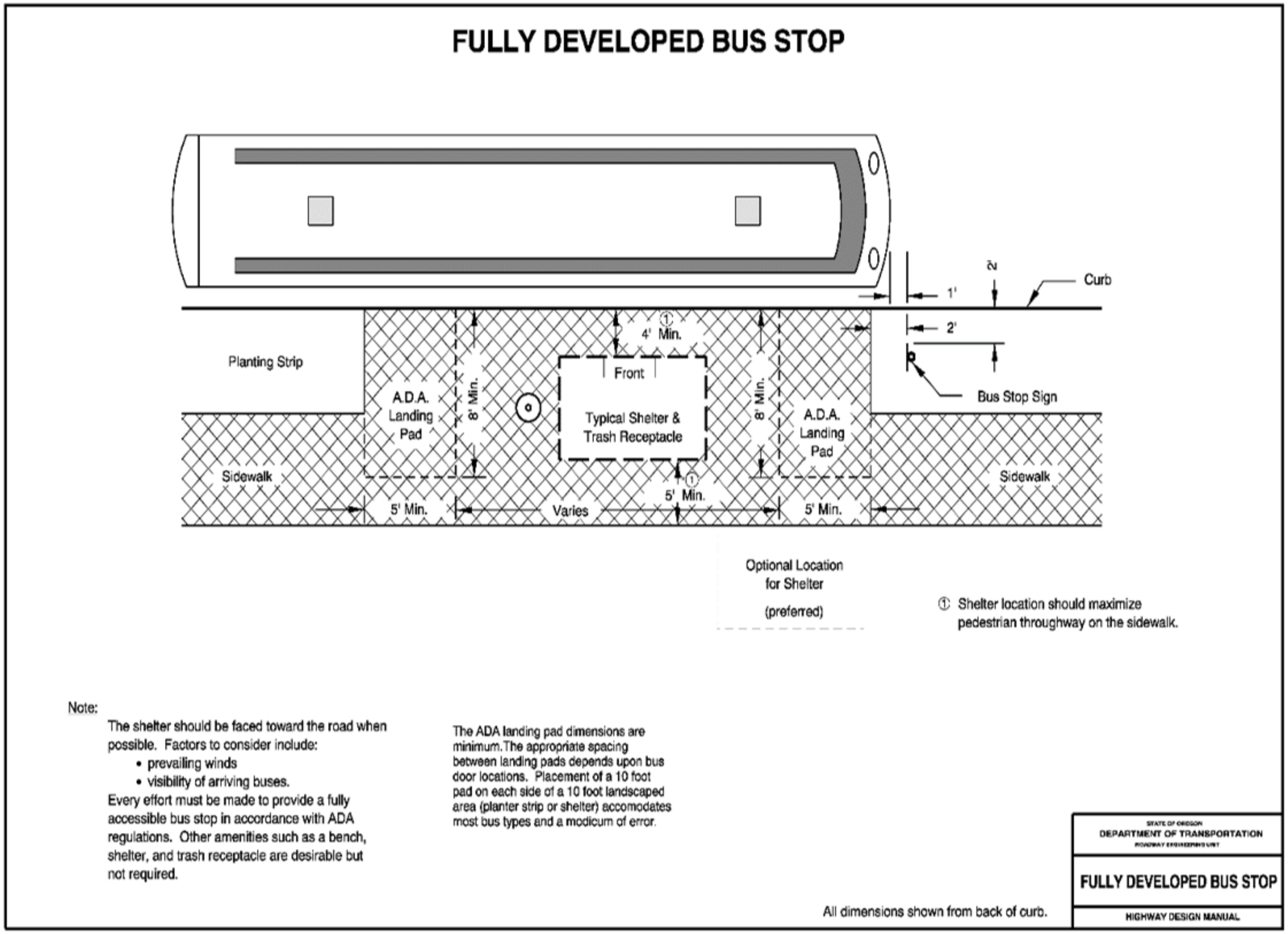


Figure 700-4: Fully Developed Bus Stop



## 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 Section 704).
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 700-5.

### 705.1.1 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 reinforced concrete pavement (see Oregon Standard Drawing DET1610 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.

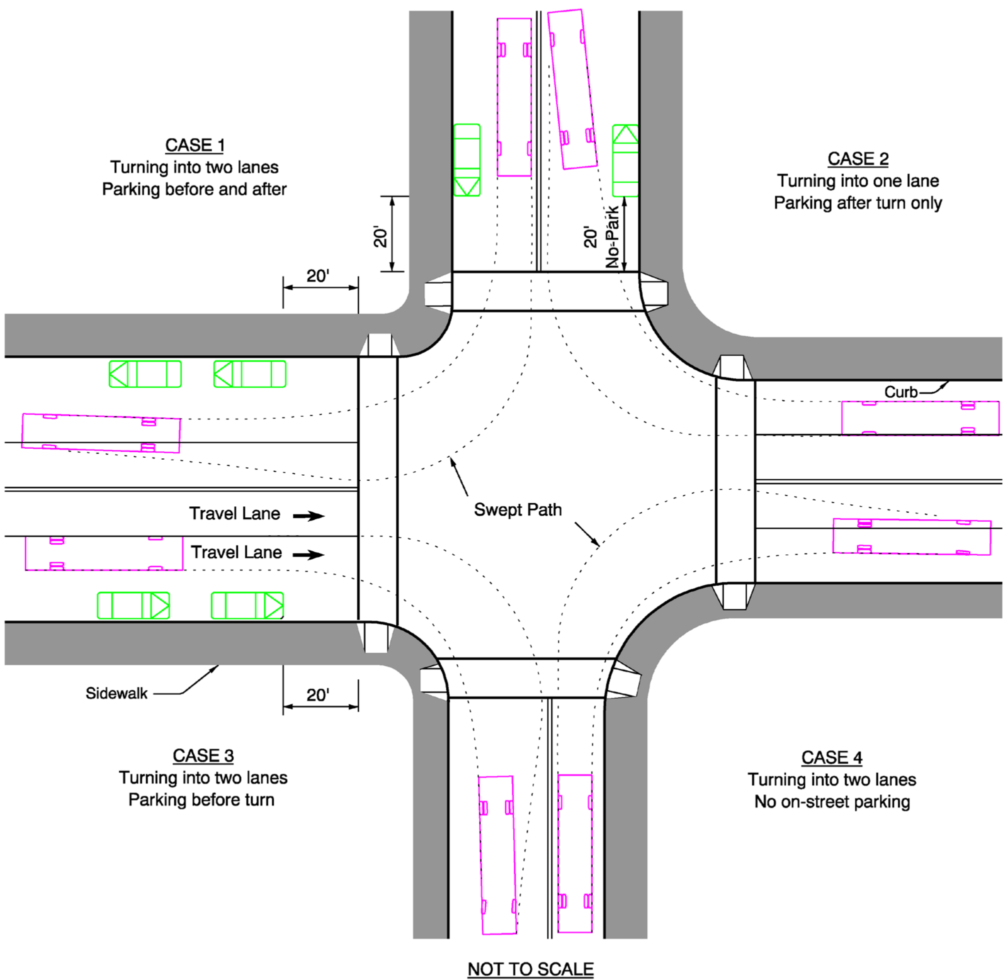
4. Potential drainage issues due to the change in cross-slope, vertical alignment or superelevation needed to fit track to roadway.
5. Lane balance may be affected on multi-lane roadways. Drivers may tend to avoid driving in the lane with the tracks.
6. Utility relocations and sloped paving patches to 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.

Figure 700-5: Typical Intersection Design for Bus

## TYPICAL INTERSECTION DESIGN FOR BUSES




NOTES: * This figure is for illustrative purposes only. Curb radii and on-street parking should be checked for vehicle tracking. A gap study may show a need at unsignalized intersections to design the curb radius so that a bus may enter a multilane roadway without encroaching upon the inside lane.

When buses and on-street parking are present, minimum width from curb to centerline is recommended to be 22'. In this illustration, buses turn from and into 14 foot lanes.

All dimensions assume no encroachment into opposing lanes and a 2 foot clearance from curbs.

STATE OF OREGON
DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING UNIT

TYPICAL INTERSECTION
DESIGN FOR BUSES

HIGHWAY DESIGN MANUAL

# 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 700-6. 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.

## 706.3.1 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.

## 706.3.2 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.

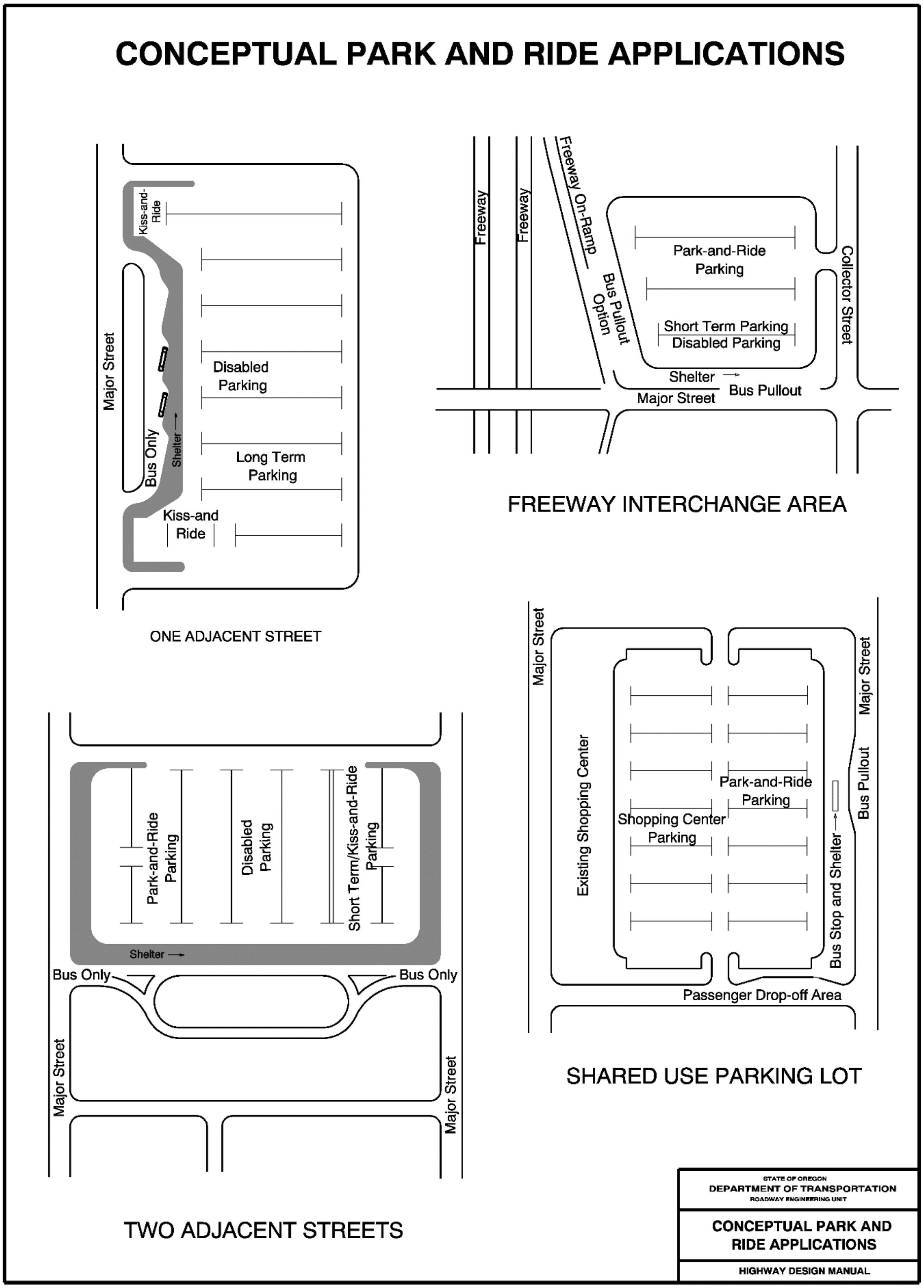
## 706.3.3 Pavement, Drainage, and Landscaping

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.

Figure 700-6: Conceptual Park and Ride Applications



## 706.3.4 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.

## 706.3.5 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.

## 706.3.6 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 can guide or separate patron traffic and transit vehicles. Park-and-ride identification signs may 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.

## 706.3.7 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.

# 706.3.8 Accessible Parking

The number of accessible parking spaces required for government buildings and publicly maintained or operated parking facilities, are subject to requirements that include ORS 447.233. See the ODOT Traffic Line Manual for detailed guidance on parking area design. Some general some additional guidelines follow. No ramp or obstacle may extend into the accessible parking space or the access aisle. Curb cuts and ramps may not be situated in such a way that they could be blocked by a legally-parked vehicle. Accessible parking spaces and access aisles shall be level with surface slopes not to exceed 2% in all directions.

# 706.3.9 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 as it relates to those amenities is located in other sections of this manual. 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 and 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. The Oregon Bicycle and Pedestrian Design Guide (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 | State Traffic-Roadway Engineer (STRE) and, for some projects, FHWA |
| Guideline | ***Bold Italics text*** | Design Decision document | Region with Tech Expert input |
| Option | *Italics Text* | Document decisions | EOR |
| General Text | Not bold or italics | Not applicable | Not applicable |

**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.

See Part 100, Section 101 for additional information.

# 801.2 Definitions

The following are definitions of words and phrases used in the Highway Design Manual (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 identify the ODOT applicable standards and practices for the design and construction on ODOT 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. Use collegiate dictionaries 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.

**Architectural Barriers Act (ABA)** - A federal law that passed in 1968 mandating facilities designed, built, altered or leased with federal funds (grants or loans) are accessible in the built environment. This includes facilities such as mass transit systems, transit centers, and rest areas.

**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 in their ability to use and operate 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 travel 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 the 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 pedestrian crosses the facility at a planned improved area. 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 segment between a sidewalk and the travel way. 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 public 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 and decorative pavers.

**Jurisdictional Transfer (JT) -** An action whereby ODOT transfers a state highway section to another jurisdiction or vice versa.

**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 alternatives to single occupancy automobiles are 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 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, enjoyable, and comfortable, including places people want to go and good facilities to get there.

**Pedestrian Realm -** The portion of a street right of way 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 Zone/Furniture Zone, the Pedestrian Zone, and the Frontage Zone of a sidewalk or walkway. Curbing is a part of the Transition Realm.

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[1] 2010 ADA Accessibility Standards, Section 106 Definitions

[2] PROWAG, Section R105 Definitions.

**Pedestrian Zone** - The portion of a sidewalk or walkway available for pedestrians to traverse, free of obstructions and contains the pedestrian access route for ADA.

**Planting Strip -** That portion of the sidewalk that accommodates street trees, shrubs, grass or other organic materials.

**State Highway System** - The state highway system encompasses all public roads and highways under ODOT ownership or jurisdiction. This definition includes those frontage roads and other public roads that may not 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 to operate.

**Shared Use Path -** 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 separated physically from motor vehicle traffic by an open space or barrier. The terms "shared use" and "multi use" are interchangeable.

**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 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. This includes the Pedestrian Zone and the Frontage Zone of the Pedestrian Realm.

**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 and 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 can 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.

**Universal Design** - The practice of creating environments and structures that can be easily accessed, understood and utilized by all people regardless of age, size and disability. Universal Design benefits all people.[3]

**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 use by pedestrians, including persons walking or using a personal assistive mobility device. Walkways include sidewalks, pedestrian lanes, shared use path, and trails. The walkway may be divided into the Buffer Zone, Pedestrian Zone, and the Frontage Zone (see Part 300).

**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.[4]

# 801.3 Acronyms

A list of acronyms specifically introduced in Part 800 is below. Acronyms defined in other Parts of the Highway Design Manual are not repeated in this section.

| | |
|---|---|
| CQCR | Concern, Question, Comment, or Request |
| 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 |

[3] National Disability Authority - https://universaldesign.ie/What-is-Universal-Design/

[4] 28 CFR Part 35 Section 35.104 Definitions

# Section 802 Approval Processes

Any deviation from a design standard, or 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 located 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. Determine the urban context and the roadway classification, and ODOT procedures for determining S.C.O.P.E. Appendix D discusses information on the Practical Design Strategy. When determining the cross section and standards to use for design, refer for Part 100 for discussion on how the Blueprint for Urban Design and Practical Design methods are applied given the roadway classification and urban context. 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 Zone per Table 800-3, but only 9 feet 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 Zone, which is better than a curb tight (curbside) sidewalk.

Under the Americans with Disabilities Act (ADA), 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 are retained on file using the roadway design exception process discussed in Section 1000. Conditions where an ADA design exception may 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 law(s) 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 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 Urban Design Concurrence Document are to be designed in accordance with the standards in Section 800. Refer to Part 300 for more discussion on the Urban Context and Urban Design Concurrence documentation.

# 802.2 ODOT ADA Curb Ramp Process Document (Appendix G)

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.

The 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 inquiries from members of the public. Utilize the on line ODOT ADA Accessibility Request Form to submit a request; this can be filled out by the individual or on behalf of an individual by an ODOT employee. 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.

The CQCR 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.*** Refer to technical bulletin RD21-01 (B), for the location of crosswalks on state highways. 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 circumstances:

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 feet 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 Unmarked 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. Appendix L, the Oregon Bicycle and Pedestrian Design Guide describes each of the following issues in detail. Refer to the Traffic Manual for additional design standards and crossing spacing requirements.

- Volume to Capacity (V/C) and Design Standards (Appendix L, page 5-3)
- Land Use (Appendix L, page 5-4)
- Transit Stops (Appendix L, page 5-4)
- Signal Spacing (Appendix L, page 5-4)
- Access Management (Appendix L, page 5-5)
- Out-of-Direction Travel (Appendix L, page 5-6)
- Midblock versus Intersection Crossings (Appendix L, page 5-6)
- 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. Refer to Section 224 and Section 900 for accommodation of other modes in design.

# 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 applies to the Public Sector (State and Local Government) under Title II and Public Sector under Title III. The ADA requires that transportation facilities accommodate the needs of people with disabilities. That means sidewalks, shared use paths, street crossings and connections to private properties are 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. People with disabilities is the largest minority group in the nation, and anyone can become a member of this population at any time during their lifetime.

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 Architectural Barriers Act (ABA)

The Architectural Barriers Act (ABA) is a Federal Law established in 1968 that mandates facilities designed, built, altered or leased with Federal Funds are accessible and useable to people with disabilities. This includes facilities constructed on federal land on behalf of the federal agency. That means federal buildings like post offices are required to be accessible. It also includes state schools, transit centers or park-n-rides, alternative fueling stations, parks and structures built with federal funds (grants or loans). These are built so people with varying abilities can use them. Examples of facilities that are required to be accessible on state right of way or on federal land include viewing areas, rest areas, picnic tables, beach access, and trails.

The ABA Standard is different than the ADA Standard; however the dimensions, slopes and requirements are very similar or identical in many cases.

# 805.3 Service Animals under the ADA

Service animals are either highly trained dogs (any breed), or can be a miniature horse under the ADA.[5] 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, 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 too high so service animals can activate the mechanism when needed.

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 in public places and service animals are often recognized by their calm and unobtrusive behavior with their focus on their human handler. Service animals 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 for example. 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

[5] CFR Part 35 Section 35.136 Service Animals

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.

# 805.4 Blind and Low Vision Users

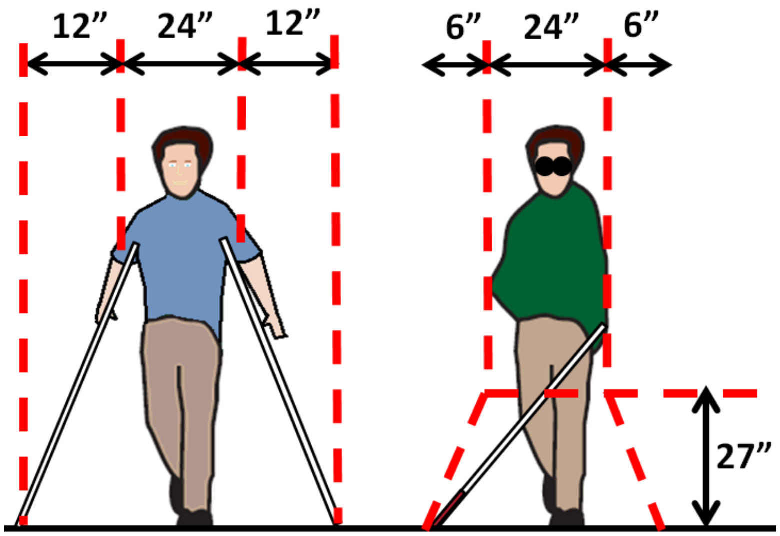
Design pedestrian facilities so people with vision impairments can track their way safely along the sidewalk or walkway, across driveway approaches and through intersections. Keeping the walkway clear of obstructions is important. Changes to the pedestrian environment can affect their ability to orient 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 with their remaining functional vision. Echolocation is used by people with vision impairments in varying degrees based on the person’s abilities.

Service animals help people navigate their environment. Service animals 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 a 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 when walking. 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 white 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 White 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 sidewalks and shared use paths. 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. Tactile walking surface indicators are the equivalent to braille underfoot. There are different geometric shapes for TWSI with emerging use in the USA. Truncated dome warning 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, railroad crossings and at transit stops.** 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 about the path of travel in the Unites States with the truncated domes pattern. While stopped, the DWS is an attention pattern that informs the user to evaluate their surroundings. The user will decide when to proceed with the 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.

# 805.5 Users of Mobility Aid 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 on the walkway.

People with physical impairments benefit from firm, level surfaces, adequate clear width, and limited cross slope. Adequate space is needed to use mobility aid devices on walkways. Pedestrians with mobility impairments are more 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 pedestrians 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 safety wheels 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 48 inches 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. Wheels on the device are typically 2 feet apart.

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).

Figure 800-2: Illustration of Variety of Wheelchairs

# 805.6 Deaf and Hard of Hearing

People who are deaf, or hard of hearing 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, and walkways that are free of obstacles. They 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 deaf or hard of hearing that they are about to enter a street crossing. Count down signal heads provide information for deaf and 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 deaf or hard of hearing, and alert them when certain sounds or words occur. Hearing service animals might be trained to assist the handler find the locator tone on the pushbutton, or alert them to an emergency alarms, 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", or percussive tones when the pushbutton is activated could be heard by the service animal to inform their handler when "walk" time is available.

## 805.7 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 equating to a stopping sight distance need for vehicles.

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, changing directions 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

Sidewalks are a portion of the public right of way located in the Pedestrian Realm used for the locomotion of pedestrians. 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, pedestrian lanes, shared use path, and trails. Paved shoulders serve pedestrians using rural highways in the absence of sidewalk in the Travelway Realm. Street crossings or crosswalks serve pedestrians connecting sidewalks across the Travelway Realm by providing a pedestrian access route in the roadway.

**Provide sidewalks 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." Refer to Section 900 for more discussion on the "Bike Bill". A sidewalk is a facility or service to provide people with transportation options. ***Limited access expressways should be evaluated for a possible exception, providing a shared use path or separated bikeway along a parallel route.*** If walkways are provided, then they are required to be accessible and usable by a person with a disability under the ADA. For people with disabilities, the public walkway may be their only option that they can use independently. Refer to Section 805 for pedestrian needs.

**When walkways are constructed, they are required to meet ADA requirements. Provide an accessible sloped entrance and exit to transition from the walkway to the shoulder when the facility terminates.** Entrance and exits are typically made with curb ramps that cut through a curb along the roadway, located most often at crosswalks which are extensions of the sidewalk. 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).

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 treatment makes a physical separation from vehicular use and the walkway surface constructed becomes exclusive for pedestrian use.

Sidewalks and shared use paths may 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 sidewalks per the Oregon Bicycle and Pedestrian Plan (Appendix L). 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 in communities. 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, FACS-STIP Tool Guide for instructions on how to access roadside inventory sidewalk need data through the FACS-STIP tools.

**Sidewalks, shared use paths and pedestrian lanes located along roadways shall have a firm, stable, and slip resistance surface.** Walkways can be constructed of many materials and meet the accessibility requirements (see Section 810.8 Walkway Surfaces) required by ADA. Sidewalks can also be used by bicyclists, but cities may ban bicycle riding on sidewalks with a local ordinance.

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 pathway 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 surface, cross slope and running slope requirements under ADA. Accessible sloped entrances and exits shall be provided where the shared use path ends, serves a crosswalk, or crosses a curb.** See Part 900 and Part 845 for additional shared use path design guidelines.

Figure 800-3: Sidewalks in Urban and Suburban Contexts

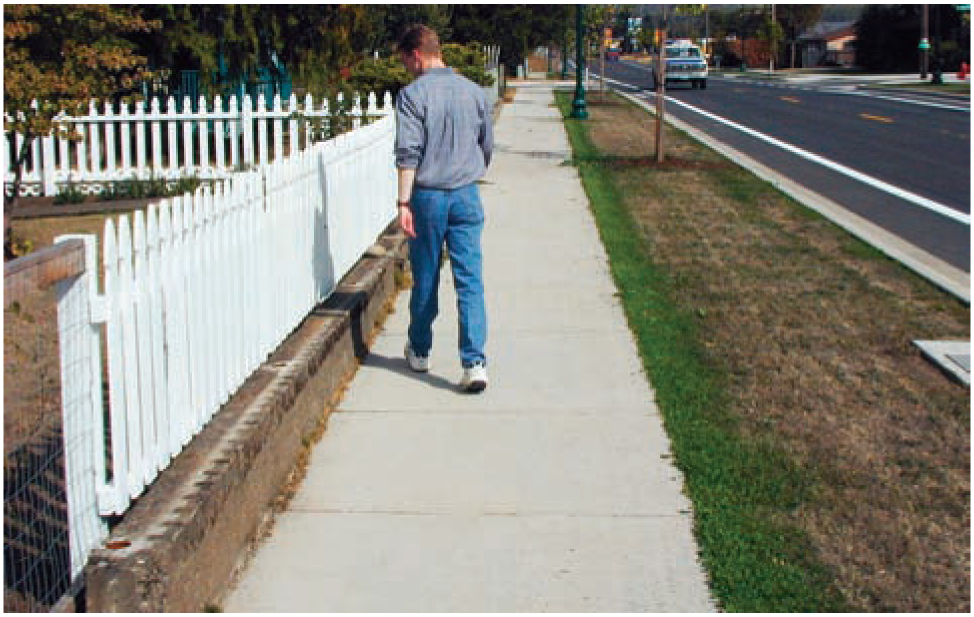


Figure 800-4: Shared Use Path on Separate Alignment from Travelway Realm


A trail is defined as a pedestrian route developed primarily for outdoor recreational purposes. Pedestrian routes that are developed primarily to connect accessible elements, spaces, and buildings within a site are not a trail. **Trails are required to be constructed of a firm and stable surface material.** "A firm trail surface resists deformation by indentations. A stable trail surface is not permanently affected by expected weather conditions and can sustain normal wear and tear from the expected uses between planned maintenances".[6] Providing a higher level of accessibility in surface material construction or other pedestrian access route requirements is not prohibited on trail systems. *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.*

Trails may be unpaved (packed gravel) if they are graded and firm (resist indentation). An unpaved path may 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 different from walkways that are used from transportation purposes (sidewalks, pedestrian lanes, and shared use paths). Trails may be designated for exclusive use by a mode of travel such as by horseback.

Figure 800-5: Trailhead and Trail in Recreational Context.


[6] US Access Board 2014, "A Summary of Accessibility Standards for Outdoor Developed Areas"

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. See shoulder width table in Part 300 for shoulder width guidelines.

Figure 800-6: End of Pedestrian Exclusive Facilities


**When roadway shoulders include pavement markings or signs that indicate the shoulder is intended for pedestrian use only, the shoulder becomes an exclusive pedestrian facility requiring the accessible route standards to be met under ADA.** See Section 810.7 for more discussion on pedestrian lanes.

# 810.1 The Pedestrian Realm

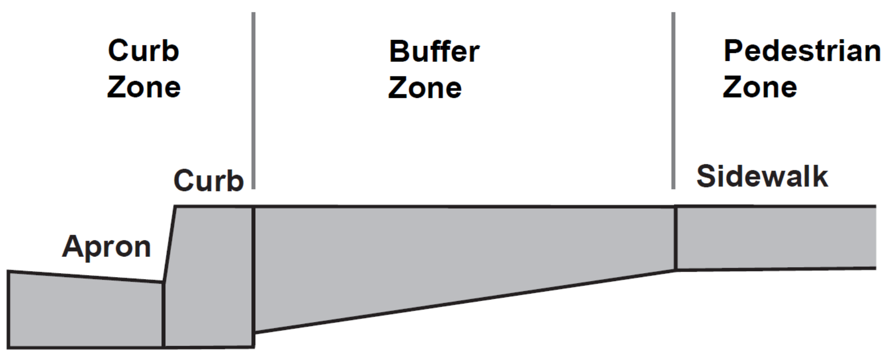
A highway cross section is categorized into Realms as described in Part 300. The Pedestrian Realm is further divided into four zones. These include the Curb Zone, the Buffer Zone, the Pedestrian Zone and the Frontage Zone. The Pedestrian Realm is adjacent to the Transition Realm. The best way to achieve the goal of a clear walking area is to design pedestrian facilities using the zone system. Each zone is a distinct area. Each zone has its function, and omitting a zone compromises the quality of the walking experience.

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 800-7: Curb Zone Transition from the Street to Sidewalk




***Provide a Curb Zone 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 as shown in RD701 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 a travel lane is directly adjacent to curb, the gutter pan is included in shoulder on-street parking measurements. **Provide a smooth, flush transition from gutter pan to roadway surface.**

The Curb Zone introduces a physical barrier for pedestrians with some disabilities and can obstruct a person from entering or exiting the pedestrian facility or walkway. **A curb ramp is required to provide access (entrances and exits) 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 construction, curb and gutter is required as shown on RD710. The curb ramp standard drawings RD900s have a basic assumption that the sidewalk is, or will be a curbed typical section. When the adjacent surface material for a separated bike lane is constructed of Portland Cement Concrete for the full width at the crosswalk, a curb and gutter can be omitted in the separated bike lane (See RD702). Curb and gutter may be integrated into the bridge deck or PCC pavement cross section when needed.

Many rural locations do not have existing curb in place for the highway cross section and will remain rural in character with separation from the Travelway Realm (for example a grassy sloped surface or ditch buffer). The same basic requirements for slopes and grade apply to the sidewalk and connections to the crosswalk for the pedestrian access route in these circumstances. ***When sidewalks do not include curbing (Curb Zone), curb and gutter is not required in this type of corridor for the pedestrian ramp (see section 815 for definition).*** **When there is no Curb Zone, the surfaces adjacent to each other must be flush and meet the slope requirements for the pedestrian access route at the pedestrian ramp.**

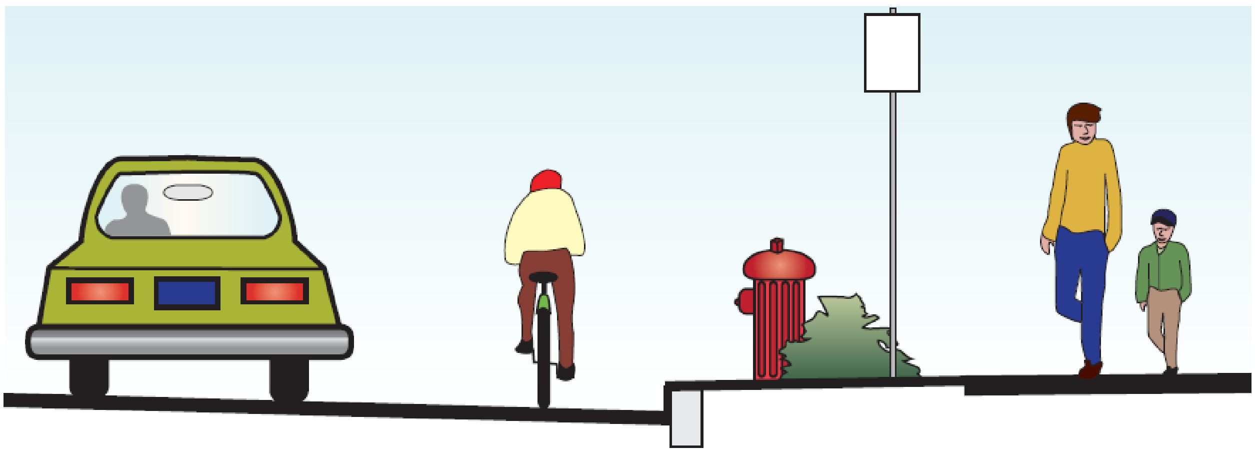
# 810.3 Buffer Zone

The Buffer Zone is also known as the Furniture Zone, or Furnishing Zone. 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.

While ranges can vary for the Buffer Zone, start with the largest width feasible during design based on the Urban Context. Larger Buffer Zones are not prohibited. ***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.***

***Provide a continuous buffered sidewalk in Commercial, Residential, Suburban and Rural Community Contexts of at least 2 feet.*** **A 3-foot buffer zone is required along the circulatory portions of a roundabout in any context (urban or rural), see RD170.** *Recommended set back widths should be 5 feet for roundabouts.* The Buffer Zone in roundabouts directs pedestrians to the crosswalk. See Section 509 for roundabout design requirements. 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 in the walkway (walking, running, or operating a mobility device) 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 Zone or walkway is preferred to be 1:10. When space is constrained a transition rate of 1:5 is permitted.* **A transition rate of 1:3 is the minimum requirement for horizontal width changes.**

Figure 800-8: Buffer Zone Used for Signs, Utilities, and Decorative Plantings

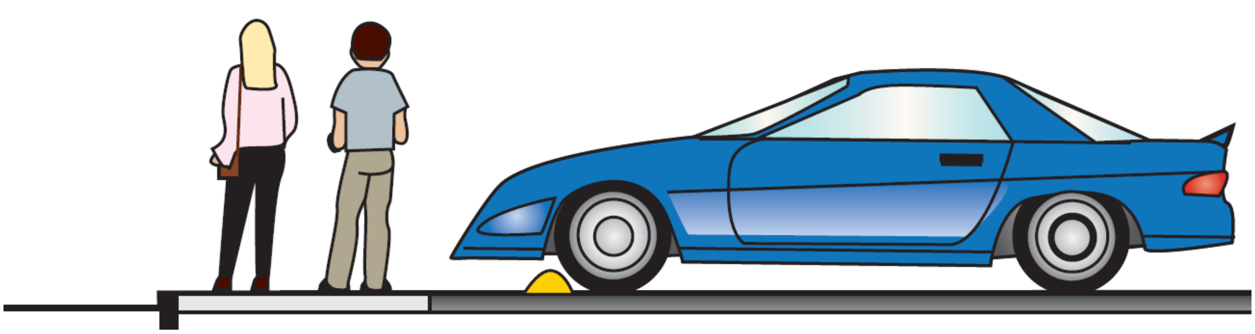


***A buffer strip should be at least 4 feet wide when planted landscaping is desired.*** Areas less than 12 square feet are difficult to support plant growth. Continuous planted buffers are not recommended in downtown areas with on-street parking because this precludes direct access to the sidewalk at the arrival point (parking space) 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.

Figure 800-9: Landscaping Providing Storm Water Treatment

**Provide a Buffer Zone at least 2.0 feet adjacent to parking so cars do not reduce the Pedestrian Zone and pedestrian access route.** Parked cars encroach into the walkway because there is an overhang distance from the wheels or side mirrors from either perpendicular or parallel parking. ***A paved Buffer Zone adjacent to parallel on-street parking spaces increases usability by providing boarding and alighting areas for accessible van ramps and mobility devices to the walkway when there isn't room for an access aisle.*** *Provide anchored (pinned) wheel stops, curbing or other treatments to prevent narrowing of the Pedestrian Zone from vehicular overhang.* 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. When angle parking is provided check the overhang distance based on AASHTO's parking lane configurations.

Figure 800-10: Wheel Stops Reduce Sidewalk Encroachment

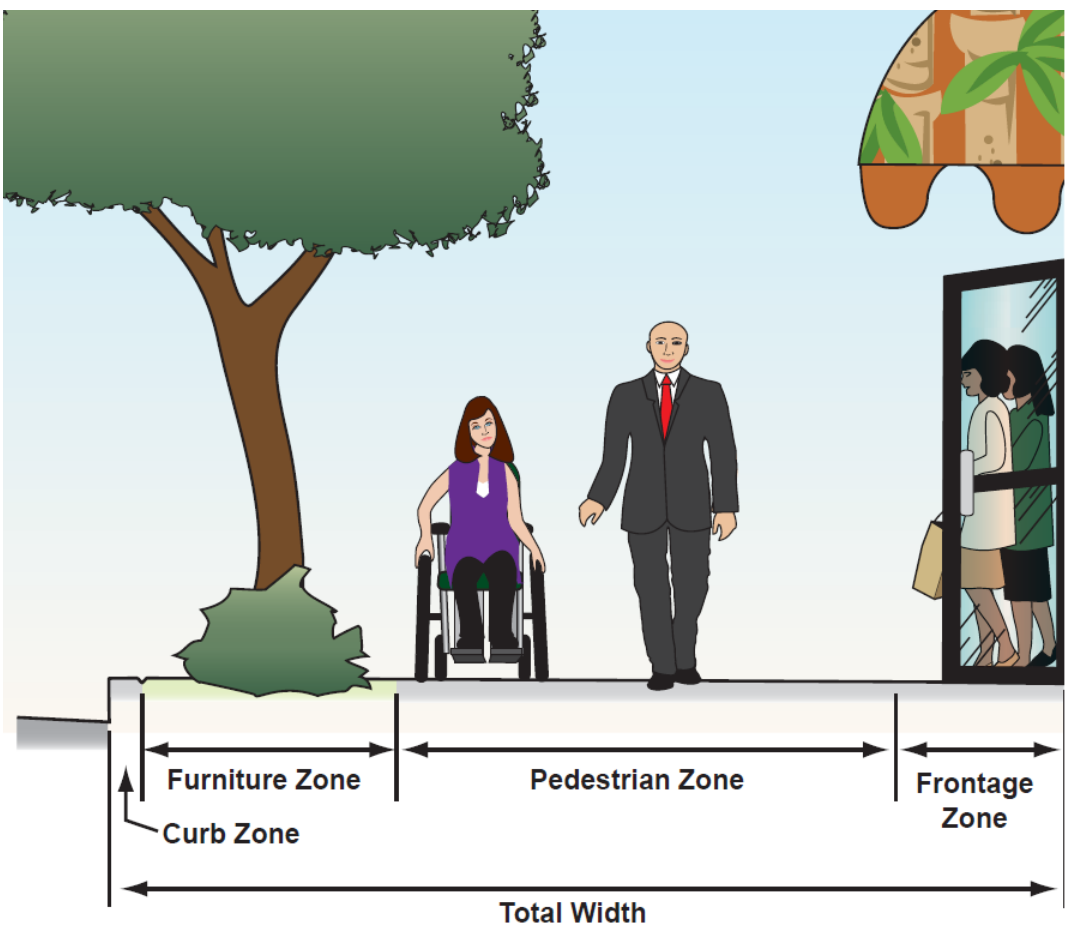


Pedestrian amenities are services provided to the public. **Provide a pedestrian access route in the Buffer Zone or furniture zone to pedestrian amenities so all people can access the services provided.** See discussion on pedestrian amenities in Section 810.10 and the pedestrian access route in Section 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, Oregon Bicycle and Pedestrian Design Guide, pages 4-2 to 4-3. Trees, street furniture and other objects should not reduce visibility of pedestrians, bicyclists and signs, especially at intersections.

# 810.4 Pedestrian Zone

The Pedestrian Zone is where people walk and is free of obstructions. All planning, design and construction documents (including permits) should clearly state the Pedestrian Zone dimension is to be clear of all obstructions. The Pedestrian Zone overlaps the same space as the pedestrian access route. The zone system makes it easier to meet the basic ADA requirements for a continuous, smooth, level sidewalk free of obstructions. Provide room for permanent obstructions such as street furniture, lighting, signs and utilities in the Buffer Zone or Frontage Zone. When the Pedestrian Zone is separated from the roadway with a Buffer Zone (furniture zone) pedestrians are further from traffic, increasing comfort and security when walking.

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 Contexts include 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 walkway width with sufficient space to accommodate desired level of pedestrian activity.

Walkway widths are exclusive of curbing. The curb is a part of the Curb Zone. ***Provide a Pedestrian Zone with the width in the range listed in Table 800-2: Pedestrian Zone Design Range below, however larger widths are not prohibited.*** **A design exception is required for the Pedestrian Zone if the width falls below the smallest dimension in the range in Table 800-2: Pedestrian Zone Design Range. At least 5 feet of the Pedestrian Zone will be continuous meeting pedestrian accessible route requirements.** *Best practice is to keep the pedestrian zone straight and continuous, rather than meandering between fixed objects or zoned areas. Providing a fully accessible Pedestrian Zone is best practice to allow flexibility for future installation of pedestrian amenities.*

Figure 800-12: Sidewalk with a Clear Pedestrian Zone

Design the Pedestrian Zone with the greatest width feasible within the design range, starting with the largest width. The Pedestrian Zone is free of obstructions, utilizing the Buffer Zone for lighting, signs, boarding and alighting areas. The Frontage Zone contains decorative planting boxes and other pedestrian amenities. **A 5-foot Pedestrian Zone requires a 1-foot paved Frontage Zone or a paved Buffer Zone so the minimum "walkable" surface width is 6 feet.**

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 |

A 6-foot wide Pedestrian Zone 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 sidewalk may be 60 inches (5 feet).** Locations where it may be justified to provide minimal facilities include local streets or where there are physical constraints. A design exception is not required on a local road if 5 feet is the road authorities standard. Coordination with the local road authority is required as some local road authorities have a wider standard for sidewalks or in identified in their Transportation System Plan. *When designing a 5-foot sidewalk, include a margin for error by stipulating an additional 2 inches in your design for construction to ensure the ADA passing requirement is met; ADA requires 60 inches minimum final construction passing width to be compliant with the regulations for the pedestrian access route.* Physical constraints might include a building foundation, a historic wall or building, or 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 allow for access unassisted by others to a destination. Pedestrian access routes (PAR) lie within the Pedestrian Realm or pedestrian circulation area. The Pedestrian Realm can be considered a pedestrian circulation area or path when the surface is constructed of a hard traversable surface, while only a portion of that surface in the Pedestrian Realm may be the pedestrian access route.

**Design at least a 60 inch 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 pedestrian access route should be of equal width.* Driveways are designed with a narrower pedestrian access route to allow vehicular entry into the private property when right of way is constrained.

Pedestrian circulation areas include all hard surfaces that are walkable and contiguous with the Pedestrian Zone or pedestrian access route including the Buffer Zone, Frontage Zone and Furniture Zone. **Pedestrian circulation areas are constructed flush adjacent to the Pedestrian Zone or pedestrian access route.** 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. Softscaping provides cues with natural materials with sound, texture, and contrast that is different than the walkable surface. Softscaping provides a more pleasant pedestrian experience when walking and enhances the community character. Able-bodied pedestrians might be able to traverse them, however softscaping materials are not accessible surfaces. Accessible surfaces must be firm, stable and slip resistant under the ADA year round.

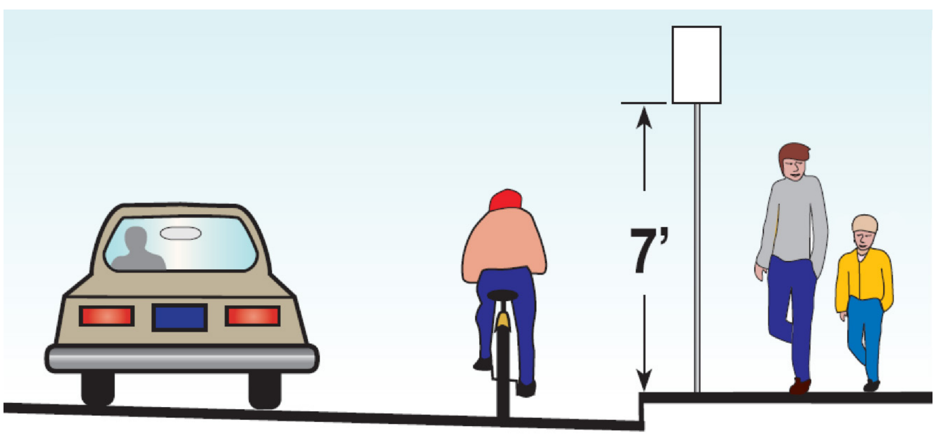
Fixed objects that reside in the Pedestrian Realm reduce the useable sidewalk width and effective Pedestrian Zone width. Temporary objects must not block the pedestrian access route. These items might include trash cans, advertising sandwich boards (A frame), feather flag signs, rental bikes or rental scooters. Select Buffer Zones and Frontage Zones widths that can accommodate these types of amenities for intermittent periods of time without blocking the pedestrian access route.

ADA requires wheelchair passing opportunities on pedestrian facilities; constructing a 60 inch (5 feet) pedestrian access route in the walkway free of all vertical obstructions ensures that standard is met without further analysis (See RD 720). *When designing a 5-foot sidewalk, include a margin for error by stipulating an additional 2 inches in your design for construction to ensure the ADA passing requirement is met; ADA requires 60 inch x 60 inch minimum passing space to be compliant for the pedestrian access route.* **At no point shall the Pedestrian Zone or pedestrian access route 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.**

**The pedestrian access route shall have a smooth surface, free of vertical discontinues, free of large horizontal openings 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 pedestrian access route is generally designed within the range of 0.5% to 1.5% cross slope to provide drainage.* The balance of the sidewalk width can be used to make up grade differences if necessary with cross slopes exceeding 1.5% to match into adjacent existing built constraints in either the Buffer Zone or Frontage Zone keeping vehicular Clear Zone in mind. See Section 400 for Clear Zone requirements. **Provide a vertical clearance at least 7 feet (84 inches) to vertical obstructions (e.g. bottom edges of signs, tree limbs, pedestrian signal heads, etc.) in all walkways and pedestrian circulation areas.**

Figure 800-14: Walkway Vertical Clearance




Crosswalks reside in the Travelway Realm and are extensions of the pedestrian access route connecting sidewalks. See Section 802 for Crosswalk Location Determinations and the Traffic Manual for where crosswalk exists on or along the State Highway. Pedestrian access route design width requirements vary at intersection corners with curb ramps or at midblock crosswalks. See Oregon Standard Drawings RD700 series for detailed curb ramp construction drawings, and Section 815 for curb ramp design information. Refer to Section 820 for discussion on accessible routes and building ramps to public entrances.

## 810.5.1 Protruding Objects

**ADA requires that objects protruding from walls (e.g. signs, fixtures, telephones, canopies, street art) are placed so their edge is not more than 4 inches from the wall or other cane detectable edge when the height of the object is between 27 inches and 80 inches above the finished walkway for any portion of the public walkway (See RD 720).** This requirement is applicable to moveable or temporary objects in the walkway. Routine maintenance is needed for tree canopies or vegetation that overlap the walkway as they are often overgrown and become a protruding object.

Protruding objects present a hazard in the walkway to pedestrians, particularly the low vision and blind community. However protruding objects are also a problem for a person sitting in a wheelchair. For example, when the object is at eye height and in the walkway or pedestrian circulation area, people with paralysis may not be able move their head out of the way of object. Protruding objects restrict the available and useable walkway space for pedestrians to circulate or congregate. These type of objects, facilities and services (water fountains, telephones, street art, trash cans, signs, decorative planter boxes, etc.) and amenities are located in the Buffer Zone or Frontage Zone and not in the Pedestrian Zone.

Mailboxes are a common protruding object in sidewalks along the state highway. When projects include a Buffer Zone that is constructed with plantings 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 sidewalks introduces added complexity and considerations for storm water runoff. Drainage curbs impacts the Clear Zone and thoughtful selection of end treatments such as a curb endings.

## 810.5.2 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 Highway Division Maintenance Operational Notice for temporary pedestrian access route plan requirements during maintenance work.***

## 810.5.3 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 or joint cover plate.** ***Transitions over the joint or plate should be designed flush as there cannot be a vertical change exceeding ¼ inch in the***

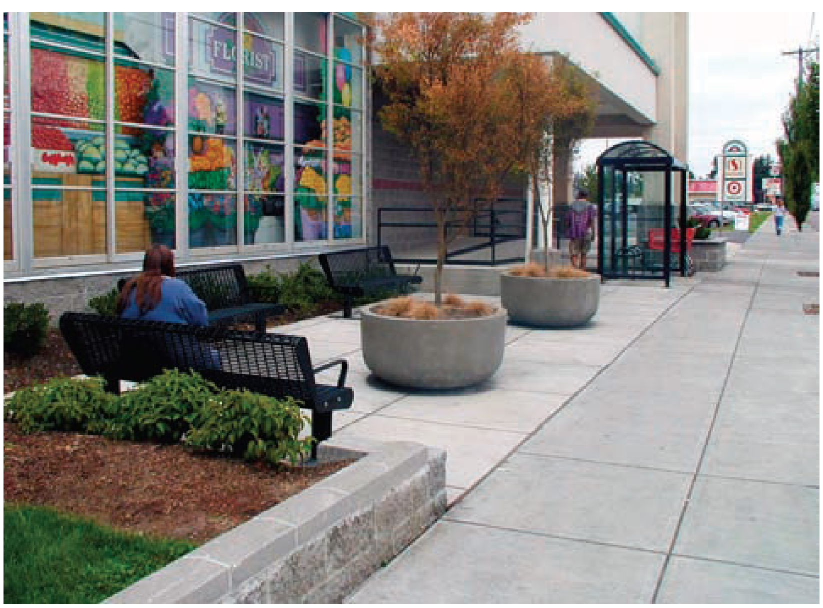
***pedestrian access route.*** Grout railing pads, decorative lighting, guardrail posts, and bridge rail connections often reduce the clear width of the pedestrian access route and pedestrian zone. **A 1-foot pedestrian shy distance is needed from each concrete barrier and/or pedestrian railings on walkways constructed on bridges.**

# 810.6 Frontage Zone

The Frontage Zone is located between the Pedestrian Zone and the private right-of-way. It is where sandwich boards, kiosks, bike racks and other street furniture can be placed. It is used by window shoppers and for outdoor dining when permitted by the road authority. ***Refer to Delivery and Operations Division Operation Notice MG14-04 for permit requirements on ODOT facilities where portions of the sidewalk are closed.*** The Frontage Zone is where people enter and exit buildings. Business frontage doors typically swing outward from the building to ensure Fire, Life and Safety egress can occur; the doorway maybe recessed from the exterior building face. **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.

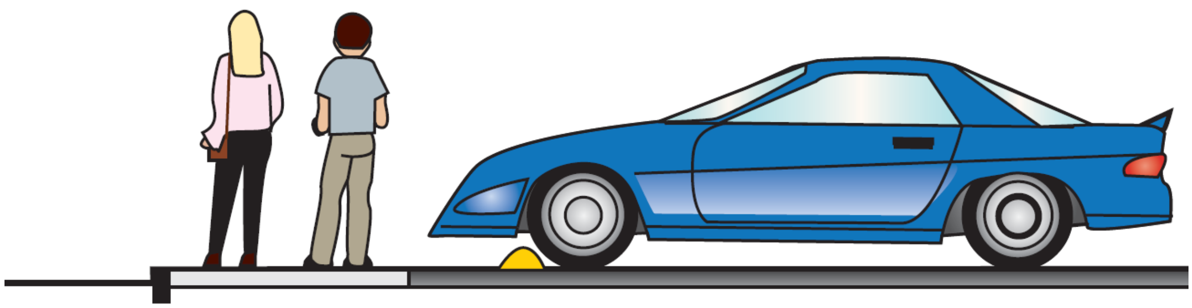
***Provide a Frontage Zone that ranges from 4 feet to 2 feet in traditional downtown/central business districts. In Central Business Districts the Frontage Zone should be 4 feet or wider to provide space for merchandise, sidewalk cafés, and opening business doors, and adjacent parking lots. A 2-foot pedestrian shy distance is needed from vertical barriers such as buildings, sound walls, retaining walls and fences.***

Figure 800-15: Generous Frontage Zone with Seating and Bus Shelter



**Provide a Frontage Zone at least 2.0 feet adjacent to parking on private right of way so cars do not reduce the Pedestrian Zone and pedestrian access route.** Parked cars encroach into the walkway because there is an overhang distance from the wheels or side mirrors from either perpendicular or parallel parking. *Provide anchored (pinned) wheel stops, curbing or other treatments to prevent narrowing of the Pedestrian Zone from vehicular overhang.* 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. When angle parking is provided check the overhang distance based on AASHTO's parking lane configurations.

Figure 800-16: Wheel Stops Reduce Sidewalk Encroachment



**Provide a Frontage Zone that is at least 1 foot in all Urban Contexts. When the Pedestrian Zone is only 5 feet wide, the Frontage Zone will need to be a hard surface (paved or concrete), see discussion in the Section 804.4 Pedestrian Zone.** 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.

# 810.7 Walkway Configurations

The Pedestrian Realm width is the summation of the Buffer Zone, the Pedestrian Zone, and Frontage Zone. Configurations for sidewalks 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 sidewalks 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. Refer to Appendix A, for the Oregon State Highway functional classification and Appendix B, for the Oregon Highway Plan classification designation on a state highway.

**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 (CC)** - 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 sidewalk widths in the Pedestrian Realm:

1. **When signs, mailboxes, or other appurtenances in the sidewalk become numerous, provide a sidewalk of at least 8 feet.** The width of a curbside sidewalk should be 8 feet in locations where the target speed is 45 mph or greater.
2. **Provide a total sidewalk width in Central Business Districts (CBDs), STAs and traditional downtowns at least 10 feet wide where buildings are located at the back of the sidewalk.** The preferred sidewalk 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.** Newly constructed or reconstructed bridge walkway widths should not 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, walkway shall be at least 7 feet wide to account for pedestrian shy distance.**

**Design exceptions are required for the sidewalks that are less than the values shown in Table 800-3**. See Section 810.3 for Buffer Zone distances requiring a design exception.

Table 800-3: 4R/New Construction Pedestrian Realm Widths (B = Buffer Zone, P=Pedestrian Zone, F= Frontage Zone)

| Oregon Highway Plan Designation [7] | Minimum Pedestrian Realm Width (B+P+F) | Buffer Zone or Frontage Zone Treatment |
|---|---|---|
| Special Transportation Area (STA), Central Business District (CBD) or Traditional Downtown | 10 feet | 1 foot paved Frontage Zone |
| Special Transportation Area (STA), Central Business District (CBD) or Traditional Downtown | 12 feet | 4 feet softscaped buffer strip |
| Urban Business Area (UBA), commercial centers and other developed areas | 6 feet | Curbside, 1 foot paved Frontage Zone |
| Urban Business Area (UBA), commercial centers and other developed areas | 10 feet | 4 feet softscaped buffer strip |
| Urban Fringe: 35-45 mph Target Speed | 8 feet | Curbside, 1 foot paved Frontage Zone |
| Urban Fringe: 35-55 mph Target Speed | 10 feet | 4 feet softscaped buffer strip |
| Expressway: 45 mph Target Speed | 8 feet | Curbside, 1 foot paved Frontage Zone[8] |
| Expressway: 45 mph Target Speed | 14 feet | 8 feet softscaped buffer strip |
| Expressway: 50-55 mph Target Speed | 14 feet | 8 feet softscaped buffer strip |
| Bridge Sidewalk and Sidewalk separated by Traffic Barrier | 7 feet | Not applicable |
| Roundabouts | 14 feet | 3-foot detectable Buffer Zone |

[7] Appendix B,"OHP Appendix D: Highway Classification by Milepoint."

[8] Curbside walkways should be avoided on Expressways or when Target Speeds exceed 45mph.

## 810.7.1 Walkway without Curb or Behind Ditch

Most sidewalks 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 sidewalks 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, sidewalks 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.**

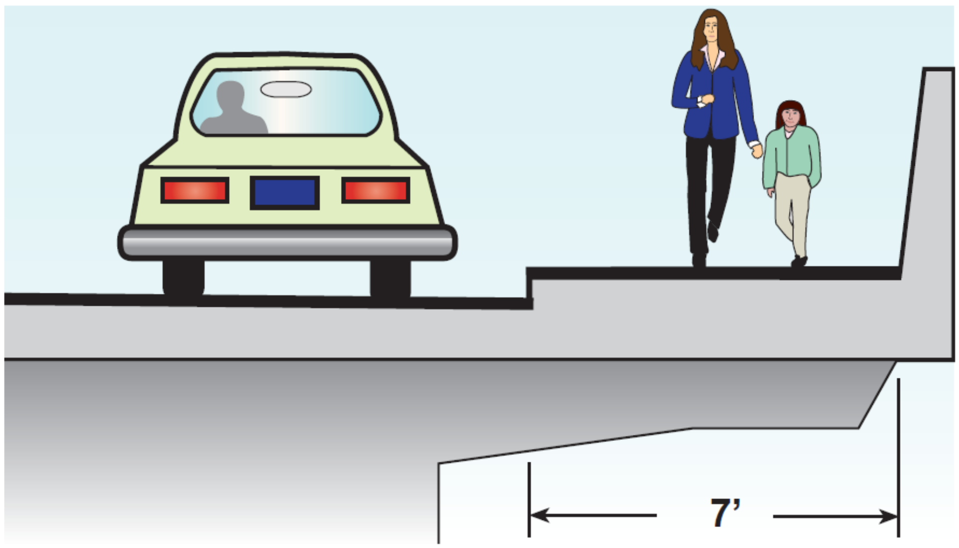
## 810.7.2 Walkways on Bridges

**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 845.

**Provide a Pedestrian Zone at least 7 feet wide on bridges when the walkway is for transportation use only to account for shy distances.** See Section 900 for shared use path design width requirements. The Pedestrian Zone is exclusive of any curb, railing or concrete barrier on the bridge. **A 1 foot pedestrian shy distance is needed from each concrete barrier and/or pedestrian railings constructed on bridge walkways.** 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. Consider wider sidewalks in urban settings with high pedestrian use based on the Urban Context. **The bridge sidewalk must not be narrower than the**

**approaching sidewalk at the bridge ends. Walkways on bridges with design speeds greater than 40 MPH require a vehicle traffic barrier at the Curb Zone.**

Figure 800-17: Minimum Bridge Sidewalk Width




Walkways 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. There is an implied curb and curb zone width (6 inches) which does not count towards the clear width requirement. 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 (See discussion in 810.5 on pedestrian access routes).

## 810.7.3 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 Pedestrian Realm is often also used for street furniture and other pedestrian amenities. Pedestrian Realms with widths 12 feet to 16 feet or greater are common in Central Business Districts.

Restaurant seating and other private business use on state right of way is not consistent with the use of the Highway Trust Funds and is generally not permitted on state owned sidewalks. ***Review the Delivery and Operations Division Notice MG14-04 for current state policy.*** Many sidewalks along the highway are under local road authority and may require additional coordination or permits if the sidewalk is closed for private business use temporarily.

Figure 800-18: Recommended Curb Side Sidewalk Dimensions

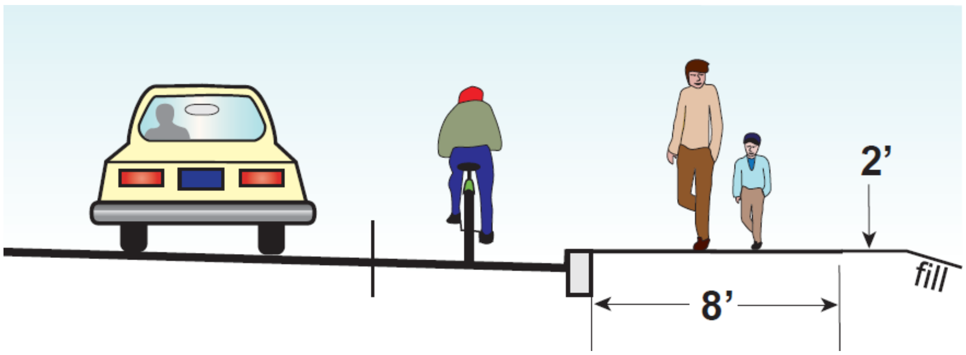
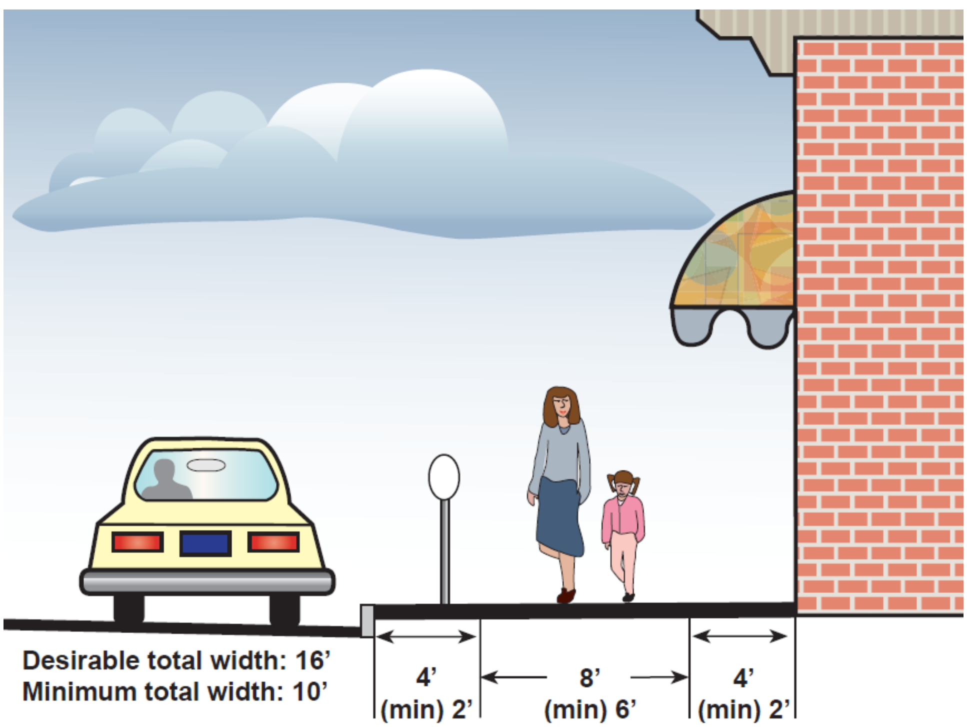



Figure 800-19: Recommended Central Business District Sidewalk Dimensions



# 810.7.4 Pedestrian Lanes

Pedestrian Lanes are a type of walkway that is at the same grade and is contiguous with the Travelway Realm. It often resembles a travel way shoulder, but it is reserved for pedestrian use. It is denoted for use by pedestrians only by the addition of pedestrian only pavement markings/icons, pedestrian only signing, a raised curb (typically a drainage curb on RD700's), or concrete barrier that separates the pedestrian travel mode from vehicular use. Pedestrian lanes use markings and buffer striping to increase the distance between motorists and non-motorized users in some locations with low traffic volumes and speeds. When pedestrian lanes are provided they must meet ADA pedestrian access route requirements including cross slope and running slopes.

Figure 800-20: Example Pedestrian Lane

Pedestrian lanes are not the preferred walkway configuration. Pedestrians are permitted to use 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 sidewalk, 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.***

# 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, pedestrian lanes 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 on site improvements, sidewalks, shared 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. Asphalt pavement surfaces are a more accessible surface for recreational trails and reduce maintenance needs, exceeding the minimum ADA requirements.

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) can meet the ADA surface requirements. Bricks and pavers will need to have a slip-resistant surface when installed; they are often smooth finishes and when wet will become slippery. Long-term maintenance costs should be recognized when selecting bricks or pavers as the walkway surface. 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 requirements. Low vision and blind travelers cannot distinguish the difference between bricks and Portland cement concrete underfoot, and confuse these type of surfacing materials as something that is intended to be walked on in many situations in other environments. Bricks and pavers can be aggravating and painful for some people with spinal cord injuries and other conditions as vibrations occur when mobility device users traverse the surface. ASTM-E3028 is a standard for determining wheelchair pathway roughness index related to comfort, passibility, and whole body vibrations.

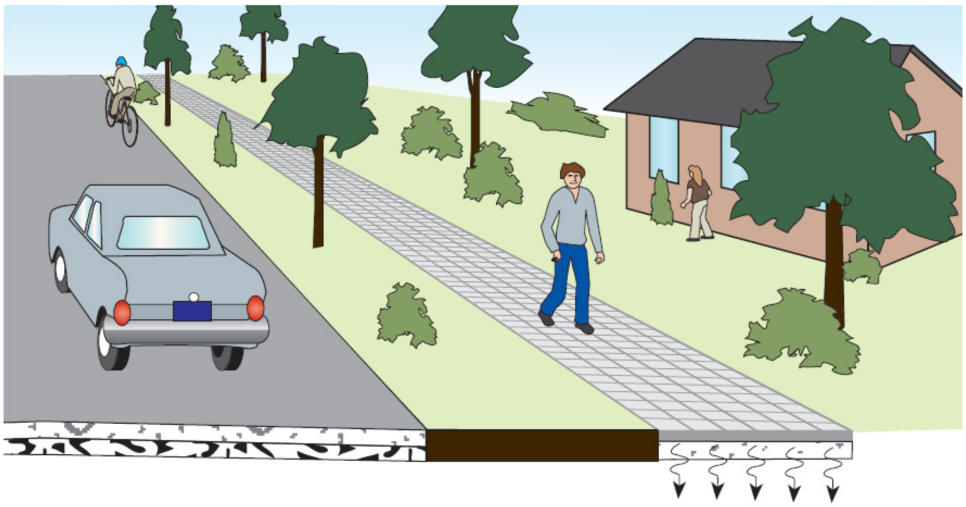
An alternative to pavers is stamped and dyed concrete. This alternative provides much of the aesthetic value of bricks with the durability and smooth surface of concrete. Decorative treatments in the street or crosswalk which consist of concrete color or scored patterns are not a marked crossing. See 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 require approval for installation.** ***Use of stamped concrete pattern area in the vicinity of curb ramps will require concurrence from the Senior ADA Standards Engineer.***

## 810.8.1 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 when a pervious walkway surface is installed. Walkways built out of conventional impervious materials (concrete) contribute little to runoff if they are separated from the roadway with a vegetated buffer zone as 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 walkways to avoid a rough surface.

Pervious walkway surface technology is evolving, and long-term maintenance is a concern. The concrete mix design is of particular importance, to avoid large voids in the final surfacing. 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. Geo-grids can be considered for the other areas of the Pedestrian Realm or Buffer Zone; it is generally considered a hardscaping treatment unless vegetated growth is incorporated in the geo-grid.

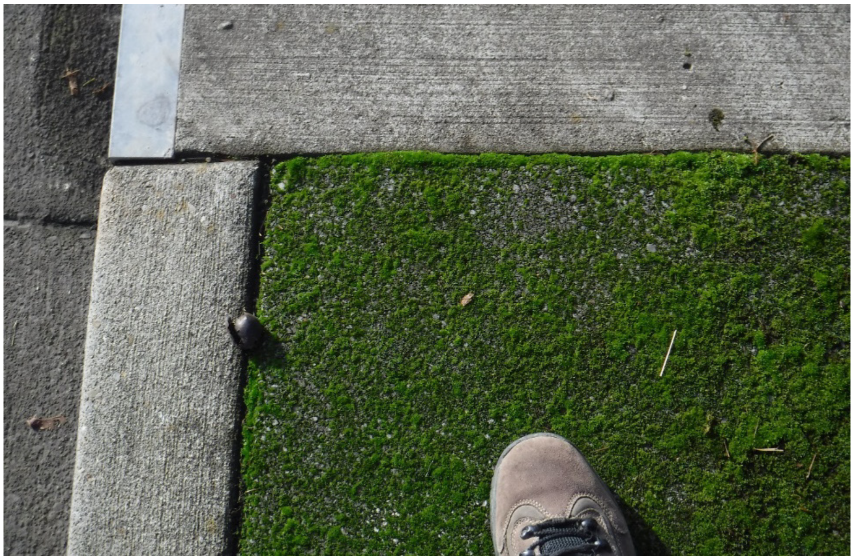
Figure 800-21: Pervious Sidewalk



Consider the natural and 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.

Figure 800-22: Porous Pavement Installed Next to Concrete Walk Illustrating Mossy Growth

Figure 800-23: Porous Pavement Installed Next to Concrete Walk Illustrating Mossy Growth



## 810.8.2 Surface Thickness

Walkways with foot traffic only are normally constructed with at least 4 inches of Portland cement concrete on top of a compacted base of crushed aggregate. When vehicular traffic is expected to occur over the walkway at driveways the thickness of Portland cement concrete is increased based on the design vehicle. ***Typical driveway construction consists of 6 inches of Portland cement concrete, 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 sidewalks.

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

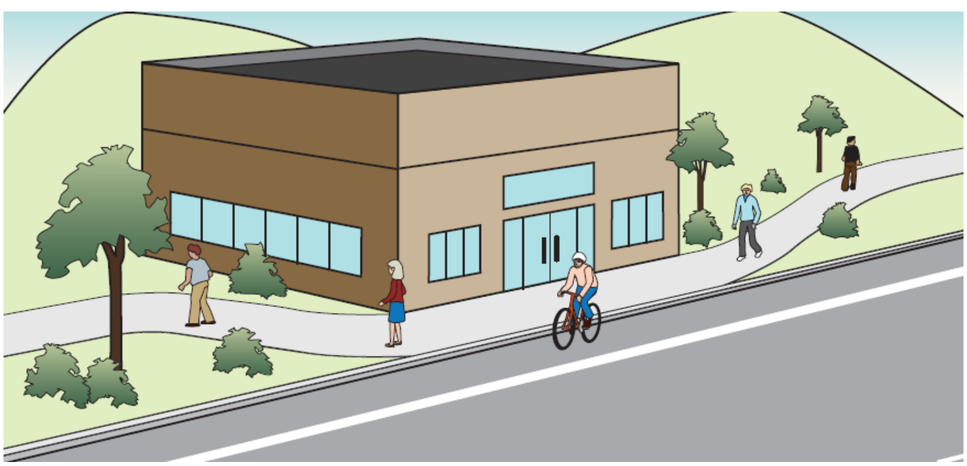
With new construction of pedestrian facilities where they did not previously exist, the desire is to create a sidewalk that is fully accessible when hard surfaces are constructed for the entire width. This ensures that over the life span of the walkway, pedestrian access routes requirements are met and have the most flexibility to ensure ADA access when pedestrian amenities and features are improved or disturbed, temporarily or permanently. A key principal is that between arrival points and destination points, there is a fully accessible route pedestrian access route per the ADA year round. A Universal Design approach is best practice when designing walkways.

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 pedestrian access route requirements with the improvement. A reduction is accessibility is prohibited with the alteration under the ADA. *The design should aim to provide a fully accessible walkway as best practice with any alteration of the walkway incorporating Universal Design.*

## 810.9.1 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 sidewalk 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 assure 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 scrutinized by the public when the sidewalk 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. 1:10 accommodates 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 for widths and alignment changes.
3. Grade breaks are required to be perpendicular to the path of travel in the Pedestrian Zone when the constructed running slope exceeds 5.0%. Design perpendicular grade breaks for slopes over 4.0%.
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:
   a) Reduce the number of accesses, thereby reducing the need for alterations at every driveway
   b) 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;
   c) 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, 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 are below:

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, pedestrian zone 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. Keep intersections tight and square to limit long and skewed crosswalks;
4. Place crossings in areas where they are expected - in line with receiving curb ramps and approaching sidewalk in the Pedestrian Zone;
5. Keep crossings parallel with the adjacent Travelway.
6. Providing accessible and audible pedestrian signals;
7. Install detectable warnings at curb ramps to identify the transition from the sidewalk to the street.

# 810.9.2 Vertical Alignment

**Sidewalks are to be designed with the same profile slope of the roadway.** A pedestrian with a disability might find that the roadway surface in the transition realm is the preferential path of travel when a sidewalk 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 or 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 as 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 820 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 utilizing a sloped surface which often requires hand braking. The Buffer Zone and Frontage Zone 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 sidewalk, 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 820 on building ramps.

## 810.9.3 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. T**he 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 when working on an alteration.* Cross slopes in the Frontage Zone 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 sidewalk 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 sidewalk 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 as part of the pedestrian circulation area, 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 2.0% 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%.**

## 810.9.4 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 pedestrian access route. The pedestrian accessible route and temporary pedestrian accessible routes are both defined terms in the Oregon Standard Specifications, which may vary slightly from the definition and use within the Highway Design Manual. Clear width is measured anywhere within the pedestrian circulation areas, along pedestrian accessible routes and the Pedestrian Zone. 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 Zone and Frontage Zone. There may be a mailbox in the path or guy-wires above the sidewalk. 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 pedestrian access route 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 sidewalk. Mailboxes and the supports are located in the Buffer Zone of the sidewalk 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.*

## 810.9.5 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. Handrails are not required on pedestrian circulation paths; however when installed they must comply with the ADA requirements. Handrails can be a mitigation tool in steep terrain on walkways or curb ramps.

Handrail in RD770 has not been crash tested for vehicle departures from the travel way, and should be consider a fixed object when installed.

**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. A singular condition might warrant pedestrian rail. Consider any OSHA requirements for areas that maintenance employees may need to occupy to perform work. Consider the combined effects of the following when determining the need for pedestrian rail, but it is not limited to these conditions. Mitigating for one factor may remove the need for a rail.

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 (V:H) 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, pedestrian railing 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: Pedestrian Rail at Back of Walkway

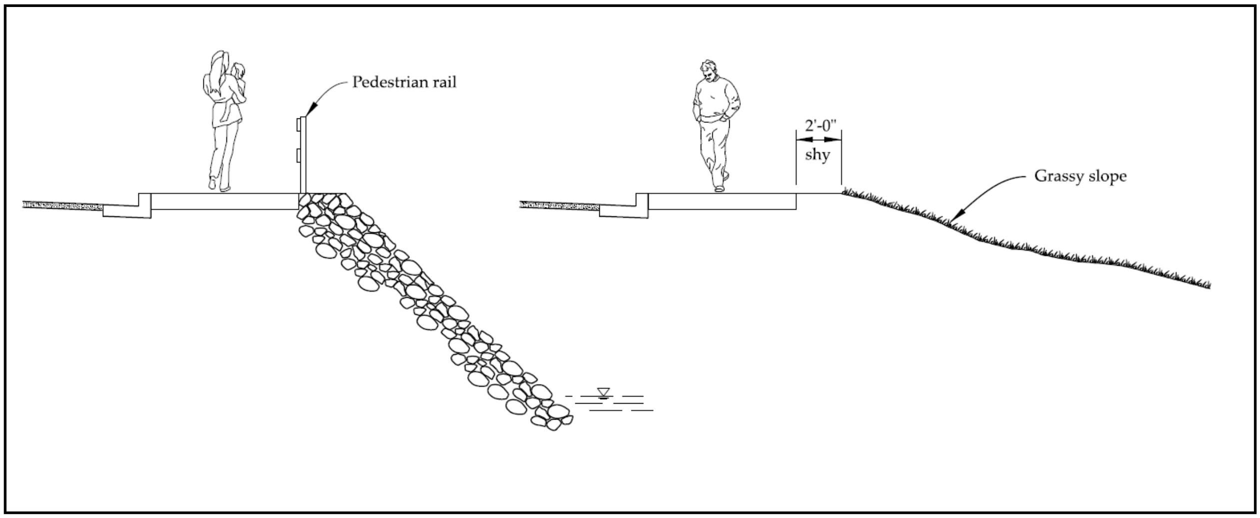
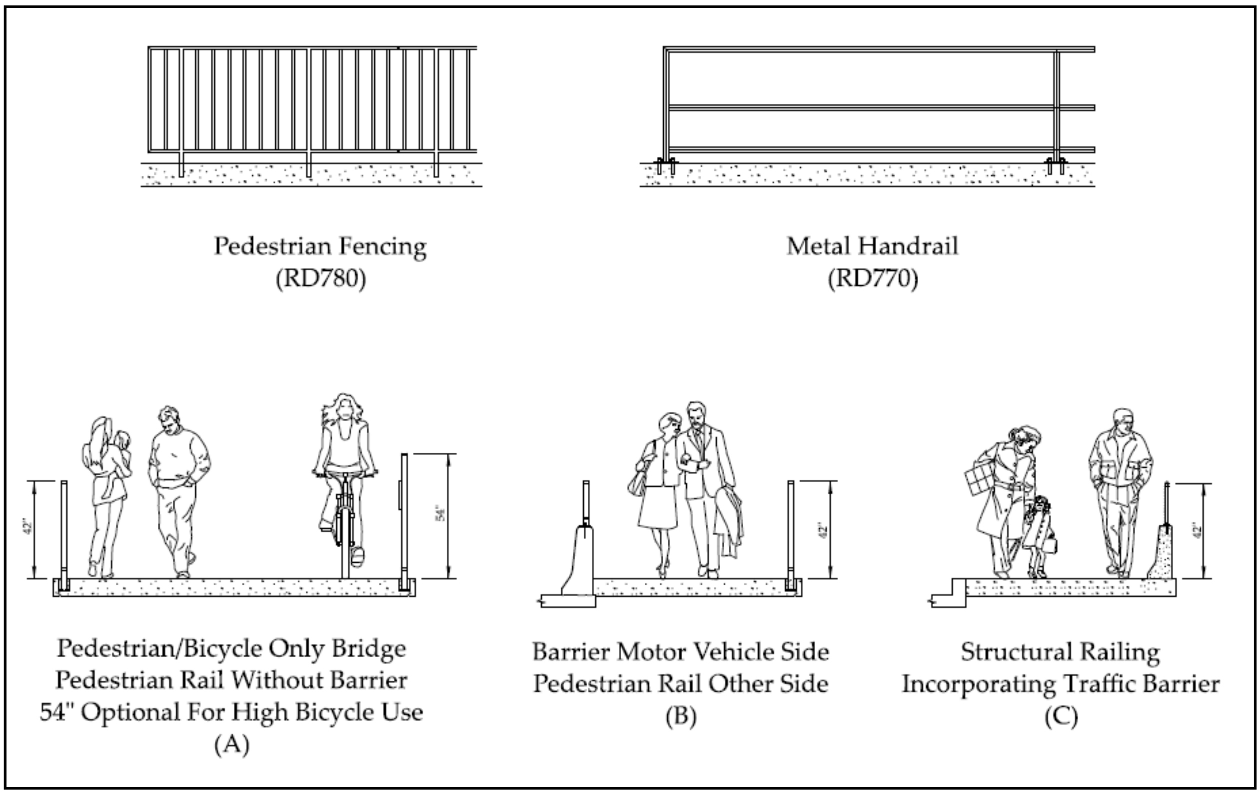



Figure 800-27: Pedestrian Rail at Bridges and Vertical Drops




**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 concrete barrier is recommended from 30 inches to 42 inches. When a concrete barrier is installed, Case C, in Figure 800-27: Pedestrian Rail at Bridges and Vertical Drops, the Pedestrian Zone width is measured from the outside edge of the barrier, 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.

# 810.9.6 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 when the walkway crosses/overlaps the driveway. Refer to Section 505 for additional driveway design considerations and styles.

***Design at least a 50 inch pedestrian access route across a driveway approach along the walkway.*** The best practice is to plan sidewalks with Buffer Zones with a width that allows the Pedestrian Zone to be a straight continuous alignment along the sidewalk across the driveway and equal to the desired Pedestrian Zone width selected for the Urban Context. This allows the pedestrian access route to be at the same elevation as the general walk and easily achieve the ADA requirements minimizing the roller coaster effect along the sidewalk. See RD 700s for driveway styles Option A, Option B, Option D, and Option E for design requirements on ODOT facilities as these are the preferred driveway configurations for the overall pedestrian experience and accessibility.

Consider reconfiguration of any radial style driveways that do not conform to the recommended dustpan style as outlined in Part 505, Table 500-1 in coordination with the access management strategy for the project. This improves the pedestrian access route, clarifies expectations of pedestrian priority over vehicular right of way, and removes curb ramps that may not be necessary from the ODOT inventory. Fully lowered parallel driveways, Option G, are not the preferred choice for pedestrian accessibility as there are often insufficient cues for many low vision or blind travelers to detect the boundaries of the sidewalk from the Travelway Realm. Mobility devices travel a roller coaster effect vertical alignment when this style of driveway is used in a series. **Notify the Roadway Statewide Asset Specialist when a curb ramp is removed from the ODOT inventory due to driveway reconfiguration.**

**A pedestrian access route must be provided on driveways which are connected at street grade typically with asphalt construction and radius returns when it crosses a walkway.** 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. **Provide a fully accessible pedestrian access route when the driveway is reconstructed.** The pedestrian access route 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.

# 810.9.7 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 prevent accumulation of water.** This means they should be 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 walkway as soon as practical with a cross slope of 1.0% -1.5% depending on the surface material*.

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 particularly when constructed with a hard impervious surface. Refer to Section 509 for additional roundabout design considerations.

**Inlets are not placed 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 through 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 generally installed upstream of a curb ramp for a crosswalk when there is a Curb Zone. Water conveyance must be addressed with another approved treatment if an inlet is not provided. **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 Part 1200, Section 1211 Hydraulics for additional information and the Hydraulics Design Manual.

# 810.9.8 Pedestrian and Wayfinding Signs

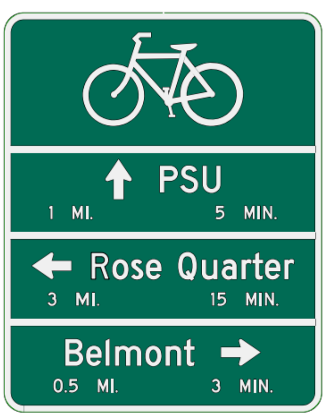
Walkways generally require little signing. **When a crosswalk is closed, it must be signed per the ORS.** Most regulatory and warning signs are directed at motor vehicle traffic. See sections on street crossings and intersections for signs required in those situations, and the Sign Design Manual.

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.

Figure 800-28: Sign Guidance for Wayfinding, 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 Zone or the Frontage Zones. **Temporary objects must not block the pedestrian access route, either privately owned or publicly owned.** Items might include trash cans, advertising sandwich boards (A frame), feather flag signs, rental bikes or parked vehicles.

## 810.10.1 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

## 810.10.2 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

## 810.10.3 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 with seating 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 805.4 and Part 700 for additional considerations for boarding and alighting areas for transit services.

Figure 800-31: Bus Shelter in Buffer Zone

## 810.10.4 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; seek guidance from ODOT's landscape architects. Refer to Section 406 for additional guidance on roadside tree placement. 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 walkways (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 and prevent the vegetation from becoming a protruding object**.
5. Planting strips should be wide enough to accommodate plants grown to mature size.

# 810.10.5 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 feet x 4 feet 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 sidewalk adjacent a roadway. **The clear space must be free 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.*

# 810.10.6 Parklet 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.**

# 810.10.7 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."[9] The extension of the handrail provides a surface to bear weight when negotiating the first and last steps of the stairway per the ADA.

[9] Kierstan Boyd, "Depth Perception," American Academy of Ophthalmology, https://www.aao.org/eye-health/anatomy/depth-perception

# Section 815 Curb Ramps

Curb ramps allow pedestrians with varying abilities to enter and exit the sidewalk or other similar pedestrian facilities and walkways. 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 systems 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 ODOT Curb Ramp Process in Section 802 and included in the Highway Design Manual , Appendix G, for additional discussion on how curb ramps are incorporated in the design development and construction contract process. Review the general intersection design principles in Section 506 when designing curb ramps.

There are multiple components that are constructed to build a curb ramp system. 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 system 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 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 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 may be utilized as an additional route for pedestrians when the primary access route is constructed and is fully accessible. See Section 810 on walkway design.

Figure 800-32: 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. It may also be referred to a sidewalk ramp or curb cut in portions of this manual.

**Building ramps** - A system of geometric components which serve both private and public buildings developments to allow pedestrians to access the business 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 or walkway 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 Ramp** - Curb ramp system where the ramp run(s) entering the Travelway Realm have centerline(s) parallel with the intended crosswalk.

**Gutter Flow Slope** - The grade at the gutter flow line at the bottom of a Ramp Run position 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. This is an ODOT specific convention.

**Curb Running Slope** - The surface slope on the top of the curb that connects to the ramp run, directional curb, gutter pan, or travel way roadway surface.

**Pedestrian Ramp** - An accessible sloped connection along the walkway. This occurs 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 in the walkway.

**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 ODOT’s ADA Curb Ramp Process (Appendix G). Triggering activities occur when an alteration occurs that effects the usability of a pedestrian crosswalk, sidewalk or walkway, and therefore presents the opportunity to construct a curb ramp to the ADA standards. When the concrete material (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 ADA Transition Plan for other ADA project needs that need incorporation into the project scope. Consult with the Active Transportation Liaison for CQCR requests that are to be addressed with the project scope.

# 815.3 Curb Ramp Configurations

**Curb ramps and blended transitions must be wholly contained within the pedestrian street crossings or marked crosswalk served**; see **Criteria Q** on the ADA Curb Ramp Design 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, or walkway.** 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 ADA Curb Ramp Design Checklist.

One of the greatest factors when 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. Review Section 400 for clear zone and roadside tree evaluations at intersections.

**Provide a curb ramp for each crosswalk on or along the state highway with vertical curbing in the Curb Zone.** This includes Tee intersections on the public streets. This corresponds to the ADA 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 sidewalk. *If one crosswalk 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 crosswalk and provides physical and visual cues that discourage pedestrians from using the closed crosswalk. Review any design stipulations in the crosswalk approval letter from the STRE or road authority.* 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. ***Stop bars when used are to fall within the range of 4 feet to 30 feet from the edge of traveled way and should be placed 2 to 3 feet from the back throat of the curb ramp opening on the side street (See the Traffic Line Manual).***

*Providing curb ramps that have ramp run centerlines parallel to the intended street crossing is preferred (Directional Curb Ramp)*. A single diagonal curb ramp may be misinterpreted 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 of diagonal curb ramps is not uniform throughout the United States therefore it can mislead users. When two curb ramps are not 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 curb ramp that serves each street crossing provides a clearer and more uniform message to all individuals.

**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 letter for other items specified which may need incorporation 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 avoid construction of a curb ramp. Curb ramps are to provide access for all pedestrians to enter and exit the sidewalk and connect to the crosswalk. Pursue a crosswalk location determination following the procedures in the Traffic Manual if the presence of a legal crosswalk is in doubt (See Section 802.5).

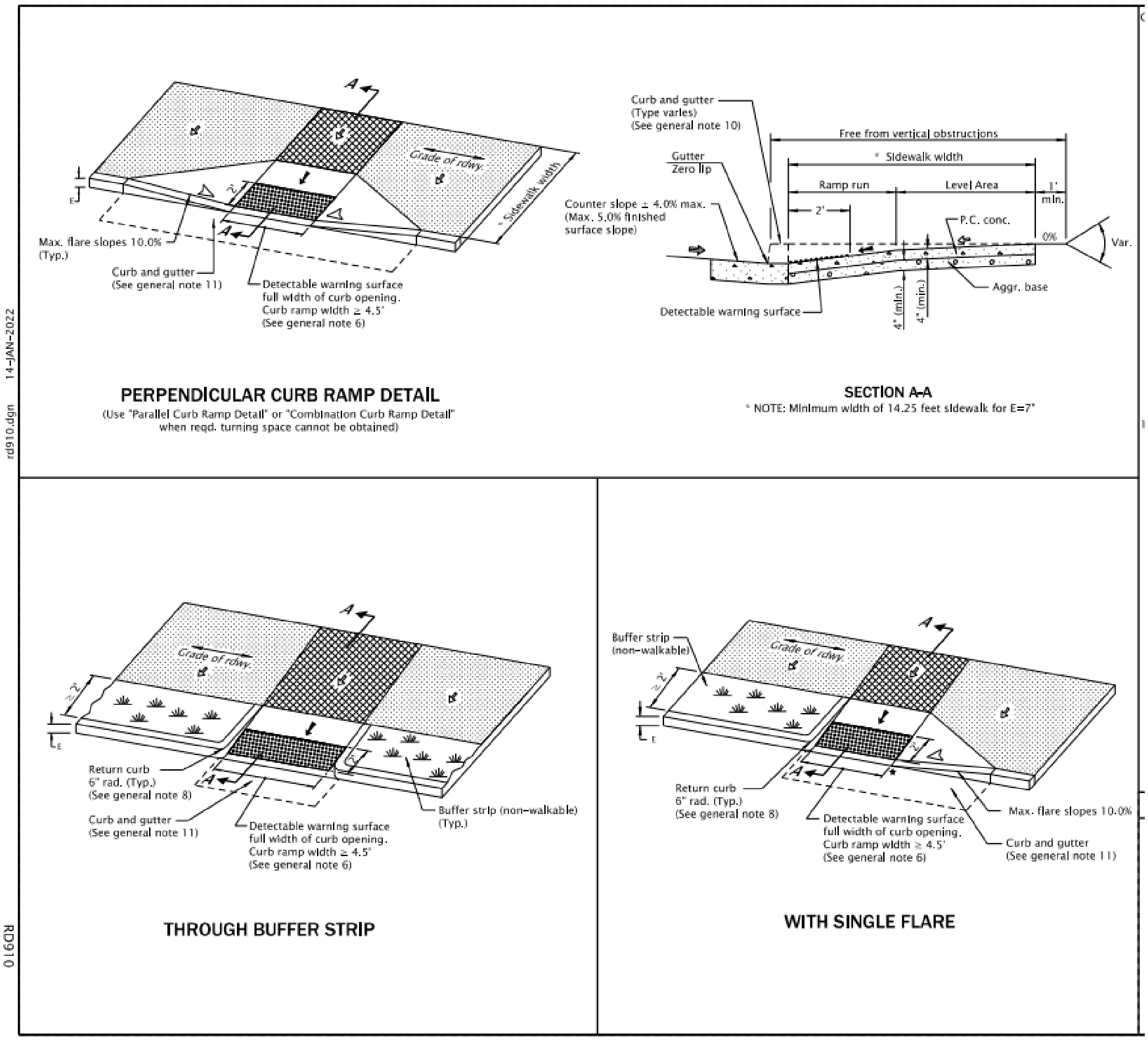
## 815.3.1 Perpendicular Curb Ramps

"Perpendicular curb ramps have a running slope that cuts through or is built up to the curb at right angles or meets the gutter grade break at right angles where the curb is curved."[10] 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. 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

[10] PROWAG Preamble R304.2

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 ADA Curb Ramp Design Checklist.

Figure 800-33: Perpendicular Curb Ramp System

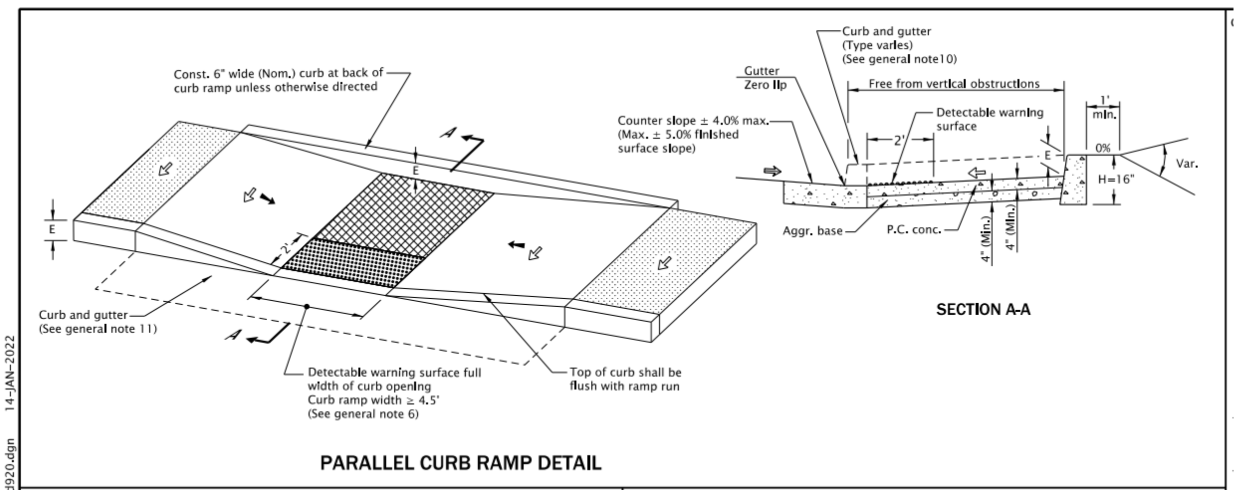



Review the [RD900 series](RD900 series) for additional layouts and construction requirements on perpendicular curb ramps systems. The Figure 800-33 above is an example of a perpendicular curb ramp.

# 815.3.2 Parallel Curb Ramps

“Parallel curb ramps have a running slope that is in-line with the direction of sidewalk travel and lower the sidewalk to a level turning space where a turn is made to enter the pedestrian street crossing."[11] 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.

Figure 800-34: Parallel Curb Ramp System




Review the RD900 series for additional layouts and construction requirements on parallel curb ramps systems. The Figure 800-34 above is an example of a parallel curb ramp.

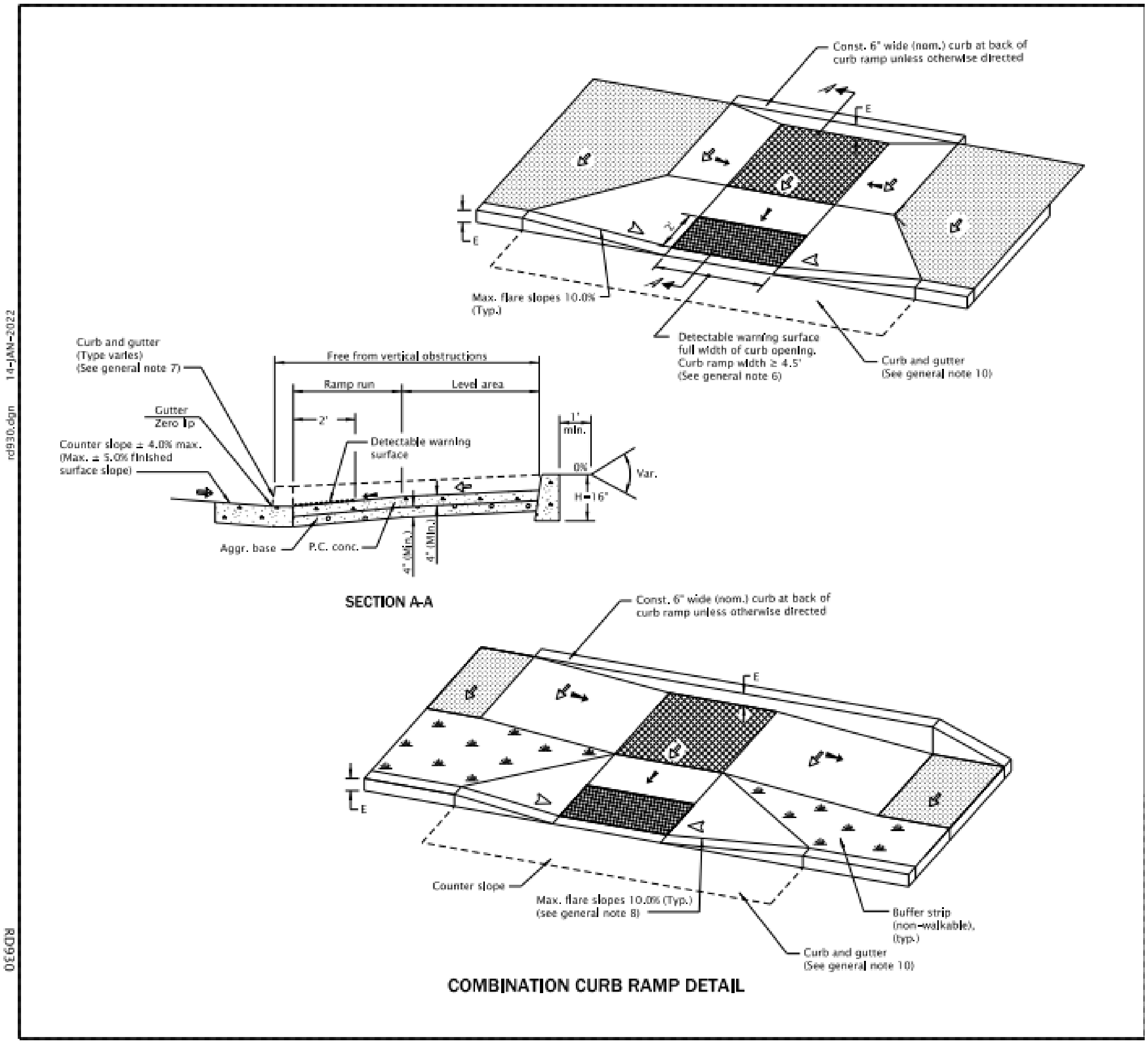
## 815.3.3 Combination Curb Ramps

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 ramp runs (one perpendicular and one parallel to the curbline) 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

[11] PROWAG Preamble R304.3

directional curb ramps that align parallel with the intended crosswalk. Directional curb ramps are the preference for design.

Figure 800-35: Combination Curb Ramp System




Review the RD900 series for additional layouts and construction requirements on combination curb ramps systems. The Figure 800-35 above is an example of a combination curb ramp.

## 815.3.4 Curb Ramps Next to Driveways

As discussed in the walkway design section (Section 810), curb ramps provide pedestrian access to the sidewalk or walkway. 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. Identify the system limits of both the curb ramp system and driveway system on the plan set details to reduce confusion during contract administration on unique designs. *Consider deeper concrete surface thickness for ease of construction and conforming to the driveway performance needs.* **Older designs where the curb ramp and driveway are one facility shared by the pedestrian and vehicle providing access from the Travelway Realm is no longer permitted.** In rare circumstances would that be considered a viable solution.

Details are shown for new driveway construction with horizontal separation distances for accessible routes which include 5 feet between successive 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 combination that meets all accessible route requirements and functions for the design vehicle. **Provide at least 5 feet of separation between the driveway throats and edge of the curb ramp throat (typically the turn space or level area) Criteria P.** Refer to the local jurisdiction driveway construction standard drawings, Options H thru Options N, when space is constrained between the driveway and curb ramp locations. The flared construction is much smaller.

Designs that utilize a raised curb section to physically separate the curb ramp opening and driveway throat are evolving. ***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.

## 815.3.5 Pedestrian Ramps and Pedestrian Pads

Pedestrian Ramps are similar to curb ramps, except they do not cut through 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 pedestrian access route. Pedestrian Pads are level areas that are constructed to provide accessible access to a pedestrian feature 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 of pedestrian ramps and pedestrian pads.

## 815.3.6 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.

## 815.3.7 Blended Transitions

Blended transitions are surfaces or connections with running slope surfaces under 5.0% located at the street entrance for the crosswalk connecting to the pedestrian access route of the walkway. Note, that pedestrian crossings in the traveled way should not exceed 5.0% in the direction of pedestrian travel. Crosswalk surfaces should not have running slopes exceeding 5.0% along the pedestrian access route beginning at the Curb Zone and entering the travel way. This does not preclude running slopes 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 to meet the requirements for ADA.*** 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 slope in the pedestrian access route 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 pedestrian access route connecting to the curb ramp system for the sidewalk.** 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 5.0% along the centerline. Raised crosswalks at street crossings are a common form of blended transitions where the surface is flush with the concrete walk following the cross slope of the roadbed.

# 815.4 Geometric Controls for Curb Ramps

## 815.4.1 Curb Ramp Design Checklist

The ADA Curb Ramp Design Checklist (ODOT Form No. 734-5184) is a companion for curb ramp system 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, 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: Construction Allowance for Slopes 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 | | ✓ |

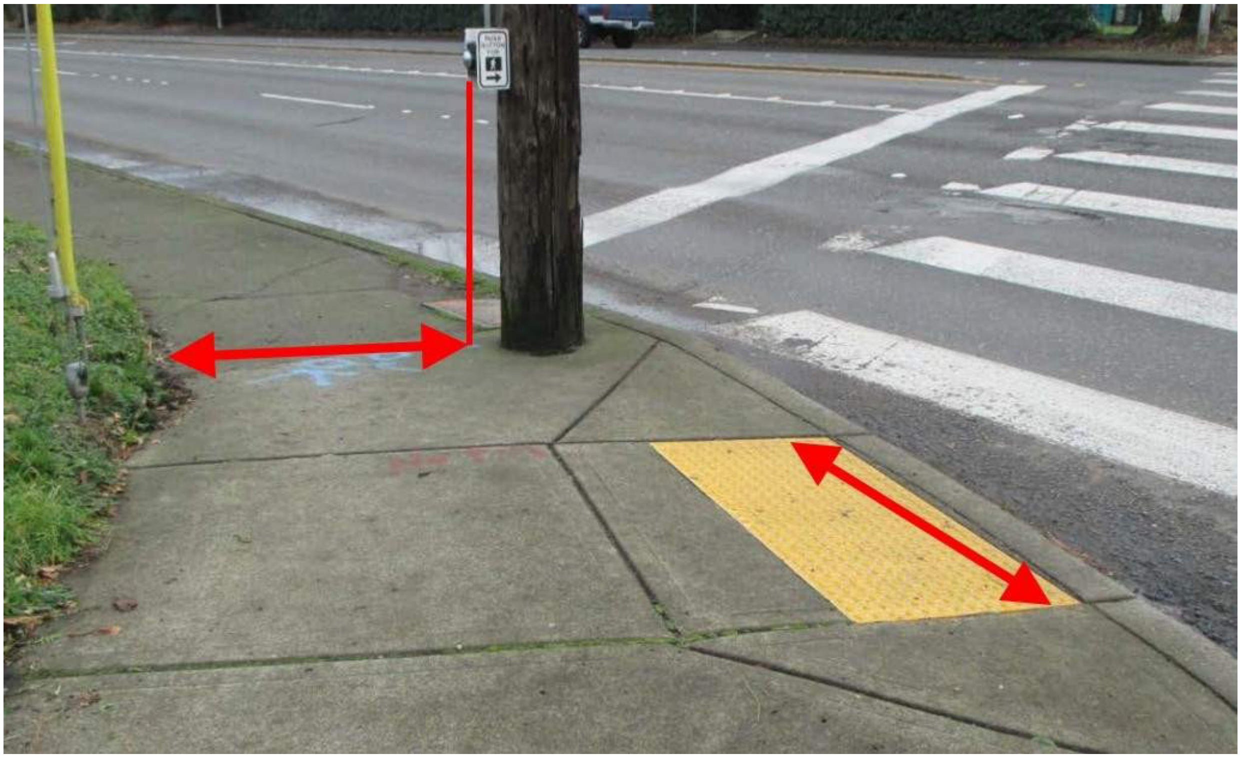
# 815.4.2 Clear Width

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 pedestrian access route clear width. Curb ramp flares, curbs and obstructions 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 system type and configuration. The design criteria for clear width of the pedestrian access route 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 system.** 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 pedestrian access route 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 ADA Curb Ramp Design Checklist. *Best practice is to design the pedestrian access route 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 800-36: Pedestrian Access Route Clear Width



**Provide a clear width through a cut-through island at least 5.5 feet.** This ensures people in the crosswalk have the ability to pass each other when walking (e.g. walking in opposing direction). This corresponds to **Criteria F2** the ADA 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* through *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 through crosswalk, widths above 5.5 feet are recommended and provide for greater pedestrian capacity in the pedestrian access route. *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 through 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- through of the crosswalk alignment to discourage vehicles from entering it. Crosswalks at roundabouts must accommodate bicycle traffic through 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 refer to 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 ADA 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.

## 815.4.3 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 mitigation 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%*. Refer to Section 810 on walkway design hydraulics for additional information.

Figure 800-37: Water Accumulation at Curb Ramp


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 800-38 and Figure 800-39 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 ADA 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 ADA Curb Ramp Design Checklist.

Figure 800-38: ODOT Exhibit D for Design Gutter Flow Slope Conditions

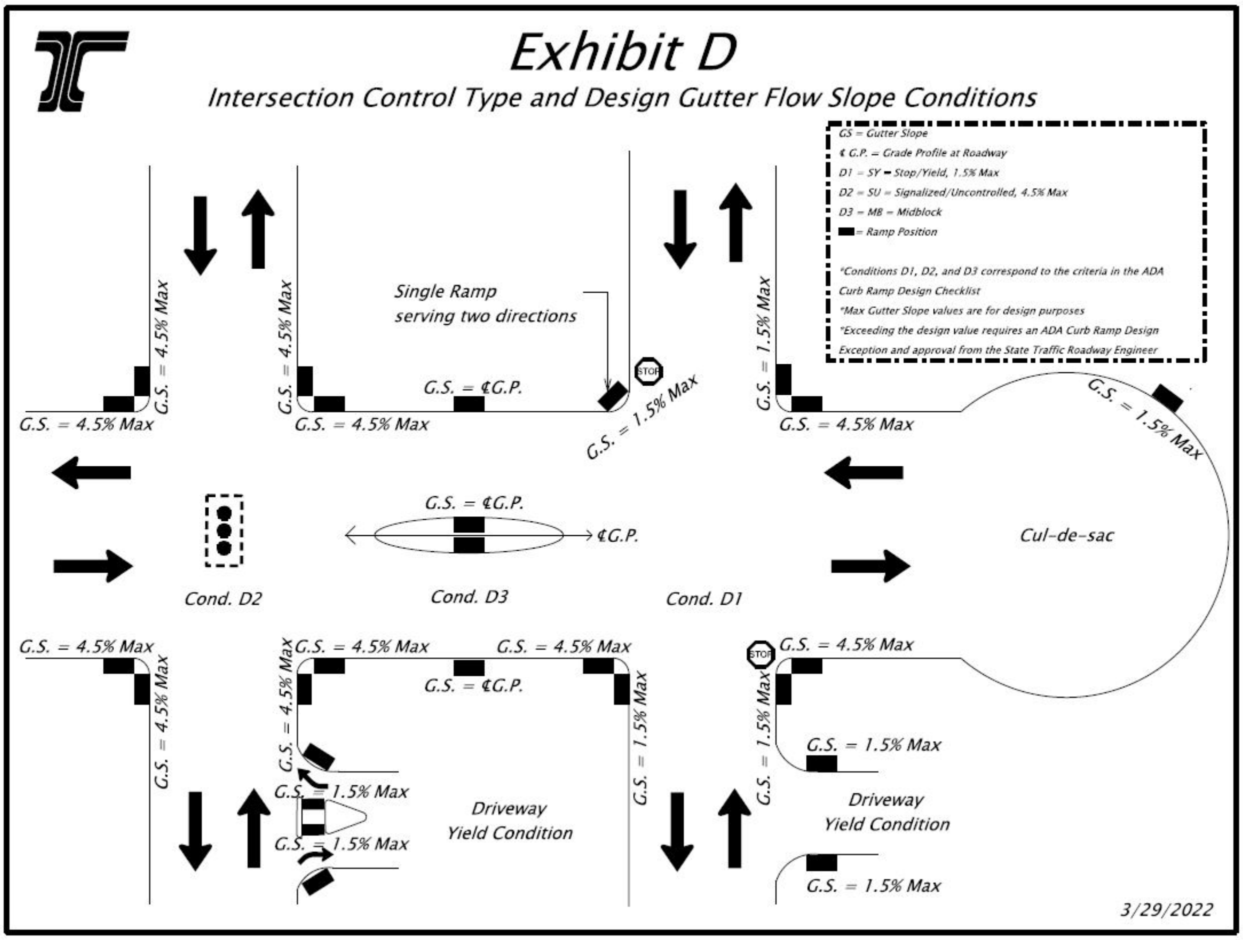
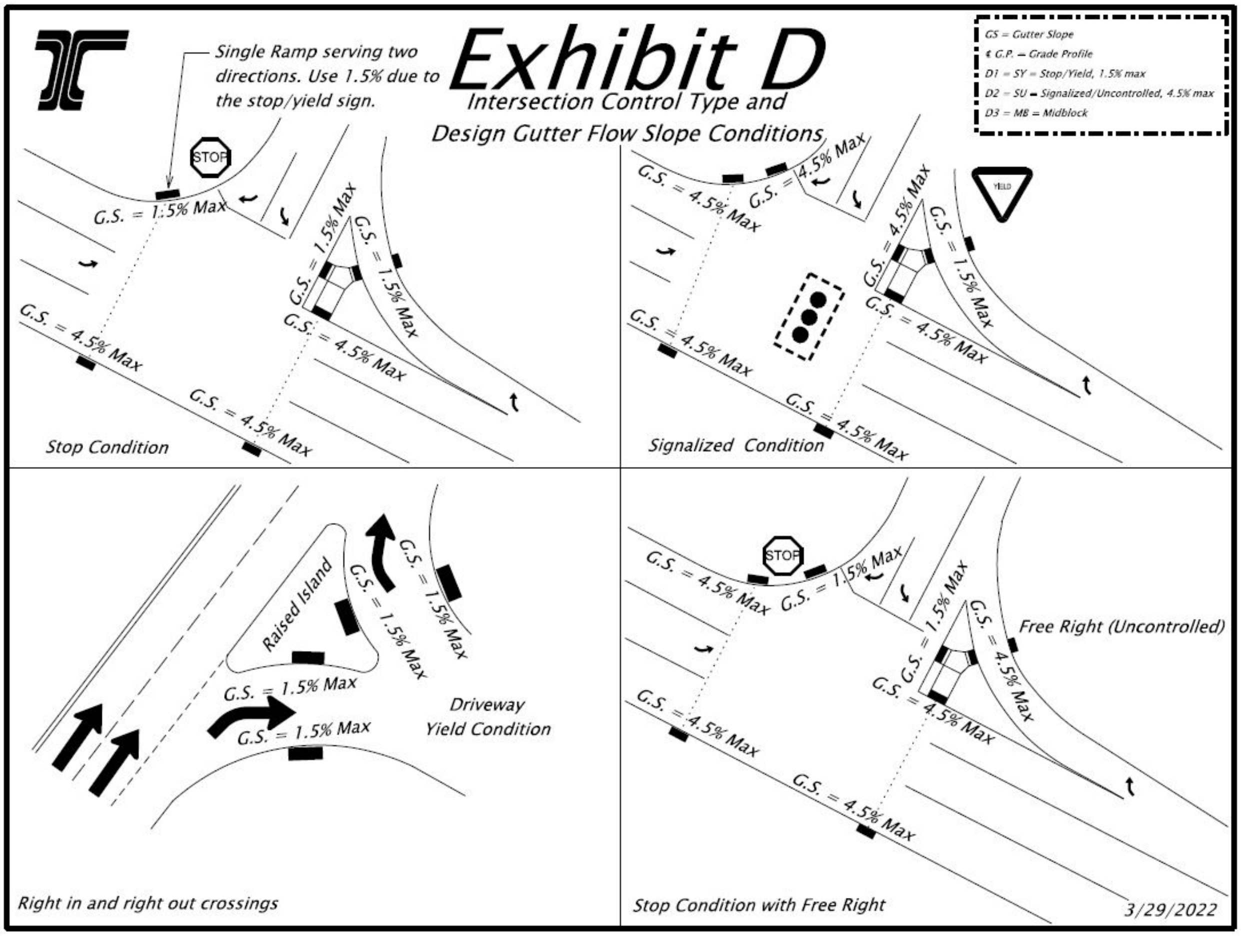


Figure 800-39: ODOT Exhibit D for Design Gutter Flow Slope Conditions for Right Turns




*Provide an inlet upstream of the curb ramp or other approved drainage mitigation.* **Inlets and drainage grates are not permitted in the pedestrian access route 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 through in the direction of pedestrian travel. When there is not a dominant direction of pedestrian travel, the ½ inch opening cannot be exceeded in any direction.** 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.

# 815.4.4 Cross Slope

The cross slope is the grade of a surface perpendicular to the running slope of the 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 ADA Curb Ramp Design 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: Cross Slope 1 and Gutter Flow Slope Interdependencies for the criteria needing design exceptions listed on the ADA Curb Ramp Design Checklist **Criteria C** and **Criteria D**.

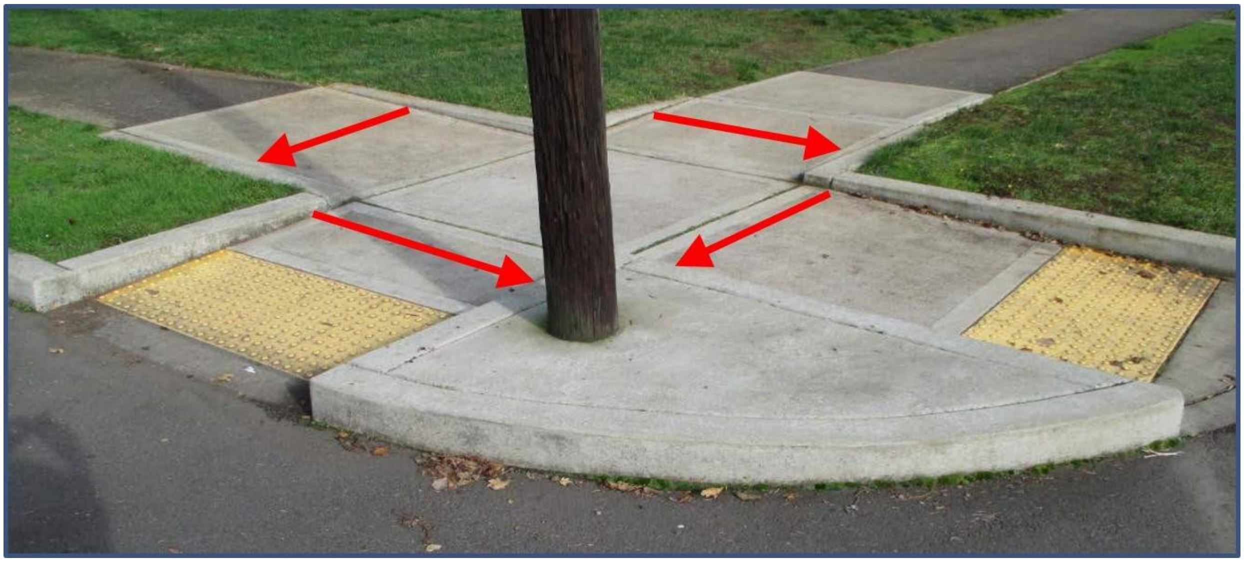
Table 800-6: Cross Slope 1 and Gutter Flow Slope Interdependencies

| 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 ADA Curb Ramp Design Checklist. These islands are typically used for right turn channelization shown in RD700s; refer to Figure 800-39: ODOT Exhibit D for Design Gutter Flow Slope Conditions for Right Turns 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 ADA Curb Ramp Design Checklist. **Criteria C1**, and **Criteria C2** and **Criteria C3** are interdependent with the gutter flow slope and intersection control type.

Figure 800-40: Arrows Showing 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 type is not a stop control with a stop sign or yield sign, the gutter flow slope is permitted to exceed 1.5%. 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 ramp systems on a radius to ensure a perpendicular grade break, **Criteria T**, at the bottom of the ramp run. See RD905 for examples of the directional curb component. **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 from new construction to match existing conditions. Often 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 on transition panels when required for the curb ramp system design**. These are discussed in the preceding paragraph See RD722 for transition panel requirements. Transition segments of a 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.** *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.

# 815.4.5 Ramp Run

A ramp run is one of the ramp surfaces 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 (both running and cross slope at the same time) 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. When perpendicular grade breaks are not constructed, mobility devices cannot maintain 4 points of wheel contact on the surface, resulting in instability when navigating the path of travel. Power assisted devices often have the power assisted wheels in the front (front wheel drive), so front wheel contact is necessary to move forward.

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:

- this adds complexity for the pedestrians disabilities
- increases operational crossing distances/time for the pedestrian using the crosswalk
- requires an additional clear space too reorient in the roadway free from vehicular traffic in the shoulder

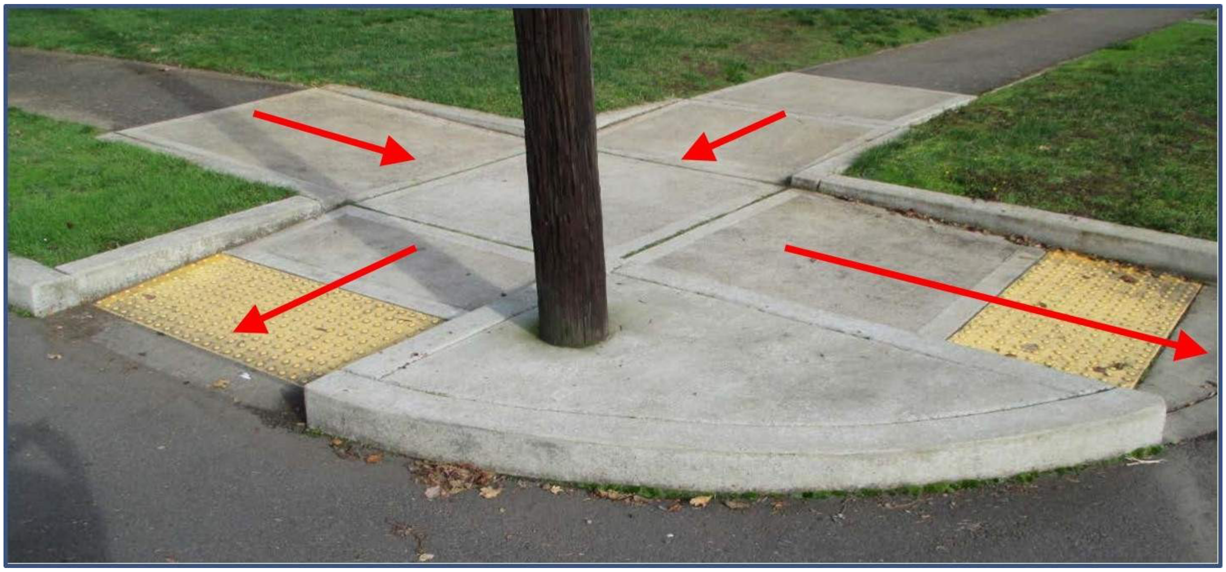
Each ramp run is assigned a position number for the curb ramps system. The entry or exiting ramp run to the curb ramp system is assigned the position number 1. The additional ramp runs in the curb ramp system are numbered counter clockwise from the turn space or level landing. The maximum number of ramp run positions for a curb ramp system is three based on ODOT's asset methodology.

Figure 800-41: Four 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 800-42 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 ADA Curb Ramp Design 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 800-42: Running Slope Arrows on Ramp Runs



The ramp run length is the horizontal distance measured on the ramp run (includes the directional curb component when present). 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***. *The wheel points of contact distance is typically 24 inches in either direction, however it varies based on mobility device. 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 15.2 feet to mitigate the steep slope .*** This is often the mitigation for ramp runs requesting exceptions under the ADA 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. ***Designs should not exceed 11.5% algebraic grade difference***. Deviations for the separation distance is requested under the ADA Curb Ramp Design Checklist **Criteria P.** Reversing sloped ramp runs create a peak in the pedestrian access route which can become a physical barrier for passage by some types of mobility devices. Many power assisted wheelchairs and scooters only have 1 inch of vertical clearance. Refer to the standard drawing(s) for driveway construction

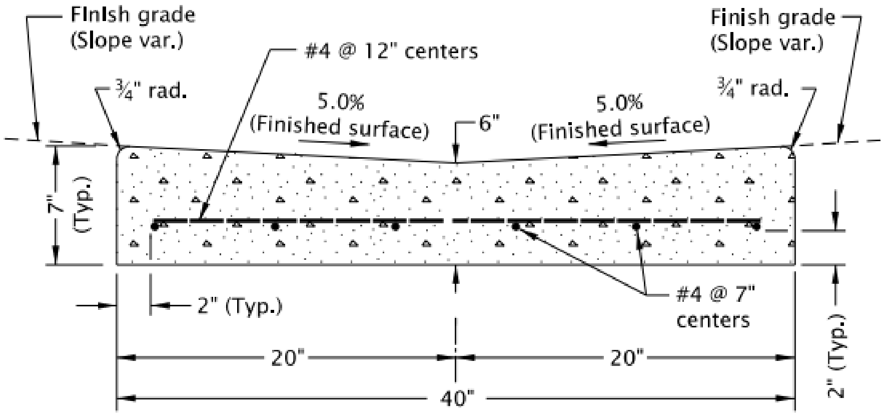
(See RD700s) where this circumstance is mostly likely to occur when curb ramps and driveways are very close to each other. ***The 5.0 feet of separation between the parallel ramp runs may also serve as the passing space required for pedestrian access routes, and when the space is level it provides a 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.

## 815.4.6 Directional Curbs

A directional curb may be present on curb ramps with a radius. It is typically triangular-shaped and it is the 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, and provide a perpendicular grade break for the ramp run. This allows for the preferred ramp run 1 alignment to be constructed (parallel with the intended crosswalk it serves) 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% at final construction.** Running slope measurements are parallel to the ramp run. ***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, reduce the number of grade breaks along the pedestrian access route, 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 or Valley Gutter as shown in RD700s; rebar is not needed. Designers must evaluate the geometrics to ensure ponding or accumulation of water does not occur locally on the directional curb.

Figure 800-43 Oregon Standard Drawing Valley Gutter




The length of the directional curb varies based on the geometrics of the intersection corner radius. 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 in the Travelway Realm. Lengthen directional curbs when ramps runs are steep due to terrain to provide a relatively flat area for ascent or descent. Avoid excessively long directional curb layouts for curb ramps.

**Grade breaks are set behind the detectable warning surface panels when flares are constructed with a directional curb, see RD900s.** Detectable warning surface product installation is not very constructible over grade breaks or 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, based on the intersection control type**. 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.

Figure 800-44: Curb Ramp System with a Directional Curb


## 815.4.7 Curb Running Slope

The curb running slope is the surface slope on the top of the curb that is cut through and typically 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 DET1752 for designing curb running slopes on the curb ramp system***. Curb running slopes provides the "V" section for drainage in most cases. ***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 0.0 -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 the curb ramp running slope is opposite of the ramp running slope (negative) 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. Reversing sloped 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.

Figure 800-45: Water Accumulation at Curb Ramp on Landing/Turn Space

**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%. 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 ADA Curb Ramp Design Checklist.

When monolithic curbing and ramp runs are designed for construction, the grade break is located at the gutter line in these circumstances. Constructing two design slopes on the ramp run and curb running slope is not practical in monolithic construction. 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 pedestrian access route. **The grade break must perpendicular to ramp run 1; see Criteria T on the** ADA Curb Ramp Design Checklist**.**

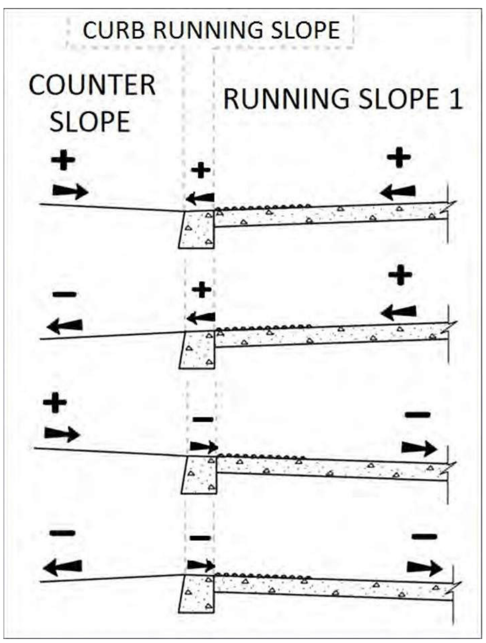
## 815.4.8 Counter Slope

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 pedestrian access route.

Figure 800-46: Curb Running Slope Convention



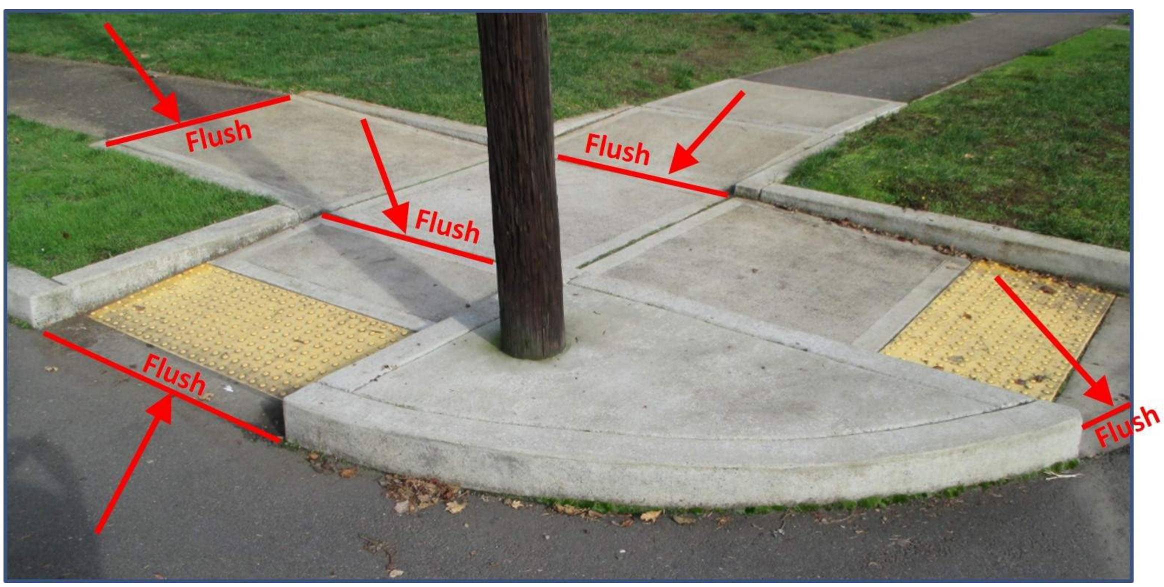

The positive slope convention is based on a typical curb ramp system that conveys storm water at the gutter line in a "V" section. A "V" section occurs when the counter slope, the curb running slope, and the ramp running slope are configured to collect water with the gutter line as the lowest elevation 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.

## 815.4.9 Lips

**Flush connections are required at grade breaks along the pedestrian access route and pedestrian circulation areas.** 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.

Lip height is the vertical difference between two adjacent surfaces, measured within the curb ramp proximity limits. 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 be anywhere within the curb ramp system proximity limits that includes ramp runs, level areas, turn spaces, and transition panels on the sidewalk. 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. Curbs for vehicles are a vertical differences of 4 inches or more (See Part 300, Section 308 for curb types).

Figure 800-47: Locations Where Lips Might Occur




Curb returns typically 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.

# 815.4.10 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 ADA Curb Ramp Design 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%.* **Provide at least 1 foot of constant height curb exposure (reveal) between adjacent flares on curb ramp systems**. This corresponds to **Criteria G3**. *Recommended design value is 15inches, to ensure 1 foot of separation is achieved during final construction.* **The minimum reveal height or exposure shall be at least 3 inches.** This corresponds to **Criteria N** on the ADA Curb Ramp Design Checklist . The area provides multiple functions at the intersection including:

1. hydraulic drainage conveyance
2. pedestrian detectability with a white cane
3. visual and detectable distinction between the curb ramps
4. edge delineation for vehicles turning at the intersection.

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. Softscape surface types that might be constructed adjacent to a flare could include but are not limited to loose round durable rock, grass or native seed, lava rock, or planted areas with bark dust. Hardscape surfaces include but are not limited to colorized PCC, stamped patterning, tooled patterning, brick or unit pavers.

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 ADA Curb Ramp Design 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. Remove fixed objects to the extent practical to improve sight lines and 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 pedestrian access route.*** 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.

## 815.4.11 Turn Spaces and Level Landings

Turn Space is an area to allow mobility devices to change direction along the curb ramp or in the pedestrian access route, 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/Landings are required to access public building entrances.** Section 820 discusses building ramp design.

Provide a turn space and level landing at least 4.5 feet 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 ADA 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.*

Figure 800-48: Wheelchair Maneuvering For Turns

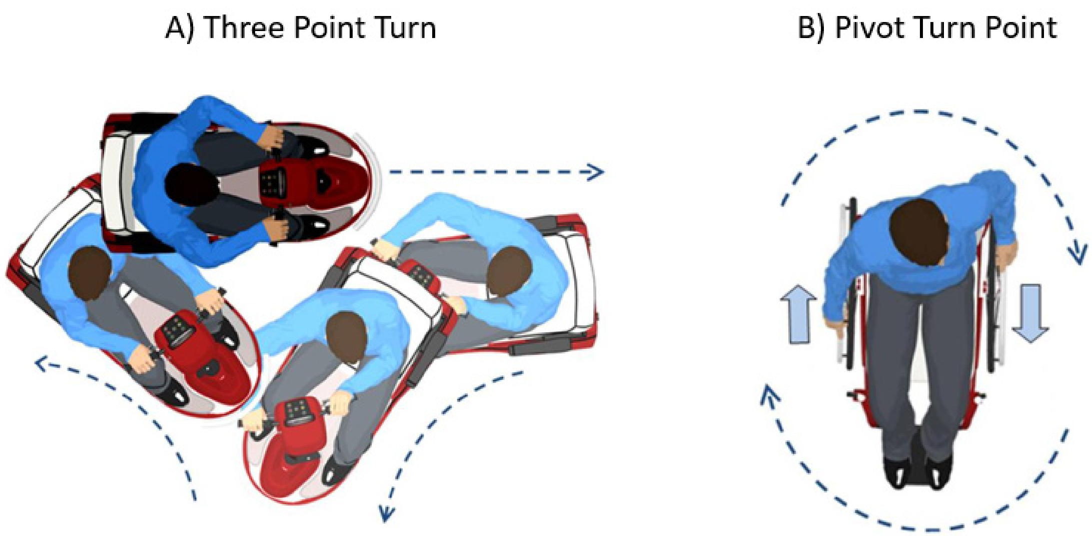



Figure Source: US Access Board Guide to the ADA Accessibility Standards

Level landings 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 ADA 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, such as a school crossing or rectangular rapid flashing beacons. The reach-range height for children is lower when seated in a wheelchair in comparison to typical adult. 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.

## 815.4.12 Clear Space

**Provide at 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 pedestrian access route**. *Clear space for the pedestrian access route is not required to be level, although as level as practical is desired.* **Provide a**

**4-foot by 4 foot 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 ADA 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 ADA Curb Ramp Design Checklist . Design the clear space utilizing the wheelchair design vehicle 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 ADA 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.

**When the push button is located in an alcove condition, the width of the clear space for the parallel approach shall be at least 5.0 feet at finished construction.** Alcove conditions occur when the space is confined on three sides partially or completely and the depth is 15 inches or larger. ***Minimum design dimension of a pedestrian pad in a rural setting should be 5.2 feet x 5.2 feet to account for entry, exiting , turning and activation of the pushbutton on the pedestrian pad.***

# 815.5 Curb Ramp Details in Contracts

Refer to current Technical Bulletin RD17-02(B) and/or the ODOT Roadway CAD Drafters Manual. Review DET1720 and DET1721 for Curb Ramp Detail requirements and instructions.

# 815.6 Curb Ramp Inventory and Inspection

Refer to the ODOT ADA Curb Ramp and Push Button Field Guide and the ODOT certification training materials for curb ramp inspection. The certification course is three parts and available online for designers and inspectors located at the ADA Asset and Inspection webpage.

# 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.[12] **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**.[13] Refer to the illustrations below for general building ramp requirements and applicable regulation sections.

[12] Section 206.4 2010 ADA Standards

[13] Directional Signs an Inaccessible Entrances, see regulation section 216.6

Figure 800-49: ADA Building Ramps Accessible Routes Illustration, source US Access Board

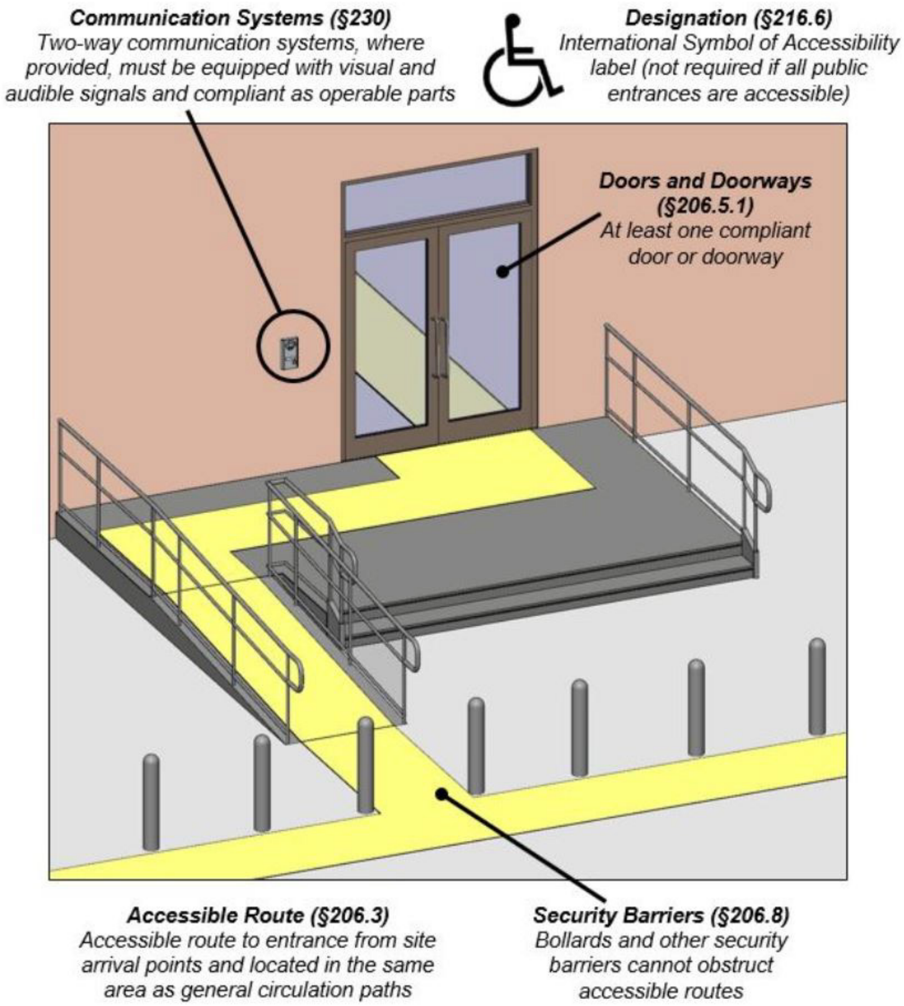
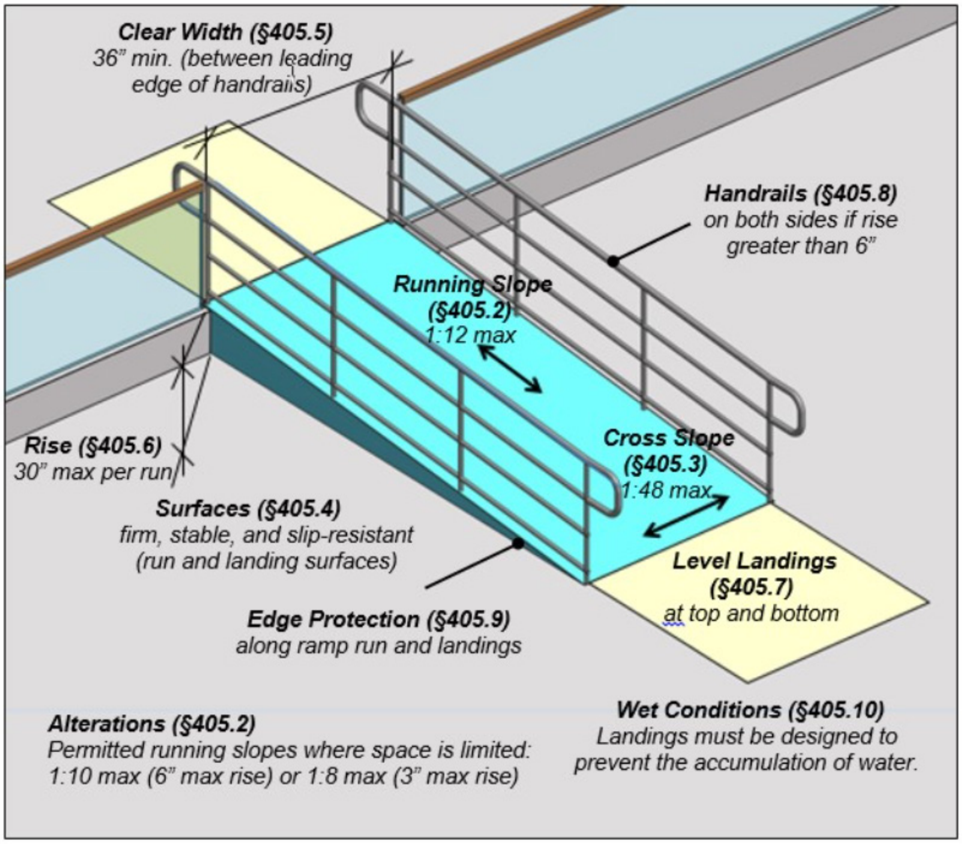


Figure 800-50: ADA Building Ramps Illustration, Source US Access Board and CFR




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 Senior. ADA Standards Engineer. Documentation for design exceptions on building ramps is captured on the general design exception form to document any ADA exceptions.

Handrail is used for pedestrian access 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.

# Section 821 Tactile Walking Surface Indicators

Section Reserved. See Section 805.

## 821.1 Detectable Warning Surfaces

Section reserved, See Section 805, Section 815, Section 830, Section 840, and Section 845. Refer to the Oregon Standard Drawings Series RD900s.

## 821.2 Detectable Guide Strips

Section reserved, See Section 805, Section 815, Section 830, Section 840, and Section 845. Refer to the Oregon Standard Drawing Series RD900s.

# 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 crossings. The range of Target Spacing for pedestrian crossings ranges from 250 feet to 1500 feet based on the Urban Context. Target Spacing of pedestrian crossings is located in Section 310 of the Traffic Manual. 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. A full discussion on how the spacing targets were developed is available in Volume 2 of ODOT's Blueprint for Urban Design.

Safe and convenient pedestrian crossings cannot be considered in isolation from the following issues, which should be addressed when seeking solutions to specific problems. Appendix L, the Oregon Bicycle and Pedestrian Design Guide describes each of the following issues in detail.

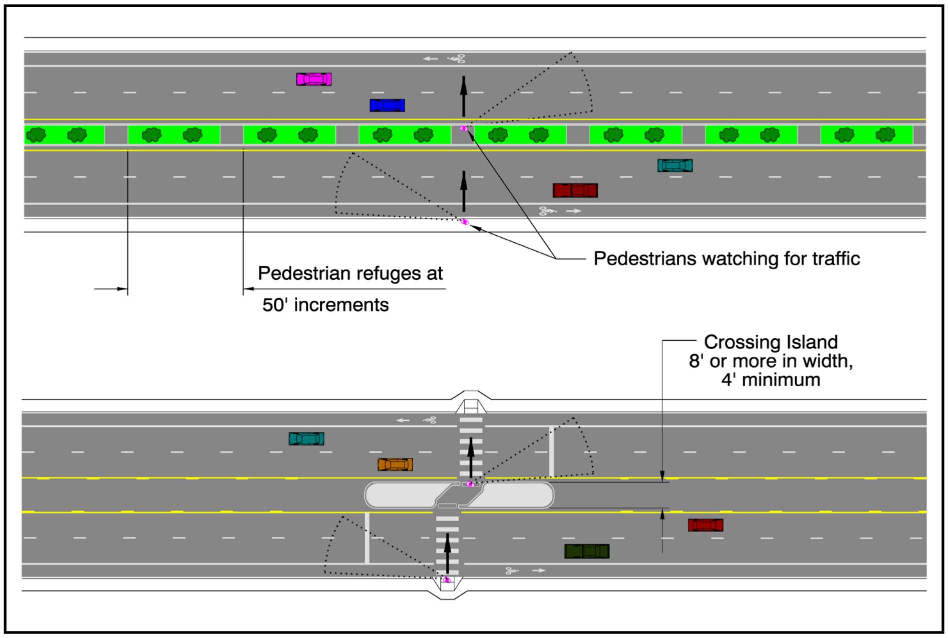
- Volume to Capacity (V/C) and Design Standards (Appendix L, page 5-3)
- Land Use (Appendix L, page 5-4)
- Transit Stops (Appendix L, page 5-4)
- Signal Spacing (Appendix L, page 5-4)
- Access Management (Appendix L, page 5-5)
- Out-of-Direction Travel (Appendix L, page 5-6)
- Midblock versus Intersection Crossings (Appendix L, page 5-6)
- 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 Freight Mobility Policy, Appendix C, in relation to ORS 366.215 regarding a reduction in vehicle carrying capacity.

# 830.1 Raised Median Design and Crossing Islands

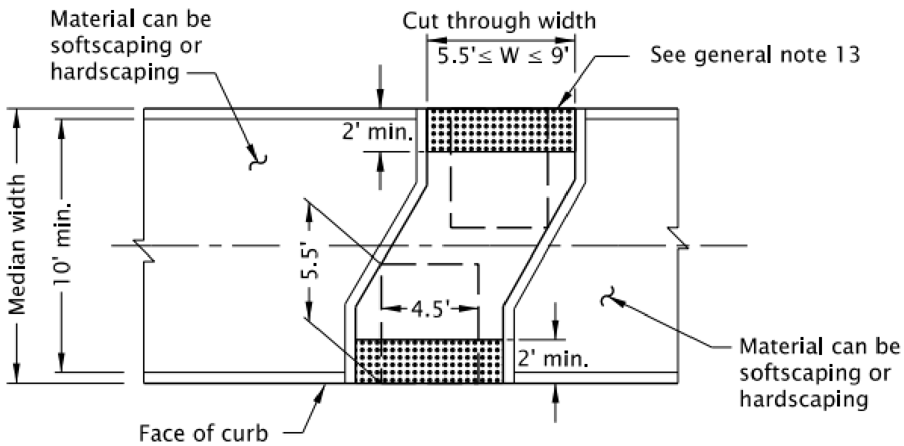
Raised medians are a solution in locations where pedestrian crossings are not isolated to a single location and crosswalks are not marked. Raised medians benefit pedestrians on two-way, multi-lane streets, as they allow pedestrians to cross only one direction of uncontrolled traffic at a time. Raised medians should be constructed so they provide a pedestrian refuge by ensuring that they have a smooth level accessible surface and pedestrian access routes through them. On landscaped medians, plants should be low enough so they do not obstruct visibility, and are 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.

Figure 800-51: Continuous Raised Median versus Cut-Through Crossing Island




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 and to be considered useable by pedestrians. See Part 800Section 835 for bicycle crossing accommodation. **Provide truncated domes in the cut-through if the cut-through length can provide at least 2 feet of separation between detectable warning surface panels consisting of truncated domes, This corresponds to Criteria R2 on the ADA Curb Ramp Design Checklist.** *The cut-through area may be angled up to 45 degrees to position pedestrians to face oncoming traffic for a portion of the crossing.* ***The curb line is aligned parallel with the intended crosswalk at the entry and exit points to provide orientation cues for low vision and blind pedestrians, and this treatment removes potential tripping concerns.***

Figure 800-52: Angled Median Cut-Through Crossing




MEDIAN CUT-THROUGH CROSSING
(Asph. conc. surface shown)

***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 perpendicular curb ramps. Poles should be mounted away from curb ramps and out of the pedestrian path.

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 and configuration.

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:

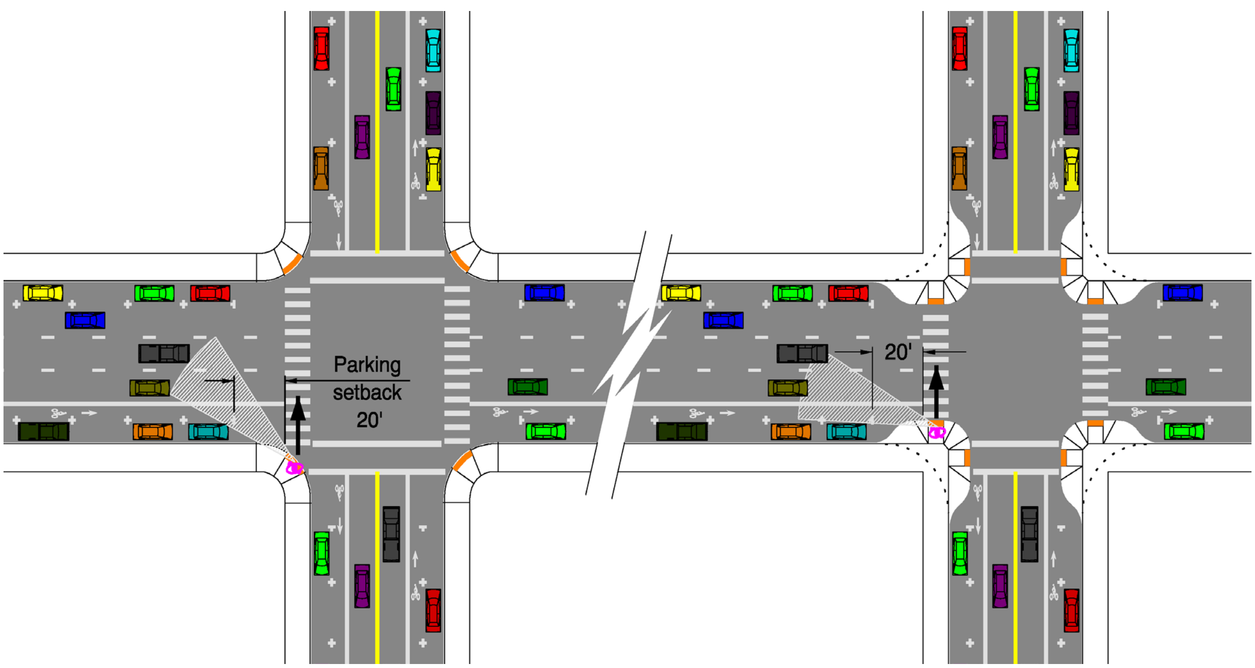
- Allowing pedestrians to cross fewer lanes at a time, and to judge conflicts separately;
- Providing a refuge so that slower pedestrians can wait for a break in the traffic stream;
- Reducing the crossing distances (which provides signal timing benefits)Providing an opportunity to place easily accessible pedestrian push-buttons.
- Simplifying signalization where the right turn lane can be left un-signalized.

# 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 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 and Section 506 for more guidance of curb extension design.

Figure 800-53: Sight Lines with Curb Extensions



When curb extensions aren't viable due to the need to accommodate larger semi-trucks, a truck apron has a similar effect for delineating passenger car travel paths. 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.

# 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, see Section 502 on accommodations of truck turning. 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 sidewalk (See RD900s).** Truck aprons are not a place for pedestrians to wait to cross the street. See discussion in Section 800 on 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 and required approvals.

Marked 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 pedestrian access route surface requirements.

# 830.5 Enhanced Crosswalks and Crossings

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 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 of operations 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, the Oregon Bicycle and Pedestrian Design Guide, 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, the Oregon Bicycle and Pedestrian Design Guide, pages 6-20 to 6-25.

## 830.5.1 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, the Oregon Bicycle and Pedestrian Design Guide (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.

## 830.5.2 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.

## 830.5.3 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. 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 feet to 8feet in width, or two openings, each 5 feet 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 in 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 crossing 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. Review the Railroad Diagnostic Meeting site notes for improvements and actions required for the project.

Railroad crossings include conventional rail cars used for transporting goods and freight. Operating speeds may vary from 40 mph to 80 mph. Light rail vehicles are commonly known as light rail, streetcars, or trolleys and travel at low speeds,25 mph to 35 mph typically. Streetcars operate in the travel lane used by vehicles in the travel way realm. High-Speed or Rapid Rail trains generally reach traveling speeds of 150 mph to 220 mph.

## 840.1 Geometric Controls

Walkways crossing a rail track 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.***[14] **At rail crossings equipped with automatic protective devices, the traffic control device support shall be at least 5 feet from the nearest walkway edge to the centerline of the rail signal mast.**[15] 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 800-54: Skewed Walkway and Rail Track Crossing

**The vertical clearance of a traffic control device over the walkway shall be at least 8 feet about the finished surface of the walkway.**[16] **When the rail crossing is a shared use path, the vertical clearance shall be at least 10 feet.** ***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*

[14] MUTCD Section 8C.13

[15] OAR 741-120-0025

[16] MUTCD Section 8D.03

*line when provided.* **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.**

Detectable warnings surfaces are placed in advance of the sidewalk and rail track interface to alert pedestrians with vision impairments of the presence of the rail crossing. **Criteria R3,** on the ADA Curb Ramp Design Checklist discusses detectable warning placement based on the type of rail operation service. **Place detectable warnings at rail crossings either:**

1. **In between the range of 12-feet plus 8-inches to 15 feet from the nearest rail track for heavy (freight) rail, or.**
2. **At least 6-feet from the nearest rail track for light rail.**

***Detectable warnings should be placed immediately in advance of the marked walkway stop line if present. 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.*** **Detectable warnings are installed full width of the walkway.** Refer to the RD900's for additional details. Striped markings may be used to delineate the dynamic envelope of railway at pedestrian crosswalks. Consult the Senior ADA Standards Engineer and Traffic Section when the project is looking to incorporate marked indicators at rail crossings for approval.

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,
- locations in school zones,
- inadequate sight distance of the pedestrian at the rail crossing,
- multiple set of rail tracks that need to be crossed.

**Automatic pedestrian gates when provided shall be a placed between 2.5 feet and 4 feet maximum above the walkway surface. 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, an emergency egress route should be designed to leave the rail track area.*

Pedestrian rail crossing should be channelized with detectable pedestrian railing 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. Refer to Part 900 for additional design guidance on Shared Use Paths.

Figure 800-55: Shared Use Path

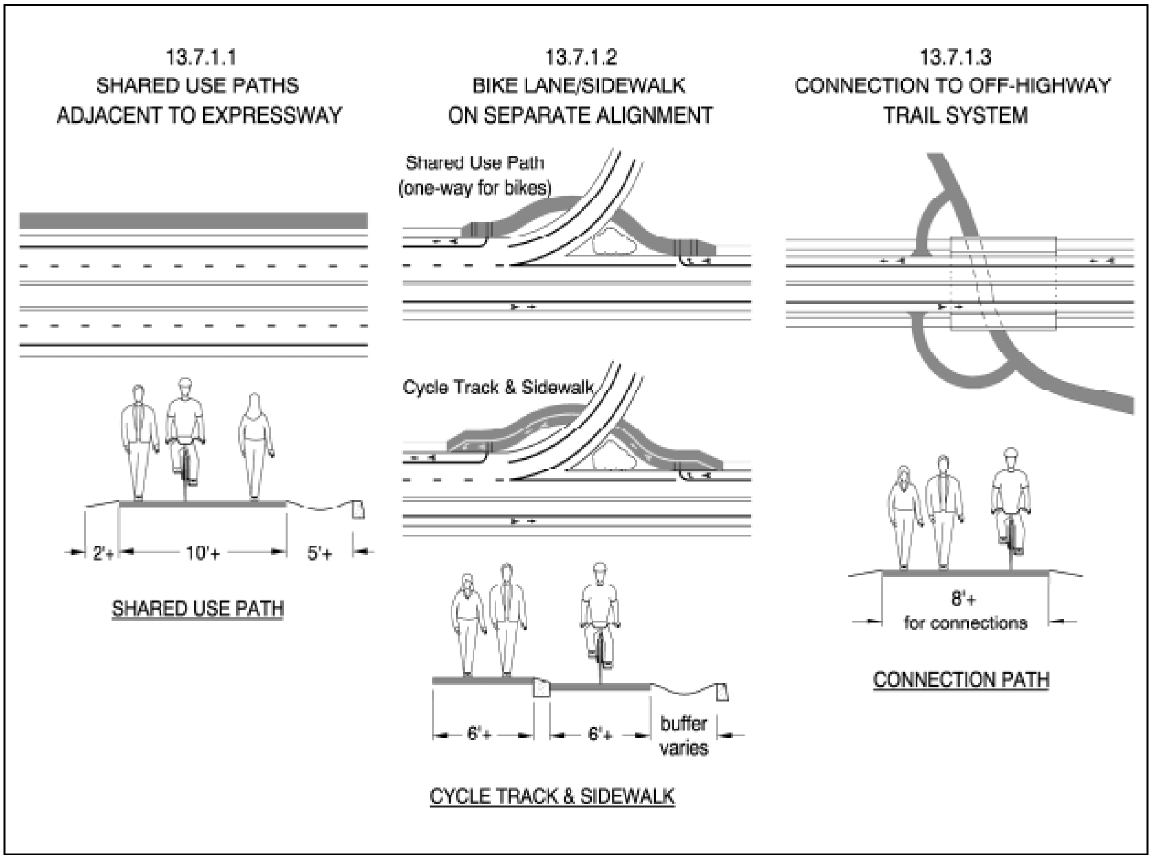
***Paths accommodate many users***

## 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. Sections 961 through 968 have design information that apply to all types of shared use paths.

Separated pathways may be constructed on ODOT facilities in any of the following three contexts:

Figure 800-56: 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.

See Chapter 7 of Appendix L, the Oregon Bicycle and Pedestrian Design Guide 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.

## 845.1.1 Share Use Path Operations

**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 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 at least 16 feet of clear width comprising of two 5-foot bike lanes and a 6-foot walking area (Pedestrian Zone).** *Provide a clear width between 16 feet and 20 feet for mode separated facilities. 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 or TWSI installed to guide them to the intended area along the path. Consult the Senior ADA Standards Engineer for these type of treatments along with Traffic Unit for pavement markings to ensure a consistent message is designed. 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 are; mode separation is best achieved with some grade separation via curb (Refer to Section 900s).

At roundabouts, the sidewalk becomes mixed use with bicyclists. Bicyclists operate in one-way flow and two-way flow for pedestrians. Widen the sidewalk width to at least 10 feet where bicyclists enter the sidewalk. **Provide at least 8 feet of clear width on a bike ramp to allow bicyclists to merge from the bike lane onto the sidewalk a distance of 165 feet in advance of the yield line to the circulatory roadway of a roundabout.** See Section 8.6 and Appendix L, the Oregon Bicycle and Pedestrian Design Guide, Figure 1-40. Refer to the RD900s and RD1100s for placement of detectable features at bike ramps.

## 845.1.2 Parallel Systems to the 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 (reverse flow) of motor vehicle traffic on highways with frequent driveway or street access. Since expressways are designed for access restriction to motorists, many of the conflicts are mitigated. Crosswalks entry and exit points to the shared use facility need to be planned in coordination with motor vehicle restrictions on the highway. 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.

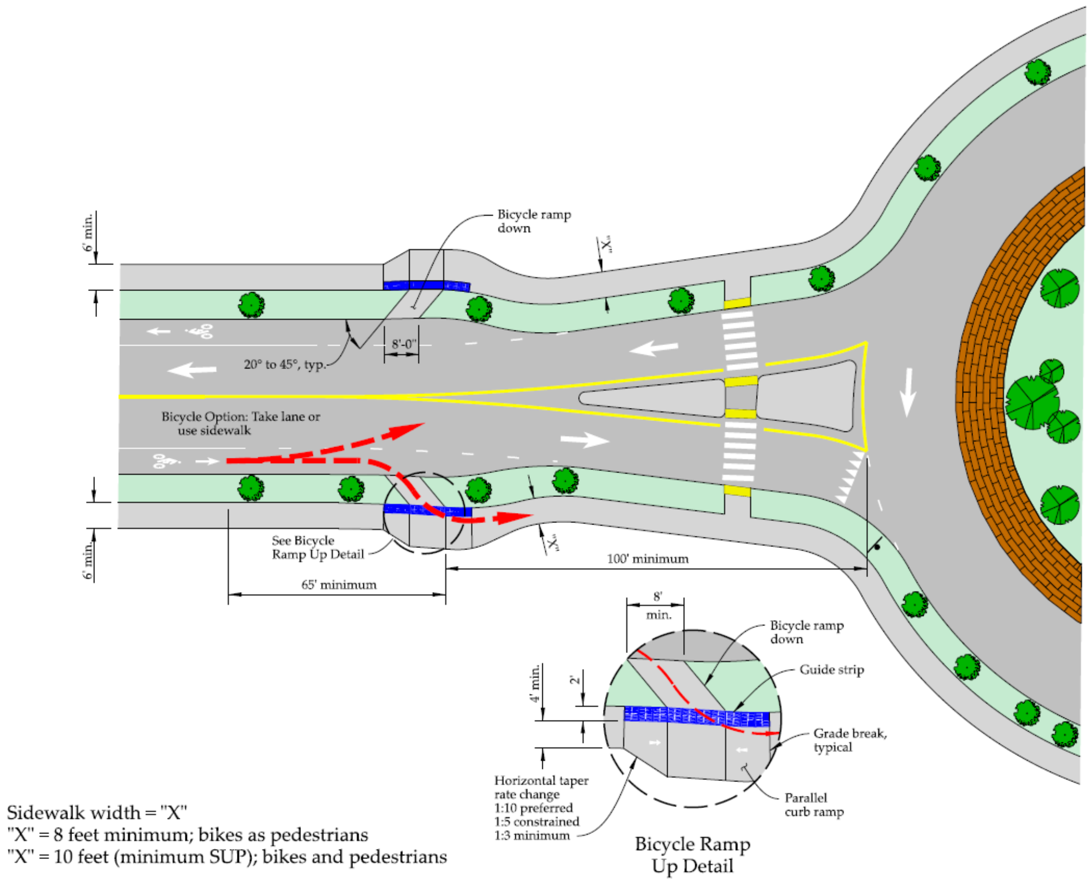
## 845.1.3 Roundabouts

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 800-57 below) is provided to exit the bike lane on approach to the roundabout and use the sidewalk and crosswalks in the manner of a pedestrian. This walk 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 pedestrian use 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 serve bicycle traffic. If there is no sidewalk on the approach road to a roundabout, the entrance ramp to the sidewalk serving the roundabout functions for both bicyclists and pedestrians. Use a pedestrian curb ramp style rather than a bicycle ramp in that case. **An entrance and exit to the sidewalk must be provided where the sidewalk terminates to transition a pedestrian to the shoulder.** Refer to the RD900s for detectable warning treatments at bike ramps. An important function of bicycle ramps that merge onto the sidewalk is the interface between people walking and biking. In order to mitigate the potential for sight-impaired pedestrians to inadvertently walk onto a bike ramp, tactile edge detection is needed along the border of the walk. One option for a detectable boundary is to use detectable guide strips. **A tactical walking surface indicator shall be included adjacent to bicycle ramps (see Section 821.2).** ***Detectable warning surfaces consisting of truncated dome panels located at the bottom of the curb ramp in addition to the detectable guide strip is not prohibited, therefore it does not need to be removed if already in place.***

See Section 980 through 983 for more design of bicycle ramps.

Figure 800-57: Bike Ramp Connection to Sidewalk on Roundabout Approach Street




# 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 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 Technical 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, clear zones less than 2 feet and shy distances less than 1 foot from vertical element such as railings, walls and fences**. See Chapter 7 of Appendix L, the Oregon Bicycle and Pedestrian Design Guide 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.

## 845.2.1 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 design cross-slope is 1.5% (2.0 % finished surface) to provide drainage, in a crown section or shed section.** See also Section 965.

## 845.2.2 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 profile grade is steeper than 4.5% (5.0% finished surface) on shared use paths that are not on the same highway alignment with an adjacent roadway.** To meet ADA requirements, the vertical profile grade of separated shared use path shall not exceed 5.0% at finished construction. See Section 966 for more information.

## 845.2.3 Surfacing

The surface material should be 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 the walkway surface and pedestrian access route requirements in Section 810. Depth of asphalt construction 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.

## 845.2.4 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 8 feet of clear width to allow for a minimum width multi-use pathway condition. In locations where bicycle riding on the sidewalk is prohibited by statute, appropriate signage is necessary to inform bicyclists.

### 845.2.5 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.

### 845.2.6 Vertical Clearance

**Provide a vertical clearance above the finished surface of the shared use path at least 10 feet for the full width of the pathway.** The standard clearance to overhead obstructions is 10 feet to ensure adequate clearance of a person upright on a mobility device, riding a bicycle, and for occasional maintenance vehicle or equipment. Where fixed objects or natural terrain prohibit the 10 feet of vertical clearance, 8 feet is the minimum vertical clearance.

## Section 850 Pedestrian Trail Design

Many recreational trails cross the state highway system and are available for pedestrian use. Users may use these trail systems as transportation links, and use is not prohibited except when signed for a specific mode. Multi-use trails may include accommodation of additional users, such as equestrians. 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 845 and Section 900 for at-grade path crossings. See Appendix L, the Oregon Bicycle and Pedestrian Design Guide, 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. For multiple tread trails that accommodate horses, consult the Equestrian Design Guidebook for Trails, Trailheads and Campgrounds.

## Section 855 Emergency Egress Routes

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 | State Traffic-Roadway Engineer (STRE) and, for some projects, 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 | Not Applicable | Not Applicable |

**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.

See Part 100, Section 101 for additional information.

# 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** - a three level distinction to characterize how much separation is between a bikeway and motor vehicle travel. The three levels are Tier 1 (separated bike lane or shared use path), Tier 2 (bike lane in a shoulder) and Tier 3 (shared lane), discussed in Section 940

**Bike Bill** - Oregon Statute ORS 366.514, discussed in Section 912.1

**Bike Lane** - that part of the highway adjacent to the roadway that is designated for bicycle travel, delineated from the adjacent travel lane by a single stripe. Synonyms not used in the HDM: shoulder bikeway, shoulder bike lane

**Bike Ramp** - defined in Section 980

**Bikeway** - any lane or way designated for use as a bicycle route. Synonyms not used in the HDM: Bicycle trail

**BLTS (Bicycle Level of Traffic Stress)** - defined in Chapter 14 in the ODOT Analysis Procedures Manual[1] and discussed in 922.1

**Buffered Bike Lane** - defined in Section 945.1 - that part of the highway adjacent to the roadway that is designated for bicycle travel, delineated from the adjacent travel lane by two stripes that delineate a buffer zone.

**Essential Transportation Link** - defined in Section 930

**Floating Bus Stop** - defined in Section 984

**Highly Confident Bicyclist** - defined in Section 922

**Interested, but Concerned Bicyclist** - defined in Section 922

**Multiway Boulevard** - defined in Section 949

**Separated Bike Lane** - that part of the highway adjacent to the roadway that is designated for bicycle travel, separated by a street buffer that contains a vertical element (e.g. curb, parking). Synonyms not used in the HDM: cycle track, protected bike lane, separated bike path

**Shared Use Path** - a facility designated for shared use by bicyclists and pedestrians that is located within or outside of the highway right-of-way. Shared use paths located along a highway within the right of way are also referred to as "side paths". Shared use paths may use striping to indicate preferred areas for bicycle and pedestrian travel, but do not provide vertical/detectable delineation between modes. Synonyms not used in the HDM: multi-use path, multi-use trail, bicycle path

**Shoulder** - that part of the highway adjacent to the roadway, delineated from the adjacent travel lane by a stripe, that may be used for bicycle travel as well as other functions such as parking

**Side Path** - defined in Section 948 and 0 - A facility designated for shared use by bicyclists and pedestrians that is located within the highway right-of-way. Side paths may use striping to indicate preferred areas for bicycle and pedestrian travel, but do not provide vertical/detectable delineation between modes.

**Sidewalk** - defined in Section 800.

**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)<br>Chapter 2 (Road Diets) | Chapter 4 - Selection Process<br>Chapter 7 - 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 | Side Paths 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 - Bike Ramps<br>Chapter 7 - 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 programs, services and 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.

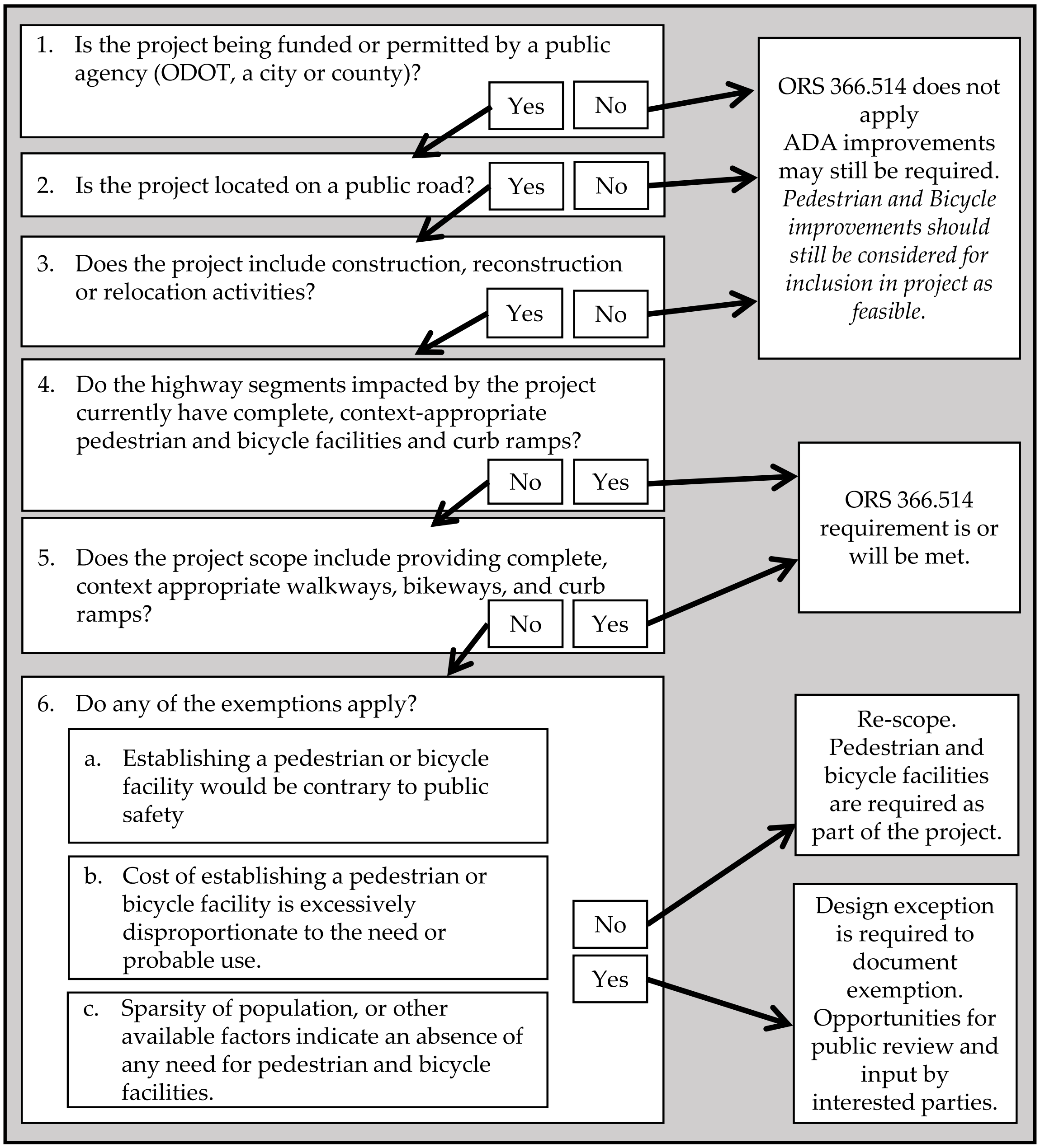
Appropriate walking facilities are generally considered to be present when sidewalk exists on both sides of a highway for urban areas, shoulders in rural areas, paths or a connected network of low-stress local streets parallel to freeways and expressways. Appropriate biking facilities is discussed in 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, documentation[13] is required to ensure that the exemption allowed opportunities for public review and input by interested parties. The documentation provided by the project team consists of a summary of public involvement activities, input received and ODOT responses, including whether and/or how input was incorporated into the project. Where public involvement activities were not included in a project, documentation may include a letter from an organization that represents bicycle and pedestrian needs for the local agency or from the Oregon Bicycle and Pedestrian Advisory Committee (OBPAC) and ODOT responses to the letter. 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[6] and the Oregon Bicycle and Pedestrian Plan[4].

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[5]. 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).

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.

# 920.2 Shared Lane – (ORS 814.430, 811.065)

Oregon Statute ORS 814.430 affects shared lane conditions. It requires people riding in a shared travel lane to ride as close as practicable to the curb or edge of roadway if they cannot ride at the normal speed of traffic. The statute provides reasonable exemptions for passing, turning, and avoiding hazards. 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.

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.

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. The way that bicyclists ride in the travel lane affects how motor vehicles pass. Motor vehicles either change lanes to pass or keep to the left side of the lane to slowly pass bicyclists while bicyclists ride as far as practicable to the right. ORS 811.065 requires drivers who pass bicyclists to drive to the left of the bicycle at a distance sufficient to prevent contact with the person operating the bicycle if the person were to fall into the driver’s lane of traffic. The actual distance prescribed in the statute has not been identified.

The statute applies when sharing the same travel lane at speeds above 35 mph. The distance is not applicable if the vehicle and bicycle are not in the same lane.

When allocating space in the cross section of a road to travel lanes, a wide outside travel lane may affect the way that motor vehicles pass bicyclists. In order for motorists to safely pass bicyclists in accordance with this statute, drivers must reduce speed to 35 mph or less or move to another lane. Wide outside lanes are discouraged on higher speed roads; providing a striped bike lane is generally preferable.

# 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 all ages and 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.

Many individuals with disabilities use adaptive bicycles, tandem bicycles, or adult tricycles to meet their transportation needs and stay active. These types of bicycles have longer and/or wider wheel bases than typical diamond frame bicycles, resulting in different turning radius, cross slope, and queuing space needs. These needs should inform design of refuge island widths and queueing spaces at path crossings and island cut troughs where people on bicycles may need to make turns.

# 920.4 Use of Pedestrian Facilities (ORS 814.410)

People on bicycles are legally allowed to ride on sidewalks in Oregon, unless prohibited by local ordinance; however, 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 safety and 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 when approaching or entering crosswalks, driveways and curb ramps when a motor vehicle is approaching.

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 crossing against the pedestrian don't-walk signal since they could proceed with vehicles if 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. This means that turning vehicles must still yield to people riding bicycles through an intersection even when no bike lane striping is present.

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.

When designing for motor vehicles, it can be desirable to maintain a uniform roadway cross section by minimizing changes to the driving environment. Although maintaining a uniform cross section is generally desirable for bikeways, people riding bikes are able to transition between different types of bikeway facilities as long as the connections are direct and intuitive. For example, a bike lane may ramp up to a shared use path or separated bike lane then ramp back down to a shared lane as conditions change along a corridor.

# 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.

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 whether a bicyclist is required to follow statutes for riding in a Bike Lane versus riding on a Sidewalk.

# 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 traffic operations require users to proceed as pedestrians. When designing a separated facility, ensure that bicyclists have access to move into the road where needed to make turns, avoid debris, or pass other users as necessary.

# 920.8 Stop as Yield (ORS 814.414)

Per ORS 814.414, 814.416, 811.260 (11, 15) and 811.265, a person riding a bicycle is allowed to slow to a safe speed, check for cross traffic and proceed without stopping at stop signs and at flashing red lights. Thus, the traffic operation for a bicyclist is the same as would be for a yield sign. When evaluating intersection operations with stop signs or flashing red lights, use the design assumption that bicycle traffic operates with yield control.

# Section 921 Design for Bicyclist Safety

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, Safe Systems Approach 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]**Error! Reference source not found.**, 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. This means that ODOT crash data likely amounts to less than 1 in 5 serious injury crashes involving a bicyclist. Serious injury crashes may be occurring due to deficient infrastructure, human factors or other causes. As a result, bicycle safety and crash risk factors should be considered in project design, even if there is no documented crash history in a project area. The following are design factors to mitigate the probability of fixed object crashes and individuals falling off bicycles.

## 921.2.1 Restricting Motor Vehicles on a Bikeway (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. Bollards should also not be placed near curves in pathways due to limited sight lines and tendency of bicyclists to travel in the middle of a path on curves. 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. See ODOT Traffic Line Manual[11] Figure 440-B for object hazard striping detail. Bollard design should consider emergency services and maintenance access needs along a path. Flexible delineators, that collapse when struck by a bicyclist, should be considered.

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.

## 921.2.2 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. Uneven grates may be marked as an obstacle until they can be repaired. See ODOT Traffic Line Manual[11] for marking details.

Grates with bars perpendicular to the roadway must not be placed at the bottom of curb ramps, 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.

# 921.2.3 Bikeway-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 Department of Transportation. The Commerce and Compliance 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.

### 921.2.4 Pavement on Bikeways

Poor pavement quality and pavement seams can create a crash hazard for bicyclists because bicycle tires can easily become hung up in large potholes or uneven joints. Crash hazards are reduced when pavement cuts are located on or near the bike lane stripe and at least 4' of clear ridable width is provided without pavement seams. Longitudinal cuts parallel to the direction of bicycle travel (e.g. utility trenches) should be avoided in bike lanes and other areas used by bicycles to minimize crash risk from uneven seams that develop as patched pavements settle. If trenching is required in the bike lane, it is preferable to repave the entire bike lane width. See ODOT Pavement Design Guide[14] Section 6.1.4 for joint locations for paving.

## 921.3 Using Bicycle Crash Data

[Placeholder for section. 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
- Adult group bicycling
- Family group bicycling

# 922.1 Bicyclist Typologies

The six design user categories are derived from four levels of bicycle user comfort and skill that 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, which is not a design user category. In addition to design user categories that are based on a bicyclist typology, three additional categories are based on conditions. The school-age child bicyclist is a more specific design user than the interested but concerned category in places where a route is intended for school children. Bicycle facilities that are often used for groups of bicyclists may be designed for the capacity of many users riding together. Bicycling can be a social mode of transportation, so side-by-side riding may be expected on any bicycle facility and accommodated when possible. Side-by-side riding should be designed for when the design user category is a group.

The FHWA Bikeway Selection Guide[20] elaborates on the four 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. BLTS 1 is suitable for all ages and abilities. BLTS 2 is less suitable for young children, but is suitable for teens and adults with adequate bicycle handling skills. BLTS 3 is suitable for most observant adult bicyclists. BLTS 4 is suitable for only experienced and skilled cyclists.

The type of bikeway accommodation and its BLTS affects people of different bicyclist typologies in their decision whether to ride. 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. A facility designed for interested but concerned users (BLTS 1) will typically provide a transportation option for all potential bicycle riders, whereas a facility designed only for highly confident riders (BLTS 4) is unlikely to attract many new potential bicycle riders or provide a realistic alternative to driving for many users.

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 than surveying the typology of users along that highway.

A greater portion of bicyclists who ride on rural highways tend to be highly confident riders. However, individuals without other transportation options also ride on rural highways. There may also be latent demand for bicycle trips that are not taken because of traffic conditions. 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
Likelihood that Design User Profile Will Ride[28]

| Level of Traffic Stress | Highly Confident Individual | Somewhat Confident Individual | Interested, but Concerned Individual | School-aged Individual Child | Adult Bicycle Group | Family Group |
|---|---|---|---|---|---|---|
| BLTS 1 | Likely | Likely | Likely | Likely | Likely | Likely |
| BLTS 2 | Likely | Likely | Sometimes | Sometimes | Likely | Sometimes |
| BLTS 3 | Likely | Sometimes | No | No | Likely | No |
| BLTS 4 | Likely | No | No | No | Sometimes | No |

## 922.2 Selecting the Design Users

[Placeholder for future content]

## 922.3 Design Controls Based on Design User

[Placeholder for future content]

# Section 923 Design Vehicles

[Placeholder for future content]

## 923.1 Design Vehicle Descriptions

[Placeholder for future content]

## 923.2 Selecting the Design Vehicle

[Placeholder for future content]

## 923.3 Design Controls Based on Design Vehicle

[Placeholder for future content]

# 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 OAR 734-020-0045 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 Tourism Route
- Recreation Route
- School Route
- Off-chute

# 930.1 Essential Transportation Link

If a highway is the only route between two points, it is an essential transportation link.

# 930.2 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.

# 930.3 Limited Access Route

Where 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.

# 930.4 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.

# 930.5 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.

# 930.6 Designated Tourism 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.

# 930.7 Recreation Route

Any other recreational path or route that is not designated with an official route name or number.

# 930.8 School Route

Any route that is used by school children is a School Route. This network role may overlap categories above.

# 930.9 Off-Chute

Any route that is a dead-end to a destination is an off-chute (e.g. route from a trail head, park and ride lot, transit station, etc.)

# 930.10 Selecting the Bikeway Network Role(s)

[Placeholder for future content]

# 930.11 Design Controls Based on Bikeway Network Role

[Placeholder for future content.

Consideration should include the following factors, which will be added as future content. Considerations include network development, trip length, connectivity, continuous versus interrupted flow.]

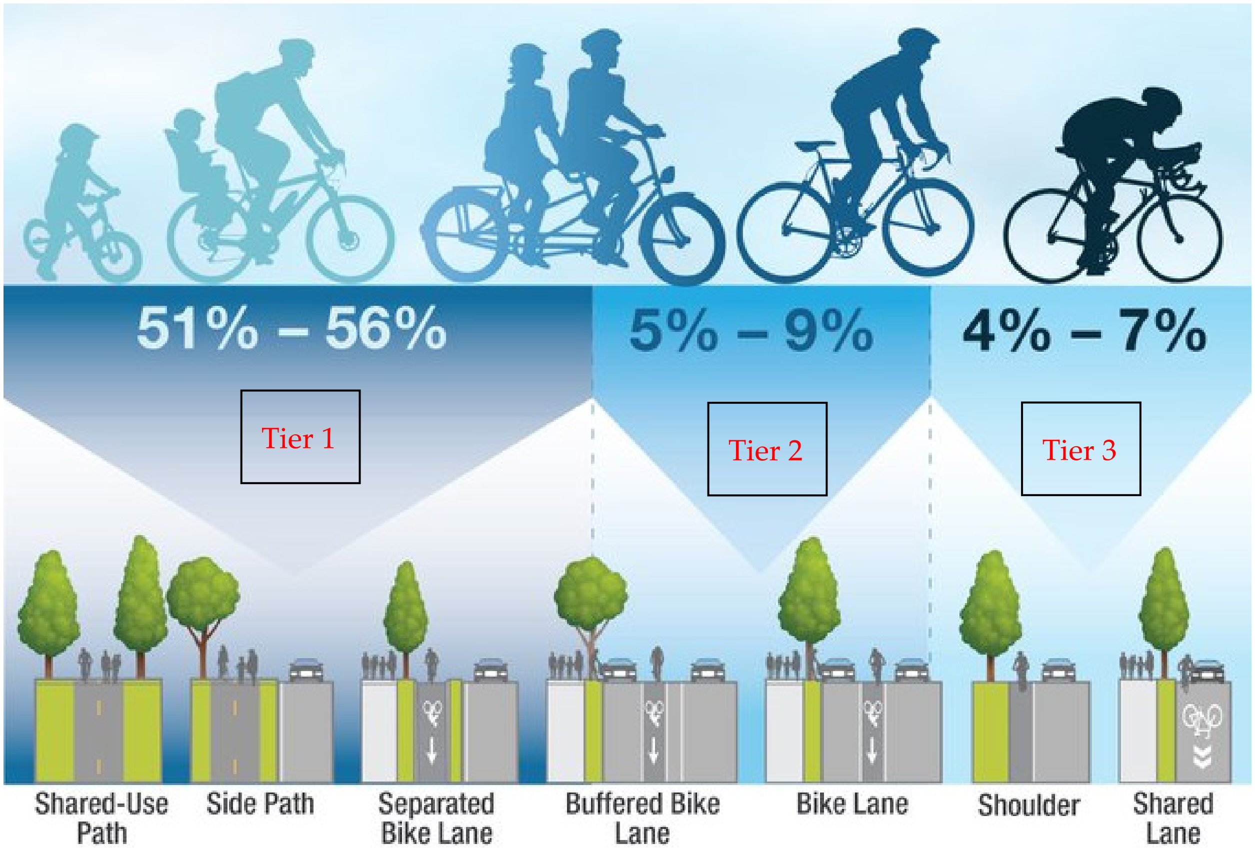
# Section 940 Bikeway Tiers

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 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 vertical 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. This horizontal space functions as a safety buffer that may occasionally be used by oversized vehicles or by bicyclists to pass one another.

The third way (Tier 3) is by having bicycle traffic share the same travel lane on the roadway with motor vehicles. A narrow shoulder may also function as a Tier 3 facility if the shoulder width is insufficient for bicycle travel without encroaching into the travel lane.

Figure 900-2: Bikeway Tiers [20]

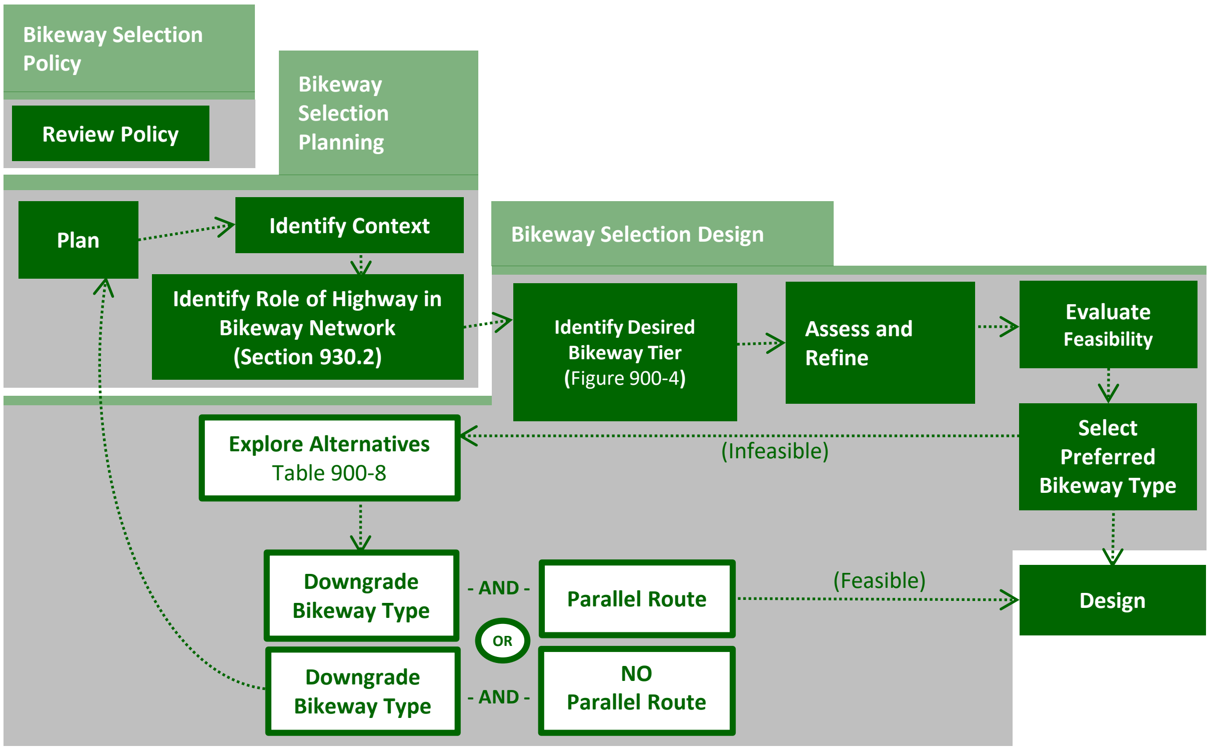



# Section 941 Urban Bikeway Selection Process

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 947.

Figure 900-3 is a flowchart that outlines the steps necessary to select the appropriate bicycle facility.

Figure 900-3: Bicycle Facility Selection Process [20]




The flowchart is divided into three parts: policy, planning and design.

# 941.1 Review 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. Section 910 through 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 known, 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 0.

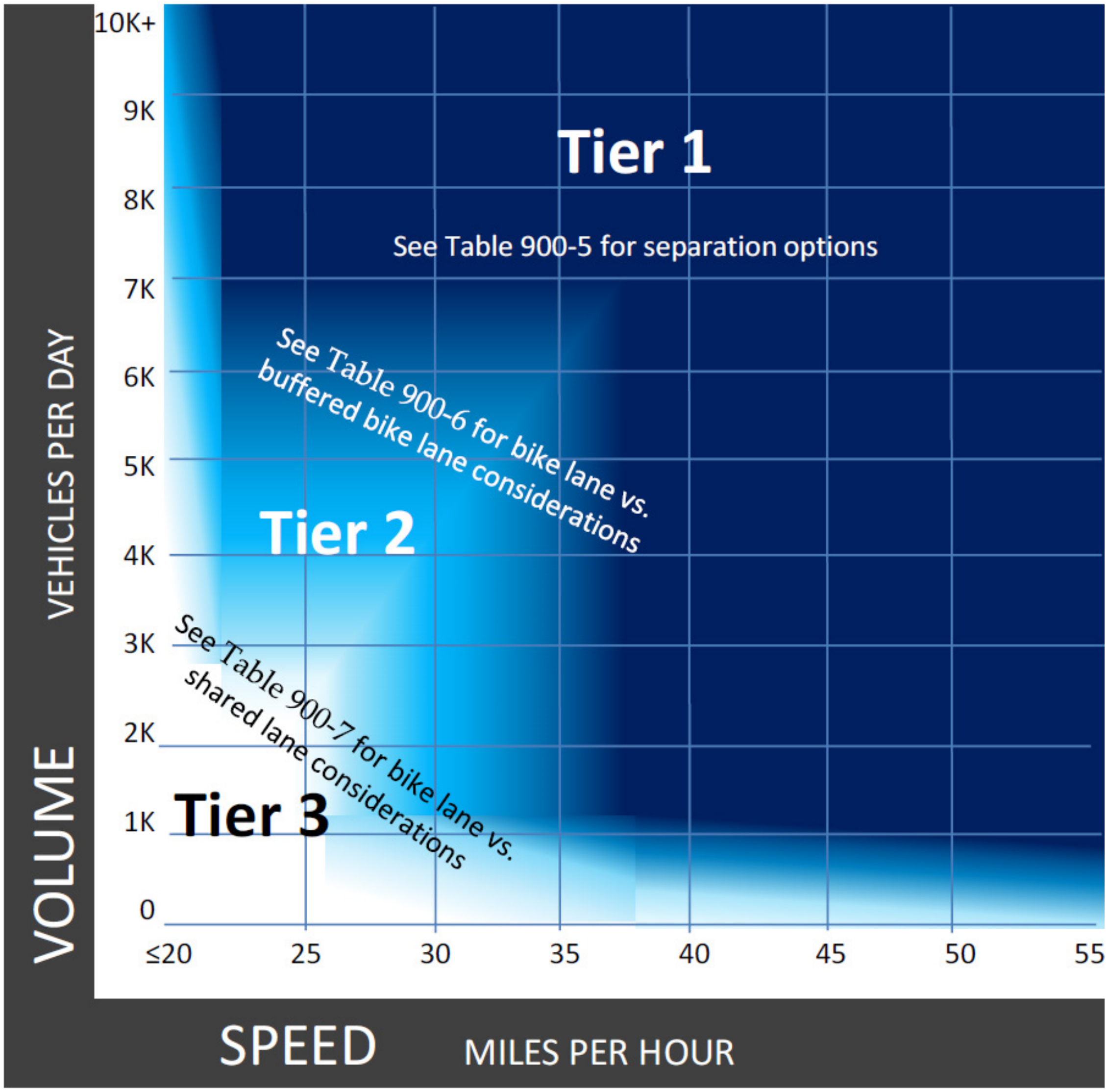
The role of the highway in the overall bikeway network affects how much an improvement to the bike facility might affect bicycle ridership. When the highway is the only route for bicyclists to a destination, it is more critical that the bikeway is context appropriate. When the highway is inside of a comprehensive bike network, such as a street grid, there may be alternative routes to a destination, aside from the bike accommodations on the highway.

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 900-4. 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[20]




# 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 | Right 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 0 | | | | | | | |

*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.

## 941.4.1 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 | |

*On-street parking may be used as a street buffer only where on-street parking exists or is appropriate in the highway context.

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.

## 941.4.2 Tier 2 – Buffered Bike Lanes and 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 is generally 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[20].

Table 900-6 Tier 2 Considerations – Need for Separation (Buffered Bike Lane versus Bike Lane)

| Consideration | Buffered Bike Lane | Bike Lane |
|---|---|---|
| Traffic Volume | Above 10% of ADT at peak hour | Evenly distributed |
| Vehicle Mix | High percentage of heavy vehicles | Low heavy vehicle percentage |
| Curbside activity | Conflicts with parked cars or other activity requires frequent merging | Low curbside activity |
| Driveway frequency | Driveways are spaced further apart | Frequent driveways |
| Schools | Used as a school route | Not used as a school route |
| Continuity | Connects to separated facility | Doesn't connect to separated facility |
| Transit Considerations | Frequent transit stops | Infrequent transit stops |

## 941.4.3 Tier 3 - Shared Lanes

When the traffic volume and speed result in a Tier 3 bicycle facility, bike lanes are not always required. Bicyclists can ride in the travel lane with motor vehicles where speeds are 25 mph or less and traffic volumes are low. 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 to the shared lane from a shoulder or bike lane that drops. The positioning of the shared lane marking also encourages bicyclist to position themselves toward the center of the travel lane where they are more visible to drivers and drivers are encouraged to pass by changing lanes as they would for another motor vehicle, rather than by passing closely in the same lane. Shared lane marking on wider outside travel lanes of 14′ to 15′ may also help increase driver awareness of bicyclists who choose to keep right and help facilitate vehicles safely passing bicycles at a low speed.

Table 900-7 Need for Separation (Bike Lane versus Shared Lane)

| Consideration | Bike Lane | Shared Lane |
|---|---|---|
| Proximity to urban center | Further away, suburban areas | Urban center |
| Building set back | Parking lots front street | Buildings at back of walk |
| On-street parking | High turnover | Low turnover |
| Block length | Long block length | Short block length |
| Traffic signal coordination | Timed above posted speed | Timed below posted speed |
| Traffic Volume | Above 10% of ADT at peak hour | Evenly distributed |
| Number of Travel Lanes | More than two | Two or less |
| Grade | Uphill | Downhill |
| Schools | Used as a school route | Not used as a school route |
| Continuity | Connects to bike lanes | No bike lanes on approach |
| Other high-use indicators | Indications of high use | No indicators |

Narrow bridges, tunnels, and other locations that reduce the width of a highway may 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 Section 309.1 in the ODOT Traffic Manual[12].

# 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 existing 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′ |
| Suburban Fringe: 50-55 mph or Expressway: 45 mph | Shoulder | 8′ |
| | Bike Lane or Buffered Bike Lane | 8′ |
| Expressway: 50-55 mph | Shoulder | 8′ |
| Freeway | Shoulder | 10′ |

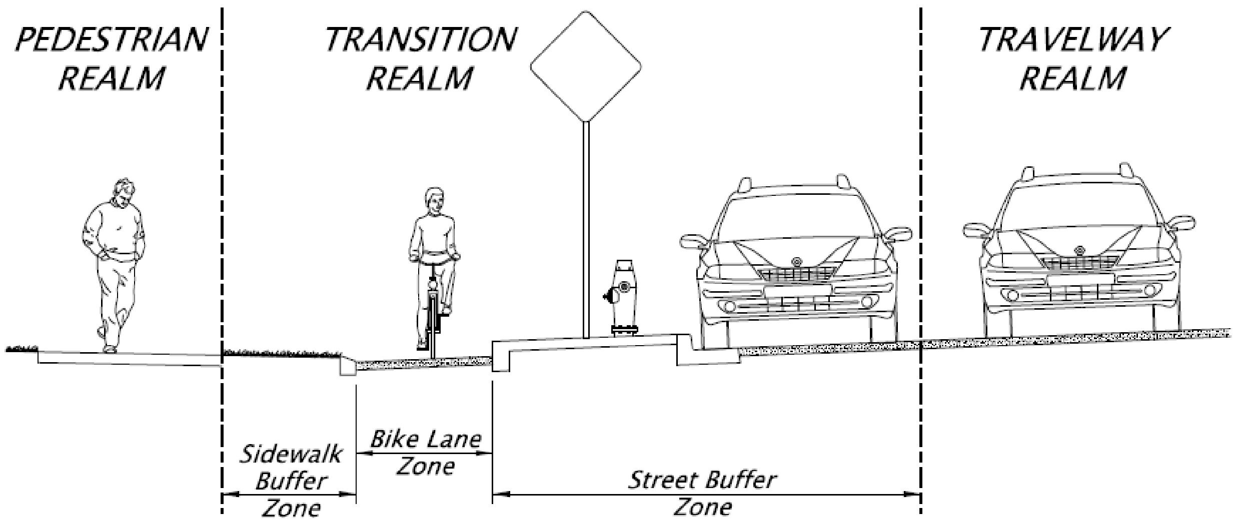
# Section 942 Transition Realm and Zones

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.*

## 943.1.1 Bike Lane Zone for Tier 1

The bike lane zone is the portion of a separated bike lane intended for bicycle travel, exclusive of buffer space. Shared use paths combine the widths of the Bike Lane Zone and the Pedestrian Zone. Refer to Section 960 for Shared Use Path widths.

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 width of the bike lane zone is also affected by maintenance. If a separated bike lane will be swept using a maintenance vehicle, the width of that vehicle may control the width of the bike lane zone. Where the bike lane zone is adjacent to a pedestrian zone, a maintenance vehicle may be able to sweep both together when the boundary between zones is a bike lane curb or if they are at the same level.

***The standard 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.** Where the bike lane zone is adjacent to an accessible on-street parking access aisle (less than 200 feet in length), the bike lane zone may be reduced to 4-feet without a design exception. **Otherwise, 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.

A raised bike lane is a type of Tier 1 bikeway 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. Since a bike lane edge stripe is typically placed on the road below the curb, the total width of a raised bike lane includes the curb together with the bike lane zone. Since 1-foot on each side of the curb functions as shy distance, the bike lane zone width is the same for a raised bike lane as for a separated bike lane. Separated and raised 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 bike lane zone 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.

## 943.1.2 Bike Lane Zone for Tier 2

The bike lane zone is equivalent to the bike lane width for a shoulder or bike lane. The bike lane zone is the bike lane portion of a buffered 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 high use or on high-speed facilities. However, a wider lane could be mistaken for a motor vehicle lane or parking area. In areas with additional roadway width, a painted buffer stripe can be used to clarify that the space is intended for bicycle use.

# 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.

A fundamental design decision needs to be made as to how bicycles and pedestrians travel on a corridor. The decision whether to separate or mix pedestrian and bicycle traffic should be consistent for as long a corridor as feasible. ***At a minimum, the design separation method should***

***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.

## 944.1.1 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 required 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.

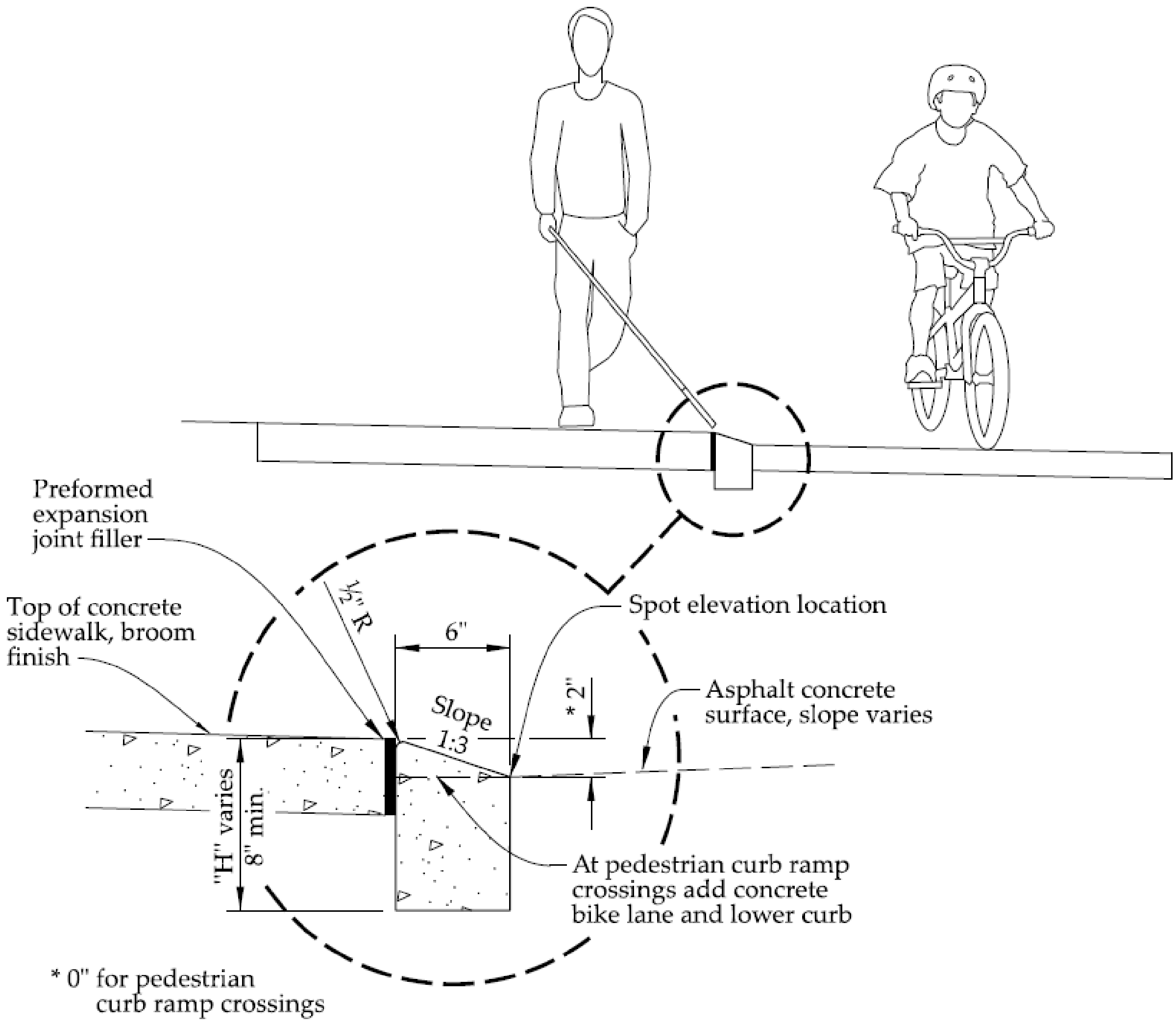
Some shared use paths may be designed with separate lanes for bicyclists from pedestrians. Sidewalk-level separated bike lanes can be equivalent to the mode-separated shared use path. Mode-separated paths can exist either where modes are allowed to mix, or where modes are not intended to mix. Where there 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.**

## 944.1.2 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 separate 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 | Other |
|---|---|---|---|---|---|
| Downtown | 0′ | 8′ | 2′ | 3′ | 2' |
| Urban Mix | 0′ | 8′ | 2′ | 4′ | 2' |
| Commercial Corridor | 0′ | NA | 2′ | 5′ | 2' |
| Residential Corridor | 0′ | NA | 2′ | 5′ | 2' |
| Suburban Fringe | 0′ | NA | 5′ | 5′ | 2' |
| Rural Community | 0′ | 8′ | 2′ | 4′ | 2' |
| Rural | 0′ | NA | 5′ | 5′ | 2' |

* On-street parking may be used as a street buffer only where on-street parking exists or is appropriate in the highway context.

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 eleven 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

A Buffered Bike Lane is a facility where traffic striping alone is used to separate the Bike Lane Zone from the travelway to create a safety buffer. 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 0 and Section 0.

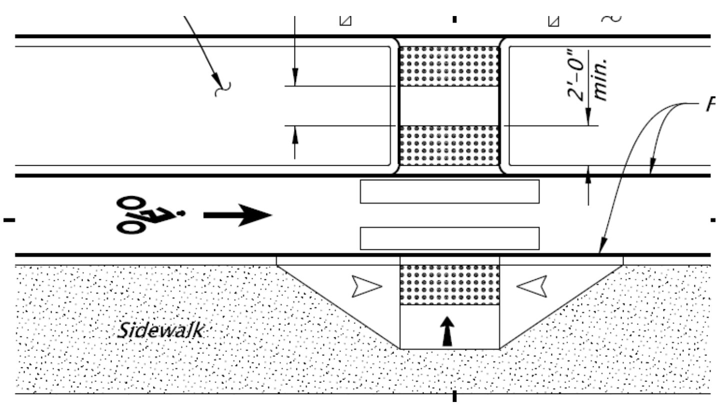
# 945.2 Parking Lane

[Placeholder for future content]

# 945.3 Raised Island Buffer

[Placeholder for future content] See Standard Drawing RD1140.

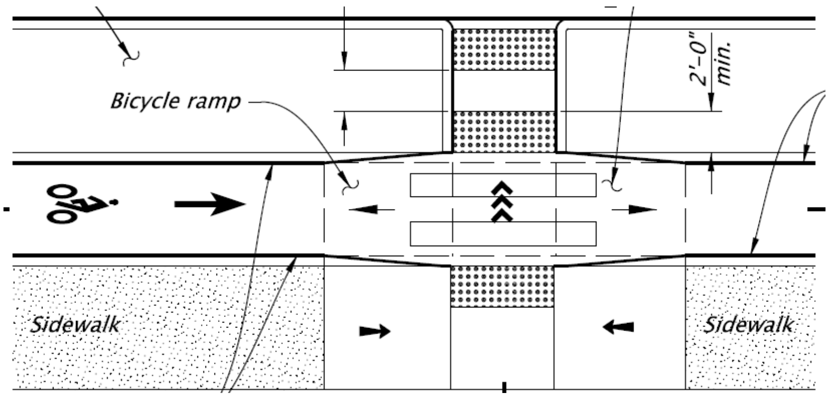
Figure 900-7: Island Buffer Cross Section at Street Crossing




# 945.4 Landscape Buffer

[Placeholder for future content] See Standard Drawing RD1140.

Figure 900-8: Landscape Buffer Cross Section at Street Crossing




# 945.5 Delineator Post Buffer

[Placeholder for future content]

# 945.6 Traffic Separator Curb Buffer

[Placeholder for future content]

# 945.7 Planter Box Buffer

[Placeholder for future content]

# 945.8 Concrete Barrier Buffer

[Placeholder for future content]

# 945.9 Guardrail Buffer

[Placeholder for future content]

## 945.10 Irrigation Ditch Buffer

[Placeholder for future content]

## 945.11 Bio-swale Buffer

[Placeholder for future content]

# 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. When evaluating usable shoulder width, do not include the portion of shoulder occupied by rumble strips, if present.

## 946.1 Shoulders

Shoulders provide for safety, capacity and maintenance area along highways. Standard shoulder widths in 4R projects are listed in Table 900-10 and minimum shoulder widths in 3R projects are listed in Table 900-11.

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)

| Average Running Speed | Design Year Volume (ADT) | | |
|---|---|---|---|
| | <750 | 750 – 2000 | >2000 |
| 50 mph or over | 2′ | 3′ | 4′ |
| Under 50 mph | 2′ | 2′ | 4′ |

## 946.2 Designated Tourism Route 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 tourism route 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 tourism route 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 tourism route 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 tourism route 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 mile points, 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.

[Placeholder for more content:
Evaluating Design Alternatives and Trade-offs to select a Bikeway & Hierarchy for Selecting the Next-Best Alternative]

## 947.1 Prioritizing Widths Between Zones

[Placeholder for future content]

### 947.1.1 Variability in Zone Widths

[Placeholder for future content.

This section will address:

- Passing spaces
- On-Street Parking
- Intersections]

# Section 948 Two-way and Contra-Flow Bikeways

Bicycle traffic is typically accommodated in both directions of travel by providing a bike lane on each side of a road. 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. Striping for contra-flow bicycle lanes are given in the ODOT Traffic Line Manual, Section 412.[11]

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 one side of 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 (see Section 948.1). Shared use paths that are not along a road do not need to be evaluated for one-way versus two-way operation.

Two-way shared use side paths are a preferred bicycle facility for limited access expressways or urban freeways and may be discouraged in other areas. Side paths are discussed in 0.

Although one-way separated paths may be intended for one direction of bicycle travel, they will often be used as two-way facilities. 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 Operation

Evaluate the following design considerations to determine whether bi-directional bicycle traffic is appropriate on one side of a roadway.

## 948.1.1 Driveways and Intersections Along Route

Two-way bicycle lanes and side paths are affected by each driveway and cross street approach along the route.

When bicycle traffic rides against the normal, predicted flow of motor vehicle traffic, conflicts can occur at driveways and cross streets. Crash risk is higher where cyclists ride facing traffic[26].

Bicyclists expect to proceed along a route without stopping at each driveway or minor side street. When bicyclists are required to stop or yield at cross-streets and driveways, stopping disrupts their momentum. Bicyclist's perception of safety on a protected facility may result in unexpected higher bicycle speeds when crossing intersections and driveways and in turn may increase the likelihood for crashes, especially where sight distance is limited.

Since the speed of bicyclists is faster than pedestrians, many drivers misjudge reaction time and proceed prematurely. Consequently, motor vehicles approaching side streets and driveways may proceed without noticing bicyclists.

Each vehicle approach may cause four potential conflict scenarios.

1. Approaching motor vehicles may stop on the cross-street or driveway and block the path.
2. A motor vehicle turning right from a side street or driveway may not expect to see a cyclist coming from the right.
3. A motor vehicle turning left onto a side street or driveway may not expect see a cyclist coming in the opposite direction.
4. A motor vehicle turning right onto a side street or driveway may not expect see a cyclist coming from the opposite direction.

Each conflict scenario is affected by the speed of bicycle travel along the route and whether motorists are able to notice and react.

Drivers often focus on oncoming traffic from the left without glancing to the right since motor vehicle traffic on the right is on the opposite side of the street. Thus motorists crossing the path do not notice bicyclists coming from the direction opposite to prevailing traffic.

A bi-directional bikeway may therefore be discouraged in areas with frequent driveway or street access.

## 948.1.2 Transition at the Ends of Bi-directional Route

When a two-way bicycle lane or side path begins or ends, bicyclists riding against traffic could continue to travel on the wrong side of the street. Wrong-way travel by bicyclists is a major cause of bicyclist-to-automobile crashes. A two-way bicycle lane or side path should not be implemented unless considerable care is taken to address safety issues posed by entering and exiting the two way facility.

To provide safe transitions to and from two-way bicycle lanes and side paths, entrances and exits from the path will require careful consideration and integration into the design. Depending on the context and origin/destinations to and from the two way facility on one side of the road, additional crossings may needed, resulting in additional conflict zones to be mitigated. Paradoxically, the side path and its planned crossings could reduce the number of conflicts for a cyclist. Trip generation and conflict analysis is recommended.

## 948.1.3 Position and Sight distance

Position refers to the location of the side path and its user in relation to the driver on the roadway. Sight distance is critical at intersections and crossings with side paths. This is also discussed in the two previous sections. A cyclist on a two-way bicycle lane or side path, even when going in the same direction of traffic, are not within the normal scanning area of turning drivers. In addition, a cyclist riding contra to the flow does not see the signage and signals posted for roadway users that a driver and a cyclist going in the same direction see, missing valuable cues for safety. In some cases, the proximity of a side path to the roadway creates a condition where barriers or railings are needed to separate traffic. These barriers can obstruct sight distance and make it challenging for maintenance. Evaluating visual barriers at crossings is recommended.

## 948.1.4 Space Available

A sidepath should use the same design criteria as a shared use path. It is recommended to have at least a 5 foot buffer between the edge of asphalt of the roadway and the path. This may require additional rights of way. Side paths can also be constrained by fixed objects, such as buildings, utilities, furniture and waterways. It is recommended to evaluate the available right of way to accommodate a side path.

## 948.1.5 User Compliance

Some bicyclists may choose to ride in the roadway rather than the side path because of some of the issues with conflicts discussed in this section. Bicyclists choosing to ride in the street instead of using the side path may be hassled by other road users.

## 948.1.6 Turns

Turning movements for cyclists on a side path are the same as for pedestrians. Generally, left turns involve yielding to cross traffic twice instead of only once and thus inducing unnecessary delay.

## 948.1.7 Continuity

[Placeholder for future content]

## 948.1.8 Conditions for a Successful Side Path

- Bicycle and pedestrian use is anticipated to be high;
- The traffic conditions (high-speed, high-volumes) on the adjacent roadway are such that on-road bikeways and sidewalks may be undesirable;
- The path can be kept separate from motor vehicle traffic, with few roadway or driveway crossings;
- There are no reasonable alternatives for bikeways and sidewalks on nearby parallel streets;
- There is a commitment to provide path continuity throughout the corridor;

- The path can be terminated at each end onto streets with good bicycle and pedestrian accommodation, or onto another safe, well designed path;
- There is adequate access to local cross-streets and other facilities along the route;
- Any needed grade-separation structures do not add substantial out-of-direction travel;
- The total cost of providing the path is proportionate to the need. This evaluation should consider the costs of: grading, paving, drainage, fences, retaining walls, sound walls, crossings, signs and other necessary design features;
- Grade-separated structures needed to eliminate at-grade crossings;

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 lower than a shared travel lane condition.[33] Survey results indicate that separated bike lanes are preferred over shared lanes or on-street bike lanes by both cyclists and motorists[34]Another research report concludes that two-way separated bike lanes are preferable on one-way streets on the right side, rather than the left[35].

# 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. One of the exemptions 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.

If a parallel route is chosen as a solution, minimal pedestrian and bike facilities should still be provided along highways, if feasible, even when there are parallel routes. Such facilities provide access and refuge in the case of a vehicle breakdown or other emergency. It may also be needed for connections to destinations and transit stops along the highway, as well as trips by individuals who may not be familiar with the local network and the availability of the parallel route. Except in highly constrained areas, parallel routes should generally be an "alternative" additive element to the bicycle network rather than the only route option provided.

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 or parallel to an expressway. 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 highway 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 bicyclists may prefer to travel on alternate routes. Tier 2 bikeways without buffers 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.
- Adequate facilities on proposed parallel route must exist before a Bike Bill design exception based on 'other available ways' can be approved. Planned future improvements to bring a parallel route up to state standards are not acceptable.

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

[Placeholder for section]

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.

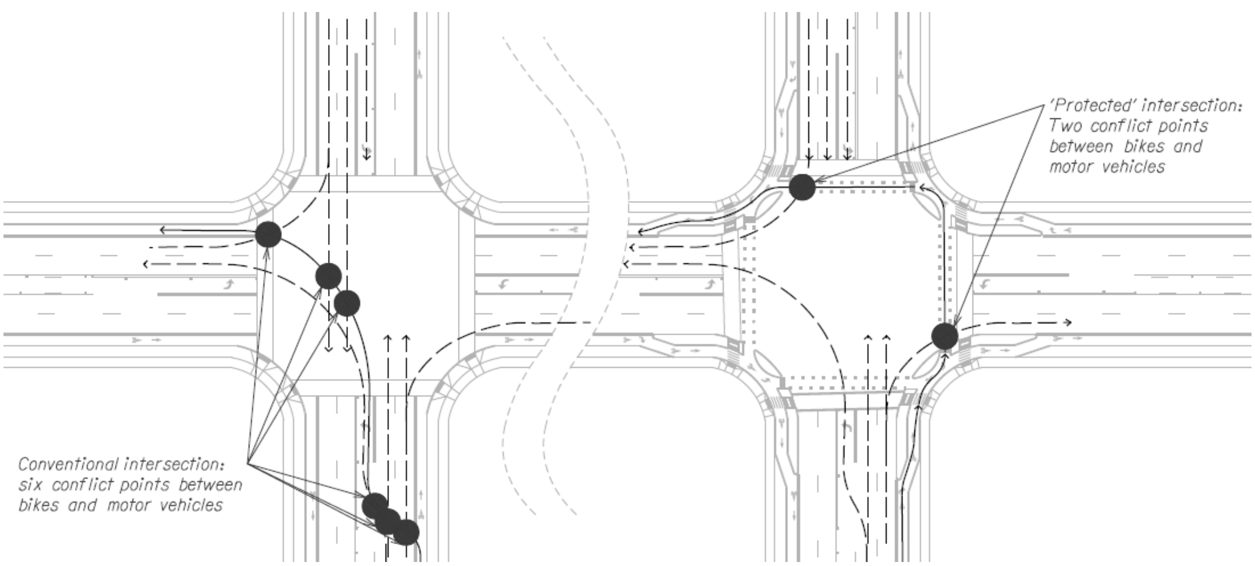
# Section 950 Intersection Design

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. Other intersection design principles for pedestrians and bicyclists are discussed in detail in sections 224.1, 830.5 and Section 920 and in Appendix L, pages 6-1 and 6-5.

# 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 minimizes and mitigates conflict points and 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 953 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.

[Placeholder for future content]

# Section 952 Intersection Sight Distance

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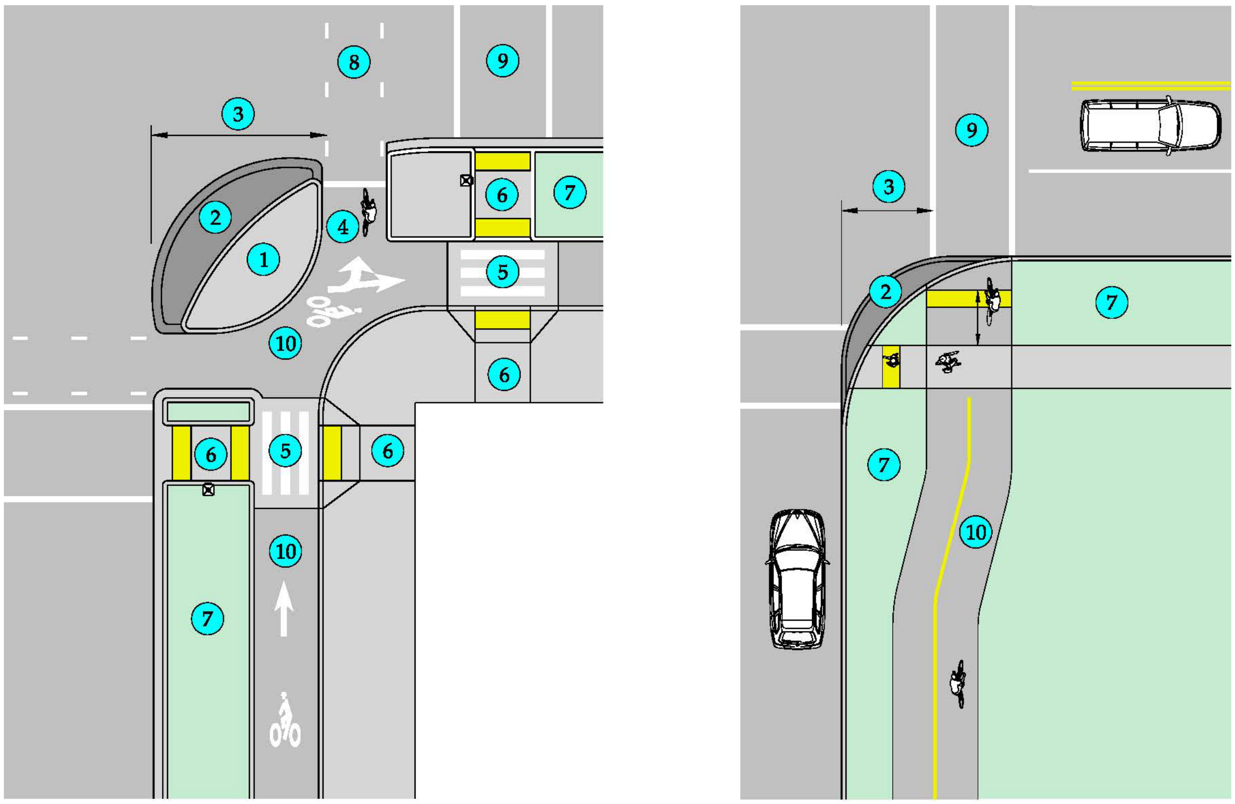
# Section 953 Protected Intersections

A ‘protected’ intersection uses traffic islands between bicycle and motor vehicle lanes to reduce and 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 are shown in Figure 900-10. Where a street has a shared use paths rather than bike lanes, some of the design elements can be included in the intersection design.

Figure 900-10: Protected Intersection Design for Separated Bike Lanes and Side Paths




# 953.1 Design Elements of a Protected Intersection

Ten design elements are shown in Figure 900-10. These include:

1. Corner Island
2. Truck Apron
3. Motorist Yield Zone
4. Advance Bicycle Stop Line with Queuing Area
5. Crosswalk in Bike Lane
6. Curb Ramps on each side of the Bike Lane
7. Street Buffer
8. Extension of Bike Lane in Street Crossing
9. Crosswalk
10. Bicycle Path Horizontal Curvature

### 953.1.1 Corner Island, Truck Apron and Motorist Yield Zone

The corner island has three functions. First, it positions bicyclists to create an advance stop line. Second, it shifts the crossing away from the intersection corner to create a Motorist Yield Zone. Third, it establishes the curb line for vehicle turns in lieu of the corner radius. The radius of the corner island should allow the design vehicle to turn without encroaching onto the island. Since the curb radius can affect vehicle turning speed, a truck apron may supplement the corner island to control turning speeds for vehicles other than the design vehicle. When vehicles turn, the size of the corner island should enable a vehicle to stop and wait for bicycles without blocking traffic. The optimal motorist yield zone distance is 6-feet to 16.5 feet. The corner island should maintain sight lines between turning vehicles and bicyclists.

### 953.1.2 Advance Bicycle Stop Line with Queuing Area

The advance bicycle stop line has two functions. First, it positions bicycles to be clearly visible to drivers who are stopped at the stop bar and who are turning. The positioning also helps approaching bicyclists. Second, it functions similar to a left turn bike box for side-street traffic to wait with stopped mainline bicycle traffic, while being outside of the path of cross street bicycle through traffic. The minimum length of the queuing area is 6-feet, measured from the corner island to the bike lane. If the available space for a queuing area is less than 6-feet, bicycles may block through side street bicycle traffic.

### 953.1.3 Pedestrian-Bicycle Conflict Area Features

Several design elements are necessary to separate bicycles from pedestrians to ensure pedestrian accessibility and manage conflicts between pedestrians and bicyclists. As described in 900-45Section 944, pedestrian features depend on whether or not bicyclists and pedestrians are intended to mix. If the modes are intended to remain separated, provide a crosswalk in the bike lane with curb ramps on each side of the bike lane and increase the width of the street buffer to function as a refuge island with pedestrian signal pushbuttons in the island area. If bicyclists and pedestrians are intended to mix, as in a shared use path, the curb ramps shall be equal in width to the approaching shared use path and must comply with ODOT ADA criteria for curb ramps. In both cases, the street buffer should be of sufficient length and width to accommodate bicycles stopped without encroaching into the side street bike lane or sidewalk.

Where bicycles and pedestrians are kept separate, provide space for an extension of the bike lane in street crossing parallel to the crosswalk. Where the modes are mixed, a crosswalk is sufficient for both.

### 953.1.4 Horizontal Alignment Geometry

The design speed for the alignment of the bicycle path through the Protected Intersection area should be reduced since bicyclists must slow down to cross conflict areas. Where the street buffer is increased to create a 7-foot refuge island, the alignment of the bike lane includes curves as is called "bend-out deflection." Beginning of bend-out deflection is determined by the length necessary to create a 7-foot refuge island.

## 953.2 Retrofitting with Protected features

[Placeholder for section]

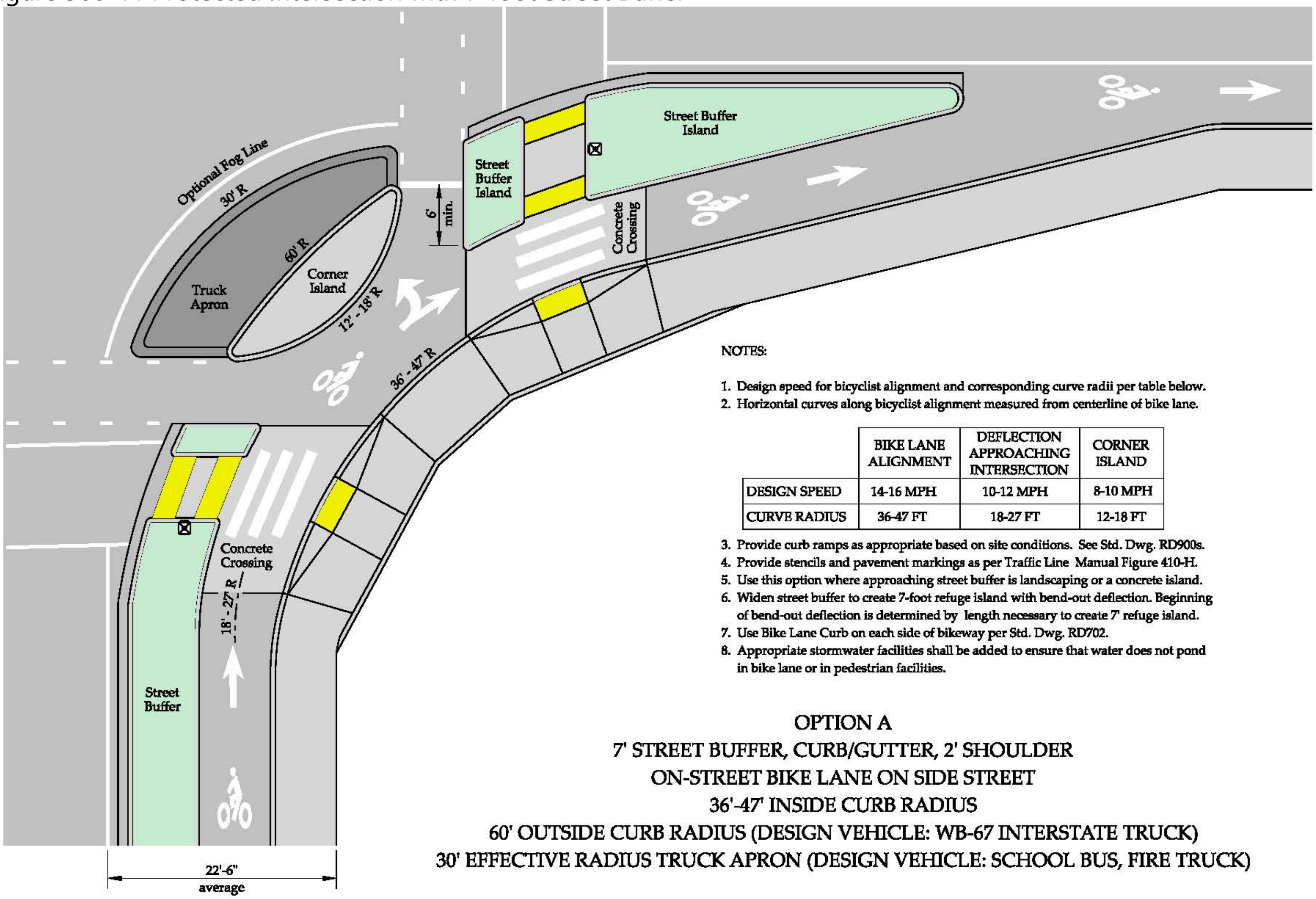
Protected intersections should be considered when upgrading intersections, even if the approaches don't currently have separated or buffered bike lanes because the segments can be upgraded later in coordination with pavement preservation or other efforts.

## 953.3 Protected Intersection Layouts

The following example designs illustrate how the design features of a protected intersection may be applied at an intersection. These examples are not comprehensive.

## 953.3.1 Protected Intersection Layout with Wide Buffer

Figure 900-11 Protected Intersection with 7-foot Street Buffer




NOTES:

1. Design speed for bicyclist alignment and corresponding curve radii per table below.
2. Horizontal curves along bicyclist alignment measured from centerline of bike lane.

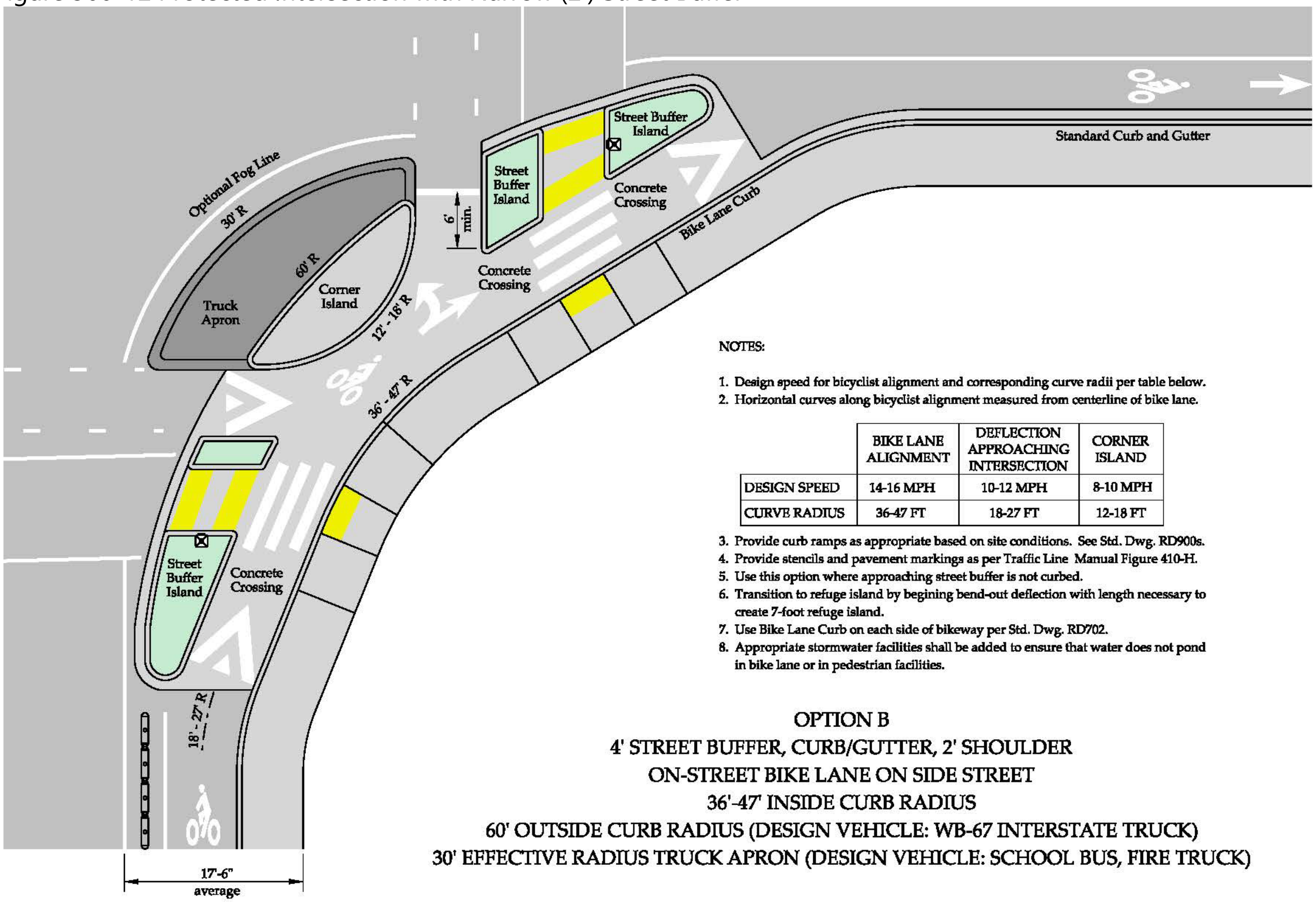
| | BIKE LANE ALIGNMENT | DEFLECTION APPROACHING INTERSECTION | CORNER ISLAND |
|---|---|---|---|
| DESIGN SPEED | 14-16 MPH | 10-12 MPH | 8-10 MPH |
| CURVE RADIUS | 36-47 FT | 18-27 FT | 12-18 FT |

3. Provide curb ramps as appropriate based on site conditions. See Std. Dwg. RD900s.
4. Provide stencils and pavement markings as per Traffic Line Manual Figure 410-H.
5. Use this option where approaching street buffer is landscaping or a concrete island.
6. Widen street buffer to create 7-foot refuge island with bend-out deflection. Beginning of bend-out deflection is determined by length necessary to create 7' refuge island.
7. Use Bike Lane Curb on each side of bikeway per Std. Dwg. RD702.
8. Appropriate stormwater facilities shall be added to ensure that water does not pond in bike lane or in pedestrian facilities.

OPTION A
7' STREET BUFFER, CURB/GUTTER, 2' SHOULDER
ON-STREET BIKE LANE ON SIDE STREET
36'-47' INSIDE CURB RADIUS
60' OUTSIDE CURB RADIUS (DESIGN VEHICLE: WB-67 INTERSTATE TRUCK)
30' EFFECTIVE RADIUS TRUCK APRON (DESIGN VEHICLE: SCHOOL BUS, FIRE TRUCK)

## 953.3.2 Protected Intersection Layout with Narrow Buffer

Figure 900-12 Protected Intersection with Narrow (2′) Street Buffer




NOTES:

1. Design speed for bicyclist alignment and corresponding curve radii per table below.
2. Horizontal curves along bicyclist alignment measured from centerline of bike lane.

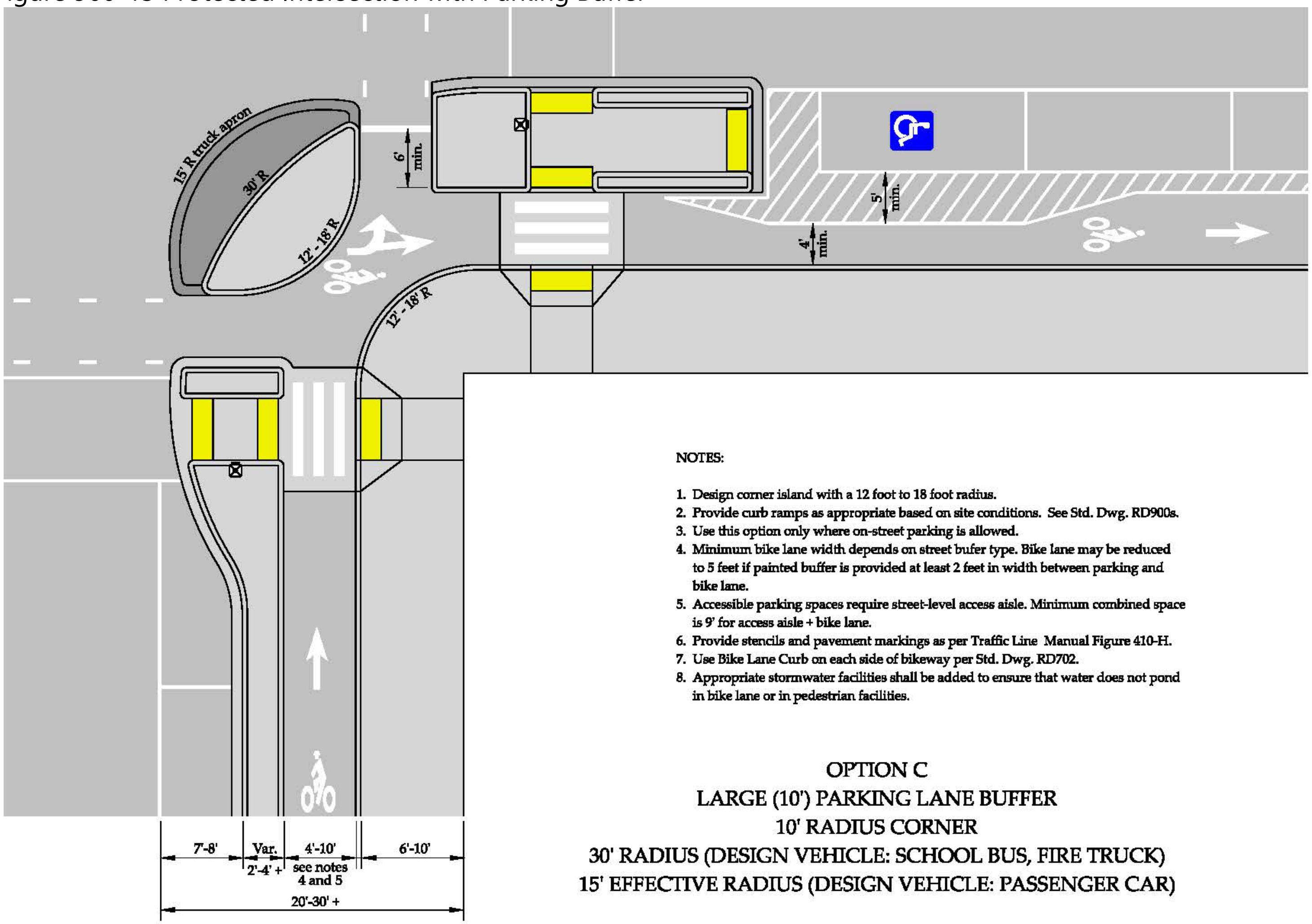
| | BIKE LANE ALIGNMENT | DEFLECTION APPROACHING INTERSECTION | CORNER ISLAND |
|---|---|---|---|
| DESIGN SPEED | 14-16 MPH | 10-12 MPH | 8-10 MPH |
| CURVE RADIUS | 36-47 FT | 18-27 FT | 12-18 FT |

3. Provide curb ramps as appropriate based on site conditions. See Std. Dwg. RD900s.
4. Provide stencils and pavement markings as per Traffic Line Manual Figure 410-H.
5. Use this option where approaching street buffer is not curbed.
6. Transition to refuge island by begining bend-out deflection with length necessary to create 7-foot refuge island.
7. Use Bike Lane Curb on each side of bikeway per Std. Dwg. RD702.
8. Appropriate stormwater facilities shall be added to ensure that water does not pond in bike lane or in pedestrian facilities.

OPTION B
4' STREET BUFFER, CURB/GUTTER, 2' SHOULDER
ON-STREET BIKE LANE ON SIDE STREET
36'-47' INSIDE CURB RADIUS
60' OUTSIDE CURB RADIUS (DESIGN VEHICLE: WB-67 INTERSTATE TRUCK)
30' EFFECTIVE RADIUS TRUCK APRON (DESIGN VEHICLE: SCHOOL BUS, FIRE TRUCK)

# 953.3.3 Protected Intersection Layout with On-Street Parking

Figure 900-13 Protected Intersection with Parking Buffer



# Section 954 Conflicts at Turn Lanes

**Bicycle lanes shall 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 mitigated**. Mitigations include traffic signal control, geometric alignment, or grade-separation. Solutions with geometric alignment are discussed in Section 954.1.

## 954.1 Freeway-style Ramp Crossings

Conflicts between motor vehicles, pedestrians and bicyclists often occur at interchange areas due to the high volume of vehicle turns. To mitigate potential conflicts, the design of intersections serving freeway entrance and exit ramps should keep turning speeds slow and maximize visibility between bicyclists and motorists. Turning speeds are slowest at right-angle intersections and where the corner radius is minimized. The route of the bicyclist should be visible to the motorist. Skewed approaches also increase the crossing distance. Free-flow ramps should be avoided. Where they exist, physical features should be used to enhance sight lines and encourage slowing and yielding behaviors. Physical features may include minimized corner radius or truck aprons. Signs may be considered to further enforce the yield condition for unprotected pedestrian and bicycle crossings. Consider grade separation or signalization 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.

Pedestrian and bicycle traffic must be accommodated through interchange areas to avoid freeways creating gaps and barriers in the local walking/biking network.

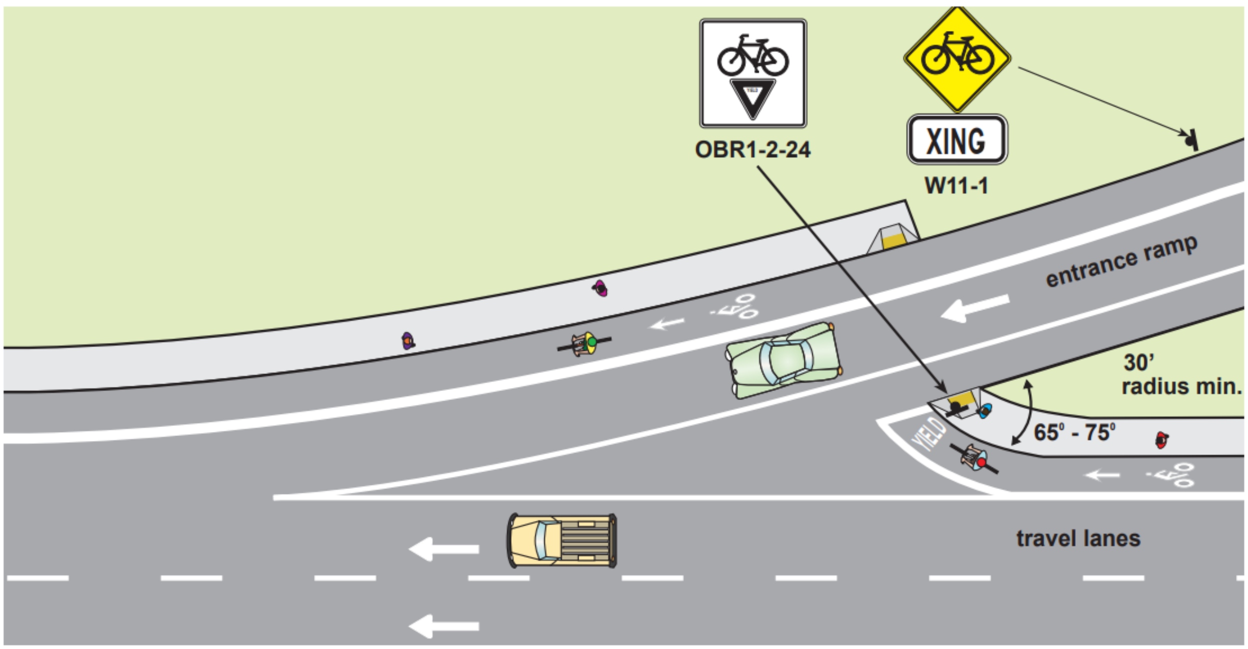
While bike lanes and sidewalks are not appropriate on limited access freeways, they are common on urban parkways, which often have freeway-style designs such as merging lanes and exit ramps rather than simple intersections. Traffic entering or exiting a roadway at high speeds creates difficulties for bicyclists and pedestrians. The following designs help alleviate these difficulties.

### 954.1.1 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

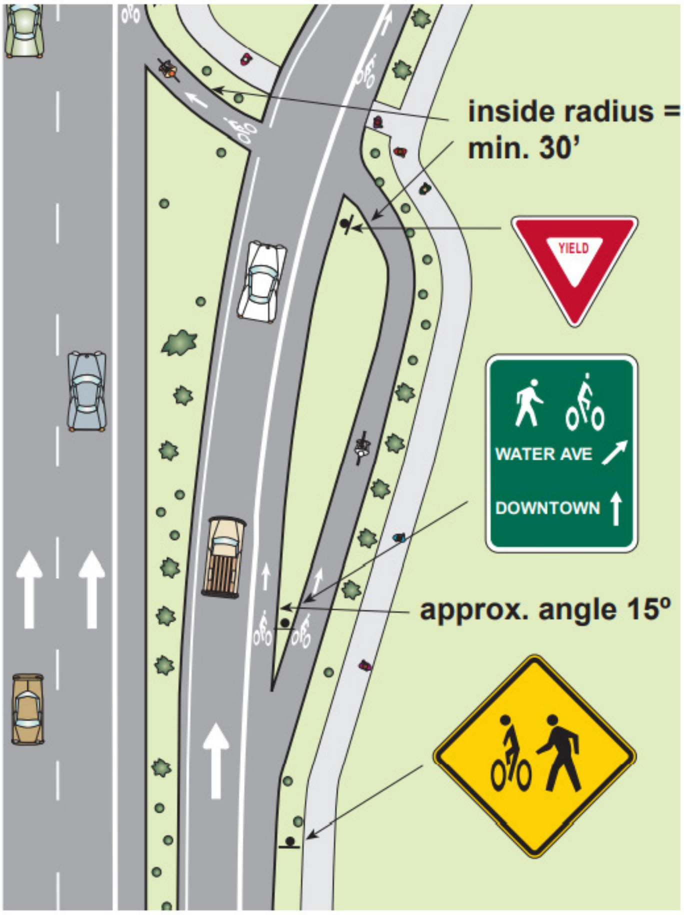



## 954.1.2 Exit Ramps

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 955 Bikeway Street Crossings

[Placeholder for future content]

## 955.1 Side-street Bike Route Crossings

[Placeholder for future content]

## 955.2 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.

## 955.3 Grade-Separated Crossings

Though grade-separation appears to offer greater safety, the excessive added travel distance and grade change often discourages pedestrians who want to take a more direct route. A grade separated crossing must offer obvious advantages over an at-grade crossing to ensure that they will be used and justify the significant additional cost.

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-foot high bridge. ADA requires ramps to not exceed a 5% grade. Twenty feet of rise at 5% requires a 400-foot ramp in level terrain, for a total additional distance of 800 feet for both sides, approximately equal to two city blocks of out-of-direction travel. Higher clearance may be required over railroad tracks. This can be mitigated with stairs with a bike channel, or a series of ramps and landing with a level landing for every 2.5 feet in rise. Overcrossings are more successful where the roadway to be crossed is sunken.

Under crossings 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. Under crossings 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.

## 955.4 Crossbikes

[Placeholder for future content]

# Section 960 Shared Use Path Design

Shared use paths are facilities for people to walk, jog, run, stroll, skate, bike, and use any of various mobility devices while being physically separated from a 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. 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. Some shared use paths may include accommodation of additional users, such as equestrians. (See Section 855).

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.

# 960.1 Shared Use Path Configurations

Figure 900-16 illustrates various shared use path configurations as well as a similar configuration that is a separated bike lane, rather than a shared use path.

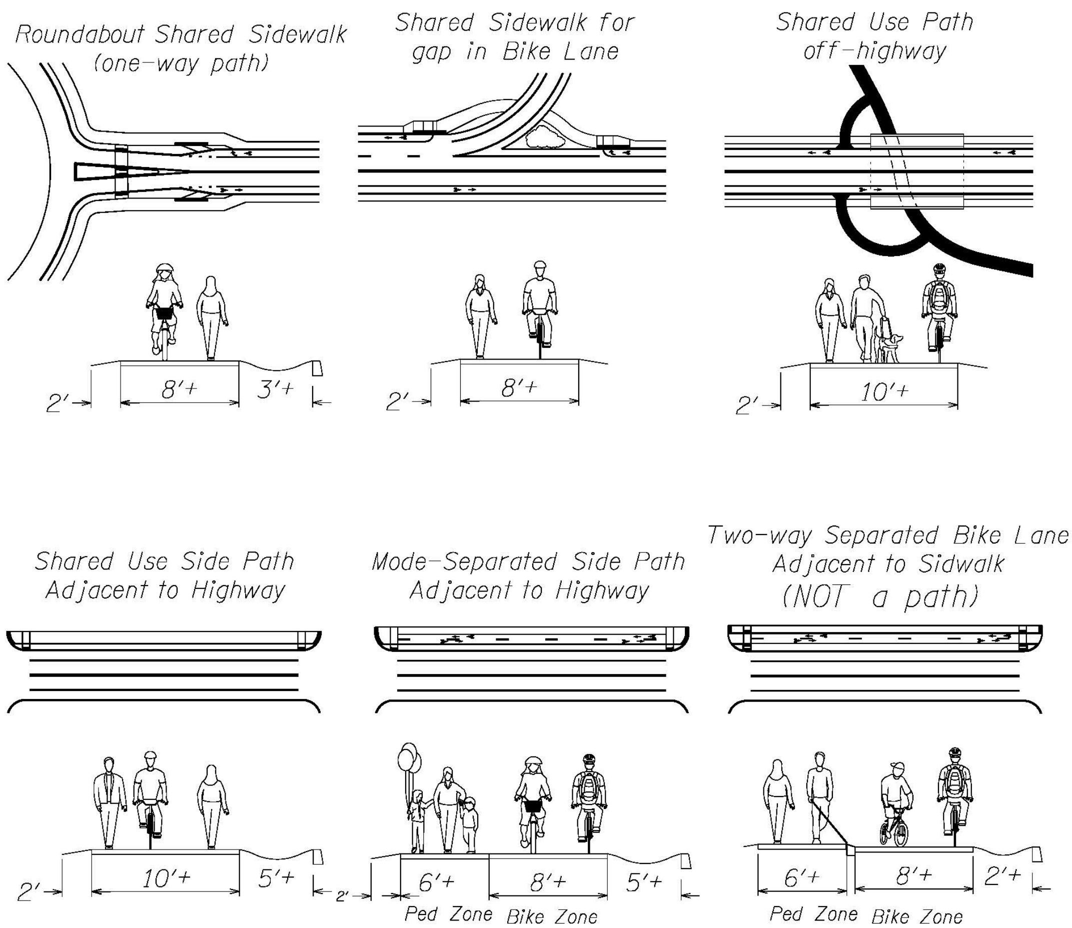
The top left and top middle illustrations are wide sidewalks that are shared with bicycle traffic. Where a bicycle lane joins a sidewalk, see 0 and Section 981.

The bottom row illustrates three scenarios with facilities within the highway right-of-way where pedestrians and bicyclists are physically separated from the travel way realm. Side paths are shared use paths that are parallel and adjacent to a road. Side path design is described in 0. Mode-separated side paths are described in Section 971. Two-way separated bike lanes adjacent to sidewalks are not shared use paths, though the operations are similar. They are also described in Section 971. Considerations for two-way bicycle facilities (side paths and separated bike lanes) are given in Section 948.

The top right illustration is a shared use path that is apart from a highway. It may include connections to a highway or it may be entirely on an independent alignment. 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 shared use paths on independent alignments as well as side paths. Section 921.2 has design information for restricting motor vehicle encroachment on a path with bollards and design at rail crossings. See Chapter 7 of Appendix L for additional information. In addition to design requirements in this manual, consider guidance in the AASHTO Guide for the Development of Bicycle Facilities[15].

Figure 900-16: Types of Shared Use Path




# Section 961 Path Width

Shared use paths outside a highway are not divided into zones as are sidewalks and bikeways. For paths along a highway, the path width substitutes for the sum of the pedestrian zone and the bike lane zone. The footprint of a path includes shoulder/shy distance as discussed in Section 963. The standard path width is the paved portion of the path, and typically does not include the shoulder/shy distance. **10 feet is the minimum standard width for a shared-use path**; *they should be at least 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 shoulder/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 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 in the range between 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 shared sidewalk connection paths.** When pinch points occur or where long term usage is expected to be low, 8 feet is the minimum clear width for shared use paths and requires a design exception.

When mode separation is desired between pedestrians and bicyclists, additional width is required. **Provide a clear width between 14 feet and 20 feet for mode separated shared use paths.** *It is preferable to 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 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 944).

At roundabout approaches, bike lanes should ramp up to the sidewalk. The shared sidewalks operate as shared use paths, though bicycle travel is intended to be one-way while travel for pedestrians is intended to be two-way. Widen the sidewalk to 10 feet, minimum 8 feet. **Provide 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 for bike ramp design.

# 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 ride or step or ride on it without ankle twisting or losing balance and that does not result in loose gravel or other material being tracked onto the path. 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 beyond the pavement 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 and compacted 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 900-1 - Radius of Curvature Based on Lean Angle

$$R = \frac{0.067V^2}{\tan\theta}$$

R = radius of curvature.

V = design speed. See 0 for selecting the appropriate design speed;

$\theta$ = the lean angle, typically 20 degrees.

Equation 900-2 –Radius of Curvature Based on Superelevation Rate

$$R = \frac{V^2}{15 \times (e + f)}$$

R = radius of curvature.

V = design speed. See 0 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 Table 900-13. 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 traverse 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.

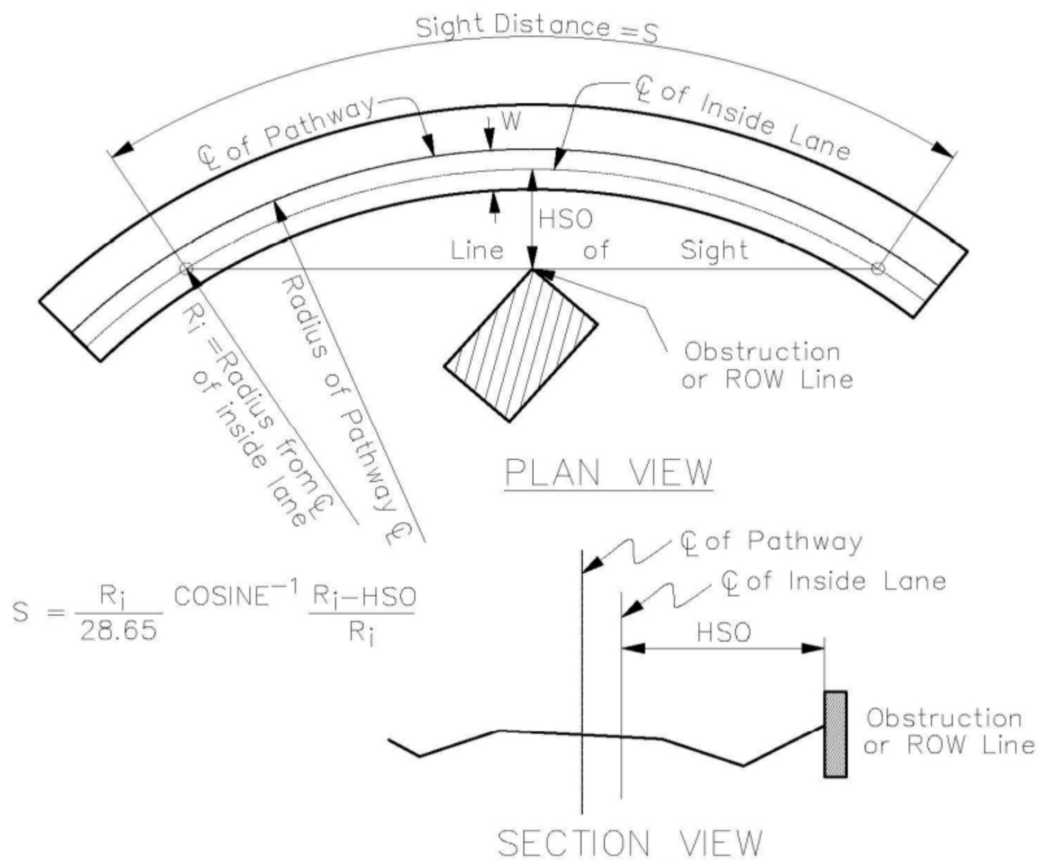
Equation 900-3 Horizontal Sightline Offset (HSO) for Horizontal Curve

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

Equation 900-4 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[16], 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. A recumbent bicycle may be used as an alternative 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 900-5 Stopping Sight Distance

$$S = 30\sqrt{\frac{L}{A}}\, OR\ S = \frac{L}{2} + \frac{2025}{\ }$$

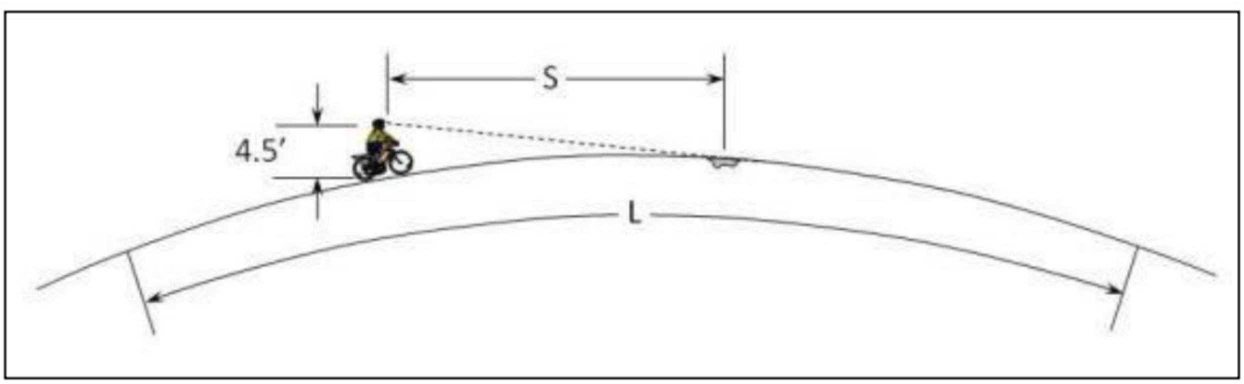
Where:

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[16], Figure 14-33)

## 966.1 Path Grade

**The grade of a shared use paths shall be 5.0% or less, except at ramps or along a road.** The best practice is to design the alignment of a path lower than 5.0% in order to minimize the chance that it will exceed 5.0% when constructed. Concrete paths may be designed at 4.5% and asphalt paths may be designed at 4.0% in order to provide construction tolerance.

Shared use paths located along roadways above 5% grade may follow the grade of the road. **When the shared use path is parallel with the mainline highway alignment, the walkway shall not exceed the roadway grade.**

An ADA design exception is required where a vertical grade is designed to be 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%.

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.

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 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.

# 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 future content]

# Section 970 Side Path Design

When designing shared use paths that run alongside a highway, there are design and operational challenges. See Section 948.1 for a list of considerations for side paths and two-way separated bike lanes. The design of a side path must consider each conflict point along the path. Aside from conflict point mitigation, side paths shall meet most design requirements for shared use paths. Rather than shoulder/shy distance on both sides of the path, one side of the path is adjacent to the road. Section 945 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 future content; specific side path design, incorporate Michigan side path guide[27]]

# Section 971 Mode-Separated Side Paths and Two-way Separated Bike Lanes

The minimum total width required for a mode-separated path is described in Section 961. The typical 16-foot section 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 mode separated side path.

Section 901 discusses considerations for one-way versus two-way bicycle travel on one side of a road.

Section 961 through Section 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 future section discussing slopes, etc.]

# Section 981 Bike Lane to Shared Use Path

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.

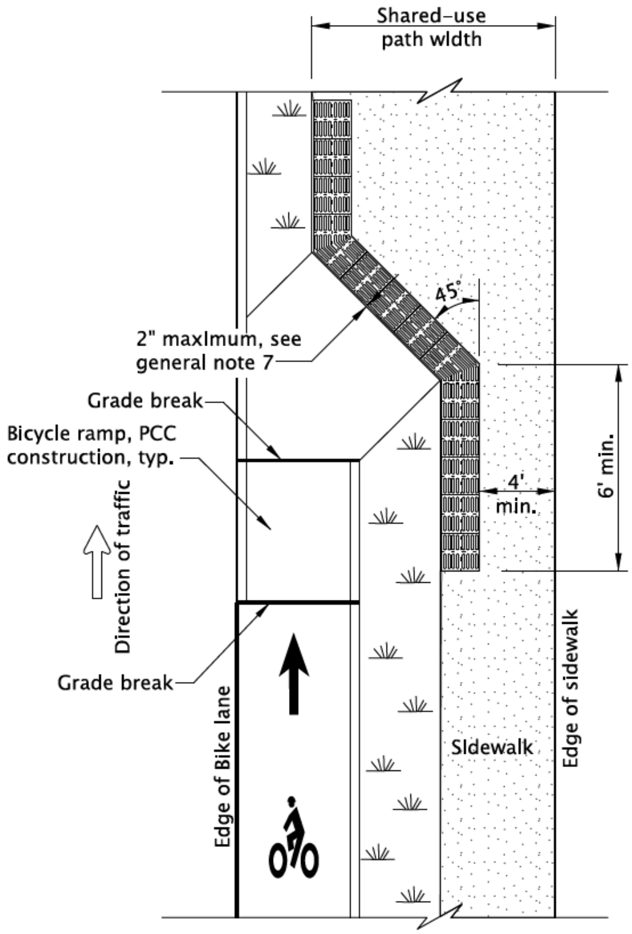
In general, bicyclists will be given a choice to enter a roundabout as a vehicle and occupy a lane until exiting the roundabout, or to use the sidewalks and crosswalks as pedestrians. For these bicyclists, a bike ramp is provided through the curb zone to exit the bike lane on approach to the roundabout 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).

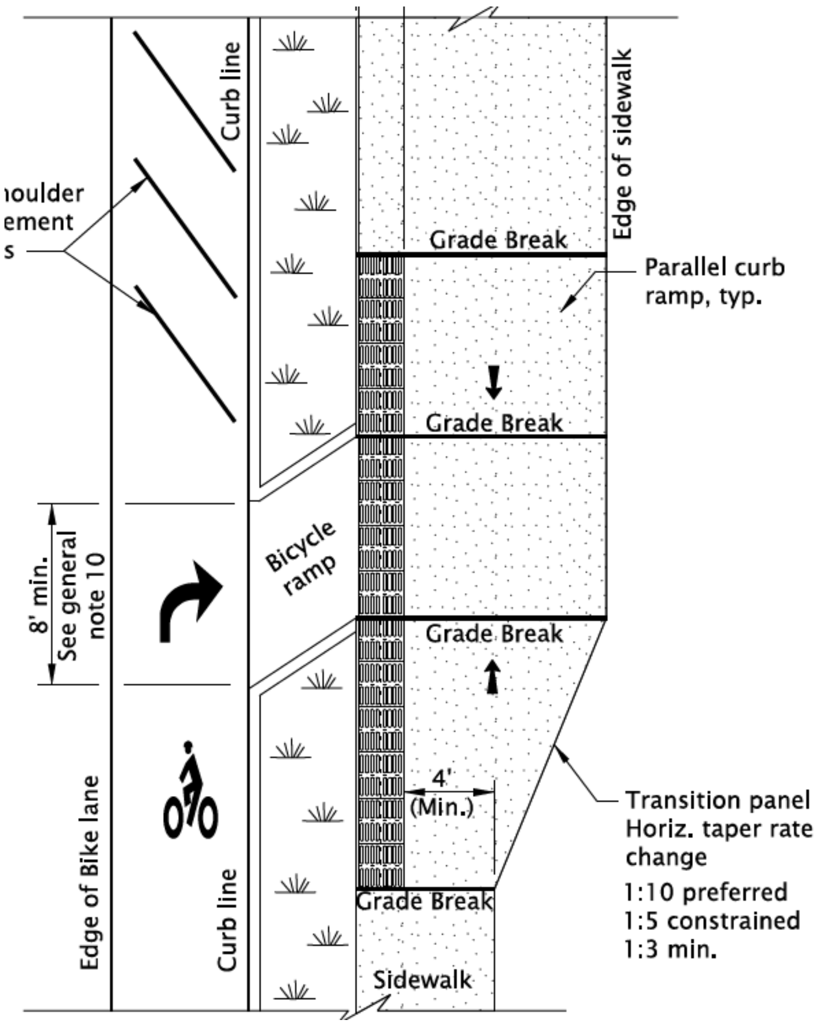
Where a bike ramp is in line with the approaching bike lane, the bike ramp may be equal in width to the approaching bike lane. See Figure 900-16.

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 a minimum 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

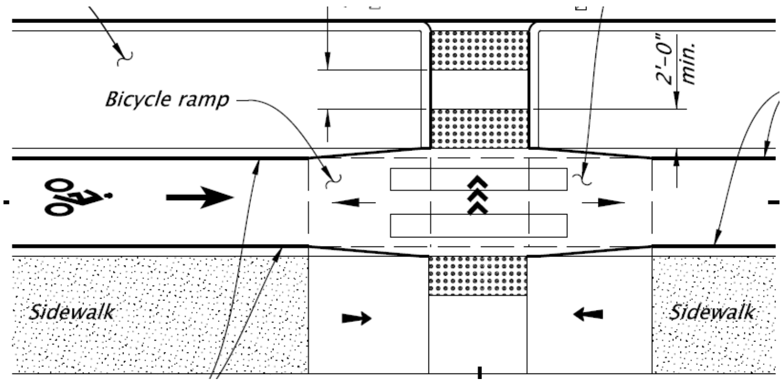
[Placeholder for future content] See Standard Drawing RD1140.

# Section 983 Bike Lane at Raised Crossings

[Placeholder for future content]

See Standard Drawing RD1140. Raised crosswalks and raised intersections

Figure 900-21 Bicycle Ramp to a Raised Crosswalk




# 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 and may also include bike parking. 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 future content; including operational benefits of providing separated bike lanes on transit corridors (space for buses to pull out of traffic)]

# 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.

[Placeholder for content – discussion on minimum widths for bike lane adjacent to parking to avoid door zone issues]

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 areas with land use destinations. 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. Some bicycle racks may be placed with greater spacing to accommodate cargo and adaptive bicycles, which are larger. 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;
- Support the frame at two locations;
- 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 future 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. A preferred location for bike share and scooter share stations is in proximity to transit stops where feasible.

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 future content]

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.

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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.

# Section 1002 Definitions

**ADA Curb Ramp Design Exception (Form 734-5112)** - 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.

**Certified Local Public Agency** - A local agency that has achieved or maintains certification per the processes in Section B of the ODOT Local Agency Guidelines for Certified Local Public Agencies. https://www.oregon.gov/odot/LocalGov/Pages/LAG-Manual.aspx

**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. The roadway General Design Exception Request Form requires a professional engineering seal from both the Engineer of Record (EOR) and the State Traffic-Roadway Engineer.

**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 prior to discussion or in coordination with Technical Services.

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.

Although most design exceptions are requested when the design does not meet minimum standards, a design exception may also be requested when applying new design concepts or tools that are not governed within existing standards. For experimental treatments, the design exception process will documents decisions and be a formal methods for seeking FHWA approval when required. The design exception is also used as documentation when ODOT is evaluating the efficacy of roadway treatments.

# 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) may review and approve 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 1000-2. 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:

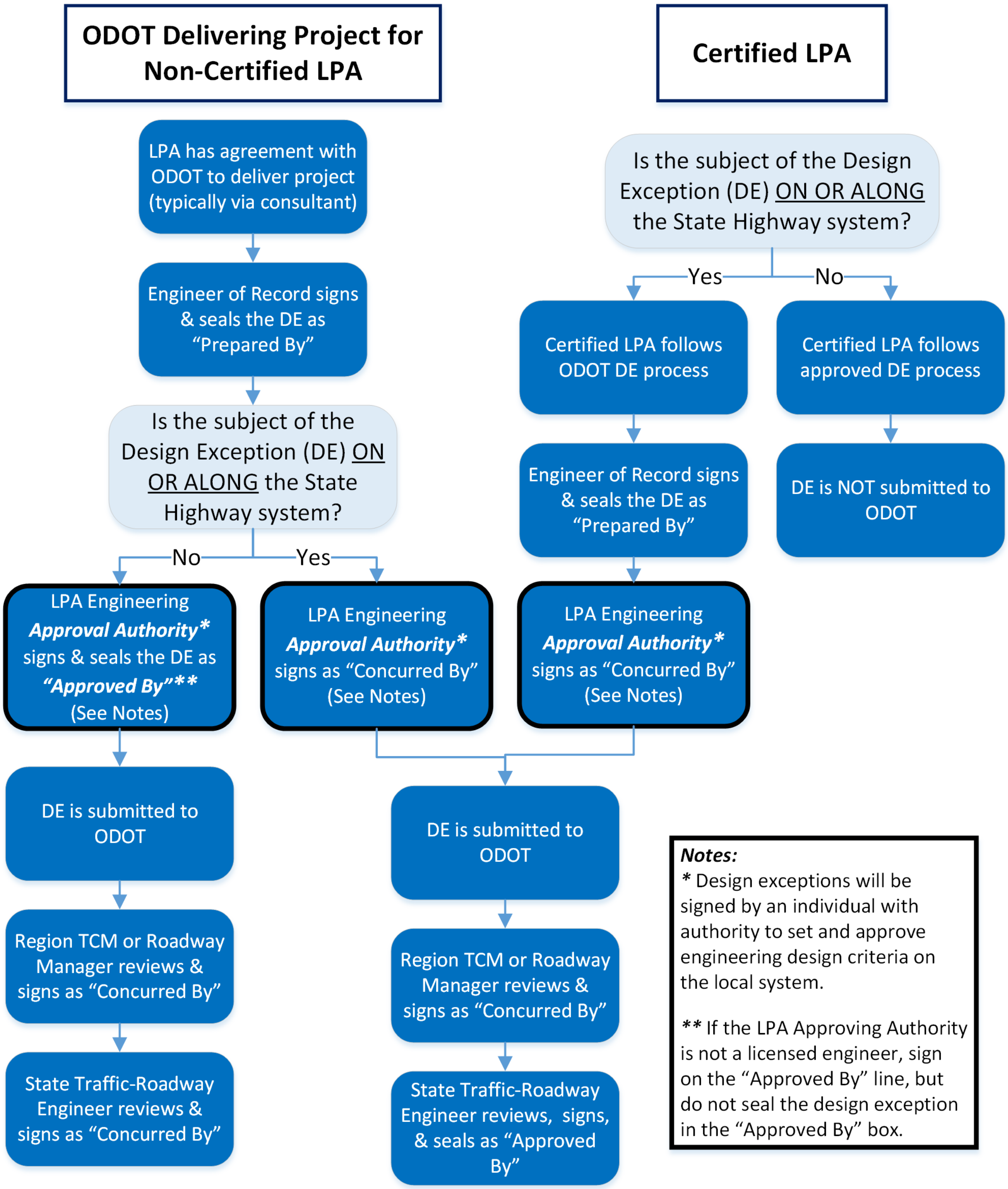
- Excessive construction cost or cost/benefit
- Compatibility with adjacent sections
- No plans for improvement of adjacent sections in the foreseeable future
- Proposed improvements or changes in standards for the highway corridor
- Preservation of historic property or scenic value
- Additional right 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 may also needs to review and approve design exceptions for some projects. However, the local public agencies (LPA) may process and approve design exceptions according to Figure 1000-1.

Figure 1000-1: Local Public Agency (LPA) Project General Design Exception Approval Process



### 1003.5.1 Non-Certified LPA Projects Delivered by ODOT

When a non-certified LPA has an agreement with ODOT for delivery of a project, 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. For non-certified LPA projects being delivered by ODOT, submit design exception requests on ODOT's design exception request form.

Figure 1000-1 and the following provide the design exception review process for non-certified LPA projects being delivered by ODOT:

- If the subject of the design exception is on or along the State Highway:
    - Use the ODOT design exception request form
    - Engineer of record seals and signs as "**Prepared By**"
    - LPA engineering approval authority signs as "**Concurred By**". The LPA engineering approval authority is the individual with authority to set and approve design criteria on the local system.
    - Design exception is submitted to ODOT for approval
    - Region Technical Center Manager or Region Roadway Manager reviews and signs the design exception as "**Concurred By**"
    - State Traffic-Roadway Engineer reviews, seals, and signs the design exception as "**Approved By**". The State Traffic-Roadway Engineer's signature should be the last signature applied to the form.
- If the subject of the design exception is NOT on or along the State Highway:
    - Use the ODOT design exception request form
    - Engineer of record seals and signs as "**Prepared By**"
    - LPA engineering approval authority seals and signs as "**Approved By**". The LPA engineering approval authority is the individual with authority to set and approve design criteria on the local system. If the LPA engineering approval authority is not a licensed engineer, the box designate for the approver's seal will be left blank.
    - Design exception is submitted to ODOT for approval
    - Region Technical Center Manager or Region Roadway Manager reviews and signs the design exception as "**Concurred By**"
    - State Traffic-Roadway Engineer reviews and signs the design exception as "**Concurred By**". The State Traffic-Roadway Engineer's signature should be the last signature applied to the form.

For curb ramps on or along the state highway, ADA curb ramp design exceptions are approved with ODOT's processes and forms described in Section 1006. Designers involved in local agency contracts should contact the project manager or contract administrator named as the agency point of contact in the contract.

## 1003.5.2 Certified LPA Projects

Certified local agencies approve design exceptions on federally-funded projects, except those on bridges and state highways. The Local Agency Certification Program uses an established compliance review process to ensure certified local agencies follow their established design exception approval procedures.

Figure 1000-1 and the following provide the design exception review process for Certified LPA projects:

- If the subject of the design exception is on or along the State Highway:
    - Certified LPA follows the ODOT design exception process and uses the ODOT design exception request form
    - Engineer of record seals and signs as "**Prepared By**"
    - LPA engineering approval authority signs as "**Concurred By**". The LPA engineering approval authority is the individual with authority to set and approve design criteria on the local system.
    - Design exception is submitted to ODOT for approval
    - Region Technical Center Manager or Region Roadway Manager reviews and signs the design exception as "**Concurred By**"
    - State Traffic-Roadway Engineer reviews, seals, and signs the design exception as "**Approved By**". The State Traffic-Roadway Engineer's signature should be the last signature applied to the form.
- If the subject of the design exception is NOT on or along the State Highway, the Certified LPA follows their design exception process that was approved during the certification process and does NOT submit the design exception to ODOT for approval.

For curb ramps on or along the state highway, ADA curb ramp design exceptions are approved with ODOT's processes and forms described in Section 1006. Designers involved in local agency contracts should contact the project manager or contract administrator named as the agency point of contact in the contract.

### 1003.5.3 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 MAP 21 NHS Roles and Responsibilities, 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 in the design. Processing of exceptions to design standards will be undertaken as soon as agreement is reached in the Region. Figure 1000-2 shows the General Design Exception request form.

Local Public Agency (LPA) project design exceptions follow a slightly different process (see also Figure 1000-1).

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 final incorporation of design features into project plans and/or other documents.

## 1004.1 Draft Design Exception Reviews

The Engineering and Technical Services Branch (ETSB) Roadway Engineering staff review design exceptions and provide the State Traffic-Roadway Engineer with a formal recommendation for approval or rejection. Early informal consultation with Roadway Engineering staff is encouraged, through submission and review of draft design exceptions.

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, place the draft in the ProjectWise folder for the project, and notify the ETSB Roadway Engineering staff by email to the ODOT Design Exception inbox at ODOTDesignExceptions@odot.oregon.gov. The draft document should contain the information for the request, and be named using ODOT's ProjectWise naming conventions. For general 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. Only after the design exception request is ready for final submission should the information be moved to the automated ADA Curb Ramp Design Exception form.

# 1004.2 Design Exception Procedures

The following steps define the design exception procedure for ODOT projects:

**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 1000-1 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. Depending on the design exception, the State Traffic-Roadway Engineer may submit the request letter to FHWA for review and approval. 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 regularly 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 Engineering and Technical Services Branch stores electronic copies of all design exceptions approved by the State Traffic-Roadway Engineer.

**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 or new construction 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.

### 1004.3.1 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.

### 1004.3.2 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.

### 1004.4.1 Technical Infeasibility

Technical infeasibility is when the physical constraints do not allow for a solution, or there are conflicting interests, such as federal regulations or state laws, that do not allow for a solution.

Accessible requirements are to be incorporated to the maximum extent feasible, if a standard cannot be achieved. 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.

Structural infeasibility might occur on existing bridges when modified or altered with a construction project. Structural infeasibility is extremely rare on new construction of a structure or bridge as ADA requirements can be planned for in advance during the design. Documentation of any unique characteristics of terrain limitations impacting ADA requirements are processed on the General Design Exception. Accessibility is required to the maximum extent feasible, requiring coordination and creativity with other technical disciplines.

Sometimes the designer is unable to place the geometric requirements for the feature without adverse impacts to historic or archeological artifacts. Historic Properties means those properties that are listed or eligible for listing in the National Register of Historic Places or properties designated as historic under State or local law.[1] The goal of consultation with State Historic Preservation Offices (SHPO) is to identify historic properties potentially affected by construction improvements, assess its effects and seek ways to avoid, minimize or mitigate any adverse effects on historic properties as stipulated in 36 CFR Part 800 – Protection of Historic Properties. 36 CFR, 800.5 (1) states "An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association." Examples of adverse effects are also described in 36 CFR, 800.5 (2)(v) which states "Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features" would be considered an adverse effect. Early coordination and consultation with SHPO is necessary to ensure the needs of the disability community and historic preservation are met. Solutions often require creativity, a deviation from standard engineering practice, and consideration of evolving best practices from technical disciplines in order to achieve ADA requirements to the maximum extent feasible.

[1] 28 CFR Part 35, 35.104 Definitions

# 1004.4.2 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 Delivery and Operations 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:

Delivery & Operations 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: ______________________

Delivery & Operations Division Administrator

Oregon Department of Transportation

### 1004.4.3 CQCR ADA Improvement Projects

The public can use the ODOT Office of Civil Rights Concern, Question, Comment or Request (CQCR) Form to provide feedback or make requests for ODOT to address accessibility issues on the state transportation system. CQCRs are incremental improvement projects on the transportation system to address a specific concern or barrier for an individual along a specific route traveled. 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. 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

## 1005.1.1 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.

## 1005.1.2 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.

## 1005.1.3 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, type, and severity 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

## 1005.1.4 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.

## 1005.1.5 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.

### 1005.1.6 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.

### 1005.1.7 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 1000-1 for a list of data needed for exception justification.

Table 1000-1: Data Needs For Exception Justification

| Design Exception Data for 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 General Design Exception Request Form. Select fields within the form have been numbered, with additional information provided below the figures.

Figure 1000-2: General Design Exception Request Form (Page 1 of 3)

**OREGON DEPARTMENT OF TRANSPORTATION**
**GENERAL 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: 4** | **1 ☐ 2 ☐** | | **Mileage Type: 5** | | **0 ☐ Z ☐** |
| **End MP:** | | **Mileage Overlap Code: 6** | | | **0 ☐ 1 ☐ 2 ☐** | | |

**PROJECT DATA**

| | | | | | |
|---|---|---|---|---|---|
| **Bid Date:** | | **Functional Classification:** | **7** | | |
| **Current ADT (Year):** | | **Design ADT (Year):** | | **% Trucks:** | |
| **Vertical Clearance Route: 8** | ☐ **Yes** ☐ **No** | | | **Posted Speed:** | |
| **Funding:** | | | | **Design Speed: 9** | |
| **Current Estimate:** | | | | **Target Speed:** | |
| **Additional Cost to Meet Standard:** | | **Path Design Speed (if applicable):** | | | |
| **Design Category:** | **3R** ☐ **1R** ☐<br>**4R** ☐ **SF** ☐ | **NHS:** ☐<br>**Non-NHS:** ☐ | | **Top 10% 10 SPIS Site:** | **Yes** ☐<br>**No** ☐ |
| **Is design feature within a historic district or adjacent to an eligible resource?** | **Yes** ☐<br>**No** ☐ | **Limits of district or location of eligible resource:** | | **MP:** to | |
| **Context:** | ☐ Rural ☐ Urban; (List Context) | | | | |
| **Urban Design Concurrence Document (UDC):** | **Yes** ☐ **No** ☐ (If "Yes", attach to form) | | | | |

| | | |
|---|---|---|
| **Design Exceptions** | | |
| **FHWA Controlling Criteria for all NHS Facilities**<br>(Interstates, Freeways, and Design Speed ≥ 50 mph) | | |
| ☐ Design Speed **11** | ☐ Structural Capacity | |
| **FHWA Controlling Criteria for "High-Speed" NHS Roadways** | | |
| ☐ Lane Width | ☐ Superelevation | ☐ Pavement Cross Slope |
| ☐ Shoulder Width/Shy Distance | ☐ Stopping Sight Distance | ☐ Vertical Clearance |
| ☐ Horizontal Alignment | ☐ Grade | |
| **ODOT HDM Requirements** | | |
| ☐ ADA Standards **11** | ☐ Diagonal Parking | ☐ Sidewalk or Walkway Width |
| ☐ Bike Lane/Shared Use Path Width **12** | ☐ Interchange Spacing | ☐ Spiral Length |
| ☐ Bridge Rail **11** | ☐ Median Width | ☐ Superelevation Runoff |
| ☐ Bridge Width | ☐ Parking Width | ☐ Vertical Alignment |
| ☐ Clear Zone (Region DE for 3R) | ☐ Pavement Design Life | ☐ (Other) |
| ☐ Design Life and V/C Ratio | ☐ Pilot Design Treatment | |

**1** **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 “Local” for the highway number.

**2** **Key Number:** The ODOT unique 5-digit number given to each project. For projects that have not been assigned a key number (such as development projects), mark this field as "N/A".

**3** **EA Number and Sub-Job:** The ODOT internal account number for the project including the sub-job number. For projects that have not been assigned an EA number, (such as development projects), mark this field as "N/A".

**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** **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.

**11** **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. Projects need to scope construction improvements to meet the ADA requirements. 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 and is extremely rare. Exceptions are generally limited to technical infeasibility and conflicts with historic preservation. Design must demonstrate accessibility is obtained to the maximum extent feasible.

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.

12 **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 Request Form (Page 2 of 3)

**OREGON DEPARTMENT OF TRANSPORTATION**
**GENERAL DESIGN EXCEPTION REQUEST**

**Description of Exception:** **13**
*(Identify each exception, and concisely describe the difference between the standard and the design element requiring an exception. If multiple exceptions are included on a single form, number each exception and maintain order throughout the form.)*

**Description of Project:** *(From Project Charter)*

**Location of Design Feature:** *(If multiple exceptions are listed, use bullets, numbering, or a table.)*

**Crash History & Potential:** *(Include analysis of data, specifically as it applies to requested exception)*
**14**

**Reasons for Not Attaining Standard:**
*(Explain in detail why the design standard cannot be met. List the constraints, such as cost/ benefit, crash history, environmental, etc. Include alternatives explored & benefits of not attaining standards, if applicable.)*

**Effect on Other Standards:** **15**
*(Identify other standards or best practices affected by not meeting (or meeting) the standard.)*

**Compatibility with Adjacent Sections:**
*(Describe how the design feature compares to the same, or similar, features in the vicinity of the project.)*

**Probable Time before Reconstruction of Section:**

**Mitigation for Exception Included in Design:** **16**
*(Identify mitigations to the effects of not meeting the standard. What considerations were made?)*

**Supporting Documentation:** **17**
*(Attached electronic documents to form. Include the appropriate Plan Section, Cross Section, Alignments Sheets, Plan Details, UDC Document, photos, etc.):*

**13** **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. However, for LPA projects, do not group items that are on or along the State Highway with items that are not.

When multiple exceptions are contained in one form, number the exceptions in this section and keep consistent numbering throughout the remaining sections in the document. Provide a clear description of each exception, including the proposed design, the standard requiring an exception, and existing conditions if applicable.

**14** **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 number, types, and severity of crashes and the relationship to the design exception.

**15** **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. Are other design exceptions or deviations requested and approved that relate to the request from other technical disciplines or roadway?

**16** **Mitigation:** Include the items that are included in the project to mitigate the specific effects of the proposed design exception. There are suggested items to use in the HDM in Part 200.

**17** **Supporting Documentation:** The Design Exception submittal must include appropriate plan section, cross section, alignment sheet and plan details. Digital pictures may also be included.

Figure 1000-4: General Design Exception Request Form (Page 3 of 3)

**OREGON DEPARTMENT OF TRANSPORTATION**
**GENERAL 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 (State Traffic-Roadway Engineer for LPA projects off State Highway) **18**

______________________
Print Name

**Concurred By:** ______________________ **Date:** __________
ODOT Region Tech Center Manager or Region Roadway Manager

______________________
Print Name

**Approved By:** ______________________ **Date:** __________
State Traffic-Roadway Engineer
(LPA Approval Authority for LPA projects off State Highway) **19**

______________________
(Print Name)

| **PREPARED BY:** | **APPROVED BY:** |
|---|---|
| Engineer of Record<br>Professional Engineer Seal | State Traffic-Roadway Engineer<br>Professional Engineer Seal<br>(LPA Approval Authority for LPA Projects off State Highway) **19** |

**18** **Concurred By:** When a non-certified LPA has an agreement with ODOT for delivery of a project, and the subject of the design exception is not on or along the State Highway, the State Traffic-Roadway Engineer signs on the "Concurred By" line instead of the "Approved By" line. In these cases, the LPA engineering approving authority approves the design exception. See Figure 1000-1.

**19** **Approved By:** When a non-certified LPA has an agreement with ODOT for delivery of a project, and the subject of the design exception is not on or along the State Highway, the State Traffic-Roadway Engineer signs on the "Concurred By" line instead of the "Approved By" line. In these cases, the LPA engineering approving authority approves the design exception. See Figure 1000-1.Include the items that are included in the project to mitigate the specific effects of the proposed design exception. There are suggested items to use in the HDM in Part 200.

Note: On all projects, exceptions are required when the geometric design elements in Table 1000-2 do not meet or exceed the minimums given in the ODOT Highway Design Manual for the type of project.

Table 1000-2: Design Exception List

| Design Elements / Features | FHWA Controlling Criteria | | Requires ODOT Approval[2] for All Projects |
|---|---|---|---|
| | May Require FHWA approval for all NHS Facilities | May Require FHWA Approval "High-Speed" NHS Roadways[1] | |
| Design Speed | √ | √ | √ |
| Structural Capacity | √ | √ | √ |
| Lane Width | | √ | √ |
| Shoulder Width/Shy Distance | | √ | √ |
| Horizontal Alignment | | √ | √ |
| Grade | | √ | √ |
| Stopping Sight Distance | | √ | √ |
| Pavement Cross Slope | | √ | √ |
| Superelevation | | √ | √ |
| Vertical Clearance | | √ | √ |
| Clear Zone[3] | | | √ |
| ADA Standards | | | √ |
| Bike Lane/Shared Use Path Width | | | √ |
| Bridge Rail | | | √ |
| Bridge Width | | | √ |
| Design Life and V/C Ratio | | | √ |
| Diagonal Parking (Jointly with State Traffic Engineer) | | | √ |
| Interchange Spacing | | | √ |
| Median Width | | | √ |
| Parking Width | | | √ |
| Pavement Design Life | | | √ |
| Pilot Design Treatment | | | √ |
| Sidewalk or Walkway Width | | | √ |
| Spiral Length (curves 1 degree or sharper) | | | √ |
| Superelevation Runoff (match spiral length) | | | √ |
| Vertical Alignment | | | √ |
| Other[4] | | | √ |

[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] For non-certified Local Public Agency projects, ODOT concurs with design exceptions for items not on or along the State Highway. The local agency approval authority approves the design exception.

[3] 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.

[4] 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.

# Section 1006 ADA Curb Ramp Design Exception Requests (Form 734-5112)

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.

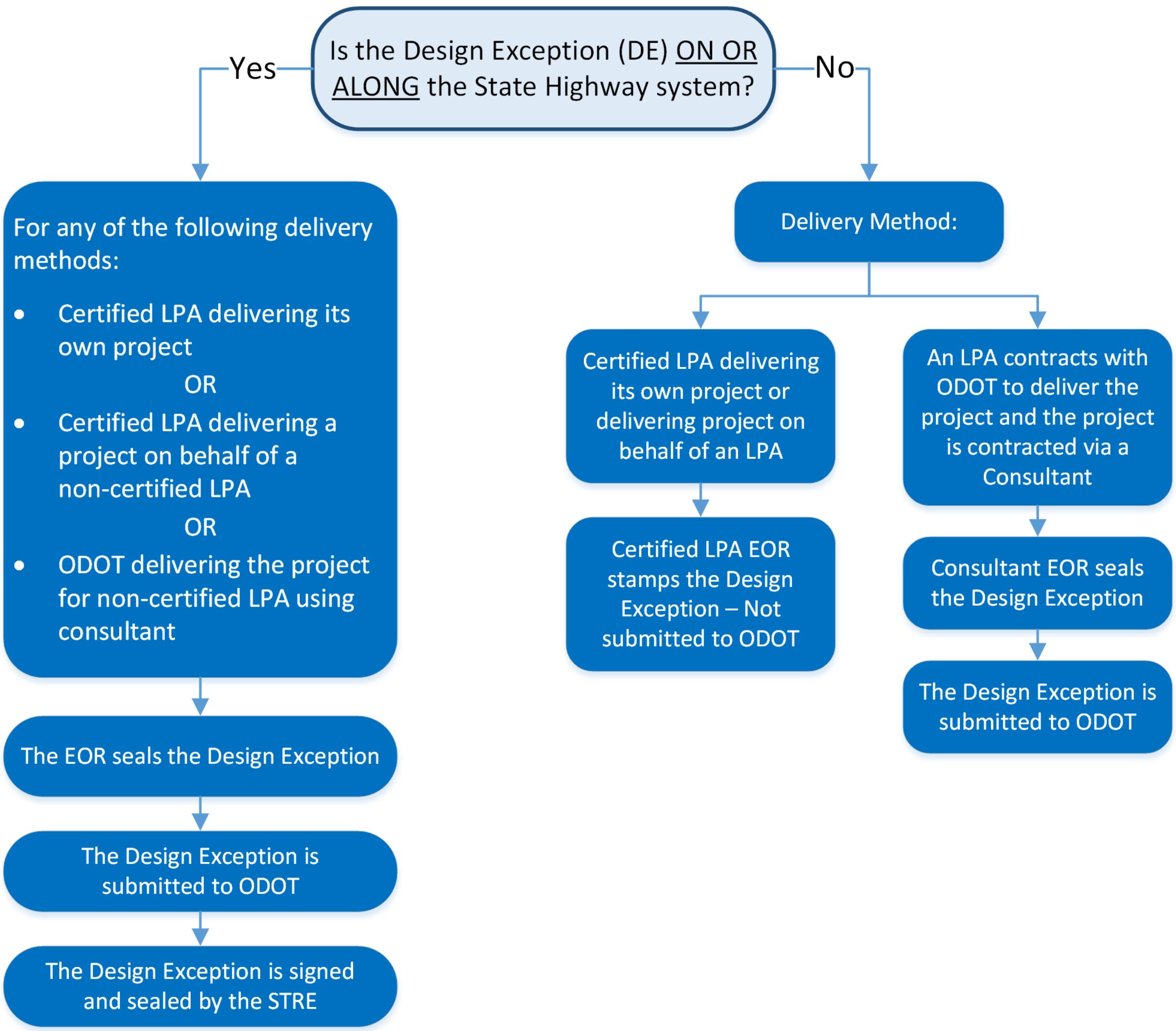
Although the current ODOT General Design Exception form lists ADA Standards as one of design elements that requires a design exception for not meeting current guidance, that form does not have the detail that is needed in the justification of design exceptions for non-compliant curb ramps. The ADA Curb 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.

## 1006.1.1 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, Transportation Project Manager, or Project Leader as appropriate. 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 1000-5: Local Public Agency Project ADA Design Exception Approval Process




# 1006.2 Informational Needs

Design exceptions requests require a sufficient amount of information and design work to justify the 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:

1. Location of the curb ramp based on ODOT's Linear Reference Method and mile point.
2. Project construction information and funding.
3. A diagram of the intersection with curb ramp corner number information.
4. Description of the curb ramp criteria with the specified values planned for design.
5. Description of the project purpose and need from the project business case, and triggering construction work for the curb ramp.
6. Reason for not attaining the standard for each criteria that cannot met and a description of alternatives explored.
7. Effects on other standards related to roadway design or relevant laws.
8. Mitigation incorporated in the design to offset the impact of not obtaining the standard.
9. 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.

## 1006.2.1 Location Information

ODOT 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. Exhibit"A" Curb Ramp Location and Numbering, and Exhibit "B" Curb Ramp Types are located on the web at:

https://www.oregon.gov/odot/About/pages/assetandinspection.aspx

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, in the Appendix 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.

**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 when there are unique milepoints along a highway. The O Code indicated regular mileage. The Z code indicates an overlap in the milepoints. During realignment that lengthens the highway, an overlap in the mile points 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 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.

**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 street 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.

## 1006.2.2 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, 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:

1. why is a project occurring, use information from the business case and project charters
2. whether there are multiple standards or scopes of work on the project ( e.g new signal at intersection but paving only several miles outside of that).
3. whether pavement surfacing is included;
4. what surface treatment is used and what is the length or limits of pavement surfacing work;
5. whether sidewalk is constructed and where;
6. whether traffic signals will replace pushbuttons, walk signals or controllers
7. whether bridge work is maintenance focused or rehabilitation of decking or sidewalk, or includes guardrail replacement.

# 1006.2.3 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.

# 1006.2.4 Description of the 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?)

# 1006.2.5 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 for each curb ramp geometric criteria requested. 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.

# 1006.2.6 Effects on Other Standards

Describe how the design compliance cannot be achieved because of 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. Described design decisions balancing the trade-offs with other engineering standards, best practices or other conflicting interests which are impacted due to achieving an ADA requirement including other technical disciplines (e.g. hydraulics, typical section, bridge rail safety). Describe any feature that would be affected because of compliance with the ADA requirement.

### 1006.2.7 Mitigation Incorporated

Curb ramp design is required to be accessible and usable 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. For example hand railing might be used to offset steep terrain and slopes on the walkway.

### 1006.2.8 Supporting Documents

Include the appropriate Plan Section, Cross Section, Alignment 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 and 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 an 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 Form 734-5184 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. ADA Curb Ramp Design Check List is located on the web at:

https://www.oregon.gov/odot/Forms/Pages/default.aspx

Discussion on each of the design criteria is included in Part 800, Part 900 and the Signal Design Manual. 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.

# 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/Engineering/Pages/Design-Exceptions.aspx

Signatures are obtained by forwarding the document via an automated email generated by the "Submit" button on the form 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, 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** 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://ecmnet.odot.state.or.us/DesignExceptions/Search.

## 1006.5.1 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. 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 ODOT Project Controls Office (PCO).

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

## 1102.3.1 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.

# 1102.3.2 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

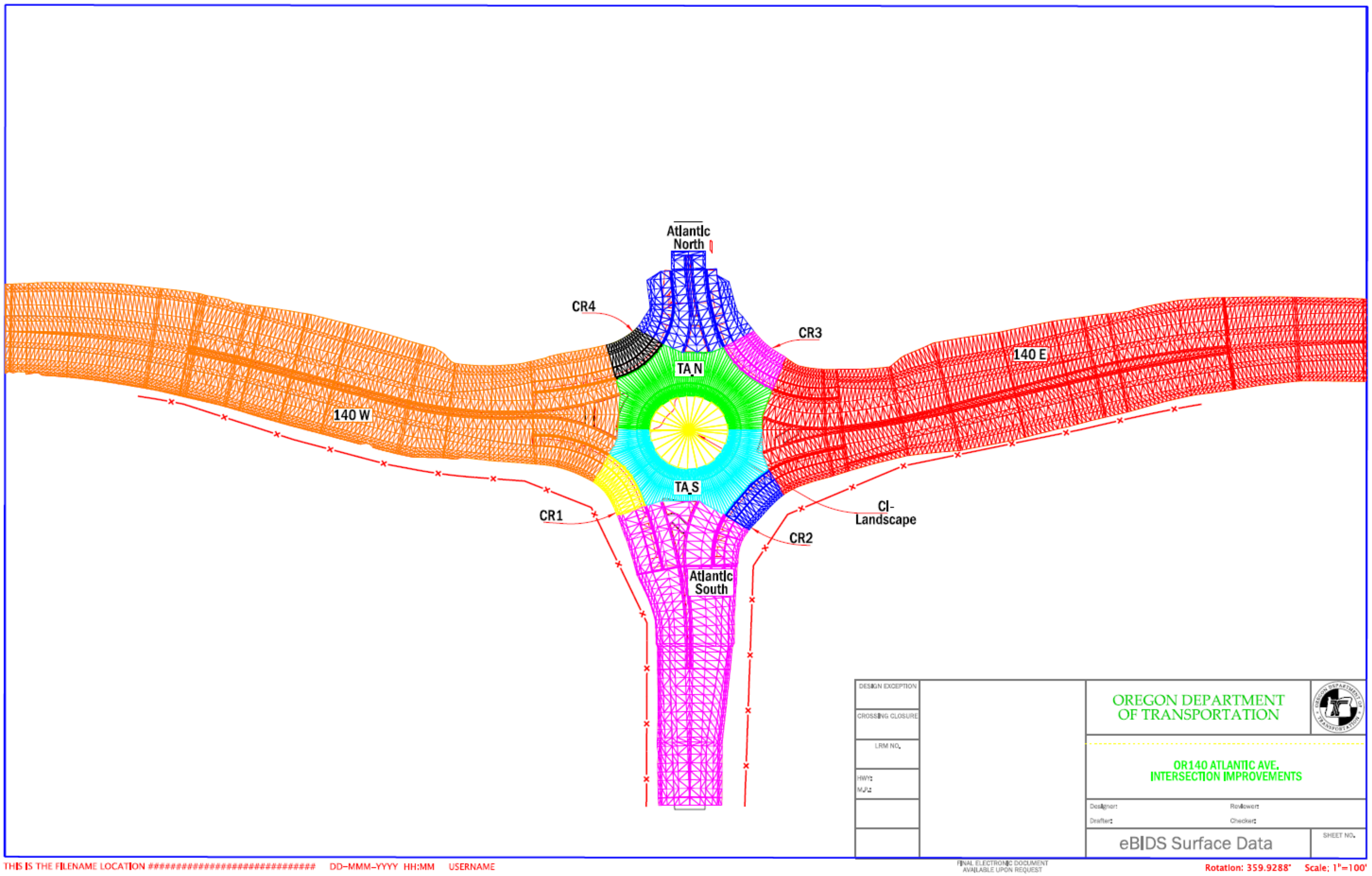
**COMPUTER FILE INDEX - eBIDS Handoff**

| | | | |
|---|---|---|---|
| **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



## 1102.3.3 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.

## 1102.3.4 Original Ground Survey

Survey provides the original ground surface data, which 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. The designer includes the LandXML file(s) in the design package.

# 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. Include a completed copy of the handoff checklist (ODOT Form No. 734-5019) with the data package.

Figure 1100-3: eBIDS Handoff Checklist

Oregon Department of Transportation

**QUALITY CONTROL OF ROADWAY DIGITAL DESIGN**

eBIDS Handoff Checklist*

| 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 | |

# 1102.4.1 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

STATE OF OREGON 1859

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.

# 1102.4.2 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. Provide the alignments in both the LandXML format and a text report. See Figure 1100-5 and Figure 1100-6 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

# 1102.4.3 Surfaces

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. Non-triangulated features and surfaces, other than the top, are helpful but not required.

# 1102.4.4 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:

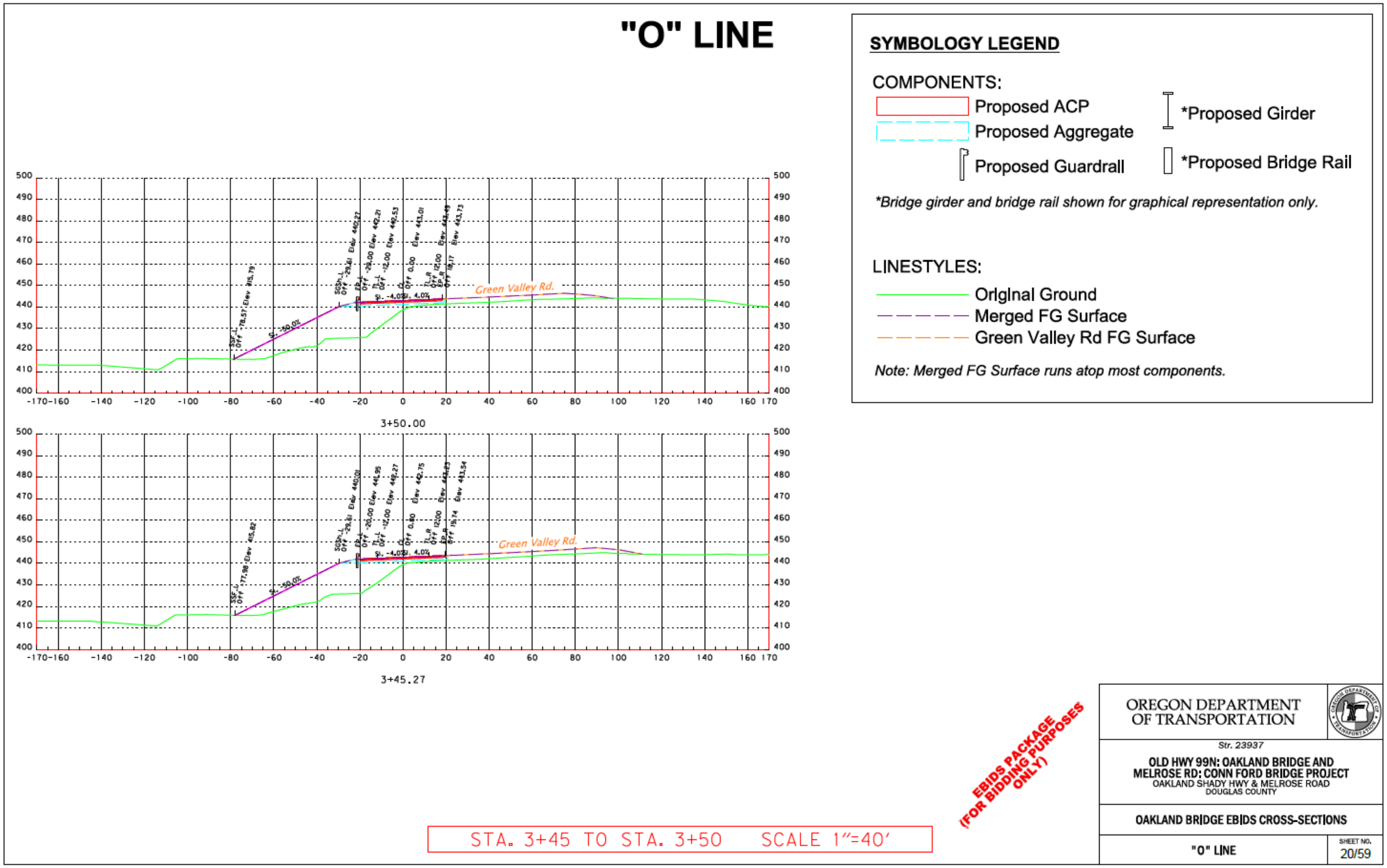
- Typical section changes
- Alignment cardinal points
- Drainage facilities
- Taper start and stop locations
- Guardrail and barrier limits
- Centerline of approaches
- Curb or pavement return points
- Luminaire and signal pole locations

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.

Figure 1100-7: Sample eBIDS Cross-Section



# 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, text files, or PDF 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.

  Coordination with other disciplines may be required and source information should be obtained from the discipline performing the work.

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, the 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:

- Alignments
    - Alignments match plans
    - Stationing matches plans

    - Alignment integrity is suitable
    - Alignment names match the names on plans
    - Only alignments used for final model included; no alternative or early versions
- Surfaces
    - Accurate triangulation
    - Suitable triangle density
    - Abutting finish grade surfaces match
    - Abutting subgrade surfaces match, if applicable
    - Design model surfaces and features tie into original ground
    - Features match plan
    - Component depths match typical section thicknesses
    - Constructability
    - Reasonable transitions between differing slope rates
    - 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
- 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
- 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 grade lines 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

## 1201.4.1 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.

## 1201.4.2 Stream Crossings

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.

Normally, overtopping is not desirable, but may be required to accommodate regulated hydraulic considerations.

Provide the required waterway opening to meet fish passage requirements.

See also Section 1211 Hydraulics.

# 1201.5 Structure Clearances

See Part 300 for additional information on all clearances.

## 1201.5.1 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).

## 1201.5.2 Horizontal Clearances for Highway Traffic

Normally the bridge roadway width will equal the approach roadway width plus 4 feet for bridge rail shy distance.

## 1201.5.3 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.

## 1201.5.4 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.

## 1201.5.5 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. See also Section 1211.

## 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 judgment 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 judgment 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

Due to the variability of soil and rock, the design and construction of embankments and cut slopes require investigation, laboratory testing, and geotechnical analyses. The following is a short list of common geotechnical issues encountered during project delivery. Since every project is unique, the list is not exhaustive, and the GDM must be consulted for all geotechnical design elements.

## 1202.2.1 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.

### 1202.2.2 Designing Inclinations for Cut Slopes and Embankments

Inclinations for cut slopes and embankments under 10 feet in height can be designed by the roadway engineer with an inclination no steeper than 1V:2H. Inclinations outside of this criteria may be recommended by the Geotechnical Engineer. Many projects are space constrained (right-of-way, environmental avoidance, etc.) which require steeper, and/or higher slopes. Early identification and communication of these locations with the geotechnical staff is critical so subsurface investigations, laboratory testing, and analyses can be performed and recommendations can be made for the project design.

### 1202.2.3 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.

### 1202.2.4 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.

# 1202.2.5 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.

Materials used for embankment construction must be available in the required quantity, suitable for the time period when construction is anticipated, and suitable for placement and compaction at the design inclination. Use of on-site “selected” soil varies across the state and not all materials are suitable for winter construction. ODOT material sources should be explored for use, through coordination with the project Engineering Geologist or the ODOT Materials Source Manager.

Stone embankment is frequently used as an “all-weather” material, but it is significantly more expensive than other materials. Consider that if embankment construction work is scheduled to occurs between November and May, the plan details may need to account for use of stone embankment and the project should anticipate higher costs for the materials.

# 1202.2.6 Roadway Widening

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.

For roadway widening projects requiring fill, use DET2101 Sliver Fill Benching Detail, with benching dimension recommended by the geotechnical engineer. The sliver fill is the engineered prism, and any additional soil placed on top of the sliver fill, such as landscaping, must not reduce or change the slope inclination or dimensions. The geotechnical engineer should specify materials for use as fill in widening projects.

## 1202.2.7 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.

## 1202.2.8 Surface and Groundwater Control

Water control is necessary for stable slopes.

## 1202.2.9 Seismic Site Response and Mitigation Design

Consideration will be increasingly given to the seismic stability of embankments and slopes. Coordinate with the geotechnical engineer to determine if seismic analysis is needed on the project.

## 1202.2.10 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.

## 1202.2.11 Pavement Subgrade

The Pavement Unit deals with this issue to determine if wet soils will make pavement construction difficult. When significant quantities of subgrade stabilization are proposed for a project, the roadway designer should coordinate discussions between the Pavement Unit and the geotechnical engineer. The geotechnical engineer may need time to investigate and work with Pavements Unit to establish limits the of stabilization.

# 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

[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.

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 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

4 Technical Leadership Center—where Environmental Technical Specialists and Program Coordinators reside (within the Environmental Section).

5 Project Development Team.

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:

## 1203.3.1 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.

## 1203.3.2 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.

## 1203.3.3 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.

# 1203.3.4 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.

# 1203.3.5 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.

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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.

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 range of flows is found in Geo/Environmental Technical Bulletin 09-02(b) and in the ODOT Hydraulics Manual.

## 1203.3.6 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.

## 1203.3.7 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.

## 1203.3.8 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.

## 1203.3.9 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.

## 1203.3.10 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.

### 1203.3.11 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.

### 1203.3.12 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. The Project Team should hold discussions with the ODOT Commerce and Compliance Division 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
- ODOT Commerce and Compliance 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

The rail crossing order process involves strict procedures and timelines to ensure proper coordination with the affected railroad company and all other interested parties. Obtaining a rail crossing order typically takes 6 to 18 months, depending on the complexity of the proposed work.

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, complete and submit a Railroad-Highway Public Crossing Safety Application (Form 735-9202) to ODOT Commerce and Compliance Division early in the design phase. This application is typically submitted by the project team leader or designer, with assistance from the State Railroad Liaison. See OAR 741-200-0050 for information that must be included in the application. Contact ODOT Commerce and Compliance Division for questions related to the form.

# 1204.4 Railroad Roadway Plan Sheet

ODOT Commerce and Compliance Division requires a separate, sealed railroad roadway plan sheet(s) 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) and 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(s) 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
- Pedestrian and bicycle facility features (See Part 800 Part 900 for addition guidance.)

Send the final signed and stamped railroad roadway plan sheet(s) 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. (See also Part 800, Section 840 and Part 900, Section 921 for pedestrian and bicycle accommodation at rail crossings.)

# 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 in Part 300. 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 ODOT.

# 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.

# 1206.3.1 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.

## 1206.3.2 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 1200-8.
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.

$$\boxed{\textbf{Average Daily Capacity = Ideal Daily Capacity x FS x FT}}$$

- **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 1200-4 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: Reduction Factor for Presence of Trucks (FT)

| 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.

## 1207.10.1 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.

### 1207.10.2 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.

### 1207.10.3 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

## 1208.2.1 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.

## 1208.2.2 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.)

## 1208.2.3 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

## 1208.4.1 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.

### 1208.4.2 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.

### 1208.4.3 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.

### 1208.4.4 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:

# 1209.6.1 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.

# 1209.6.2 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

## 1209.7.1 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.

## 1209.7.2 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.

## 1209.8.1 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.

## 1209.8.2 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.

## 1209.9.1 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

## 1209.10.1 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.

## 1209.10.2 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.

## 1209.10.3 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.

## 1209.10.4 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.

## 1209.10.5 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.

## 1209.10.6 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.

### 1209.10.7 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

Various types of drainage facilities are required 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.

This section of the Highway Design Manual (HDM) provides guidance on hydraulic procedures for most situations encountered in highway design (with references indicating where details can be obtained). Users should always keep in mind the legal and ethical obligations of the facility owner concerning hydraulic issues.

A hydraulic engineer in the Region Technical Center should be contacted for assistance about project-specific drainage issues. The State Hydraulic Engineer and senior hydraulic engineering staff are resources available to assist Region Technical Center hydraulic engineering staff. Please refer to the ODOT Hydraulic Design Manual for more detail on policy and design guidance.

## 1211.2 Hydraulic Engineering Design Risks

One of the first steps in project delivery is the identification and characterization of project elements and the associated disciplines required to evaluate and design the project. When hydraulic engineering is necessary on a project, there are a variety of hydraulic engineering tasks and associated risks that should be evaluated. These risks can be easily mitigated by assigning professionals with the appropriate level of expertise to deliver the hydraulic engineering tasks, eliminating the need to identify these risks in the project risk register.

The following factors must be considered when evaluating the appropriate level of risk associated with project-specific hydraulic engineering features and tasks.

# 1211.2.1 Primary Risk Factors:

1. Safety to travelling public
2. Infrastructure replacement and life cycle cost
3. Environmental and regulatory requirements
4. Potential property damage and other liabilities
5. Design complexity

Site conditions and geography may also be considered. Consulting with a senior hydraulic engineer is recommended to determine the applicable project-specific risk factors.

After the level of risk has been evaluated, the risk is then mitigated by assigning professionals with the appropriate level of expertise to deliver the hydraulic engineering tasks. The five primary risk factors listed above were used to develop the contents of the matrix provided in Table 1200-5. This table should be used as a tool to quickly evaluate the appropriate level of expertise necessary to complete hydraulic engineering project tasks.

This approach replaces the past practice of using pipe diameter to determine the risk threshold.

Table 1200-5: Hydraulic Design Level of Risk

| Hydraulic Engineering Task | Low Risk | Med Risk | High Risk |
|---|---|---|---|
| **CHANNELS** | | | |
| Channel - Roadside or Median drainage and Slope 5% or flatter | X | | |
| Channel - Roadside or Median drainage and Slope steeper than 5% | | X | |
| Channel – Stream Conveyance (All locations) | | | X |
| Channel - All Others | | | X |
| **CULVERTS**[7] | | | |
| Culvert, Non-Cross (public approach crossings, access roads, side drains, etc.) | X | | |
| Culvert, Cross (State Highway) - Roadside or Median drainage only | X | | |
| Culvert, Stream Conveyance (All locations) | | | X |
| Culvert extensions | | X | |
| Culvert, Cross (State Highway) – All Others | | | X |
| **STORMWATER**[7] | | | |
| Inlet Capacity, Spacing, and Location | X | | |
| Pavement / Pedestrian Facility Drainage | X | | |
| New storm drain systems with 5 or less catch basins/manholes that do not discharge into a treatment or flow control facility | X | | |
| New storm drain systems with 6 to 10catch basins/manholes that do not discharge into a treatment or flow control facility | | X | |
| New storm drain systems with more than 10 catch basins/manholes that do not discharge into a treatment or flow control facility | | | X |
| Modification of existing inlets or storm drain piping system without collecting additional contributing area | X | | |
| Modification of existing inlets or storm drain piping system that collects additional contributing area | | X | |
| Storm drain systems with stream conveyance | | | X |
| Storm drain systems that discharge into a treatment or flow control facility | | X | |

[7] Pipe materials and outlet protection are considered an element of the primary Hydraulic Engineering Task.

Table 1200-5: (Continued) Hydraulic Design Level of Risk

| Hydraulic Engineering Task | Low Risk | Med Risk | High Risk |
|---|---|---|---|
| **STORMWATER (Cont'd)** | | | |
| Modification or removal of any existing treatment or flow control facility | | X | |
| Offsite Drainage Contribution | | X | |
| Combined flows from multiple jurisdictions | | | X |
| Flow control and associated features (detention, gates, valves, weirs, etc.) | | | X |
| Stormwater Treatment | | | X |
| Infiltration Facilities | | X | |
| Underground Injection Control Systems (UICs) | | | X |
| Stormwater Temporary Water Management | | X | |
| **OTHER** | | | |
| Bank Protection (Rivers, Natural Channels) | | | X |
| Bridge Hydraulics / Scour Analysis /Abutment Protection | | | X |
| Scour Mitigation Plan of Action | | X | |
| Downstream impacts and hydraulic connectivity zones | | | X |
| Facility Markers | X | | |
| Fish Passage (All Locations) | | | X |
| Floodplains / Floodways | | | X |
| Minor structures (headwalls, wingwalls, vaults, special manholes, cutoff walls, etc.) | | | X[8] |
| Pump Station | | | X |
| Siphon | | | X |
| Temporary Water Management | | | X |
| Tide Gates | | | X |
| Trenchless Pipe Rehabilitation | | | X |
| Trenchless Pipe Replacement | | | X[9] |
| Waterway Enhancement | | | X |
| Anything not in the Hydraulic Design Manual | | | X |

[8] Collaboration with a structural engineer may be required

[9] Collaboration with a geotechnical engineer is required

Table 1200-6: Professional Expertise Requirements

| Risk Level | Design | Quality Control |
|---|---|---|
| Low | Professional Engineer | Professional Engineer |
| Medium | Professional Engineer | Hydraulic Engineer |
| High | Hydraulic Engineer | Hydraulic Engineer |

**Professional Engineer:** a licensed engineer as described in ORS 672 and OAR 820 and regulated by the Oregon State Board of Examiners for Engineers and Land Surveyors.

**ODOT Hydraulic Engineer:** a professional engineer who specializes in the hydraulic components related to the repair and replacement of bridges, culverts, and roadway embankments. These projects occur in the river environment and adjacent to other large bodies of water such as lakes and coastal environments. These professionals also work with stormwater and help design projects that are related to the movement, control, and treatment of water. Hydraulic engineers must have a strong understanding of hydrology and fluid mechanics relating to the design and protection of the transportation system.

ODOT Hydraulic engineers also assist with water resources, flood control planning, and adhere to federal, state, and local environmental regulations and standards. They must have a strong understanding of how Oregon drainage law has been established by case history. They also create designs for flood control and waterway enhancement, and communicate with governing bodies to address their concerns about stormwater, stream stability, and scour. Hydraulic Engineering falls under the broader career category of the Civil Engineering branch of Professional Engineering. Several indications that a Civil Engineer may have expertise in hydraulic engineering include:

- Work environment (team members primarily design hydraulic features or conduct hydraulic studies)
- Mentorship received from a senior hydraulic engineer
- Number and complexity of hydraulic engineering designs completed
- Number and quality of hydraulic engineering training classes completed
- Working Title (ODOT Only) of "Hydraulic Designer/Engineer"

# 1211.3 Policy

General policies pertaining to hydraulic and drainage design are governed by several factors discussed in this section. The ODOT Hydraulic Design Manual is the primary document that provides the guidelines and state-specific policies and procedures for the design of highway hydraulic facilities within ODOT right-of-way. The ODOT Hydraulic Design 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. All engineering designs must comply with the Oregon Drainage Law, Federal Clean Water Act, Endangered Species Act, applicable state and local jurisdiction regulations, and other applicable environmental regulations.

A hydraulic and/or a stormwater report is also required to document engineering of Medium and High risk hydraulic and stormwater features as outlined in Table 1200-5. These reports are prepared by the project professional of record. See Section 1211.4 and the ODOT Hydraulic Design Manual documentation chapter for documentation guidelines.

## 1211.3.1 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. 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.

# 1211.3.2 Design Deviations

Deviations from standards in the ODOT Hydraulic Design Manual require justification and approval by the State Hydraulic Engineer. Requests for a hydraulic design deviation are prepared by the project professional of record and submitted to the Region Technical Center for initial review.

If a proposed hydraulic design cannot meet requirements as defined in the ODOT Hydraulic Design Manual, then a design deviation will be required. A few common items that would require a design deviation include:

1. Design Flood Interval Period (ODOT Hydraulic Design Manual Policy Chapter)
2. Design Spread (ODOT Hydraulic Design Manual Storm Drainage Chapter)
3. Culvert Allowable Headwater (ODOT Hydraulic Design Manual Culverts Chapter)

See ODOT Hydraulic Design Manual, Policy Chapter for the hydraulic design deviation process and Appendix A for the deviation request form.

### 1211.3.3 Cooperative Projects

Participation in cooperative projects for flood control, flood protection mitigation, or stormwater control facilities must be approved by the Regional Technical Center with the extent of participation being restricted to the amount of benefit accruing to ODOT. 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 will 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 local agency projects.

## 1211.4 Documentation

Hydraulic and Stormwater reports are essential to document engineering recommendations for projects and to provide information required for planning, environmental, the subsequent design phase, and quality control. These reports are intended to serve as a complete documented record containing the engineering justification for all drainage and stormwater installations and modifications that occur as a result of the project. See the ODOT Hydraulic Design Manual and the Hydraulic Engineering Quality Control/Quality Assurance Work Plan for more guidance on documentation.

### 1211.4.1 Hydraulic Report

Design of channels, culverts, and other hydraulic elements that are considered a high risk must be documented in a hydraulic report. These types of projects include complex hydraulic design, potential of property damage, and regulatory requirements such as FEMA floodplain permits or required fish passage conditions.

The hydraulic report is prepared by the project hydraulic engineer. This is the final report that provides detailed information for many tasks, such as structure design, roadway design, environmental documents, and permit applications. A hydraulic report is required for risk levels of medium and high for the Other, Culvert, and Channel sections in Table 1200-5. For more detailed information on the hydraulic report or additional reports, see the ODOT Hydraulic Design Manual documentation chapter.

## 1211.4.2 Stormwater Report

The ODOT Hydraulic Design Manual documentation chapter 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. The design information also may be part of the work done by the roadway designer if the drainage and roadway designs are done concurrently.

A drainage plan with design calculations and documentation is part of the design data that must be prepared on all projects. The drainage plan must address the location, size, and alignment of inlets, storm drains, small culverts, utilities, pipe materials, outlet protection for pipes, roadside ditches, and cutoff ditches. The drainage plan must be reviewed by another professional engineer, or the project hydraulic engineer as outlined in Table 1200-5 and Table 1200-7, prior to finalizing the drainage plan.

A stormwater report is required to document High risk storm drain, water quality and flow control facilities as detailed in Table 1200-5. The documentation for these projects is greater than the standard stormwater design documentation. These reports are prepared by the project professional of record. See the ODOT Hydraulic Design Manual documentation chapter for documentation guidelines. The facility design(s) incorporated in the final plans should comply with the information in the stormwater report.

## 1211.4.3 Stormwater Operational & Maintenance Manuals

ODOT requires preparing an Operation and Maintenance (O&M) manual for every stormwater control facility during the project development stage. An O&M manual describes the type of facility and how it operates, includes the drainage facility identification number (DFI number), outlines an inspection schedule, and summarizes maintenance actions for the facility. The purpose of O&M manuals is to support maintenance, protect water quality, and ensure compliance with permit requirements. Refer to Technical Bulletins GE16-01(B), GE16-02(B), and the Documentation Chapter of the ODOT Hydraulic Design Manual for guidance on the O&M manual process.

# 1211.5 Design Features

## 1211.5.1 Drainage Facility Identification

ODOT owns, operates, and maintains stormwater control facilities, underground injection control systems, and culverts across the state of Oregon. Assigning a DFI number and placing field markers assists in the accurate identification of facilities and supports data collection for asset management purposes. DFI numbers are asset numbers used to uniquely identify culverts and stormwater control facilities within ODOT's highway system. DFIs and field markers are required for all culverts and stormwater control facilities. For more information on DFIs, guidelines on field markers, and the DFI number request process, refer to the Field Marker Chapter in the ODOT Hydraulic Design Manual.

## 1211.5.2 Floodplains

The National Flood Insurance Program has established floodways and floodplains 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. Federal Emergency Management Agency (FEMA) regulations require the areas within the regulated floodway to be kept free of encroachment in order for the 100-year flood to be carried without substantial increases in flood stage or elevation. Minimum standards of FEMA limit such increases in flood stage within the floodway to no more than 1 foot, provided hazardous velocities do not result. In several jurisdictions in Oregon, community officials have adopted a floodway or floodplain that allows less than a one foot rise or, in some instances, a no rise of water elevations.

Highways adjacent to or crossing floodplains should be designed to maintain the existing water elevations and velocities for the 100-year flood event, if practicable. Floodplain boundaries can be determined by consulting the appropriate Flood Insurance Study or the project hydraulic engineer. The project hydraulic engineer should be contacted for assistance as soon as it has been determined that a floodplain or floodway exists within the project limits, and before any work in the floodway or floodplain is considered.

In some cases, constructing a project without modifying the existing floodway boundary may not be practicable. 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 hydraulic 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 Hydraulic Design Manual Legal Aspects and Bridges Chapters.

## 1211.5.3 Bridge Hydraulics

Design elements, including the roadway horizontal and vertical alignment relative to the water crossing (skew of the bridge), floodplain, channel geometry, aggradation and degradation, channel migration, and sediment and debris transport, are some of the important considerations in bridge hydraulic design. The project hydraulic engineer provides the hydraulic engineering analysis for bridge replacements over waterways. Information and design guidance on bridge hydraulics can be found in the ODOT Hydraulic Design Manual Bridges Chapter.

## 1211.5.4 Scour Protection

Scour can occur around bridges and along roadway embankments in the river environment, coastal areas, adjacent to large bodies of water, such as lakes, and can lead to catastrophic failure of structures, embankments, and roadbeds. When scour becomes critical, designing mitigation measures becomes necessary to correct the eroded areas and provide protection from future scour. The project hydraulic engineer prepares and/or reviews all proposed solutions for scour mitigation. Information on scour and bank protection can be found in the ODOT Hydraulic Design Manual Bridges Chapter and Bank Protection Chapter.

## 1211.5.5 Channels

### 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 designing 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. Project teams should also evaluate and consider existing ditches within the project limits during scoping for opportunities to modify or retrofit ditches to provide water quality benefits to nearby surface water bodies.

The peak discharge, longitudinal slope, and ground cover affect the ditch capacity. Ditches on steep slopes, as outlined in Table 1200-5, are of higher risk due to increased shear stresses on the ditch bottom and should be evaluated to assure the ditch does not erode. The discharge contributing to ditches from areas within the right-of-way is often small compared to runoff from outside the right-of-way. Evaluate each ditch for significant flows from off-site contributing areas. The standard 6-inch deep ditch should be used on all projects unless the calculated peak flows indicate insufficient capacity or instability.

Shear stresses may 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 Hydraulic Design Manual Channels Chapter.

### 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 slope rounding meets original ground slope (see Section 323 Rounding Cutbanks).

## 1211.5.6 Roadway Drainage

Roadway drainage systems typically include curbs, gutters, inlets, manholes, ditches, and a network of storm drain pipes that convey surface runoff collected by the system to an outlet location. The system should adequately drain the roadway runoff to the discharge point without surcharging inlets and minimize the potential for surface flooding and erosion of properties adjacent to the right-of-way.

### Inlets

Storm drain inlets are used to collect surface runoff and discharge the flow to an underground storm drainage system. Inlets are typically located in gutter sections, paved medians, roadside ditches, and median channels. Each inlet should be checked for efficiency, flow capacity, and spacing (on continuous grades and at sag locations). Inlets used for the drainage of highway surfaces can be divided into six classes:

1. Grate inlets
2. Curb-opening inlets
3. Slotted drain inlets
4. Combination inlets
5. Trench drain inlets
6. Bridge deck drains

Inlet design considerations include, but are not limited to, the location of the inlet (on-grade vs. sag), selecting the storm event, limiting the allowable spread (extent of water on the road surface), inlet and grate type, inlet clogging factors (to account for debris), and compatibility with pedestrian/ADA/bicycle facilities. For bridge deck drain applications, the design is complicated by the structural and architectural requirements of bridges and coordination with the bridge designer is critical. Information on inlet selection and design is provided in the ODOT Hydraulic Design Manual Storm Drainage Chapter.

### Storm Drains

Storm drain pipes are used to convey water from inlets to a desired outlet location such as a channel, waterbody, or other pipe system. Storm drain systems should be designed to protect the highway from flooding at the appropriate recurrence interval (design event). Each storm drain 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 professional of record. For more complex storm drain systems, the design is performed by the project hydraulic engineer. The drainage plan must be reviewed by another roadway designer or the project hydraulic engineer prior to finalizing the drainage plan. The professional expertise requirements and levels of risks associated with storm drain system designs are outlined in Table 1200-5 and Table 1200-7. Storm drain design guidance and documentation requirements are provided in the ODOT Hydraulic Design Manual Storm Drainage Chapter and Documentation Chapter.

## 1211.5.7 Culverts

All culverts should be evaluated for capacity, allowable headwater, outlet velocities, and protection. An existing culvert should not be extended, replaced, or undergo rehabilitation without first conducting a thorough evaluation of the pipe’s existing capacity and structural integrity. Whenever possible, culvert extensions shall be designed using the same pipe material and size, and match the existing slope. Pipe rehabilitation or replacement may be required if the culvert has exceeded the service life.

The project hydraulic engineer provides the engineering analysis for all culvert design with a level of risk of High as outlined in Table 1200-5. FHWA’s HY-8 software is the approved application for performing hydraulic culvert analysis. For all hand calculations, refer to HDS-5 for calculation forms, charts, and nomographs for culvert design.

Refer to the culvert and pipe rehabilitation chapters in the ODOT Hydraulic Design Manual for design policy and procedures.

# 1211.5.8 Fish and Wildlife Passage

Check with the ODOT Region Environmental Coordinator to determine if fish or wildlife passage will be required at all proposed highway-stream crossing projects, regardless of stream or drainage size. If fish or wildlife passage is required, the project hydraulic engineer will provide the engineering analysis as outlined in Table 1200-5.

# 1211.5.9 Pipe Materials

Concrete, metal, and thermoplastic pipe are available for use on projects. The site conditions and design criteria will determine which materials are viable options. Selecting the appropriate type of pipe material for a project is dependent on several factors including: size and strength, fill height, service life, corrosion and abrasion potential, and debris. Alternate materials must satisfy the requirements in the preceding list. The use of metal and concrete pipes is an excellent structural and longevity choice if care is taken regarding the pipe bedding and pipe zone backfill material. In situ soil, pipe zone backfill, and water samples must be taken at each site to measure soil and water pH and resistivity. Lack of design consideration in the determination of gauge size and/or coating of metal pipe can ultimately result in failure of the roadway. Refer to the Pipe Material chapter in the ODOT Hydraulic Design Manual for design policy and procedures to extend pipe service life, and Chapter 3 of the Geotechnical Design Manual, Section 3.5.5.5, for guidance on sampling.

Thermoplastic pipe is an excellent economical alternate material. Corrugated High Density Polyethylene (HDPE) is ideal for median drains, roadway approach culverts, and systems adjacent to the highway. Corrugated HDPE is not recommended for cross culverts under the highway system due to a thin wall profile, lack of strength, and the propensity to have misalignment of joints. Solid wall HDPE has a thicker wall profile and is a great option for cross culverts under the highway. The solid wall HDPE is joined by a fusion process which eliminates joint issues. However, care must be taken during pipe bedding and compaction to eliminate pipe sag.

Care must be given to the end treatment(s) used in culvert applications. Sloped ends of all HDPE pipe require additional end treatments to prevent the folding up of end sections during normal and high 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. Solutions to this problem are to use a paved end slope for smaller pipes or a reinforced concrete collar for larger pipes. Refer to the Culvert Chapter in the ODOT Hydraulic Design Manual for more information on end treatments.

# 1211.5.10 Stormwater Control Facilities

## Water Quality Treatment

Projects that trigger stormwater management mitigation for water quality are required to provide treatment of the stormwater runoff from the project's contributing impervious area (CIA). Stormwater water quality triggers (including exemption activities) and the CIA definition are detailed in the Water Quality Chapter of the ODOT Hydraulic Design Manual. The delineation of the CIA may be done by the project hydraulic engineer or water quality specialist. This information is used to determine the extent of the treatment area, to design/size treatment facilities, and support permitting and environmental documents. Various local jurisdictions have special requirements that must also be addressed.

Water Quality Best Management Practices (BMPs), including engineered treatment facilities and non-engineered techniques, can be used to provide water quality mitigation for the project. The stormwater designer should evaluate treatment approaches and techniques in the following order:

1. Use of the adjacent unaltered right-of-way as a treatment area
2. Modification of the right-of-way (slopes, soils and/or vegetation) to provide treatment
3. Use of small, distributed treatment facilities along the length of the project
4. Use of large, consolidated treatment facilities
5. Off-site project mitigation

All water quality facilities must be reviewed or designed by the project hydraulic engineer. Refer to PDLT Notice 05 (PD-05), the Water Resources Specialist Manual, and the Water Quality Chapter of the ODOT Hydraulic Design Manual for project requirements and design guidance.

## Flow Control

Detention or flow control 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. ODOT's goal is to reduce runoff generated from transportation-related projects first before using engineered stormwater facilities to meet water quantity standards. All flow control facilities must be reviewed or designed by the project hydraulic engineer. Refer to the Storage Facilities Chapter of the ODOT Hydraulic Design Manual for project requirements, including actions that trigger the need for flow control mitigation, and design guidance.

## Underground Injection Control Systems (UICs)

Underground injection control systems (UICs) are a stormwater management tool that can be installed and used within the limits prescribed by ODOT's UIC Permit. A UIC is a system, structure, or activity that is created to place fluid below the ground or subsurface. Dry wells and systems that use perforated pipes to infiltrate stormwater into the subsurface are considered UICs. Other common stormwater UICs include, but are not limited to sumps, infiltration galleries (i.e. infiltration trenches with underdrain pipes), trench drains, and drill holes. Design of UICs requires determining the soil infiltration rates and ground water levels at the facility site. Techniques for establishing soil infiltration rates, including laboratory, field-testing, and groundwater monitoring methods, are provided in the Geotechnical Design Manual. Refer to Technical Bulletin GE07-03(B) and the Water Quality Chapter of the ODOT Hydraulic Design Manual for guidance on UIC requirements.

## Facility Maintenance Considerations

All stormwater control facility designs must include recommendations for appropriate preventative maintenance to ensure the facility operates properly. Project stormwater control facility designs must include features that will minimize and facilitate maintenance operations. Stormwater control facilities that require extensive or specialized maintenance activities or equipment are discouraged. The responsible Maintenance District should be consulted early and throughout the design process to obtain maintenance review and concurrence. Include documentation from maintenance in the project stormwater report.

## Cost Considerations

The construction and maintenance costs for different stormwater mitigation options vary. The project hydraulic engineer must ensure maintenance is a consideration in design and in determination of long-term operation and maintenance costs. The goal is to select a stormwater control facility that minimizes lifecycle costs while achieving regulatory stormwater requirements, overcoming site constraints, and ensuring public safety. Cost-effective stormwater control facilities should be selected based on lowest overall costs, including maintenance, construction costs, and right-of-way costs for the life of the facility.

## Geotechnical Investigation for Stormwater Facility Design

Stormwater control facility design includes understanding the soils, geology, geologic hazards, and groundwater conditions at the project site. This typically involves conducting a geotechnical investigation to evaluate the site's suitability for infiltration, to establish the infiltration rate for design, to evaluate slope stability, and obtain other geotechnical design information needed to design and assess the constructability of the facility. Project engineering geology staff should be consulted as early as possible in the scoping phase to identify the adequacy and available geotechnical data/information in support of stormwater and drainage facilities. Project engineering geology staff will need to include stormwater facility investigation in their project SOW when existing data is insufficient. Guidance on geotechnical investigation can be found in the Geotechnical Design Manual and in the ODOT Hydraulic Design Manual Water Quality Chapter and Storage Facilities Chapter.

### 1211.5.11 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 riprap 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 should be designed by the appropriate level of expertise as outlined in Table 1200-5 and in accordance with the ODOT Hydraulic Design Manual.

# 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. For preservation projects, contact pavement services so that they can schedule testing, complete testing, and complete Preliminary Design work prior to formal project kick off.

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. For pavement preservation projects, the Pavement Designer needs to validate final scope through testing and analysis prior to formal project kick off. Any changes in the project scope could require additional fieldwork 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 (see Section 7.1 of 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

## 1213.2.1 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

# 1213.4.1 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.

### 1213.4.2 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 regulatory 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 1200-7: 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 |
| 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* |
| 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 |

* For Commercial and other Contractor Option sites, the permit is obtained by the Contractor, Site Operator, or Landowner.

Table 1200-8 (Continued): List of Permits and he Units Responsible

| Permit | Issuing Agency | Responsible Party |
|---|---|---|
| Section 404 of Clean- Water Act Permits | U.S. Army Corps of Engineers | Environmental Permits Coordinator |
| Water Well | Oregon Water Resources Department | Operations (Building Manager) |
| Construction Permit | Property Owner | Right of Way |
| Environmental Documents | | Environmental Services |
| Wetlands Report | See Note | See Note |
| Cultural Resources Report | See Note | See Note |
| DEQ Indirect Source Permit | See Note | See Note |
| Noise Study Report | See Note | 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

## 1215.2.1 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.

# 1215.2.2 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.

# 1215.2.3 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.

# 1215.2.4 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.

## 1215.2.5 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.

## 1215.2.6 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)

# 1215.2.7 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.

# 1215.2.8 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, against which other deliverables are measured. 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

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

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 ODOT CAD Manual (OCM). Following the methods shown will assist both drafters and designers in keeping a more consistent look and feel to the ODOT plans. The ODOT CAD Manual (OCM) 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 ODOT CAD Manual (OCM). 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 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 BA01.

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 ODOT CAD Manual (OCM). 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.

# 1302.6 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.

# 1302.7 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.

# 1302.8 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.

# 1302.9 Plans, Construction Notes, and Profiles

## 1302.9.1 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.

## 1302.9.2 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.

Round quantities of surfacing, earthwork, and watering materials using Table 1300-1.

Table 1300-1: Quantity Rounding

| 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 greater | 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 (OCM). 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 ODOT CAD Manual (OCM).

# 1302.9.3 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.

## 1302.9.4 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.

## 1302.9.5 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.

## 1302.9.6 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.

## 1302.9.7 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.

## 1302.9.8 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.

### 1302.9.9 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.

## 1302.10 Specifications

### 1302.10.1 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.

### 1302.10.2 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 00100 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 typically used for the construction of buildings.

### 1302.10.3 Project Special Provisions

Every project has unique circumstances, so the 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. Edits not allowed by the instructions in the boilerplate 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.

### 1302.10.4 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.

## 1302.11 Final Estimate

### 1302.11.1 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 project charter. It is usually the amount shown in the Statewide Transportation Improvement Program (STIP). 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.

# 1302.11.2 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 PCO 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.

# 1302.12 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 |

| HWY # | HIGHWAY NAME |
|---|---|
| 255 | CARPENTERVILLE |
| 068 | CASCADE HWY NORTH |
| 160 | CASCADE HWY SOUTH |
| 301 | CELILO-WASCO |
| 487 | CELILO-WASCO SPUR |
| 007 | CENTRAL OREGON |
| 372 | CENTURY DRIVE |
| 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 |

| HWY # | HIGHWAY NAME |
|---|---|
| 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 |
| 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 |

| HWY # | HIGHWAY NAME |
|---|---|
| 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 |

| HWY # | HIGHWAY NAME |
|---|---|
| 026 | MT. HOOD |
| 046 | NECANICUM |
| 102 | NEHALEM |
| 131 | NETARTS |
| 162 | NORTH SANTIAM |
| 138 | NORTH UMPQUA |
| 123 | NORTHEAST PORTLAND |
| 370 | O NEIL |
| 041 | OCHOCO |
| 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 |

| HWY # | HIGHWAY NAME |
|---|---|
| 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 |
| 390 | SERVICE CREEK-MITCHELL |
| 291 | SHANIKO-FOSSIL |
| 290 | SHERARS BRIDGE |
| 042 | SHERMAN |
| 181 | SILETZ |

| HWY # | HIGHWAY NAME |
|---|---|
| 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 |

| HWY # | HIGHWAY NAME |
|---|---|
| 010 | WALLOWA LAKE |
| 044 | WAPINITIA |
| 053 | WARM SPRINGS |
| 431 | WARNER |
| 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 |

# 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 21 | | 13.66 | 57.48 | No | 06-Rural Minor Arterial |
| 21 | | 57.48 | 57.93 | No | 16-Urban Minor Arterial |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 140 | | 40.46 | 49.05 | No | 06-Rural Minor Arterial |
| 140 | | 49.05 | 50.72 | No | 14-Urban Principal Arterial-Other |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 281 | | 1.18 | 5.09 | No | 06-Rural Minor Arterial |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Hwy # | HIGHWAY NAME | Beg MP | End MP | NHS | Functional Classification |
|---|---|---|---|---|---|
| 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

## Oregon Highway Plan 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
> Salem OR 97301-2530
>
> 503-378-5849.

# 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] |
| 002 | CW | Wyeth Rd. | 47.89 | Frontage Rd. | | | 47.98 | Wyeth Rd. | Historic Columbia River Gorge Bike Route |

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 | 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 |

| 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 | 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 |
| 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 |

| DESIGNATED BIKEWAYS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Highway | | Route | Begin MP | Begin St. | Xing MP | Xing St. | End MP | End St. | Designated Bikeway |
| ID | Suffix | Name | | | | | | | |
| 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 |
| 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 |

| DESIGNATED BIKEWAYS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Highway | | Route | Begin MP | Begin St. | Xing MP | Xing St. | End MP | End St. | Designated Bikeway |
| ID | Suffix | Name | | | | | | | |
| 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 |
| 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 |

| DESIGNATED BIKEWAYS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Highway | | Route | Begin MP | Begin St. | Xing MP | Xing St. | End MP | End St. | Designated Bikeway |
| ID | Suffix | Name | | | | | | | |
| 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 |
| 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 |

| DESIGNATED BIKEWAYS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Highway | | Route | Begin MP | Begin St. | Xing MP | Xing St. | End MP | End St. | Designated Bikeway |
| ID | Suffix | Name | | | | | | | |
| 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 G

## ODOT ADA Curb Ramp Process

## Project Requirements

## July 2022

OREGON DEPARTMENT OF TRANSPORTATION

# ODOT ADA Curb Ramp Process

## Project Requirements

July 2022

This document comprises ODOT project requirements based on the Federal Americans with Disabilities Act (ADA). It applies to projects that receive State or Federal funds or for projects on or along the State Highway. It is intended to provide guidance for addressing pedestrian accessibility requirements during the development of project bid packages. This package includes a checklist and detailed instructions with links to useful resources and contacts. It is intended for use by local agencies that have not received LPA ADA Certification, Consultants and ODOT staff.

## CONTENTS

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 following is intended to help guide your agency or project team through the requirement process and expectations set by the Oregon Department of Transportation (ODOT) as an obligation to receive such funds. The following document provides milestones, detailed instructions, and a checklist to assist you in meeting the requirements of your project.

This ADA Curb Ramp Process is based on 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.

Critical Project Curb Ramp Milestones

**Scoping**
- ✓ Verify scope of ADA obligations based on project type and work
- ✓ Conduct site visit to assess curb ramps and other pedestrian facilities
- ✓ Obtain curb ramp condition data
- ✓ Request additional survey data at intersections
- ✓ Begin preliminary curb ramp design

**Design Acceptance Package/Design Verification Package**
- ✓ Draft Curb Ramp Detail Sheets
- ✓ Utilize Curb Ramp Check List to assess design criteria
- ✓ Begin draft Design Exception Request process, if applicable
- ✓ Begin Crosswalk Closure Request process, if applicable
- ✓ Begin draft for Temporary Pedestrian Accessible Route (TPAR) as part of TCP
- ✓ Begin ROW and Easement requests if needed

**Advance/90% Plans**
- ✓ Complete Curb Ramp Detail Sheets
- ✓ Complete TPAR in TCP
- ✓ Final submittal of Design Exceptions with signatures, if applicable
- ✓ Obtain Final Crosswalk Closure Approvals, if applicable
- ✓ Finalize ROW and Easement Approvals if needed
- ✓ Complete Construction Specifications for final review

**PS & E/ Final Plans**
- ✓ Approved Design Exceptions, if applicable
- ✓ Final Curb Ramp Detail Sheets with DE approval numbers
- ✓ Crosswalk Closure Approval letters, if applicable
- ✓ Final Construction Specifications
- ✓ Final TPAR

**Pre-Closeout, 2nd Note**
- ✓ Conduct Curb Ramp Inspection with certified inspector
- ✓ Submit completed passing Curb Ramp Inspection Forms to:
  - ✓ 1) Email link on the ODOT Curb Ramp Inventory Form
  - ✓ 2) State's Project Manager

# 1. Scoping

## 1.1 Curb Ramp Evaluation in Project Scoping

When scoping projects, pedestrian curb ramp evaluation is required on new construction, full rebuild and alterations to existing facilities. The term "on or along the State Highway" refers to public sidewalk and accessible route features 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 accessible route feature resides. Project teams that scope new construction projects should be aware of the applicable ODOT ADA curb ramp standards and consider them in early phases of design to ensure the footprint of the project is adequate to provide the required accessibility features. Scoping requirements for right of way are outlined in the Technical Service Directive 18-03(D).

### 1.1.1 New Construction and Full Rebuild Projects

When scoping new construction and full rebuild projects, projects must comply with current ODOT ADA Standards and ODOT policies. In addition to the TSB 18-03(D) right of way scoping directive, the ODOT ADA Transition Plan should also be reviewed for accessible feature priorities that have been established and is to be used to evaluate the need for improvements included in the project scope of work. Contact the region's liaison for existing or outstanding ADA Concern, Questions, Comment, and Request's (CQCR) that could be considered for inclusion with the project scope of work to remedy the concern or request.

All pedestrian facilities are required to be ADA compliant and are to be fully accessible with new construction. New construction projects are those improvements that construct pedestrian facilities where no previous public right of way existed (i.e. virgin horizontal alignments and 4R projects). Fully rebuilt projects have already established an existing public right of way and are considered alterations to the facility. Alterations on existing facilities must be accessible to the maximum extent feasible (see section 2.1.2). A list of applicable ODOT documents is listed in Section 6, but may not be comprehensive as new policies or guidance is developed. For the most current information refer to the ODOT Engineering for Accessibility website.

### 1.1.2 Construction Work on Existing Facilities

When working on existing facilities it must be determined if the work is an alteration or maintenance activity. Alterations are projects with changes to an existing facility that affects or could affect the usability of the facility and are therefore projects that are required to construct or upgrade any missing or non-compliant curb ramps. Alterations such as resurfacing, signal work and sidewalk work are project activities that could trigger curb ramp evaluation. Regular maintenance is not considered an alteration; ODOT has published two Maintenance Operational Notices that provide the distinction between maintenance and alteration work for paving and signal work on or along the highway: MG100-107 and MG144-03. For the most current information refer to the ODOT Engineering for Accessibility website.

ODOT Highway Division Maintenance Operation Notice MG100-107, titled *Guidelines for Pavement Maintenance Activities and their impact on ADA requirements* addresses pavement maintenance. Figure 1, Definition of Maintenance Patching, on the last page of the operational notice illustrates the narrative. The policy in the notice is consistent with the '*Department of Justice/Department of Transportation Joint Technical Assistance on the Title II of the Americans with Disabilities Act Requirements to Provide Curb Ramps when Streets, Roads, or Highways are Altered through Resurfacing*'.

ODOT Highway Division Maintenance Operation Notice MG144-03, titled *Traffic Signal Work and Americans with Disabilities Act (ADA)* addresses maintenance work on signals on or along the state highway and includes an informative Question and Answer section.

If an alteration in your project requires evaluation of the existing curb ramps, use the evaluation described in Section 0 below. Existing inspection data for curb ramps on or along the State highway is available through the ODOT TransGIS site and the ODOT FACS-STIP site. If there is missing data, contact ODOT's ADA Inventory Program Lead. When a curb ramp asset is removed from the state system with a construction activity, contact the ODOT's ADA Inventory Program Lead. For example, an asset is removed when a driveway is reconfigured from a curb radius style to a dust pan style approach, or when sidewalk infill occurs which removed the curb ramp access to the shoulder.

Project teams must be aware that in Oregon, crosswalks exist at all intersections per ORS 801.220 and missing curb ramps on the system must be addressed in the project if the project activities are considered alterations. If an investigation finds that a crosswalk location is a safety concern, an official crosswalk closure request may be submitted for approval through the Region Traffic Unit for submittal to the State Traffic-Roadway Engineer. The crosswalk closure process is covered in Section 0 in this document. Verify that existing marked crossings including mid-block or school crossings have State Traffic Roadway Engineer (STRE) approval when on or along the state highway. Requests for marked crossings may be submitted for approval through the Region Traffic Unit. STRE approval's need to be completed prior to reinstallation of the marked crossing. Compliant curb ramps are required for these locations if they do not exist.

For the most current information refer to the ODOT Engineering for Accessibility website. At a minimum, any sidewalks reconstructed with maintenance work are expected to meet ODOT sidewalk standards, provided in Oregon Standard Drawings. Links to Standard Drawings are in

Section 0 below. This may require transition panels to be added to the design to match back to existing sidewalk.

When maintenance work includes an alteration to any portion of a curb ramp, the requirement is to rebuild the entire curb ramp to meet ODOT ADA curb ramp standards.

When constraints exist that make it infeasible to rebuild a ramp to meet ODOT ADA standards, reconstruction must meet standards to the maximum extent feasible and justification must be documented with a design exception. Refer to 2.5 Curb Ramp Design Exception Process in this document.

### 1.1.3 Evaluate the Accessibility of Pedestrian Facilities

When scoping an alteration project, first determine where sidewalks exist within the scope of the project. Where sidewalks exist, they must be accessible. Curb ramps are required to allow a pedestrian to continue on the path of travel when the sidewalk ends. Existing bridges with sidewalks must also include an end of walk curb ramp at the end of the bridge if there is no sidewalk along the roadway. All intersections are crosswalks in Oregon (ORS 801.220) and if sidewalks exist at intersections, curb ramps are required for each street crossing. Signals can also affect or be impacted by curb ramp upgrades. Location of crosswalks on state highways is described in RD21-01(B). Refer to the 2.3 Accessible Pedestrian Push Button Requirements Section for information on push button requirements and their relationship to curb ramp design.

- Conduct a site visit to assess the condition of existing curb ramps and accessibility of other pedestrian facilities within scope of the project.
    - Identify locations of existing sidewalks and if curb ramps exist at adjacent intersections and at the end of sidewalk.
    - Identify locations of signals and note placement and condition of pedestrian features
  - Review curb ramp condition data from ODOT's TransGIS site. It is recommended to request additional survey data where curb ramps are to be upgraded or newly constructed or where additional right-of-way may be needed.
  - Begin preliminary curb ramp design. Use the ODOT Curb Ramp Design Check List Form 734-5184 to determine if there are design, safety, right-of-way or survey data issues.

The ODOT ADA Transition Plan should also be reviewed for accessible feature priorities that have been established and is to be used to evaluate the need for improvements included in the project scope of work. Contact the region's liaison for existing or outstanding ADA Concern, Questions, Comment, and Request's (CQCR) that could be considered for inclusion with the project scope of work to remedy the concern or request.

For questions about the curb ramp inventory contact:

**ADA Inventory Lead**

Melissa Borges, Roadway Statewide Asset Specialist

# 2. Design

## 2.1 Design Acceptance Package (DAP) / Design Verification Package (DVP)

The Design Acceptance Package (DAP)/ Design Verification Package is a critical point in the design when key elements and accessibility features included in the scope of work are identified. Alternative analysis of curb ramp designs are to be completed when it has been determined that there are no fully compliant curb ramp options prior to the DAP/DVP and are retained in project files. Design narratives stored with the project files describing the accessible upgrades included in the project are to be documented, including options explored when topography and site constraints may be challenging. By DAP/DVP, the following items should be included in the plan set:

- A draft Curb Ramp Detail sheet for each corner consistent with the ODOT details (Example of Minimum Curb Ramp Details DET1720 and DET1721).

At this stage, the curb ramp design should be adequate to ensure the necessary footprint is identified. For alteration projects, this will often require a 3D design.

Using the Highway Design Manual and the ODOT ADA Curb Ramp Design Check List Form 734-5184, assess any technical infeasibility to meet ODOT ADA curb ramp standards. Prepare draft ODOT ADA Curb Ramp Design Exception Request Forms 734-5361 for review. Draft curb ramp design exceptions shall be submitted to the Region Roadway Unit prior to being sent to the Technical Services Roadway Unit. Crosswalk closures and curb ramp design exceptions maybe interdependent and both require STRE approval on the state highway system. When developing DAP/DVP, the design should be detailed enough to identify when it is technically infeasible to meet criteria of the ODOT ADA Curb Ramp Design Check List. This is the appropriate time to submit a draft ODOT ADA Curb Ramp Design Exception Request Form. Refer to:

- Curb Ramp Design Exception Process in Section 2.5.

- Discuss possible Official Crosswalk Closure requests and other marked crossings with Region Traffic Unit staff and submit any draft Crosswalk Closure requests, if needed.
- A draft Temporary Pedestrian Accessible Route Plan (TPARP) is to be included in the Traffic Control Plans (TCP).
- Request any additional Right-of-way (ROW) and/or easements that may be needed for building compliant curb ramps. ROW acquisition can take up to one year. It is better to request any potential ROW needs early and then cancel it if it is determined that the ROW is not needed than asking for necessary ROW later in the project. Refer to the Technical Services Directive TSB18-03(D) for further guidance.

The appropriate time to develop crosswalk closures is during the development of the DAP/DVP plans. Crosswalk closure on or along the State highway must follow ODOT Crosswalk Closure process described in Section 0. All proposed crosswalk closures shall be based on relevant safety concerns. Requests for crossing closures on the state system are required to have State Traffic Roadway Engineer (STRE) approval. In addition, verify that all locations that are functioning as closed crosswalks on or along the State system are officially closed by STRE approval. If not, a Crosswalk Closure request must be approved. Projects that have other marked crossings including mid-block or school crossings on or along the state highway, must verify that the marked crossing is approved, refer to the Traffic Manual for approval process.

Curb ramp design may affect existing signal pedestrian push buttons and require relocation of the pedestrian push button to ensure reach, range and landing requirements are met. Accessible pedestrian pushbutton requirements are identified in Section 3.3.

At DAP/DVP, the project team should begin to develop a Temporary Pedestrian Accessible Route Plan (TPARP) . There will be situations where temporary easements are required to maintain an appropriate temporary pedestrian access route. Due to the time required to obtain temporary easements, a TPARP strategy should be in place prior to DAP/DVP approval. Refer to Section 0

Existing utilities both above ground and underground may require relocations or adjustments to the facility based on the curb ramp design to achieve a complaint curb ramp. Curb ramp design details require sufficient information to review and approve a relocation plan for the utility, and will require sufficient time for the utility company to move their facility.

# 2.2 Curb Ramp Detail Sheets and Standard Drawings

Use the Highway Design Manual and Oregon Standard Drawings for curb ramps design and complete the ODOT ADA Curb Ramp Design Checklist Form 734-5184. Retain the ODOT ADA Curb Ramp Design Checklist in the project design records. A curb ramp detail sheet is required for each curb ramp corner. Referencing standard drawings for curb ramps in plans in lieu of curb ramp detail sheets is no longer acceptable. The curb ramp detail sheet should conform to the following:

References:

- RD17-01(B) - ADA Sidewalk Curb Ramp Detail: Minimum Requirements in Construction Plans
    - ODOT DET 1720, Example of Minimum Curb Ramp Details Instructions
    - ODOT DET 1721, Example of Minimum Curb Ramp Details

- Standard Drawings, Roadway 700 Series - Curbs, Islands, Sidewalks, and Driveways
- Standard Drawings, Roadway 900 Series – Curb Ramps and Detectable Warning Surfaces
- Standard Drawings, Roadway 1100 Series – Bicycle Facilities
- ODOT's CADD drafting standards using the curb ramp detail menu which is on the ODOT engineering workspace

For questions about curb ramp details and standards contact:

Senior Standards Engineer

Will L. Woods, PE

Senior ADA Standard Engineer

Taundra Mortensen, P.E.

# 2.3 Accessible Pedestrian Push Button Requirements

Where a project includes signalized intersections, rectangular rapid flashing beacon (RRFB), or pedestrian hybrid beacons check the ODOT signal inventory for the pedestrian push buttons for accessibility triggers and the surrounding area for reach, range, and landing requirements. Using the ODOT ADA Curb Ramp Design Check List Form 734-5184, assess any technical infeasibility to meet ODOT curb ramp and pedestrian push button standards and prepare draft ADA Curb Ramp Design Exception Request Form 734-5361 for review, if needed. Temporary signals used in work zones must also be accessible to all pedestrians.

Audible pedestrian signals provide information in a non-visual format for pedestrians who have visual disabilities. Check if audible pedestrian signal policies are in place for the local jurisdiction and follow ODOT's policy for APS push buttons in the Signal Manual. If specific intersections have audible signal requests, send documentation of the request to ODOT's Office of Civil Rights (OCR); Attention ADA Title II Coordinator. An on-site meeting is offered and an engineering evaluation may be performed to determine if the audible signal is the appropriate treatment to include in the curb ramp and signal design. Refer to following references:

- MG144-03, Traffic Signal Work and Americans with Disabilities Act (ADA), December 1, 2017
- Traffic Signal Policy and Guidelines
- Signal Design Manual
- Exhibit C, Push Button Clear Space Surface Types
- Turn Space and Paved Shoulder Access Form 734-5245A
- Back-in Maneuver, Ramp Run and Sidewalk Access Form 734-5245B

For questions about accessible pedestrian features at signals and push button requirements contact:

- Scott Cramer, P.E. - Traffic Signals Engineer
- Katie Johnson, P.E. - Traffic Signal QC Engineer

# 2.4 Temporary Pedestrian Accessible Route Plan (TPARP) Process

ODOT's commitment to pedestrian transportation through and around highway work zones includes considerations for providing safe, efficient and accessible facilities for pedestrians.

This obligation applies to all work zones included in any of the following:

- All projects on or along the State Highway System, regardless of funding source
- All projects funded by the Federal-aid highway program
- All projects that are contracted through ODOT, including project off the State Highway System
- All projects delivered by ODOT maintenance forces off the State Highway System

When accommodating pedestrians in highway work zones, developing a pedestrian-specific temporary traffic control plan is required. A temporary pedestrian accessible route (TPAR) that matches or exceeds the existing level of accessibility shall be provided as part of the temporary traffic control plan when existing pedestrian facilities are impacted by construction, construction staging, and maintenance activities.

In cases where it is technically infeasible to provide an equal or better level of pedestrian accessibility through the TPAR design; document in writing the constraints that preclude this compliance. This documentation may be considered as a TPAR "Design Exception". It is recommended to include a "Memo to File" in the project file. The memo should include supporting correspondence, maps, and any diagrams or plan sheets that can be used to support the decision to design any portion of the TPAR with a level of accessibility less than the existing pedestrian facility. Use the Work Zone Decision Tree form to identify and document any TPAR design concepts that were evaluated as part of the design process. Include a summary statement of the TPAR design exception(s) in the Transportation Management Plan (TMP).

Where the TPAR design might deviate significantly from the existing pedestrian pathway, the designer should consider a peer review and discuss the exceptions with their lead engineer or manager. If the TPAR is being designed by a staff member, and separately sealed by an Engineer of Record, the Engineer should be given a summary of the design exceptions as part of their plan review.

If the TPAR design includes exceptions, incorporate additional temporary measures into the TPARP as enhancements including, but not limited to, pedestrian-specific signing (warning or regulatory) alerting pedestrians of any accessibility restrictions, and estimated durations of those impacts.

Additional TPARP information can be found in the current ODOT Traffic Control Plans Design Manual; within the Technical Services Directive, *Temporary Pedestrian Accessible Route Plans Required for Work Zones* – TSB17-01(D); in the Highway Division Maintenance Operational Notice – MG-Activities -2; and the following Resources:

**Resources:**

- Standard Drawings, Temporary Traffic Control 800 Series
  - TM844 - Temporary Pedestrian Accessible Routes
- Standard Details Traffic 4000 Series
  - DET4780 – Temporary Sidewalk Ramps
  - DET4781 thru DET4787 – TPAR Sidewalk Configurations
- 2021 Standard Specifications for Construction
  - SP00220 - Accommodations for Public Transit
  - SP00225 - Work Zone Traffic Control

For questions about Temporary Pedestrian Accessible Route Plans, contact:

Justin King, P.E. - State Work Zone Engineer

# 2.5 Curb Ramp Design Exception Process

ODOT ADA curb ramp design exceptions (DE) requests must be submitted to the Region Roadway Unit for review, and if appropriate, they will submit the request to the State Traffic-Roadway Engineer for approval. ODOT encourages submitting proposed design exceptions as early as possible in the design process, ideally drafting at DAP/DVP to allow for early resolution of project design issues. By DAP/DVP, the curb ramp design should be sufficiently developed to identify whether any additional Right-of-Way is needed to design and construct compliant curb ramps and any pedestrian signals to meet ODOT accessibility standards. It is important to allow sufficient time for ODOT's review and approval process Allow 1-2 months for the Region to review the proposed design exception and allow an additional month for State Traffic Roadway Engineer review. All design exceptions, including curb ramp-related exceptions, must complete the review and approval process before PS&E submittal can continue.

Process:

1. For each curb ramp design, use the ODOT ADA Curb Ramp Design Check List Form 734-5184 to determine all features of the curb ramp that do not meet ODOT ADA standards.
2. Experiment with different alternative curb ramp designs to determine if another curb ramp type or other design changes could provide full or partial compliance.
3. Compare partial compliance tradeoffs in each design.
4. If it has been determined that there are no fully compliant curb ramp options that are technically feasible, choose the most accessible curb ramp design and complete an ADA Curb Ramp Design Exception Request Form 734-5112 (Note: this is different than the ODOT General Design Exception Form). In the curb ramp DE request, describe the alternative curb ramp designs considered and why the final design was chosen from all considered options.
5. Follow Design Exception submission concurrence process on last page of the Design Exception Request form. All curb ramp design exceptions must be on the electronic form and digitally sealed

If a crosswalk has been officially closed by STRE approval, a design exception is not required to document the missing ramp or the single ramp serving a different crossing. Include the closure approval number on the curb ramp detail drawing.

**Resources:**

- ODOT Design Exception Web Page, for Digital Signatures and submittal processes
- RD16-01 (B), Technical Services Bulletin, ADA Curb Ramp Design Exception Request Form and ADA Curb Ramp Guidance, December 22, 2016.

- ADA Curb Ramp Exception Form User Guide

For questions regarding curb ramp design exceptions contact:

- Taundra Mortensen, P.E. - Senior ADA Standards Engineer
- Pamela C. Johnson, PE - ADA Standards Engineer
- Rodger Gutierrez, P.E. - Bicycle and Pedestrian Engineer

# 2.6 Crosswalk Closure Process

It is ODOT's policy to provide accessible crosswalks on the State Highway system unless the crosswalk is officially closed, by STRE approval, to all pedestrians. For crosswalk closures on the local roads, refer to **2.6.4 Crosswalk Closures on Local** Roads below. If a crosswalk has been officially closed by STRE approval, a design exception is not required to document the missing ramp or the single ramp serving a different crossing.

The decision to close a crossing must consider the safety and convenience of pedestrians. Closed crosswalks often force pedestrians to take a less direct route which is inconvenient and exposes pedestrians to more traffic conflicts.

The ODOT Traffic Manual, states that "*By statute (ORS 801.220) crosswalks exist at all locations where crosswalk markings indicate a pedestrian crossing and at all intersections (whether marked or unmarked) unless closed by official action. The absence of marked crosswalk lines at an intersection does not preclude ADA requirements for providing ADA accommodation such as adding or upgrading existing curb ramps to meet current ODOT ADA standards for all quadrants of an intersection unless a crosswalk has been closed by official action.*"

All intersections must provide ADA compliant crossings on the State Highway system unless the crossing is officially closed. There are two situations that warrant pursuing an Official Crosswalk Closure:

1. Any crosswalks that currently function as closed. For example, accessible pedestrian features, such as pedestrian signal heads or crosswalk striping, are missing at a signalized intersection or there are missing curb ramps at an intersection.
    a. Check with the Region Traffic Engineer to determine if the assumed closed crosswalk has been officially closed.
        i. If it has been officially closed, check the inventory and verify that it meets all closed crosswalk requirements as per the STRE closure approval letter and section 5.1.2 of the Traffic Signal Design Manual.

ii. If it has not been officially closed, work with the Region Traffic Engineer to determine if crosswalk closure should be processed or if the crossing should be designed as an open crosswalk.

2. The site conditions create a safety concern situation, that justify closing a crosswalk.
    a. Submit a Crosswalk Closure Approval Request Form 734-5150.

## 2.6.1 How to request an official crosswalk closure

All requests for crosswalk closures shall be submitted to the ODOT Region Traffic Unit to be submitted to the State Traffic-Roadway Engineer with an engineering study that includes:

- A narrative substantiating a geometric design or operational concern that adversely impacts safety.
- Discussion of reasonable alternate pedestrian access routes between the two points of the crossing that are being closed.
- A description of proposed closure treatments. Refer to the 2.6.3 Required Crosswalk Closure Treatments in the following section.

## 2.6.2 When to Submit a Crosswalk Closure Request

Pedestrian circulation paths and potential crosswalk closures should be established early in the project, as they effect the curb ramp design. Crosswalk closure requests should be identified and resolved prior to the DAP/DVP stage to ensure project schedule adherence. Allow 1-2 months for the Region Traffic Engineer to review the proposed closures and prepare closure request. Allow an additional month for State Traffic Roadway Engineer approval.

## 2.6.3 Required Crosswalk Closure Treatments

If a crosswalk closure is granted, a crosswalk closed sign is required along with additional detectible features. Detectible features are used to communicate to pedestrians with visual impairments that the crossing is closed. In addition, detectible features and barriers communicate to all pedestrians that a crossing is closed. ODOT's standard detectible feature is a "Crosswalk Closed" sign and barricade (refer to TM 240). Other supplemental detectible features include grass strips, landscaping, planters, bollards with chains, fencing, railings, or other barriers.

# 2.6.4 Crosswalk Closures on Local Roads

On Local roads, the State crosswalk definition (ORS 801.220) and responsibility still applies. It is recommended that local agencies develop their own crosswalk closure process with delegated authority. When deciding to close a crosswalk on a project that utilizes Federal or State Funds on the local system, follow Local Agency crosswalk closure process. If the Local Agency does not have a process, it is suggested that the Local Agency provide an official letter to document where crosswalks are not intended, and what treatments are to be applied, and retain the document in project files. If a crosswalk has been officially closed by the local agency, a design exception is not required to document the missing ramp or the single ramp serving a different crossing.

**Resources:**

ODOT Traffic Manual, Chapter 6

Oregon Bicycle and Pedestrian Design Guide, Chapter 5

The Bike/Ped Design Guide is Appendix L of the Highway Design Manual.

For questions regarding crosswalk closures contact:

Gary Obery, P.E.- Active Mode Transportation Engineer

# 2.7 Advance/90% Plans

By Advance/90% plans, the following items should be included in the plan set and submittal:

- A separate curb ramp detail design for each corner with all required components conforming to the ODOT Curb Ramp Design Check List. Ensure that curb ramps numbering information matches ODOT's Trans GIS inventory conventions.
- A complete TPAR Plan is included in the TCP plans.
- If applicable, Final Design Exception(s) with signatures.
- If applicable, Official Crosswalk Closure Approval letter(s).
- Any ROW and easement approvals, if applicable.
- Ensure that Construction Specifications meet current ODOT ADA requirements.

**Resources:**

- Oregon Standard Specification for Constructions
- RD17-01(B) - ADA Sidewalk Curb Ramp Detail: Minimum Requirements in Construction Plans
    - ODOT DET 1720, Example of Minimum Curb Ramp Details Instructions

    - ODOT DET 1721, Example of Minimum Curb Ramp Details

- Standard Drawings, Roadway 700 Series - Curbs, Islands, Sidewalks, and Driveways
- Standard Drawings, Roadway 900 Series – Curb Ramps and Detectable Warning Surfaces
- Standard Drawings, Roadway 1100 Series – Bicycle Facilities
- ODOT's CADD drafting standards using the curb ramp detail menu which is on the ODOT engineering workspace

For questions about ADA plan requirements contact:

Taundra Mortensen, P.E. - Senior ADA Standards Engineer

Pamela C. Johnson, PE - ADA Standards Engineer

William L. Woods, PE - Senior Standards Engineer

## 2.8 PS & E/ Final Plans

By Final Plans, the following items shall be included in the plan set:

- A separate curb ramp detail design for each corner is included in the plan set with all required components necessary to display conformance with the ODOT Curb Ramp Design Check List
    - Including curb ramp design exception approval number(s)
    - Conforming to ODOT CADD drafting and detail standards
- If requested, provide Official Crosswalk Closure Approval letter(s) number(s).
- Approved ADA Curb Ramp Design Exceptions.
- Ensure that Construction Specifications meet current ODOT ADA requirements.
- A comprehensive, final TPAR Plan is included in the TCP plans.

# 3. Pre-Closeout, 2nd Note, Curb Ramp Inspection

Once curb ramps are constructed, modified, upgraded, or improved as part of the Project, all curb ramps must be inspected by an ODOT Certified Curb Ramp Inspector. ODOT Certified Curb Ramp Inspectors can be from the State, Federal agency, a local jurisdiction, contractor or consultant firm and have completed the Curb Ramp Inspection Training (CRIT) through ODOT.

Post construction, an ODOT Certified Curb Ramp Inspector will conduct a curb ramp inspection and complete curb ramp inspection forms for each curb ramp. Several curb ramp inspection forms are used based on the different curb ramp styles. A list of electronic curb ramp inspection forms is available below. Curb ramps that pass the inspection will have their forms sent to the ODOT Standards Unit though a link on the electronic form. Ramps that fail the initial inspection will need to be remediated before submission of the curb ramp inspection form. For failing ramp inspections, contact the ODOT Project Manager assigned to your project. All curb ramps must pass inspection prior to 2nd note by Agency and prior to release of any Agency contractor.

**Process:**

1. Schedule an ODOT Certified Curb Ramp Inspector to inspect all curb ramps post-construction and prior to 2nd note.
   a. If your project team has an ODOT Certified Curb Ramp Inspector:
      i. Have inspector conduct a curb ramp inspection on all curb ramps in the project.
      ii. Have inspector submit passing curb ramp inspection forms to email on curb ramp inspection form, to the ODOT Standards Unit.
      iii. For curb ramps that fail inspection, contact your ODOT Project Manager.
   b. If you do not have an ODOT Certified Curb Ramp Inspector, contact your ODOT Project Manager to schedule an inspection.

Send copies of the completed ODOT Curb Ramp Inspection Forms to the ODOT Standards Unit which is sent with the Submit Button on the form . Curb ramp Inspection forms for each type of curb ramp:

- Blended Transition Curb Ramps Form 734-5020A
- Combination Curb Ramps Form 734-5020B
- Cut-Through Island Ramps Form 734-5020C
- End-of-Walk Curb Ramps Form 734-5020D
- Parallel Curb Ramps Form 734-5020E
- Perpendicular Curb Ramps Form 734-5020F
- Unique Curb Ramps Form 734-5020G

Send copies of the completed ODOT Push Button Inspection Forms to the ODOT Standards Unit.

- Turn Space and Paved Shoulder Access Form 734-5245A
- Back-in Maneuver, Ramp Run and Sidewalk Access Form 734-5245B

For questions about curb ramp inspections, contact:

Melissa Borges - ADA Program Inventory Lead

# 4. Ongoing Maintenance Agreements

If the local agency is maintaining any portion of the project, the local agency shall ensure that any portions of the project under the local agency's maintenance jurisdiction are maintained in compliance with the ADA throughout the useful life of the Project as agreed to in the Intergovernmental Agreement (IGA).

Pedestrian access will be maintained as required by the ADA. If any complaints are received by the local agency or ODOT including sidewalk, curb ramp, or pedestrian-activated signal safety or access issues are identified on portions maintained by the local agency, they shall be submitted to the ODOT's office of civil rights on the ODOT Office of Civil Rights Concern, Question, Comment or Request (CQCR) Form. Concerns and requests shall be promptly assessed and evaluated for remedies.

Any future alteration work on project or project features during the useful life of the project must comply with the ADA requirements in effect at the time the future alteration work is performed.

# 5. Jurisdictional Transfer of State Highway

States maintain a state route system to assist the traveling public in their travels. Designated routes may be composed of both state highway and local roads. Designation and elimination of state routes are under authority of the Oregon Transportation Commission (OTC). ODOT and a local municipality may enter into an agreement to transfer jurisdictional ownership of a road upon approval of a Jurisdictional Transfer Resolution, by the OTC. All highway segments under state ownership as of November 1, 2016 are subject to curb ramp remediation to make the curb ramps ADA compliant to the greatest extent feasible by December 2032 regardless of any jurisdictional transfer.

ADA construction and alteration requirements for curb ramps are still applicable. If a state highway's jurisdiction is transferred to another local municipality, curb ramps are required to meet ODOT ADA standards. Prior to the jurisdictional transfer, ODOT and the local agency will enter into an intergovernmental agreement (IGA) to determine which agency will reconstruct curb ramps.

Once curb ramps are constructed, modified, upgraded, or improved as part of a Project, all curb ramps must be inspected by an ODOT Certified Curb Ramp Inspector. ODOT Certified Curb

Ramp Inspectors can be from the State, Federal agency, a local jurisdiction, contractor or consultant firm and have completed the Curb Ramp Inspection Training through ODOT.

Post construction, an ODOT Certified Curb Ramp Inspector will conduct a curb ramp inspection and complete curb ramp inspection forms for each curb ramp. Several curb ramp inspection forms are used based on the different curb ramp styles. A list of electronic curb ramp inspection forms is in section 3.4 Pre-Closeout, 2nd Note, Curb Ramp Inspection. Ramps that fail the initial inspection will need to be remediated before submission of the curb ramp inspection form. Send copies of the completed ODOT Curb Ramp Inspection Forms to the ODOT Standards Unit.

# 6. ODOT ADA Document Links and Resources

Many of the links below and other ODOT ADA related guidance and standards can be found at ODOT's Engineering for Accessibility or the ADA Asset Inventory website.

## 6.1 Operational Notices

- MG100-107, Maintenance Operational Notice, Guidelines for Pavement Maintenance Activities and their impact on ADA requirements, October 18, 2016
- MG144-03, Traffic Signal Work and Americans with Disabilities Act (ADA), December 1, 2017
- MG-Activities-2, Maintaining Accessibility During Maintenance Work

## 6.2 Technical Bulletins Related to ODOT ADA requirements

- 101_19, Bulletin Statewide Program Unit Certification Program Office (CPO), ODOT Certification Program
- RD13-01(A), ADA ramps in Resurfacing Projects: 1991 Versus Current ADA Standards
- RD16-01 (B), Technical Services Bulletin, ADA Curb Ramp Design Exception Request Form and ADA Curb Ramp Guidance, December 22, 2016
- TSB17-01(D), Technical Services Directive, Temporary Pedestrian Accessible Route Plans Required for Work Zones, October 1, 2017

- RD17-01(B), Technical Services Bulletin, ADA Sidewalk Curb Ramp Detail: Minimum Requirements in Construction Plans, May 1, 2017
- TSB 18-03(D), Curb Ramp Scoping and Right of Way
- RD19-02(B), Measurement Criteria for Newly Constructed Curb Ramps, Driveways and Sidewalks
- RD20-01(B), Highway Design Manual 1R/3R Record of Decision and Updates and Clarification to the 1R Standard
- RD21-01(A), Curb Ramp Gutter Flow Slope Design and Design Exceptions
- RD21-01(B), Location of Crosswalks on State Highways
- RW21-01(B), Optional Alternative Acquisition Process for Construction or Alteration of ADA Ramps
- RD21-04(B), Design for Program Funded Curb Ramp Project Programmed to be Constructed in 2021 or 2022

# 6.3 Manuals

- Highway Design Manual
- Appendix L, Oregon Bicycle and Pedestrian Design Guide, Chapter 5
- Traffic Signal Design Manual
- ODOT Traffic Manual
- Oregon Standard Specifications for Construction
    - SP00200 - Temporary Features and Appurtenances
    - SP00220 - Accommodations for Public Transit
    - SP00225 - Work Zone Traffic Control
    - SP00759 – Miscellaneous Portland Cement Concrete Structures
- Bridge Design and Drafting Manual
    - BDDM Appendix A - ADA Design of Bridge Curb Ramps
    - BDDM Appendix B - ADA Bridge Work Examples
- Traffic Control Plans Design Manual
- Traffic Signal Policy and Guidelines
- Oregon Temporary Traffic Control Handbook

# 6.4 Standard Drawings and Details

- Standard Drawings, Roadway 700 Series: Curbs, Islands, Sidewalks, and Driveways
- Standard Drawings, Roadway 900 Series: Curb Ramps and Detectable Warning Surfaces
- Standard Drawings, Roadway 1100 Series: Bicycle Facilities
- Standard Details, Roadway 1700 Series: Curbs, Islands, Sidewalks, and Driveways
    - DET 1720, Example of Minimum Curb Ramp Details Instructions
    - DET 1721, Example of Minimum Curb Ramp Details
- Standard Drawing, Traffic 200 Series: Permanent Signing
    - TM240, Crosswalk Closure Detail
- Standard Drawings, Traffic 400 Series: Signals
    - TM457, Vehicle, Pedestrian Signal and Pushbutton Mounting Option Details
    - TM467, Pedestrian Signal Mount and Pedestrian Pushbutton Details
    - TM472, Traffic Signal Junction Boxes/Hand Holes
- Standard Drawings, Bridge 200 Series
    - Pedestrian Rails & Fencing
- Standard Drawings, Temporary Traffic Control 800 Series
    - TM844 - Temporary Pedestrian Accessible Routes
- Standard Details Traffic 4000 Series
    - DET4780 – Temporary Sidewalk Ramps
    - DET4781 thru DET4787 – TPAR Sidewalk Configurations

# 6.5 Tools

- TransGIS
- FACS-STIP
- ODOT Curb Ramp Design Check List Form, 734-5184
- ADA Curb Ramp Design Exception Request, Form 734-5112
- Crosswalk Closure Approval Request, Form 734-5150
- Exhibit A,Curb Ramp Corner and Ramp Position Numbering
- Exhibit B, Curb Ramp Styles
- Exhibit C, Push Button Clear Space Surface Types
- Exhibit D, Gutter Flow Slope Requirements

- ADA Curb Ramp Inspection Form Submittal Guide
- ADA Push Button Inspection Form Submittal Guide

# 7. Contacts

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## I. Work Zone Standards Engineer

Fahad Alhajri, P.E.

# 8. Checklist for Curb Ramp Process

This checklist is intended to be a tool to help guide the ADA process through your project to ensure that all ADA milestones and requirements are met. It is not a required project document.

| ✓ | Tasks |
|---|---|
| | |
| | Scoping – ADA Evaluation in Project Scoping |
| | **Verify scope of curb ramp remediation based on project type and work performed as well as ADA compliancy of sidewalks, intersections and signals in project:**<br>• Oregon crosswalks exist at all intersections and missing ramps on the system must be addressed with new construction, full rebuild and alterations.<br>• For new construction or a full rebuild, projects shall assume all pedestrian facilities including curb ramps and are required to be ADA compliant.<br>• Alterations are projects with changes to an existing facility that affects or could affect the usability of the facility. Alterations such as resurfacing, signal work and sidewalk work are typical project activities that could trigger curb ramp compliance evaluation.<br>• Normal maintenance is not considered an alteration<br>Refer to Maintenance Operational Notices **MG100-107** and **MG144-03** and *0 1.1 Curb Ramp Evaluation in Project* Scoping in this document to establish the distinction between maintenance and alteration work for paving and signal work. |
| | **Obtain Curb Ramp Condition Data**<br>• If an alteration in your project requires existing curb ramp evaluation, the ODOT curb ramp inspection process shall be used. Existing inspection data for curb ramps on the State system is available through the ODOT Trans GIS site. |
| | **Assess condition of existing curb ramps and accessibility of other pedestrian facilities within scope**<br>• Conduct a site visit to verify existing conditions for accessibility<br>    o Identify locations of existing sidewalks and if curb ramps exist at adjacent intersections<br>    o Identify locations of signals and note placement and condition of pedestrian features |

| ✓ | Tasks |
|---|---|
| | **Request additional survey data for curb ramp design if needed** |
| | **Begin preliminary design of curb ramps** |
| | **Design - Design Acceptance Package (DAP)/Design Verification Package (DVP)** |
| | **Begin draft curb ramp detail sheets**<br>• A complete DAP/DVP; will include curb ramp design adequate to ensure the necessary footprint is identified. For alteration projects this will often require a 3D design. Begin drafting Curb Ramp Design Detail sheets for each corner in project. |
| | **Utilize Curb Ramp Checklist to assess any technical infeasibility issues**<br>• Use the **ODOT Curb Ramp Design Check List** at DAP/DVP to ensure that all elements in the curb ramp design will meet ODOT ADA standards. Curb ramp detail sheets should be detailed enough to confirm if the design incorporates all ADA elements in the check list or if it is technically infeasible to meet all requirements; if not, a design exception request is needed. |
| | **Submit Draft Design Exception Requests for review if applicable**<br>• If elements of the curb ramp design cannot meet ADA standard because of technical infeasibility, this is the appropriate time to submit a **draft Curb Ramp Design Exception Request Form** for review. Refer to Design Exception Process in attached instructions.<br>• At DAP/DVP, the project team should begin to develop a **2.4 Temporary Pedestrian Accessible Route** Plan (TPARP) Process. There will be situations where temporary easements are required to maintain an appropriate TPAR. Due to the time required to obtain temporary easements a TPARP strategy should be in place prior to DAP approval. |
| | **Submit Crosswalk Closure Approvals, If applicable**<br>• Verify that all existing *presumed* closed crosswalks on the State system are *officially* closed with an approved crosswalk closure document by contacting the State Traffic-Roadway Engineer. If not, a Crosswalk Closure must be evaluated. An example of a presumed closed crosswalk is one that functions as closed at a signalized intersection; It has no pedestrian facilities, such as curb ramps or pedestrian signal heads but may not have been officially closed.<br>• All proposed crosswalk closures in the project shall be based on relevant safety concerns. Requests for crossing closures on the State system are to be submitted through the ODOT Region Traffic Manager to the State Traffic-Roadway Engineer for approval. Refer to 2.6 Crosswalk Closure Process in the attached instructions. |
| | **Request any needed ROW or easement approvals** |
| | |

| ✓ | Tasks |
|---|---|
| | **Design- Advance/90% Plans:** |
| | **Complete Curb Ramp Detail Sheets**<br>• Have completed, final Curb Ramp Design Detail sheets for each corner with all required components necessary to display conformance with the ODOT Curb Ramp Design Checklist and ready for final review. |
| | **Complete TPAR as part of the TCP**<br>• A Final 2.4 Temporary Pedestrian Accessible Route Plan (TPARP) Process is included in the plans for review. |
| | **Final Submittal of Design Exceptions with signatures , if applicable**<br>• Submit any final, signed, Curb Ramp Design Exception Request Forms for approval |
| | **Obtain copies of Final Crosswalk Closures Approvals, if applicable** |
| | **Finalize ROW and easement documentation** |
| | **Complete Construction Specifications for final review** |
| | **Design- Plans, Specifications and Estimate Submittal/PS & E:** |
| | **Approved Design Exceptions if applicable**<br>• All curb ramp designs not fully complying with the ODOT Curb Ramp Design Checklist shall have received a Curb Ramp Design Exception Request Form Approval prior to PS&E.<br>• Approved Design Exception Requests shall be noted in the corresponding curb ramp detail sheets and documented in the project file (ProjectWise when available). |
| | All approved 2.6 Crosswalk Closure Process should be in the project file (ProjectWise when available). |
| | **Final Construction Specifications**<br>• Specifications and pay items shall be consistent with the Oregon Standard Specifications for Construction |
| | **Final TPAR in TCP** |
| | **Construction-** Use the Oregon Standard Specifications for Construction |
| | **Pre-Closeout, 2nd note** |
| | **Conduct Curb Ramp Inspection with Certified Inspector** |
| | **Send a completed ODOT Curb Ramp Inspection Form(s) 734-5020 series to the**<br>1) Email link on the ODOT Curb Ramp Inspection Form and |

| ✓ | Tasks |
|---|---|
| | 2) the ODOT Standards Unit<br>for each curb ramp constructed, modified, upgraded, or improved as part of the Project. Curb ramp inspections must be completed by certified ODOT curb ramp inspector. 3. Pre-Closeout, 2nd Note, Curb Ramp Inspection instructions. |
| | **Ongoing maintenance Agreement** |
| | If agency is maintaining any portion of the Project on the State Highway System , the Agency shall ensure that any portions of the of the project under the local agency's maintenance jurisdiction are maintained in compliance with the ADA throughout the useful life of the Project as agreed to in the IGA. |

# Appendix L

## Bicycle & Pedestrian Design Guide

# Bicycle and Pedestrian Design Guide

2011

Oregon Department of Transportation

# OREGON
# BICYCLE AND PEDESTRIAN DESIGN GUIDE

## OREGON HIGHWAY DESIGN MANUAL APPENDIX L

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OREGON DEPARTMENT OF TRANSPORTATION
BICYCLE AND PEDESTRIAN PROGRAM

# ACKNOWLEDGEMENTS

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*Special thanks to the hundreds of people (the citizens of Oregon, local and ODOT staff) who contributed their ideas and recommendations regarding bicycle and pedestrian transportation.*

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# INTRODUCTION


*A complete street accommodates all travel modes, supports residences and businesses and is a community asset*

## The Importance of Good Design and Context

Well-designed bicycle and pedestrian facilities are safe, attractive, convenient and easy to use. It is wasteful to plan, design and build facilities that are little used, or used irresponsibly because of poor design. ***Inadequate facilities discourage users and unnecessary facilities waste money and resources***.

Bicycle and pedestrian facilities must be considered at the onset of transportation projects and incorporated into the design process at all stages, so potential conflicts with other modes, topography or right-of-way constraints are resolved early on. Bikeways and walkways risk being under-designed if they are considered add-on features.

Good design does more than help those who already walk or bicycle; ODOT encourages greater use of non-motorized transportation. Examples of facilities that encourage use are:

**Bike lanes** provide cyclists their own space on the road. They also:

- Establish the correct position of cyclists on the road;
- Provide bicyclists room to travel at their own speed, they can pass cars backed up at intersections;
- Reduce bicycle/pedestrian conflicts as fewer cyclists ride on sidewalks; and
- Send a message to motorists that bicyclists have a right to the roadway.

**Separated sidewalks** create a pleasant walking environment away from traffic. They also provide:

- Room for street furniture such as signs, utility and signal poles, mailboxes and bike racks;
- An opportunity for landscaping and shade-trees, increasing the appeal of a roadway; and
- A better environment for wheelchair users, as sidewalks are level at driveways.

## Context Sensitive Design

***Context should always determine which type of walkway and/or bikeway to provide, and to what standard.*** Applying standards without regard to how a facility will function within the greater context can lead to under- or overbuilt facilities, inappropriate for the context. There are several ways of defining context; they are not mutually exclusive, and should be referred to when determining what parameters to use when providing walkways and bikeways.

1. Land uses defined in broad terms: rural, urban, suburban, and urban (or suburban) fringe. This applies in clearly defined contexts such as an urban street in an established part of a city, or a truly rural road. It is harder to define context using these terms in ambiguous situations such as a rural road in a recently annexed part of a city that is being redeveloped.

➢ Utility in selecting appropriate design criteria: Moderate

2. Land uses immediately adjacent to a street: residential, commercial, institutional, industrial, or mixed use. These can help determine what destinations may be accessible on foot or by bicycle by those using that street.

➢ Utility in selecting appropriate design criteria: Moderate/High

3. The 1999 Oregon Highway Plan has identified four types of urban highway segment designations:

- Special Transportation Areas (STA),
- Urban Business Areas (UBA),
- Commercial Centers, and
- Non-Designated Urban Highways.

The Oregon Highway Design Manual also describes categories that do not meet the requirements or intent of the other highway segment designations:

- Urban Fringe/Suburban,
- Developed, and
- Traditional Downtowns/Central Business Districts.

Definitions, applicability and policies regarding these designations can be found in the Oregon Highway Plan: *www.oregon.gov/ODOT/TD/TP/orhwyplan.shtml#1999_Oregon_Highway_Plan* and the Oregon Highway Design Manual: *www.oregon.gov/ODOT/HWY/ENGSERVICES/hwy_manuals.shtml#2003_English_Manual*

➢ Utility in selecting appropriate design criteria: Moderate/High

4. "Main Street: When a Highway Runs Through it": published by the Oregon Downtown Development Association (in cooperation with ODOT), it is designed for communities that are working together to enhance the vitality of their main street (*http://www.odda.org/content/pubs.html*).

➢ Utility in selecting appropriate design criteria: High

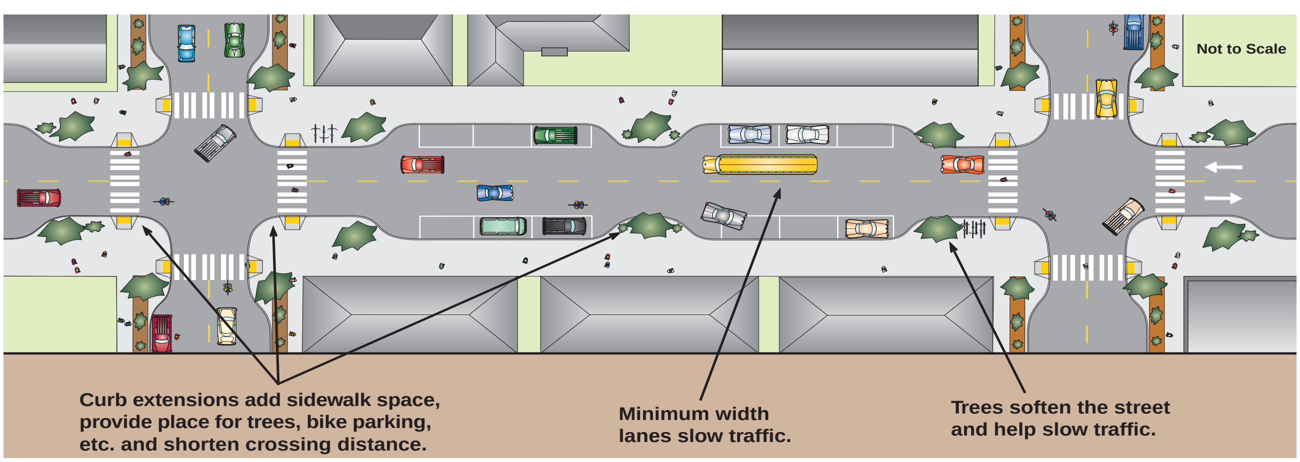



*Figure I-1: Sample illustration from Main Street Handbook*

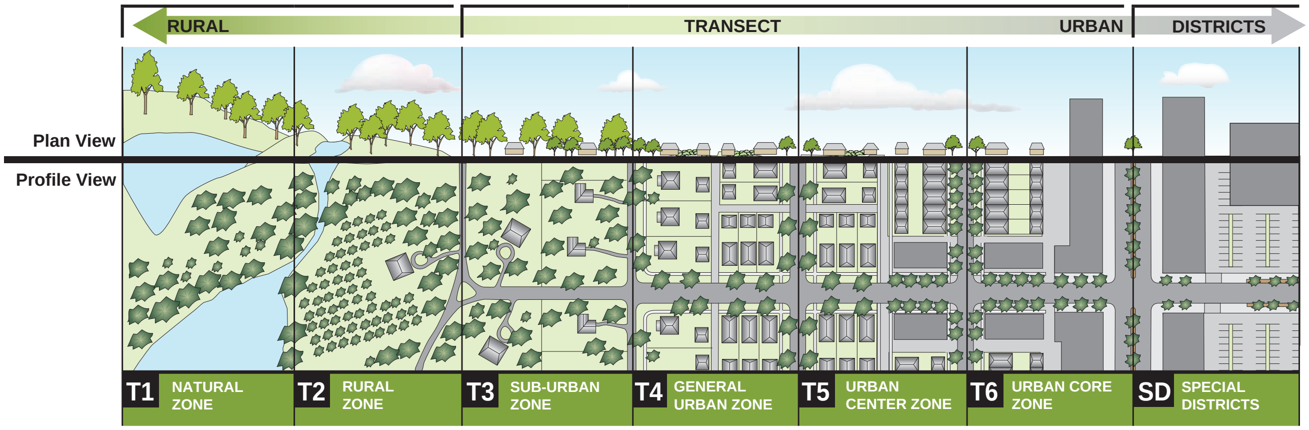



*Figure I-2: The Transect (Congress of New Urbanism)*

5. The Transect, a context classification created by the Congress for New Urbanism, a framework that identifies a continuous range of habitats from the most natural to the most urban; the 6 Transect Zones are:

- T-1 Natural Zone: lands approximating a wilderness condition, unsuited for settlement due to topography, hydrology or vegetation.
- T-2 Rural Zone: sparsely settled lands in open or cultivated state; woodland, agricultural, etc.
- T-3 Sub-Urban Zone: low-density suburban residential areas with deep setbacks, natural planting, long blocks and irregular roads to accommodate natural conditions.
- T-4 General Urban Zone: mixed-use but mostly residential urban with a range of building types with variable setbacks, and medium-sized blocks.
- T-5 Urban Center Zone: high density mixed-use buildings with retail, offices, rowhouses and apartments, a tight network of streets, wide sidewalks, street trees and buildings set close to the frontages.
- T-6 Urban Core Zone: the highest density, with the greatest variety of uses, and civic buildings of regional importance.
- Special Districts: areas with buildings that by their function, disposition, or configuration cannot conform to one of the Transect Zones.

➢ Utility in selecting appropriate design criteria: Very High

6. Portland Metro's regional street design concepts reflect the fact that streets perform many, often conflicting functions, and the need to reconcile conflicts among travel modes to make the transportation system safer for all modes of travel. Implementation of the design concepts is intended to promote community livability by balancing all modes of travel and address the function and character of surrounding land uses when designing streets of regional significance. The street design concepts fall into three broad classifications:

- Throughways emphasize motor vehicle and freight travel and connect major activity centers and provide inter-city, inter-regional and inter-state connections, with an emphasis on mobility.
- Boulevards in mixed-use areas (e.g. 2040 centers, station communities and main streets) integrate motor vehicles, freight, transit, bicycle and pedestrian modes of travel, with an emphasis on pedestrian, bicycle and transit travel.
- Streets in 2040 mixed-use corridors, industrial areas, employment areas and neighborhoods integrate motor vehicles, freight, transit, bicycle and pedestrian modes of travel, with an emphasis on vehicle mobility and special pedestrian infrastructure on transit streets.

- Utility in selecting appropriate design criteria: High

7. AASHTO Street (functional) Classification System: For the purposes of highway and street design, the American Association of State Highway and Transportation Officials (AASHTO) developed the functional classification system (or street hierarchy) to determine which design standards are applicable; the classifications are ***arterial, collector and local streets***. Local streets serve residences and short neighborhood trips; collectors gather traffic from the neighborhoods and channel vehicles onto arterials, which are designed for longer trips. Most commerce, institutions and other important destinations are located on arterials.

The street hierarchy is a planning tool for motor vehicle traffic, and is the basis for many of the design criteria in AASHTO. It is not always a practical design tool, as arterial, collector and local streets are found in a variety of land use contexts. The practice of standardizing typical sections for each of these classifications results in many streets that do not serve bicyclists, pedestrians or adjacent properties well. To effectively design for bicyclists and pedestrians, the context of the street must be considered; each context requires different design treatments - one size does not fit all. The design should match the context, not the street classification.

Also, pedestrians and bicyclists have their own needs; they may want to travel to major destinations using local streets, or conditions on arterials may be very intimidating to them (high traffic volumes and speeds, no sidewalks or bike lanes, buildings set far back and difficult to access on foot).

This manual proposes a more comprehensive approach, one more compatible with the needs of pedestrians and bicyclists. Terms such as thoroughfares and residential streets capture the essence of the function and the look and feel of a street from their perceptive. The Oregon Highway Plan (OHP) should be consulted for highway classification as it applies to vehicular traffic.

- Utility in selecting appropriate design criteria: Low

Regardless of which context or street classification system is used, land uses change over time, in most cases towards a denser, more urban form. Street projects are usually designed for a 20-year life (bridges 50 years or more), so planners and designers must consider how a planned roadway will function in the future. It is better to build facilities that may not be immediately needed, rather than come back later and retrofit them at great expense. But over design (a road widened to accommodate future traffic volumes but is too wide for the current conditions) may encourage speeding. To avoid this outcome, measures should be taken in the interim to slow traffic down, such as delineating the widened pavement with markings, so the roadway appears narrower.

## Bicyclists and Pedestrians: Similarities & Differences

Many early bikeway designs assumed that bicyclists resemble pedestrians in their behavior. This led to undesirable situations: bicyclists are under-served by inadequate facilities, pedestrians resent bicyclists in their space, and motorists are confused by bicyclists entering and leaving the traffic stream in unpredictable ways. Only under special circumstances should bicyclists and pedestrians share the same space, e.g. on shared-use paths. The modes are similar in several ways:

Location: Bicycle and pedestrian facilities, though separate from each other, are found between the motor vehicle travel lanes and the right-of-way line, often in conflict with other demands such as utilities. This can create competition for this valuable space.

*Context Sensitive Designs: Both streets serve all modes - Bicyclist on the left shares the road with traffic in an urban slow speed environment. Pedestrian on the right uses the shoulder in a rural context*

Exposure: Pedestrians and bicyclists are exposed to the elements and are vulnerable in crashes.

Behavior: Pedestrians and bicyclists can be of any age and no license is required. Their actions and reactions change with age and are sometimes unpredictable.

## Bicyclists and pedestrians differ in significant ways:

### Bicyclists

Bicyclists operate a vehicle and are legitimate road users, but they are slower and less visible than motor vehicles; they are also more vulnerable in a crash than motorists. They need accommodation on busy, high-speed roads and at complex intersections. In congested urban areas, bicyclists can often proceed faster than motorists on well-designed facilities.

Bicyclists use their own power, must constantly maintain their balance and don't like to interrupt their momentum. They like to ride side-by-side so they can interact socially with a riding companion. Typical bicyclist speeds range from 10-15 MPH, enabling them to make trips up to 5 miles or so in urban areas in about 25 minutes; this is equivalent to a typical suburban commuter trip time.

Well-designed bicycle facilities guide cyclists to ride in a manner that conforms to the vehicle code: in the same direction as traffic, usually in a position 3 to 4 feet from the edge of the roadway or parked cars, to avoid debris, drainage grates and other potential hazards. Cyclists should be able to proceed through intersections in a direct, predictable and safe manner.

### Pedestrians

Pedestrians prefer separation from traffic and are slower than bicyclists. They need extra time for crossing roadways, special consideration at intersections and traffic signals, and other improvements to enhance the walking environment. Some design details contribute to safety (illumination), some make walking more convenient (paths that provide short-cuts), and others make walking more pleasant (planting strips).

Pedestrians are the most vulnerable of road users and are often not visible to motorists. They don’t tolerate delay and out-of-direction travel, and will often take shortcuts where there is no convenient or direct access. Pedestrian facilities must be designed to meet or exceed the ADA requirements (Americans with Disabilities Act).

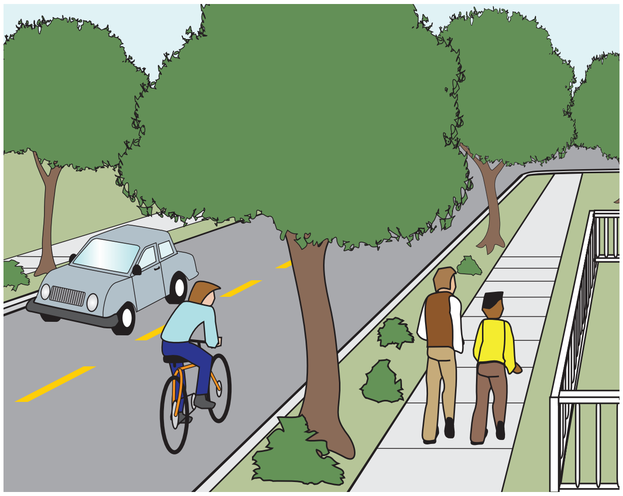


*Figure I-3: Streets can be made pleasant for all users*

On well-planned and well-designed streets (with buildings that abut the sidewalk), sidewalks provide mobility and also serve as direct access to destinations. Pedestrians simply walk on a sidewalk, enter a building, leave it and continue on their way, with no need for parking, a driveway or specially designed access. This underscores the importance of good urban design in creating walkable environments.

Typical walking speeds range from 2-3.5 MPH, enabling them to make trips up to a mile or so in urban areas in about 20 minutes; this is equivalent to a typical urban trip for errands.

## Design Standards

The design standards and recommendations in this document are for use on Oregon highways. The previous discussion on context sensitive design should be consulted when determining which standard is applicable for the context.

ODOT encourages local agencies to use the dimensions and designs recommended in this plan; local standards may exceed ODOT standards. When ODOT is constructing a bikeway or walkway in collaboration with a local jurisdiction, the more appropriate of the two designs should be used, based on the context. On some local streets, dimensions less than those recommended in this plan may also be appropriate; for example non state highways can have very narrow motor vehicle travel lanes to accommodate bike lanes.

To establish primary design practices, ODOT has adopted the American Association of State Highway and Transportation Officials (AASHTO) guidelines. AASHTO publishes the “Guide for the Development of Bicycle Facilities,” and the “Guide for the Planning, Design and Operation of Pedestrian Facilities.” Most ODOT design standards are contained in the “Highway Design Manual” (HDM).

Relationship between this document, AASHTO and the HDM: This plan contains some recommendations and best practices that exceed AASHTO and/or the HDM standards. Also included in this plan are designs that ODOT has developed for situations that are not covered by AASHTO or the HDM. On state highways, the standards in the HDM must be met as a minimum; on local agency projects where funds are administered through ODOT, the AASHTO standards must be met as a minimum; on local agency projects using local funds, local agencies can adopt AASHTO or the practices recommended in this manual.

Relationship between this document and ADA: All ODOT walkway design standards meet or exceed the minimums set by the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and the proposed Public Right-of-Way Accessibility Guidelines (PROWAG).

Relationship between this document and the MUTCD: Traffic control devices must conform to the “Manual on Uniform Traffic Control Devices” (MUTCD) as supplemented and adopted by the Oregon Transportation Commission. Oregon has developed signing and striping standards for ODOT highways; these are also recommended practices for all Oregon roads. They are contained in the ODOT Traffic Line Manual, the ODOT Sign Policy, and ODOT standard drawings. All signing and striping plans should be reviewed by a traffic engineer.

Relationship between this document, local plans and Transportation System Plans: Designers should consult adopted local TSP's to ensure designs are consistent with local adopted and acknowledged plans and standards; otherwise a local plan amendment is needed.

***Note:*** *Some dimensions referenced in this document (for example travel lane width in relation to bike lane restriping in chapter 2) are for illustration purposes only, and should not be used as roadway design standards.*

## Standards & Minimums

The standards recommended in this manual are best practices; they have been developed to create optimal conditions for most users under most conditions. Whenever possible and appropriate, facilities should be built to standard.

There are situations where standards cannot be met due to geometric or environmental constraints, or may not be appropriate, due to the context. In these circumstances, a reduced dimension may be acceptable; for every standard dimension a minimum is provided. Use of a minimum dimension should be mitigated with other design controls. However, dimensions should not be reduced to the extent that safety and usability are compromised. ODOT and many local agencies have developed processes to be followed when standards can't be met (usually a design exception or concurrence process).

There is always a range between the standard and the minimum, so intermediate values may be used. For example, the standard width for a sidewalk is 6 feet, with a minimum of 5 feet; sidewalks may also be 5.5 feet wide, depending on circumstances. In some circumstances dimensions greater than the standard are appropriate, such as on high-use sidewalks or shared-use paths.

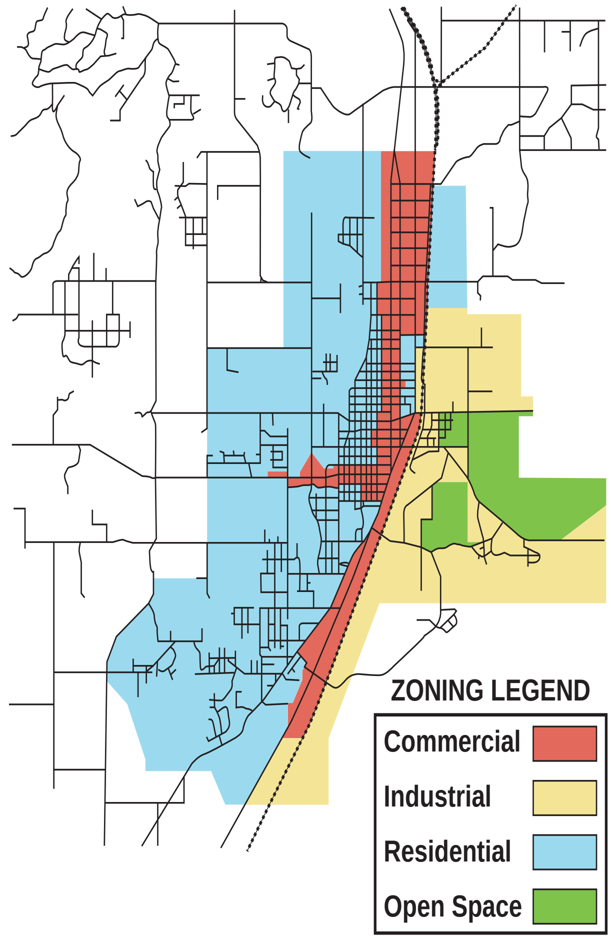



*Figure I-4: Segregated land uses increase travel distances*

## Innovative Designs

There are many innovative designs that facilitate bicycling and walking that are not yet found in existing design manuals. This plan presents ideas that have been implemented successfully in Oregon or elsewhere, to enhance the roadway environment for bicyclists and pedestrians, or to lessen the negative impacts of designs created to improve motor-vehicle flow. These practices are preceded with the following paragraph:

> *"These concepts are presented as information, to help ODOT, cities and counties to come up with new solutions to common problems."*

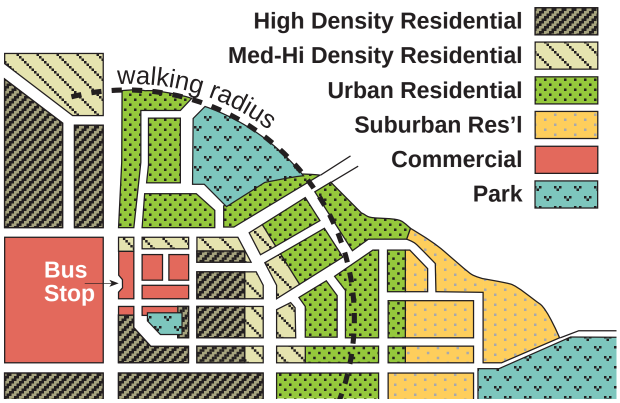



*Figure I-5: Mixed land use fosters walking and bicycling*

# Planning Issues that impact walkway and bikeway design:

## Land Use and Site Design

The ease of bicycling and walking is often determined by land use patterns. Most development patterns built since World War 2 create situations where an automobile is required for most trips, because:

- Segregated land uses increase the distance between origin and destination points;
- Destinations are designed to be readily accessible by automobile with buildings set far back, separated from the roadway with parking; and
- The resulting high traffic volumes and speeds on many streets discourage bicycling and walking.

*Fast food with direct pedestrian access*

Land use and site design patterns conducive to bicycling and walking include:

- **Greater densities,** so more residents live closer to neighborhood destinations such as stores, employment and schools;
- **Mixed-use zoning,** so destinations are closer to residential areas, making it easier to access these facilities on foot or by bicycle;
- **Multiple-use zoning,** where residences and businesses share the same structure, further reducing travel demand;
- **Locating buildings close to the street,** (ideally at the back of sidewalk) for easy access by pedestrians, and to create a sense of enclosure and comfort; and
- **A pleasant environment,** with landscaping, streetscaping and interesting building facades.

Integrating land-use and transportation planning enables new developments to implement these strategies from the onset. Communities planned to support balanced transportation make walking, bicycling and public transit attractive options.

In established communities, many of these goals can be met with in-fill development to increase density, changing zoning laws to allow mixed-use development, changing building codes and site-designs to be more accessible on foot or by bicycle, and building bicycle and pedestrian connections into and through existing, auto-oriented land uses.

## Interconnected Streets

Street patterns with cul-de-sac require a long circuitous route to cover what could be a short distance, increasing out-of-direction travel for what would otherwise be a fairly short bicycle or walking trip. Disconnected streets also result in many short driving trips being made on thoroughfares adjacent to neighborhoods, unnecessarily increasing traffic volumes on these streets, and further degrading conditions for walking and biking.

Interconnected streets offer direct routes with minimal out-of-direction travel; they also allow local trips to be made using a variety of routes, lessening the burden on adjacent thoroughfares. This creates an inherently walkable and bikeable street system.

Discontinuous streets should be linked with through streets or paths. Where the right-of-way is insufficient for a street, or where cul-de-sac are incorporated into a development, paths can be provided for bicycle and pedestrian access.

Retrofitting path connections between neighborhoods can be difficult if adjacent property owners object. Often connections become available when a street is abandoned. A 20 feet easement or right-of way can be established before the street right-of-way is vacated.

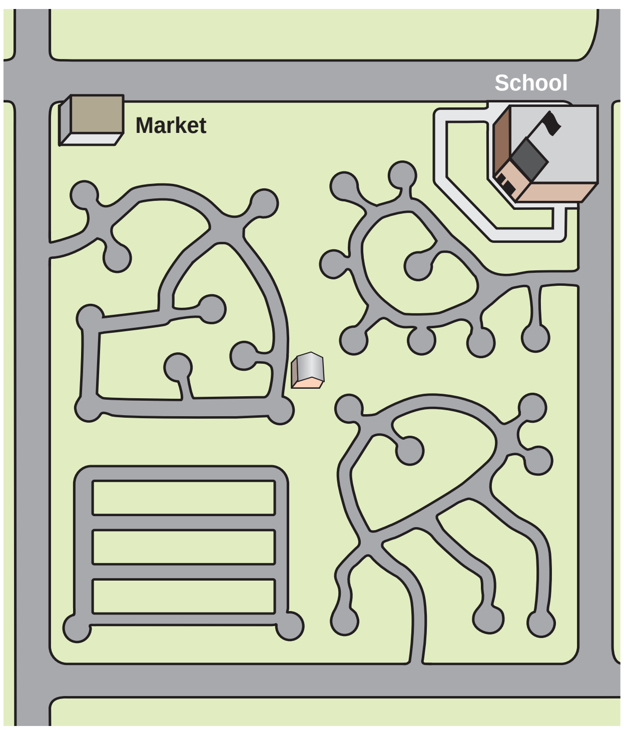



*Figure I-6: Disconnected streets increase travel distances*

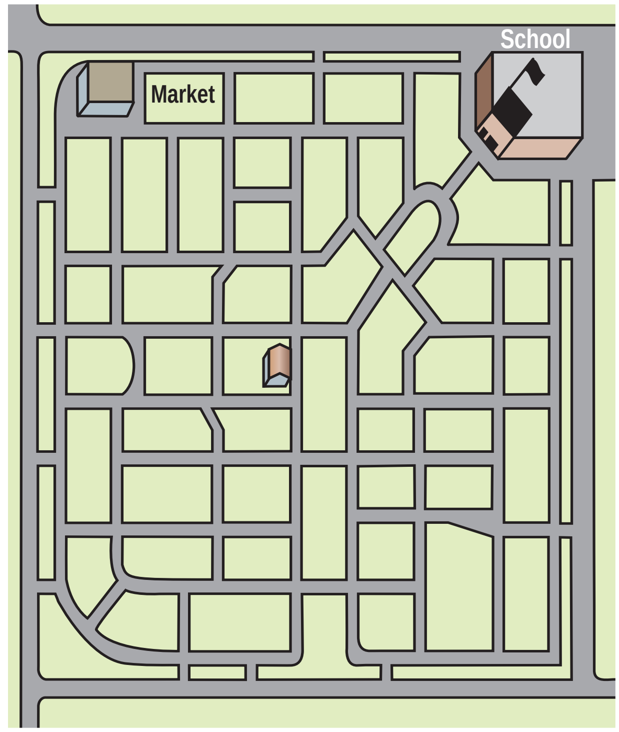



*Figure I-7: Connected streets reduce travel distances, reduce traffic and increase mode choices*

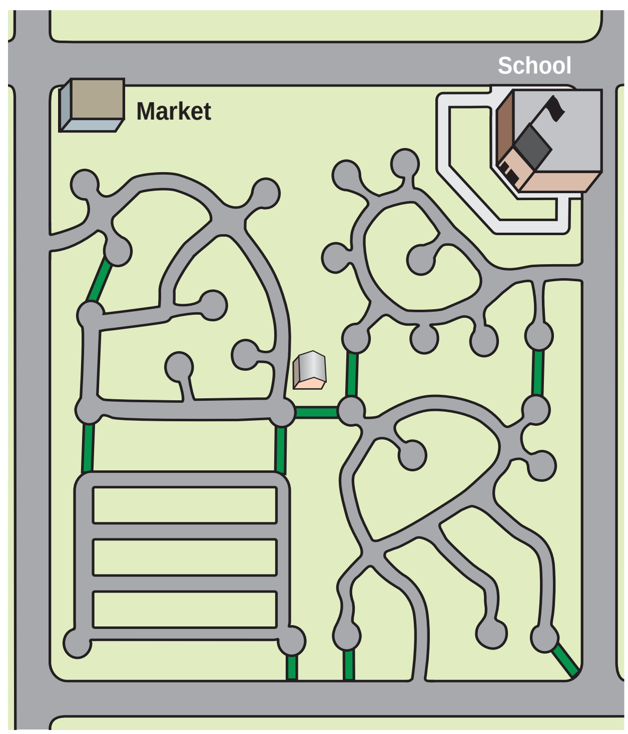



*Figure I-8: Discontinuous streets linked with paths*

## Access Management (AM)

*Unlimited accesses increase conflict points*

### Problems with Uncontrolled Access

Busy urban thoroughfares are often perceived as undesirable for non-motorized travel because of high motor vehicle traffic volumes. Yet conflicts rarely occur with users traveling in the same direction; most conflicts occur at intersections, driveways and alleys. Multiple accesses create conflicts between motor vehicles entering or leaving a roadway and bicyclists and pedestrians riding or walking along the roadway. Pedestrians crossing a roadway require gaps in traffic, but with unlimited access, vehicles entering the roadway quickly fill available gaps. Bicyclists and pedestrians are vulnerable if motorists fail to see or yield to them.

### Benefits of AM to Bicyclists & Pedestrians

The three basic access management techniques (limiting and consolidating driveways, providing raised medians, creating frontage roads) can benefit bicyclists and pedestrians in several ways:

- The number of conflict points is reduced; this is best achieved by replacing a center-turn lane with a raised median, as left turns

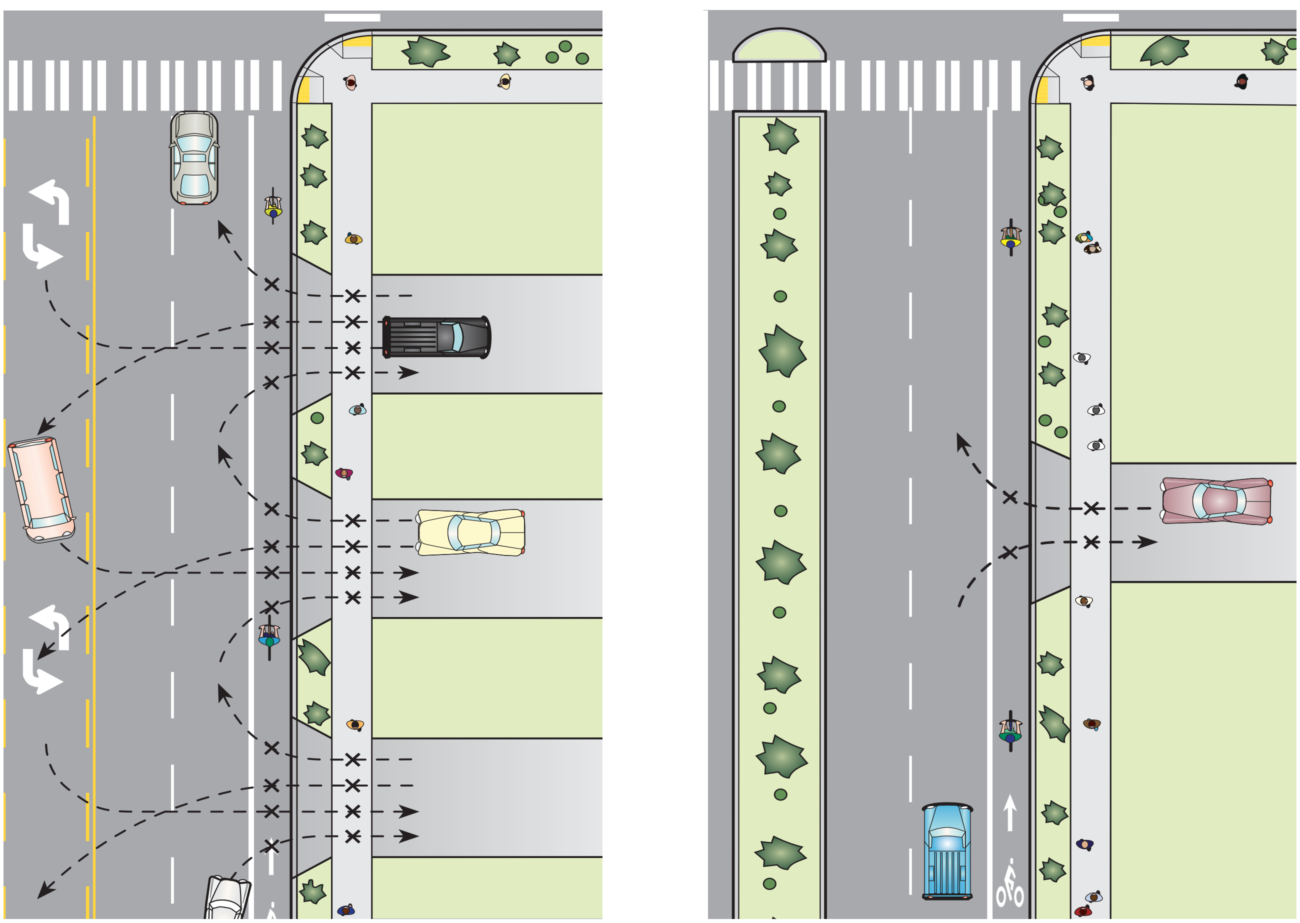


*Figure I-9: Consolidating accesses reduces conflict points, benefitting pedestrians, bicyclists and drivers.*

account for a high number of crashes for all users (drivers, bicyclists and pedestrians);

- Motor vehicles are redirected to intersections with appropriate control devices;
- Pedestrian crossing opportunities are enhanced with a raised median and fewer conflicts with turning cars;
- ADA compliance is easier, as the need for special treatments at every driveway is reduced; and
- Improved traffic flow may reduce the need for road-widening, allowing part of the right-of-way to be recaptured for bicyclists, pedestrians and other users.

While new roads can be designed using these principles, it is more difficult to retroactively reduce, consolidate or eliminate existing accesses. Yet this is an important strategy to make existing roads more attractive to bicyclists and pedestrians.

### AM Outcomes That Hinder Walking and Bicycling

The following issues must be considered and addressed when implementing access management:

- Streamlining a thoroughfare may increase traffic speeds and volumes;
- Reduced access to businesses may require out-of-direction travel, discouraging walking and bicycling; and
- Improperly designed raised medians act as barriers: pedestrians should be able to see to the other side of the street (vegetation should not decrease visibility) and curbs should be no more than standard height. Concrete barriers and tubular markers, for example, completely prohibit crossings.

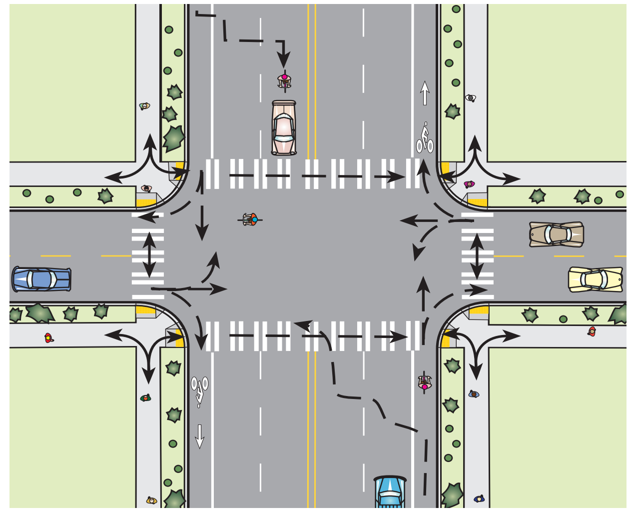


*Figure I-10: Allowable movements at an intersection*

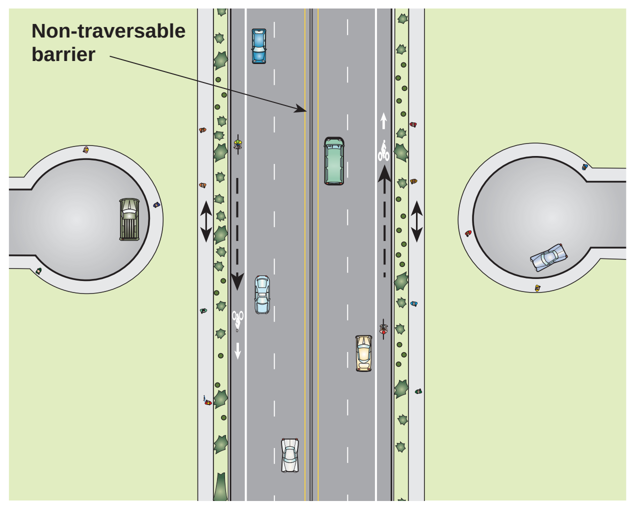



*Figure I-11: Severed connection eliminates conflicts.*

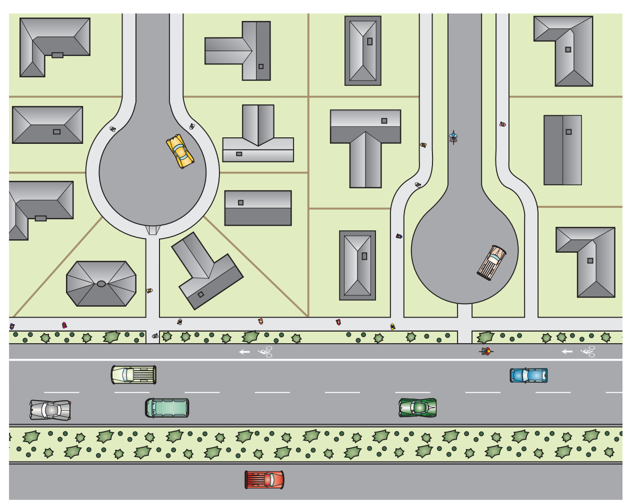


*Figure I-12: Pedestrian and bicycle connections can be preserved*

### AM and Street Connectivity

Limiting the number of street connections has a negative impact on walking and bicycling, as eliminating local street intersections eliminates pedestrian crossing opportunities, reduces pedestrian and bicycle travel choices, and increases out-of-direction travel. Wherever possible connections should be reestablished with pathways.

Where limited access thoroughfares exist in urban areas, safe and frequent grade-separated crossings should be provided, and parallel local streets should be improved for bicycle and pedestrian circulation.

## Public Transit

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.

Transit users need to cross the road safely at stops: on a street with residences and/or development on both sides, half the riders will need to cross a road when boarding or exiting a bus. Since there is an element of risk in crossing busy streets, crossing safety should be a primary consideration at transit stops. The safety of pedestrians can also be enhanced by consolidating, relocating or eliminating stops. These transit operation improvements are usually implemented by the transit agency in cooperation with the road authority.

Access to transit also involves selecting the right location for stops, especially for bus stops located on surface streets. Choosing transit stop locations for buses, light rail and Bus Rapid Transit is a complicated task, as each location must take into account three factors:

- **Passengers**: stops must be near places where there's an expectation of riders;
- **Access**: if a stop can't be located right where riders are, they must be able to get to the stop conveniently; and
- **Traffic characteristics**: buses can't always stop where riders want to be because of complex traffic patterns, especially at intersections.

Convenient access by passengers must remain at the forefront of all transit stop planning: simply eliminating stops because they are perceived as unsafe will not be satisfactory to riders who cannot walk very far. Better approaches are to make access and crossing improvements at existing stops that serve passengers well, or to relocate them to a safer and more accessible location within a reasonable walk.

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.

Bus stops should be placed in locations that are readily accessible by pedestrians, or that can be made accessible by changing the configuration of adjacent land use. This can be done by:

- Orienting building entrances to the transit stop or station;
- Clustering buildings around transit stops; and
- Locating businesses close to transit stops.

Regional and statewide public transportation systems benefit from bicycle facilities such as:

- Accommodating bicycles on buses and trains;
- Bikeways leading to stations, transit centers and park-and-ride lots; and
- Providing secure bicycle parking at these locations.


*Well planned and situated bus stop*

# Chapter 1: On-Road Bikeways

*A high volume urban street with bike lanes.*

## Types of Bikeways

Bicycles are legally classified as vehicles and are ridden on most public roads in Oregon, which are open to bicycle traffic with a few exceptions (mostly the freeways in the metropolitan area of Portland).

Roadways must be designed to allow bicyclists to ride in a manner consistent with the vehicle code.

A bikeway exists on any road that has the appropriate design treatment to accommodate bicyclists, based on motor vehicle traffic volumes and speed. The basic design treatments used for bicycle travel on roads are shared roadway, shoulder bikeway, or bike lane. A shared-use path is a facility separated from the roadway.

Bikeway types (listed with no implied order of preference):

**Shared Roadway:** Bicyclists and motorists ride in the same travel lanes. There are no specific dimensions for shared roadways. They are usually narrow, so a motorist has to cross over into the adjacent travel lane to pass a cyclist. Shared roadways are common on neighborhood residential streets, on rural roads and low-volume highways.

**Bicycle Boulevards:** The operation of a local street is modified to function as a through street for bicyclists while maintaining local access for automobiles. Traffic calming devices control traffic speeds and discourage through trips by automobiles. Traffic controls limit conflicts between automobiles and bicyclists and give priority to through bicycle movement.

**Shoulder Bikeway:** A shoulder bikeway is a paved shoulder that provides a suitable area for bicycling, reducing conflicts with faster moving motor vehicle traffic. Most bicycle travel on the rural state highway system, and on many county roads, is accommodated on shoulder bikeways.

**Bike Lane:** A portion of the roadway designated for preferential use by bicyclists. Bike lanes are appropriate on busy urban thoroughfares. They may be used on other streets where bicycle travel and demand is substantial. Bike lanes are marked to call attention to their preferential use by bicyclists.

**Shared-Use Path (formerly called bike path or multi-use path):** A facility separated from motor vehicle traffic by an open space or barrier, either within the roadway right-of-way or within an independent right-of-way. These are typically used by pedestrians, joggers, skaters and bicyclists. Shared-use paths are appropriate in corridors not well served by the street system, to create short cuts that link origin and destination points and as elements of a community trail plan. See *Chapter 7* for design standards.

## Urban/Suburban Bike Facility Separation Matrix

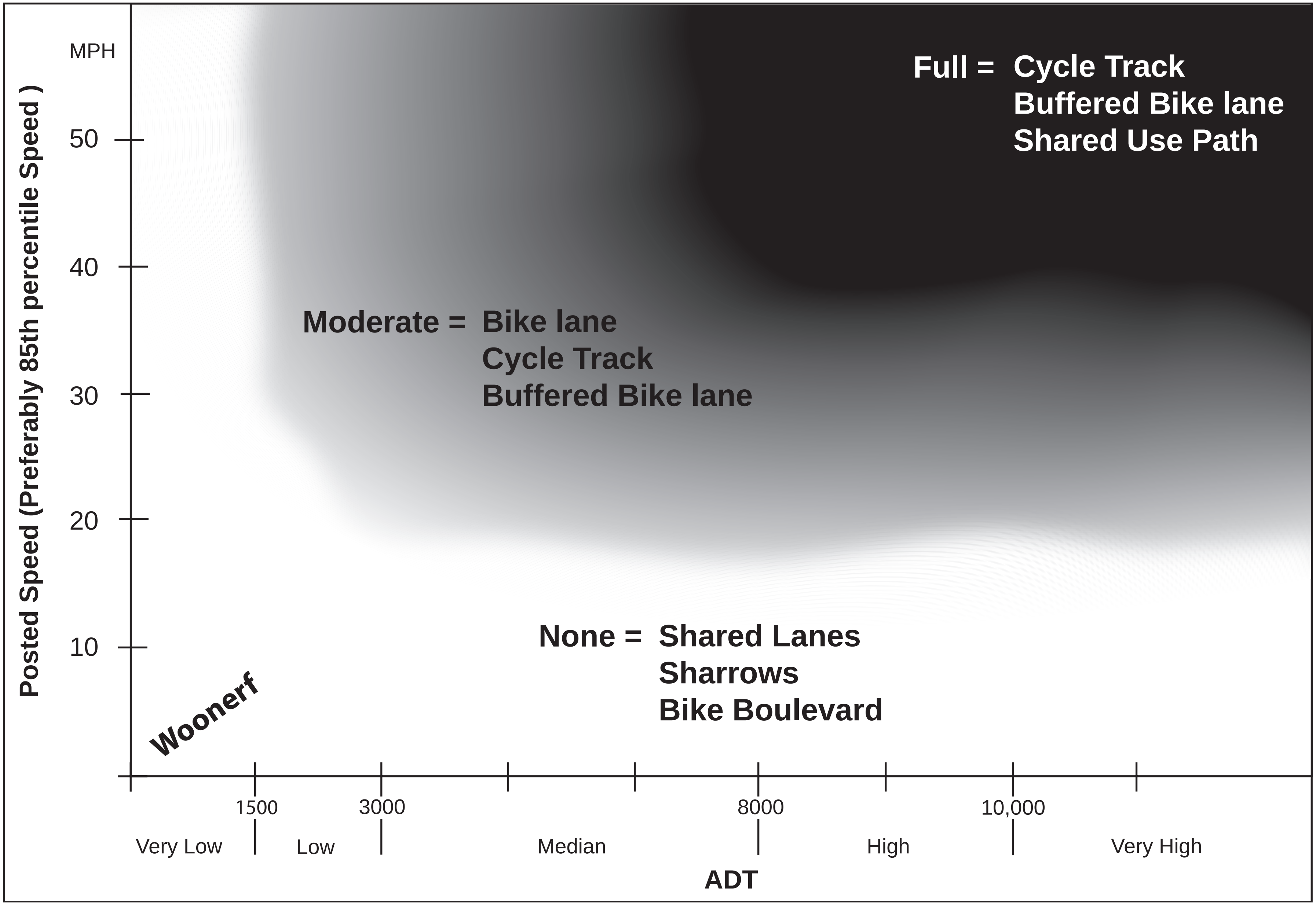
What level of separation is needed in urban/ suburban settings?

*(Refer to Table 1-2 for shoulder recommendations on rural roadways)*

The need for bike facility separation from traffic increases as motor vehicle traffic volumes increase. The chart page 1-3 can be used to determine when what level of separation is needed. When speed and volume intersect in a gray area, use Table 1-1 to guide decision-making: assess as many of the indicators in the matrix as possible. If they overwhelmingly point to an increased or decreased need for separation, the decision is made easier. In situations that are not clear-cut, many other factors should be considered and weighed, along with good judgment. Neither the chart nor the matrix should be used as absolutes.

**Note: Cycle tracks are appropriate in some urban and suburban contexts, but they are not yet widely used in Oregon. Over the life of this document it is expected that planning, design and implementation information will grow and that more cycle tracks will be built. Thus they are included in this guidance.*

## Urban/Suburban Recommended Separation Matrix



| Context | Need for Separation |
|---|---|
| **1. Land Use indicators** | |
| Urban Center, CBD | Decreases |
| Suburban | Increases |
| Buildings at back of sidewalk | Decreases |
| Buildings set back from roadway (parking lots front street) | Increases |
| On Street Parking | Decreases |
| Short block length | Decreases |
| Long block length | Increases |
| **2. Traffic speed/volume indicators** | |
| Signal coordination timed at higher than posted speeds | Increases |
| Signal coordination timed at lower than posted speeds | Decreases |
| Peak Hourly Traffic Volume greater than 10% | Increases |
| **3. Roadway characteristics** | |
| Wide roadway / multiple travel lanes | Increases |
| Steep grades: uphill | Increases |
| Steep grades: downhill | Decreases |
| **4. Bicycling demand indicators** | |
| Popular Route to School | Increases |
| Provides continuity of bike lanes, routing or trail | Increases |
| Other high-use indicators | Increases |

*Table 1-1: Separation Context matrix*

**Discussion**

Land Use influences traffic patterns and the comfort and confidence of bicyclists. Urban centers, with narrower travel lanes, buildings at the back of walk and on-street parking give cues to motorists to pay more attention to their environment and to slow down. Wide suburban streets with few potential risks to drivers increase motor vehicle speeds and decrease driver vigilance.

Buildings Setbacks determine a human scale streetscape. Buildings at the back of walk reduce motor vehicle speeds and provide direct access to destinations; under these conditions, bike lanes are less needed. Buildings set back from the roadway, with parking in front, create conditions (lowered driver vigilance, speeding) whereby bike lanes should be provided.

On-Street Parking benefits bicyclists and pedestrians by reducing motor vehicle speeds. The benefit is lower if on-street parking is under utilized, due to ample off-street parking.

- Note: building setbacks and on-street parking interrelate: buildings at the back of walk and on-street parking go hand-in-hand.

Block Length Urban centers have shorter blocks and suburban areas have longer blocks. Bike lanes are more necessary where blocks are long, as riders need to travel further on the thoroughfare to access destinations.

Prevailing Speed is related to posted speed, but drivers will drive faster if the roadway cues allow them to. Speed studies are often not practical for planning purposes; therefore the chart relies on posted speed. However, if the travel speed is known to be higher or lower than the posted speed, that information should be used to determine if bike lanes are needed.

Signal Coordination Signals timed at 25 MPH or less allow bicyclists to share the travel lane with motor vehicles; signals timed at greater than 30 MPH make sharing more difficult.

Peak Hourly Traffic Volume If a roadway with moderate traffic volumes experiences an intense peak for a sustained period of time, bike lanes are needed to provide room during this period.

Roadway Width/ Number of Travel Lanes influence the behavior of drivers and the comfort and confidence of bicyclists. Wide travel lanes and multi-lane roads increase the likelihood of speeding by drivers, decreasing the desirability of lane sharing by bicyclists.

Steep Grade Bicyclists travel uphill slowly and tend to meander. If constraints allow only one bike lane, it should be placed in the uphill direction.

Bicycle Demand is always a good reason to provide bike lanes, but lack of adequate bicycling facilities may mask a potential demand. School route, parks or community centers are reasons to favor providing a bike lane. Route continuity can be used to justify short segments of bike lanes that connect other bike lanes or a discontinuous trail.

**Trade-offs: do you force bike lanes or change the context?**

If the matrix indicates a need for bike lanes and there is simply no room for bike lanes, or the trade-offs are too burdensome, one option is to change the context so a shared roadway is more acceptable. For example, when there is a trade off between on-street parking and bike lanes, bike lanes can be eliminated if motor vehicle speeds can be reduced to less than 25 MPH, and if on-street parking is sufficiently utilized. For long segments (10 blocks or more) where constraints don't allow for bike lanes, another option is to provide a parallel route; the alternate route should be improved to favor bicycle travel (e.g. a bike boulevard).

# Design Standards

## Shared Roadways

Shared roadways are the most common bikeway type. There are no specific bicycle standards for most shared roadways. Most are fairly narrow; they are simply the roads as constructed.

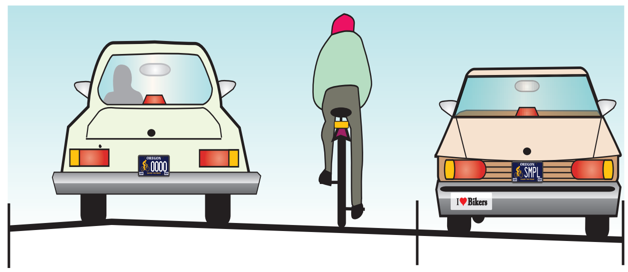


*Figure 1-1: Shared roadway*

Shared roadways are suitable in urban areas on streets with low motor vehicle speeds or traffic volumes, and on low-volume rural roads and highways. The suitability of a shared roadway decreases as motor vehicle traffic speeds and volumes increase, especially on rural roads with poor sight distance. See Bike Lane Matrix for suitability of shared roadways based on motor vehicle speeds, volumes and context.

*Low volume residential shared roadway*

On rural roads with high bicycle use or demand, roads should include shoulders where motor vehicle speeds and volumes are high.

*Street too busy for shared roadway*

Many urban local streets carry excessive traffic volumes at speeds higher than they were designed to carry. These can function better as shared roadways if traffic speeds and volumes are reduced. There are many traffic-calming techniques that can make these streets more amenable to bicycling on the road.

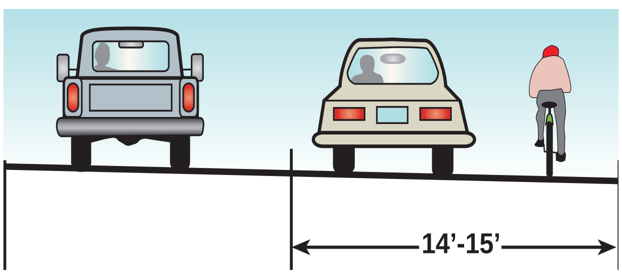



*Figure 1-2: Wide curb lane*

On major streets where a bike lane would be more appropriate, but with insufficient width for bike lanes, wide curb lanes may be provided. This may occur on retrofit projects where there are physical constraints, and all other options have been pursued, such as removing parking or narrowing travel lanes. Wide curb lanes are not particularly attractive to most cyclists; they simply allow a passenger vehicle to pass cyclists within a travel lane, if cyclists are riding far enough to the right. Wide curb lanes may also encourage higher motor vehicle speeds, which is contrary to the expressed desires of many residents; wide lanes should never be used on local residential streets. A wide lane should be 14 to 15 feet wide to allow a passenger car to pass a cyclist in the same lane. Widths 16 feet or greater encourage the undesirable operation of two motor vehicles in one lane. In this situation, a bike lane should be striped.

## Bicycle Boulevards

The bicycle boulevard is a refinement of the shared roadway concept; the operation of a local street is modified to function as a through street for bicyclists while maintaining local access for automobiles:

- Traffic-calming devices reduce motor vehicle speeds and through trips; and
- Traffic controls limit conflicts between motorists and bicyclists and give priority to through bicyclist movement.

### Advantages of Bicycle Boulevards

1. Opportunity: traditional street grids offer local streets that can be converted to bicycle boulevards;
2. Bicycle travel on local streets is compatible with local land uses;
3. Bicycle boulevards may attract cyclists who do not feel comfortable on busy streets and prefer to ride on lower traffic streets;
4. Traffic calming techniques are favored by residents who want slower traffic on neighborhood streets; and
5. Bicycle boulevards can improve conditions for pedestrians, with reduced traffic and improved crossings.

Successful bicycle boulevard implementation requires careful planning with residents and businesses to ensure acceptance.

### Elements of a Bicycle Boulevard

A successful bike boulevard project requires:

1. Selecting a direct and continuous street, rather than a circuitous route that winds through neighborhoods. Bike boulevards work best on a street grid system;

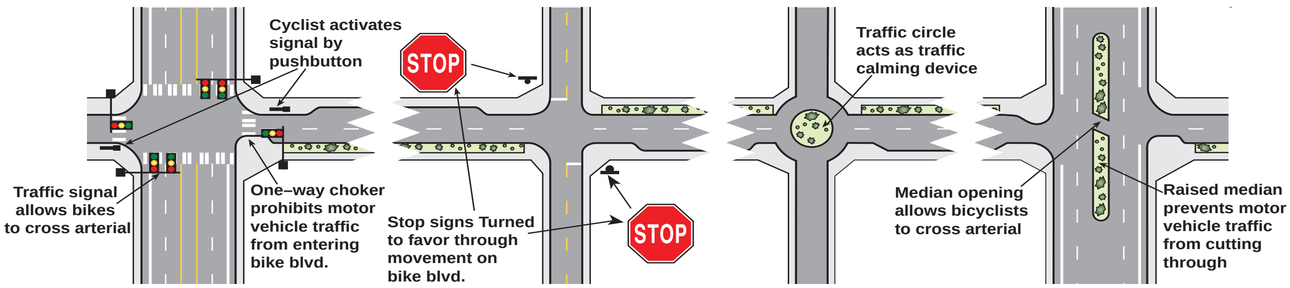



*Figure 1-3: Elements of a bicycle boulevard*

2. Placing motor vehicle traffic diverter at key intersections to reduce through motor vehicle traffic (diverters are designed to allow through bicyclist movement);
3. Turning stop signs towards intersecting streets, so bicyclists can ride with few interruptions;
4. Placing traffic-calming devices on streets to lower motor vehicle traffic speeds;
5. Placing directional signs or markings to route cyclists to key destinations, to guide cyclists through difficult situations, and to alert motorists of the presence of bicyclists; and
6. Providing crossing improvements where the boulevard crosses high-speed/high-volume streets such as:
   - Signals, where a traffic study has shown that a signal will be safe and effective. To ensure that bicyclists can activate the signal, loop detection should be installed where bicyclists ride and/or a push button that won't require dismounting; or
   - Median refuges, wide enough to provide a refuge (8 feet min) and with an opening wide enough to allow bicyclists to pass through (6 feet). The design should allow bicyclists to see the travel lanes they must cross.


*Traffic diverter limits motor vehicle traffic while allowing bicycles to proceed thru*

*Bicyclist waits at island to cross busy street*


*Mini circle slows traffic, creating conditions needed for shared roadway*

### Potential bicycle boulevard implementation problems

Problems can arise under these conditions:

1. If they're discontinuous and/or located on streets that do not provide direct access to commerce and other destinations, cyclists will have to negotiate a more hostile street environment to complete portions of their trip. *Bike boulevards must be continuous and close to corridors that serve many destinations; short connections may have to be built to provide continuity and access.*
2. They can cause motor vehicle traffic diversion onto other streets. *Neighborhood concerns must be properly addressed.*
3. Failure to provide adequate crossings of busy streets can result in unsafe conditions for bicyclists. *The planning phase must develop realistic and fundable strategies for crossings of busy streets.*

## Shoulder Bikeways

Besides giving an area for cyclists to ride, paved shoulders are provided on rural highways for a variety of safety, operational and maintenance reasons such as:

- Motorists can stop out of traffic in case of emergency, or escape potential crashes; and
- Storm water can be discharged farther from the motor vehicle travel lanes, helping to preserve the pavement.

### Width

In general, the shoulder widths recommended for rural highways in the ODOT Highway Design Manual serve bicyclists well; HDM Table 7-2 should be used when determining shoulder widths:

| Average Daily Traffic | < 400 | 400-1500 | 1500-2000 | > 2000 |
|---|---|---|---|---|
| Rural Arterials | 4' | 6' | 6' | 8' |
| Rural Collectors | 2' | 5' | 6' | 8' |
| Rural Local Roads | 2' | 5' | 6' | 8' |

*Table 1-2: Rural road shoulder widths*

When providing shoulders for bicycle use, a width of 6 feet is recommended. This allows a cyclist to ride far enough from the edge of pavement to avoid debris, yet far enough from passing vehicles to avoid conflicts. If there are physical width limitations, a minimum 4 foot shoulder may be used.

Shoulders adjacent to a curb face, guardrail or other roadside barriers must be 5 feet wide, as cyclists will "shy" away from a vertical face. Shoulders adjacent to a curb should have 4 feet of pavement from the longitudinal joint at the gutter pan. Curbed sections usually indicate urban conditions, where shoulders should be striped as bike lanes.

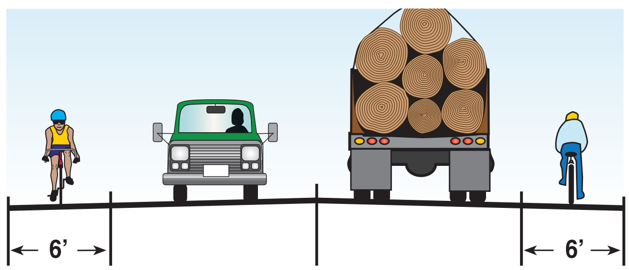



*Figure 1-4: Shoulder bikeway*

On steep uphill grades, it is desirable to maintain a 6-feet (min. 5-feet) shoulder, as cyclists need more space for maneuvering.

*Note: many rural roads are 28 feet wide, with fog lines striped at 11 feet from centerline. The remaining 3 feet should not be considered a shoulder bikeway (min. 4 feet); these are shared roadways, as most cyclists will ride on or near the fog line. But they provide an enjoyable riding experience where traffic volumes are low to moderate.*

### Pavement Design and Construction

Many existing gravel shoulders have sufficient width and base to support shoulder bikeways. Minor excavation and the addition of 3-4 inches of asphaltic concrete is often enough to provide shoulder bikeways. Pavement overlays provide the best opportunity to widen shoulders for several reasons:

- The base lift of asphalt adds structural strength;
- The final, full width lift is smooth, with no joint; and
- The unit costs are less, as greater quantities of materials will be purchased.

*Higher volume rural road with shoulders*

When shoulders are provided as part of new road construction, the pavement structural design should be the same as that of the roadway.

On shoulder-widening projects, there may be some opportunities to reduce costs by building to a lesser thickness if the following conditions are met:

- There are no planned widening projects for the road section in the foreseeable future;
- The existing shoulder and roadbed are stable and there is adequate drainage;
- The existing travel lanes are in stable condition and of adequate width;
- The horizontal curvature is not excessive, so the wheels of large vehicles do not track onto the shoulder; and
- The existing and projected ADT and heavy truck traffic are not excessive.

The thickness of pavement and base material will depend upon local conditions, and engineering judgment should be used. If there are short sections where the travel lanes must be reconstructed or widened, these areas should be constructed to normal full-depth standards.

### Joint between the shoulders and the existing roadway

The following techniques should be used to add paved shoulders to roadways where no overlay project is scheduled; in all cases the joint should not land in the shoulder, where bicyclists ride:

1. **Saw Cut:** A saw-cut inside the existing edge of pavement provides the opportunity to construct a good tight joint. This eliminates a ragged joint at the edge of the existing pavement.

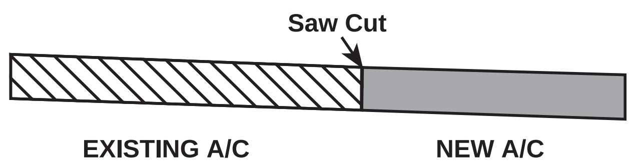



*Figure 1-5: Saw cut before adding shoulder*

2. **Feathering:** Feathering the new asphalt onto existing pavement works if a fine mix is used and the feather does not extend across the area traveled by bicyclists.

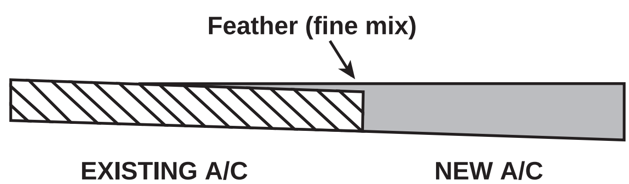



*Figure 1- 6: Feathering a shoulder*

3. **Grinder:** Where there is already some shoulder width and thickness available, a pavement grinder can be used to make a clean cut at the edge of travel lane, grind the existing asphalt to the right depth and cast aside the grindings in one operation, with these advantages:
   - Less of the existing pavement is wasted;
   - The existing asphalt acts as a base;
   - There will not be a full-depth joint between the travel lane and the shoulder; and
   - The grindings can be recycled as base for the widened portion.

New asphalt can then be laid across the entire width of the shoulder bikeway with no seams.

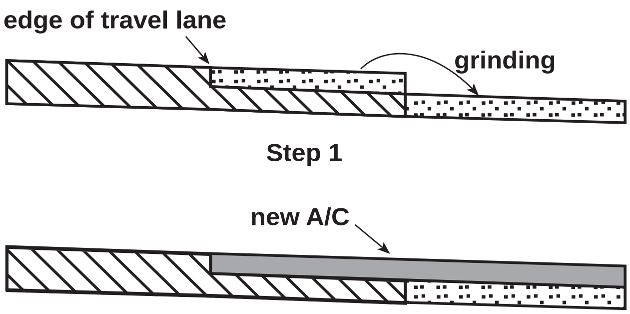



*Figure 1-7: Grinding and inlaying a shoulder*

In all cases care must be taken to avoid a rough joint in the area where cyclists ride.

### Gravel Driveways and Approaches

Wherever a highway is constructed, widened or overlaid, all gravel driveways and approaches should be paved back to prevent loose gravel from spilling onto the shoulders. ODOT standards are 20 feet for driveways, 30 feet for public road approaches.

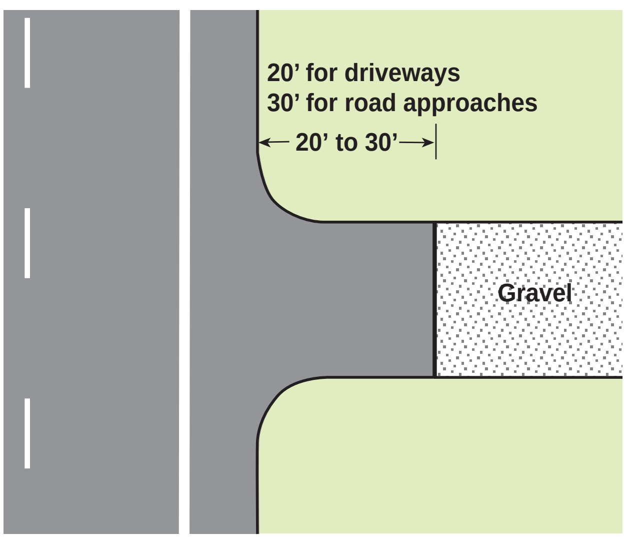



*Figure 1-8: Gravel driveway paved to limit gravel on shoulders*

Where possible, the paved section of the approach to the highway should be sloped downward away from the highway to reduce the loose material tracked on the shoulder.

*Paved driveway apron keeps gravel off shoulder*

## Bike Lanes

Bike lanes are a portion of the roadway designated for preferential use by bicyclists, and are provided on busy urban and suburban streets (arterials and some collectors). Motorists are prohibited from using bike lanes for driving and parking, but may use them for emergency avoidance maneuvers or breakdowns. Refer to the DMV "Oregon Motorized Scooter Pocket Bike Guide" for a list of vehicles allowed and prohibited in bike lanes *http://www.oregon.gov/ODOT/DMV/docs/pocketbikeguide.pdf*.

*Typical bike lane on urban higher speed/ volume roadway*

Bike lanes may also be provided on rural roadways near urban areas, where there is high bicycle use. Bike lanes are generally not recommended on local streets with relatively low traffic volumes and speeds. In this case a shared roadway is the appropriate facility. Urban arterials should have paved shoulders. Bike lanes are created by adding an 8 inches stripe and stencils.

Bike lanes are generally not recommended on high-speed rural highways; at channelized intersections, the speeds are too high to place a through bike lane to the left of right-turning vehicles (see Chapter 4, Intersection Design). Shoulder bikeways, striped with a 4 inches fog line, are the appropriate facility for these roads.

For planning purposes, refer to the Bike Lane Matrix on page 1-3 to determine whether bike lanes are needed or appropriate for any given roadway.

Advantages of bike lanes:

- Bike lanes enable cyclists to ride at a constant speed, even when traffic in the adjacent travel lanes speeds up or slows down, for example at intersections.
- Bike lanes enable bicyclists to position themselves where they will be visible to motorists.
- Bike lanes encourage cyclists to ride on the streets rather than the sidewalks.

Bike lanes are one-way facilities that carry bicycle traffic in the same direction as adjacent motor-vehicle traffic. Bike lanes should always be provided on both sides of a two-way street. One exception may be on steep hills where topographical constraints limit the width to a bike lane on one side only; in these cases, a bike lane in the uphill direction is acceptable as cyclists ride slower uphill. They can ride in a shared lane in the downhill direction.

### Width

The standard width of a bike lane is 6 feet, as measured from the center of stripe to the curb or edge of pavement. This width enables cyclists to ride far enough from the curb to avoid debris and drainage grates, yet far enough from other vehicles to avoid conflicts. By riding away from the curb, cyclists are more visible to motorists than when hugging the curb.

The minimum bike lane width is 4 feet on open shoulders, or 5 feet from the face of a curb, guardrail or parked cars. A 4-foot (min 3 feet) wide smooth asphalt surface should be provided to the left of a longitudinal joint between asphalt pavement and the concrete gutter section. It is preferable to pave the bike lane to the curb face to avoid a longitudinal joint in the bike lane.

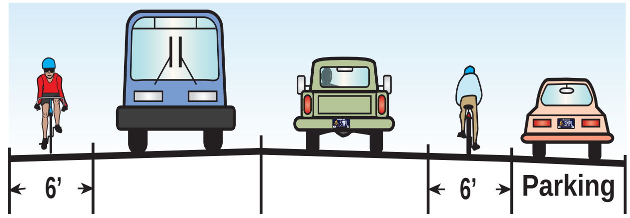



*Figure 1-9: Typical bike lane dimensions*

Shoulders wider than 6 feet may be marked as bike lanes in areas of very high use, on high-speed facilities where wider shoulders are warranted, or where they are shared with pedestrians. Care must be taken so they are not mistaken for a motor vehicle lane, turn lane or parking area, with adequate marking or signing.

A bike lane should be marked with pavement stencils and an 8 inches stripe. This width increases the visual separation of a motor vehicle lane and a bike lane. The 8-inch white stripe is a legal requirement in Oregon (OAR 734-20-055). Refer to page 1-19 for bike lane marking standards.

If on-street parking is permitted, the bike lane must be placed between parking and the travel lane, and be at least 5 feet wide.

### Bike Lanes on One-way Streets

Bike lanes on one-way streets should be on the right side of the roadway and should always be provided on both legs of a one-way couplet. The bike lane may be placed on the left of a one-way street if it decreases the number of conflicts, e.g., those caused by heavy bus traffic or dual right-turn lanes, and if cyclists can safely and conveniently transition in and out of the bike lane on the left. (See *Chapter 6* for detailed information on bike lane configurations at intersections.)

*Bike Lane on one way street*

## Contra-Flow Bike Lanes

Though riding against traffic on a one-way street is illegal, many cyclists do this if it avoids circuitous out-of-direction travel; in other instances cyclists are observed riding on the sidewalk against the flow of traffic. Rather than condone or try to prohibit these movements, contra-flow bike lanes on a one-way street should be considered under the following circumstances:

- The contra-flow bike lane provides a substantial savings in out-of-direction travel and/or direct access to high-use destinations.
- Safety is improved because of reduced conflicts compared to the longer route.
- There are few intersecting driveways, alleys or streets on the side of the contra-flow lane.
- Bicyclists can safely and conveniently transition in and out of the bike lane at either end of the block.
- The street is wide enough for a bike lane.

A contra-flow bike lane may also be appropriate on one-way residential streets; this allows cyclists to access the street in both directions.

For a contra-flow bike lane to function well, these features should be incorporated into the design:

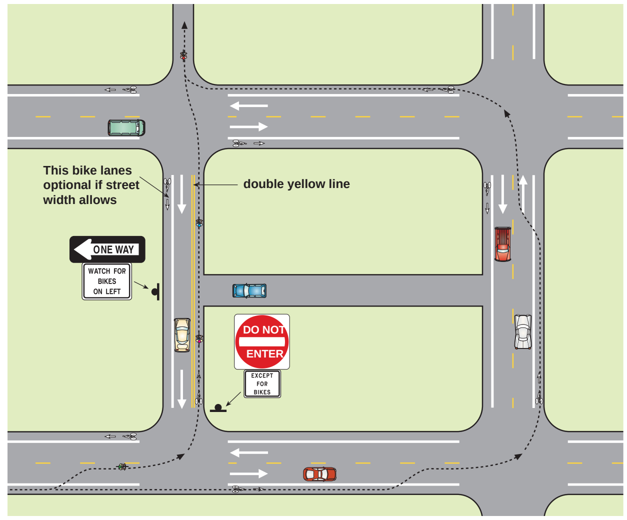



*Figure 1-10: Contra-flow bike lane reduces out of direction travel*

- The contra-flow bike lane must be placed on the right hand side of the street (to motorists' left), separated from on-coming traffic by a double yellow line. This establishes two-way operation for bicyclists, who are riding on the street legally, in a dedicated travel lane.
- Bike lane stencils and arrows must be used to clearly indicate direction of travel, and to discourage cyclists from using the bike lane against the normal traffic flow.
- Intersecting alleys, major driveways and streets must have signs indicating to motorists that they should expect two-way bicycle traffic.

*Contra-flow bike lane: One way for cars, two way for bicycles*

Existing traffic signals should be fitted with special signal heads for bicyclists; this can be activated with either loop detectors or push-buttons (these should be easily reached by bicyclists without having to dismount).

*Notes:*

1. *Where there is insufficient room to provide a bike lane in each direction, it is not necessary to provide a bike lane in the direction of prevailing traffic; bicyclists and motorists can share the road.*
2. *A contra-flow bike lane should not be installed on a two-way street, even where the travel lanes are separated with a raised median.*

## Bike Lanes and Diagonal Parking

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 on state highways.*

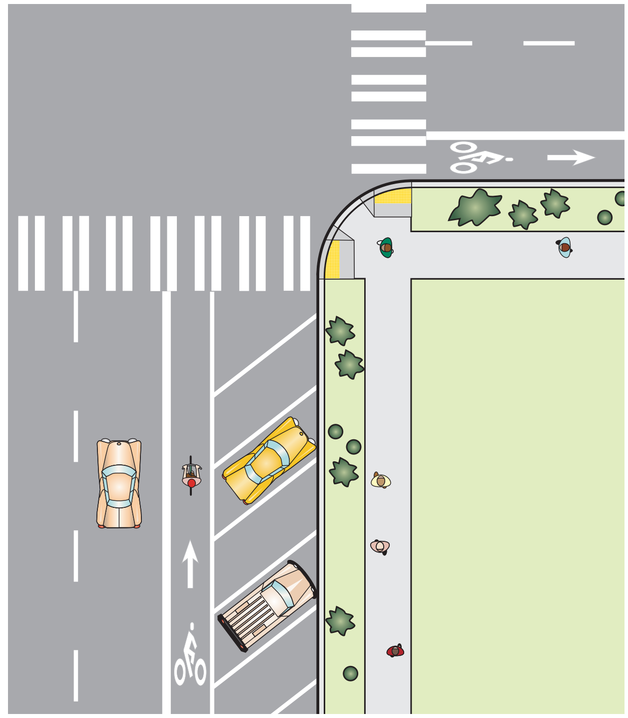


*Figure 1-11: Bike lane next to diagonal parking*

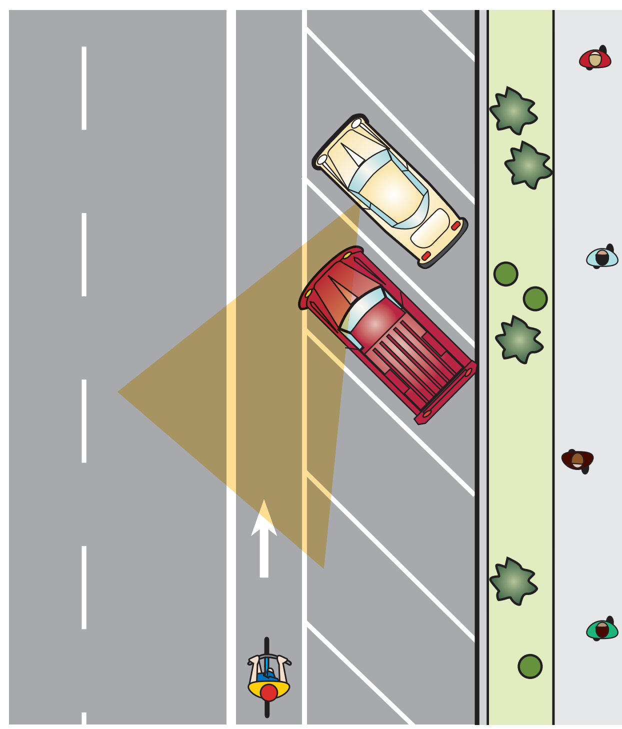


*Figure 1-12: Back in diagonal parking and bike lane*

## Bike Lanes & Bus Lanes

In most instances, bicycles and buses can share the available road space. On routes heavily traveled by both bicyclists and buses, separation can reduce conflicts (stopped buses hinder bicycle movement and slower moving bicycles hinder buses).

Separate bus lanes and bike lanes should be considered to reduce conflicts between passengers and bicyclists, with the bus lane at the curb side. Buses will be passing bicyclists on the right, but the fewer merging and turning movements reduce overall conflicts.

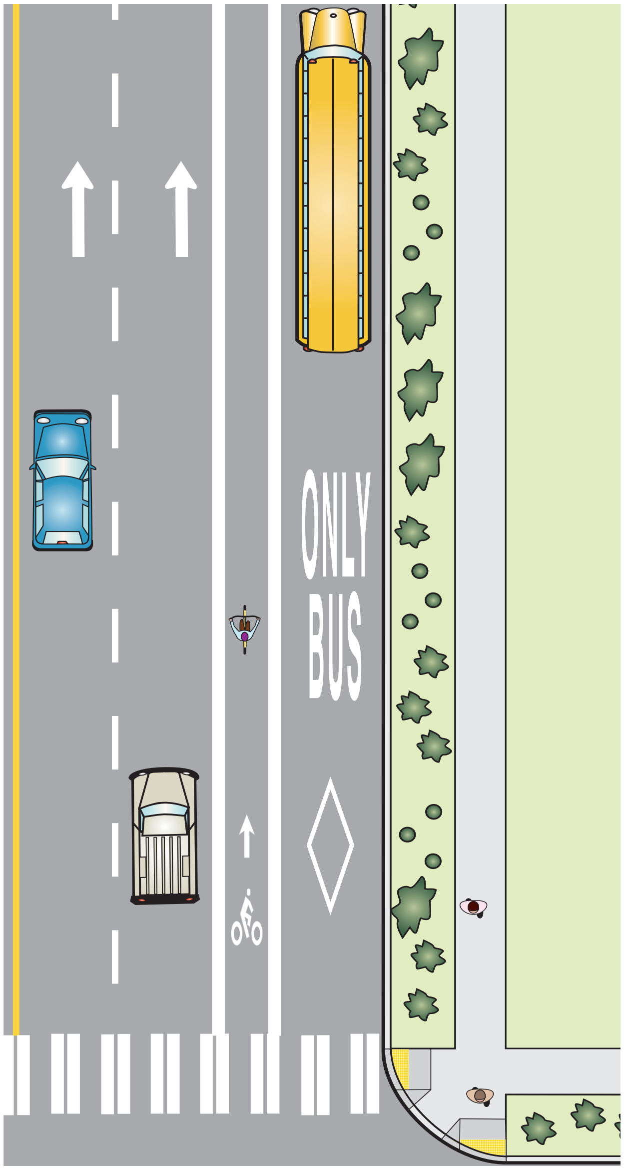



*Figure 1-13: Bike lane to the left of bus lane*


*Bike lane to left of bus lane*

## Colored Bike Lanes

Residents often express a desire to narrow a roadway to slow traffic, and so the highway has less of a visual impact on the community. Bike lanes can make a road look wider. To mitigate this effect, bike lanes can be colored so the motor vehicle space appears narrower.

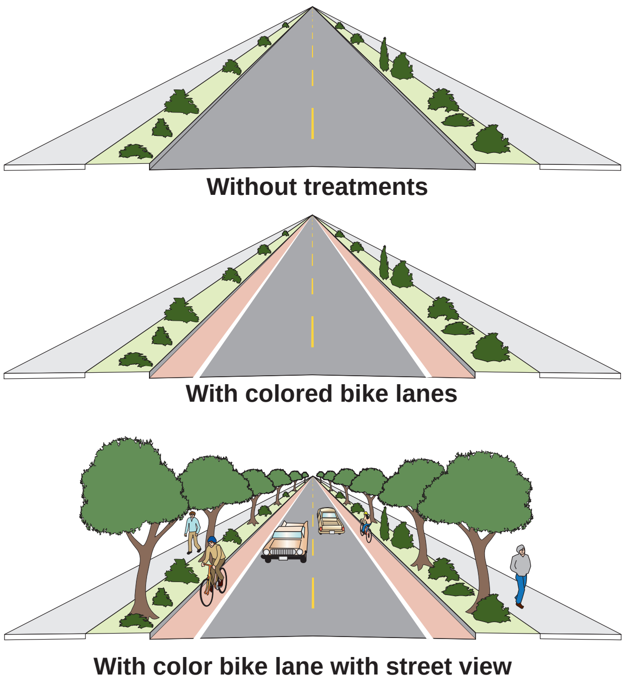



*Figure 1-14: Colored bike lanes "narrow" roadway*

There are several methods available for coloring bike lanes still under evaluation. The best is to pave the bike lanes separately, using dyed asphalt. This requires two passes of the paving machine; care must be taken to avoid a rough joint between the bike lane and the travel lanes. Another method is to cover the bike lane with a tinted slurry seal.

### Colored bike lane “narrows” street

A further method is to extend the concrete gutter pan the full width of the bike lane (5 or 6 feet). The contrast between the concrete and the asphalt roadway makes the latter appear narrower. However, concrete gutter pans can be a very uncomfortable ride for bicyclists if not constructed well: it is imperative the joints be saw-cut, not trowelled, to avoid bumps in the bike lane. When the roadway is resurfaced, the top lift of asphalt must be milled down and removed, so the new surface is flush with the gutter pan.

*Colored bike lane “narrows” street*

*Concrete bike lane provides contrast with asphalt roadway*

An 8 inches white stripe is still necessary to delineate and designate the bike lane. The 8 inches stripe can straddle the travel lane and bike lane if they are both constructed of the same material. When the bike lane is concrete and the travel lanes are asphalt, the 8 inches stripe should be wholly contained on the asphalt portion for greater visibility.

*Note: approval from the State Traffic Engineer is required for colored bike lanes on state highways.*

### Alternatives to Bike Lanes on Main Thoroughfares: Guidelines for Providing Bikeways on Parallel Routes

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. The following guidelines should be used to determine if it is more appropriate to provide facilities on a parallel local street:

1. a. Conditions exist such that it is not economically or environmentally feasible to provide adequate bike lanes on the thoroughfare; or
   b. Thoroughfare does not provide adequate access to destination points within reasonable walking distances; or
   c. Bike lanes on the thoroughfare would not be considered safe.
2. Parallel route must provide continuity and convenient access to facilities served by the thoroughfare;
3. Costs to improve parallel route should be no greater than costs to improve the thoroughfare; and
4. 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.

## SURFACE TREATMENTS

Pavement condition is important to cyclists, as they ride on lightweight two-wheeled vehicles with narrow, high-pressure tires (necessary for the bicycle's inherent efficiency). Rough surfaces and imperfections such as joints can cause a rider to loose control and fall. Debris such as gravel and glass are also problems, and these can be addressed through maintenance. Adequate drainage is critical to cyclists, as they ride in the area where water ponds when drains get clogged, or surface irregularities prevent water from entering drain grates.

### Surface Types

The preferred roadway surfacing for bicycling is a finely graded asphaltic concrete. Rough open-graded mixes are very uncomfortable for cyclists, as they cause vibrations and increased rolling resistance, contributing to greater cyclist fatigue.

*Chip seal ends at motor vehicle travel lane*

### Chip Seals

Chip-sealed surfaces are particularly unpleasant to ride on and should be avoided when possible. Where used, chip seals should be limited to the travel lanes on roads and highways with paved shoulders: the shoulders should NOT be chip-sealed. On roads with no shoulders (where cyclists ride in the travel lanes), chip seals should use a fine mix and be covered with a fog or slurry seal.

### 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 that 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.

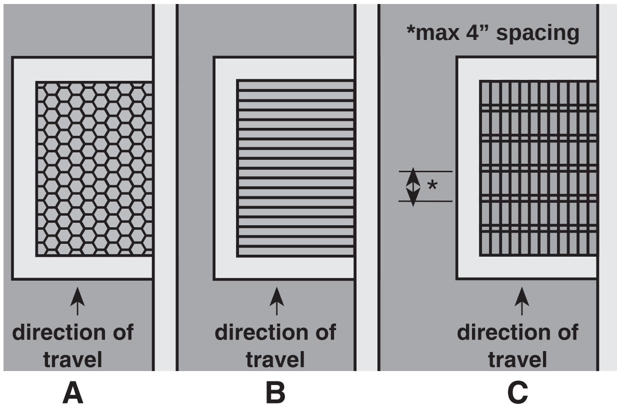



*Figure 1-15: Bicycle safe drainage grates*

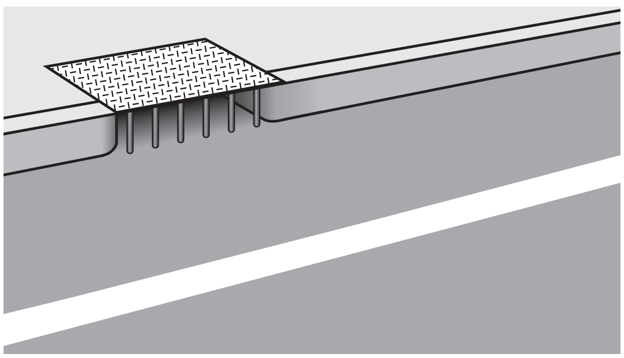


*Figure 1-16: Curb inlet drainage grate*

## 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.

*Concrete RR crossing with rubber flanges*

## Crossing Surface

The four most commonly used 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.

## Crossing Angle

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.

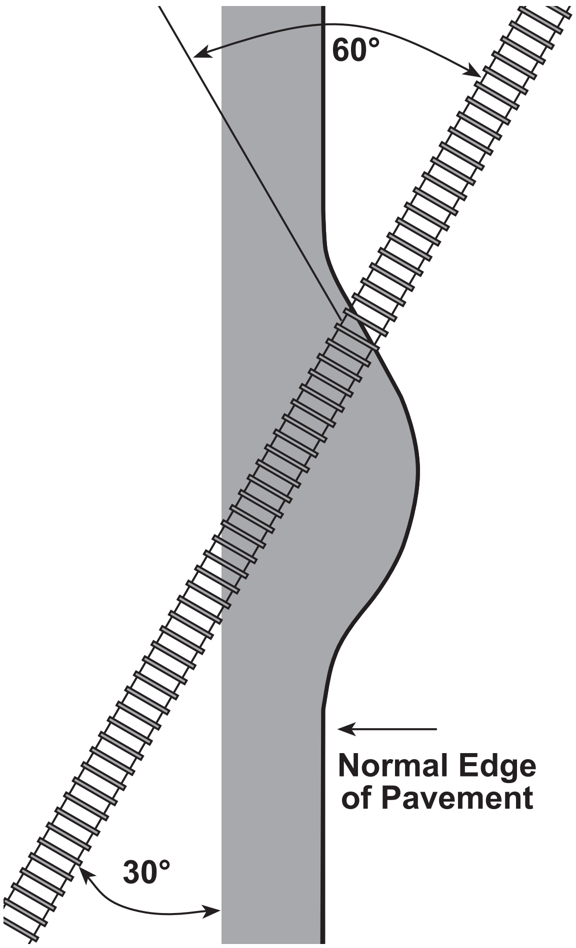



*Figure 1-17: Bulged RR crossing*

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.

*Rail crossing S curve*

### Flange Opening

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.

*Bicycle unfriendly RR crossing*

### Rumble Strips

Rumble strips are provided to alert motorists that they are wandering off the roadway. They are most common on long sections of straight freeways in rural settings, but are also used on some two-lane undivided highways. Rumble strips should not extend across the entire width of the shoulder, because they create an unridable surface for bicyclists. Rumble strips should not be used if they leave less than 4 feet of rideable space.

Bicycle friendlier rumble strips adjust the placement and width of the rumble strip and provide gaps for bicyclists to leave the shoulder to make a left turn or to avoid debris. A minimum of 4-feet of ridable shoulder is required and 12-foot gaps on 40 to 60 foot intervals is recommended. On narrower shoulders rumble strips can also be cut directly at the fog line, leaving the entire shoulder available for cycling. Rumble strips must be dropped before pinch points.

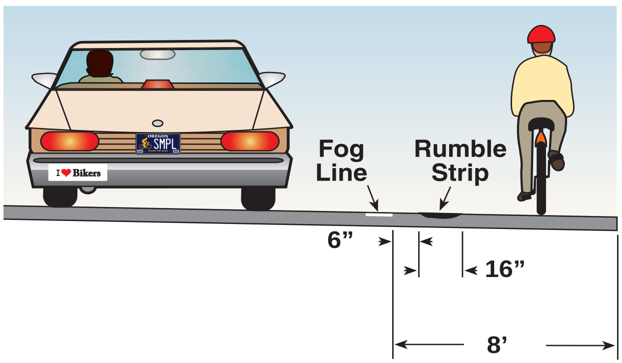



*Figure 1-18: Bicycle friendlier rumble strips*

*Well placed rumble strip leaves room for bicyclists*

Another alternative is the use of profiled fog lines. They are highly retro-reflective, alert drivers when they’ve strayed from the travel way, and leave the entire width of the shoulder available for bicycling. Should a bicyclist need to cross the fog line occasionally, the bumps are not too severe. They should not be used on narrow shoulders (under 4 feet) as they will be located in the area where cyclists prefer to ride.

For the most up-to-date information on rumble strip placement, design and alternatives, refer to the ODOT Traffic Manual and standard drawings.

*Profiled edge stripe*

## SIGNING AND MARKING OF BIKEWAYS

### Introduction

Signing and marking of bikeways must be uniform and consistent for them to command the respect of the public and provide safety to users. Signing and marking must be warranted by use and need. Signing and markings of bikeways on the state highway system should conform to the recommendations of this section. To provide uniformity and continuity, cities and counties are encouraged to adopt these standards. Consult the MUTCD, the ODOT Traffic Manual and the ODOT Traffic Line Manual for up-to-date details and dimensions.

Well-designed roads make it clear to users how to proceed, and require very little signing. Conversely, an over-abundance of warning and regulatory signs may indicate a failure to have addressed problems. The attention of drivers and bicyclists should be on the road and other users, not on signs on the side of the road. Over-signing degrades the usefulness of signs, causes distractions, creates a cluttered effect, is ineffective and wastes resources.

**Language Barriers:** The message conveyed by signs should be easily understandable by all roadway users: symbols are preferable to text.

**Sign Placement:** Signs placed adjacent to roadways must conform to adopted standards for clearance and breakaway posts and should never block the accessible pedestrian route.

## Shared Roadways

### Signing

In general, no signs are required for shared roadways. Bicyclists should be expected on all urban local streets, which are mostly shared roadways.

The W11-1 sign alone indicates a bicyclist crossing point. To inform roadway users that bicyclist can be expected in the travel lane it may be helpful to install bike warning signs (W11-1) with the supplemental plaque ON ROADWAY (OBW1-5) or ON BRIDGE ROADWAY (OBW1-7). Signs should be placed in advance of the roadway condition and are primarily used to indicate a short segment of shared travel lane. If the roadway condition is continuous, an additional rider “NEXT XX MILES” may be used.

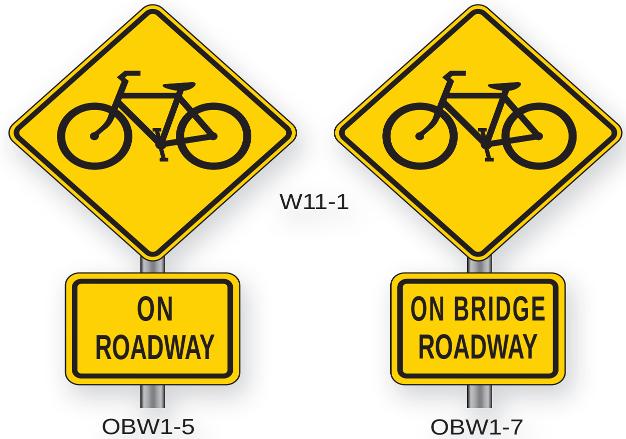



*Figure 1-19: W11-1 with riders*

The SHARE THE ROAD (W16-1P) rider indicates a shared travel lane. It is specific to bicyclists only when paired with W11-1 and has the same function as the sign combinations shown above. ODOT convention is to use the W11-1 plus OBW1-5 or OBW1-7.


*Figure 1-20: W16-1P*

CW11-1 Should be used in temporary work zones to indicate a shared lane condition.


*Figure 1-21: CW11-1*

R4-11 is regulatory and is used to indicate a permanent shared lane condition. It may be used in conjunction with the shared lane marking (sharrow). The need to use R4-11 is an indication that the bicycling facility is not intuitive, nor comfortable for most bicyclists. Better quality bicycle accommodation should be provided in lieu of signs. See the MUTCD for further guidance.


*Figure 1-22: R4-11*

Directional and route signs are useful where bicyclists are directed to follow a routing that differs from the routing recommended for motorists. The routing must have obvious advantages over other routes, such as safety, convenience, or when the main roadway is hostile to bicycles. BIKE ROUTE (D11-1) signs lack sufficient information and often lead to areas poorly suited for bicycling. Better options exist. Bicycle destination guide signs are preferred.

*Figure 1-23: D11-1*

The Portland Bureau of Transportation, in cooperation with ODOT, developed the OBD1 series of bicycle route guide signs, the preferred sign series in Oregon. Additionally, the MUTCD (2009 edition) D1 sign series provides any number of bicycle route guide sign options.

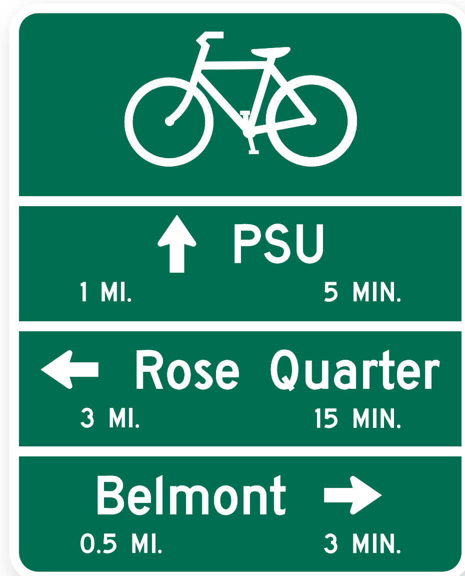



*Figure 1-24 Bicycle route guide sign OBD1-3c*

Bicycle route guide signs are used to indicate a preferred route for bicyclists. They should be used when the signed route provides a clear advantage to bicyclists such as:

- A low volume street
- A short cut
- A flatter route
- A bicycle boulevard
- A bicycle specific destination
- An alternate to a busy, bicycle unfriendly thoroughfare

The b-series signs are used for multi-modal routes. The c-series provides travel time and distance information.

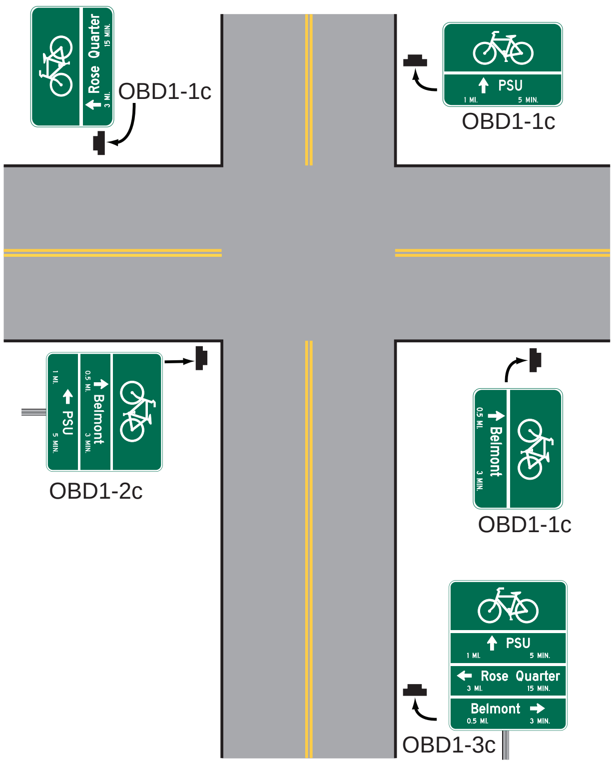



*Figure 1-25: MUTCD Figure 9B-6 with Oregon Supplement OBD1 signs*

### Bike Boulevards

Signing and marking conventions for bicycle boulevards continue to evolve. OBD1-3c signs should be adequate to convey route information to cyclists. Additionally, Portland and Eugene have developed bike boulevard route signs by adding the name of the bike boulevard, complimented with a Designated Bicycle Boulevard pavement marking.

*1st Generation bicycle boulevard pavement marking*

*2nd Generation bicycle boulevard pavement marking (indicates turn)*

### Sharrows

Sharrows, also known as “shared lane markings,” are a new form of pavement marking included in the 2009 MUTCD. They are primarily intended for use on narrow, low-speed roadways with on-street parking. Their primary purposes are to:

- Encourage bicyclists to ride away from the door zone; and
- Indicate to drivers where to expect cyclists.

Sharrows should be used on streets with high bicycle demand, and where there is potential competition for the use of a narrow lane. Early observations indicate that bicyclists ride further from parked cars (reducing their risk of being hit by an opening car door), and drivers more safely share the road with bicyclists.

*Sharrows indicate where bicyclists should position themselves in the roadway*

## Shoulder Bikeways

### Signing

In general, no signs are required for shoulder bikeways. Bicyclists riding on shoulder bikeways are well served with adequate width and smooth pavement.

### Marking

A normal 4 inches wide fog line stripe is used on shoulder bikeways.

*Shoulder bikeway on higher volume rural road*

## Bike Lanes

### Bike Lane Designation

Bike lanes are officially designated to create an exclusive or preferential travel lane for bicyclists with the following markings:

- An 8 inches white stripe; and
- Bicycle symbol and directional arrow stencils.

Where a bike lane is next to parking, parking should be defined by parking space markings or a solid 4 inches stripe. Optional NO PARKING signs (R7-9 and R7-9a) may be installed if problems with parked cars occur; in many jurisdictions, painting curbs yellow indicates that parking is prohibited. Where the bike lane ends, sign OBW1-9 may be used where cyclists enter the motor vehicle travel lanes.

### Stencil Placement

Stencils should be placed after most intersections; this alerts drivers and bicyclists entering the roadway of the exclusive nature of the bike lanes. Stencils should be placed after every intersection where a parking lane is placed between the bike lane and the curb.

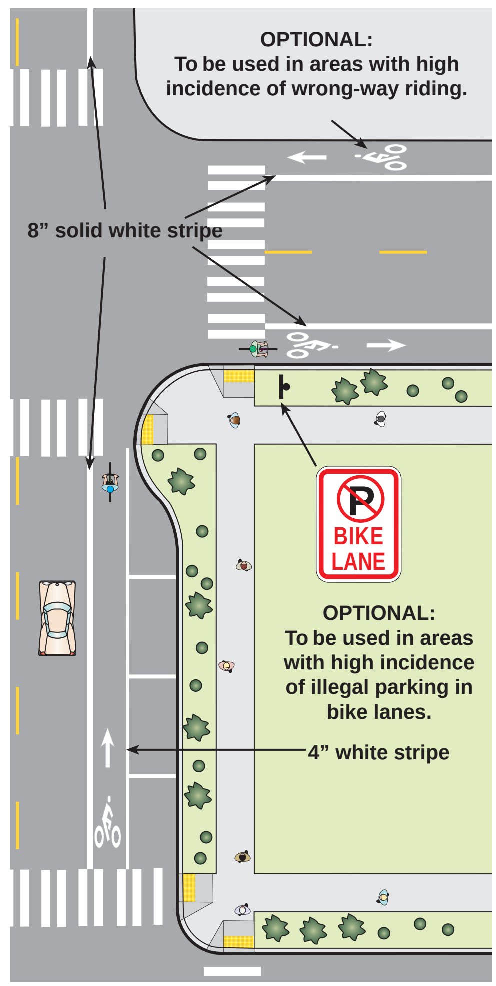



*Figure 1-26: Oregon standard bike lane marking*

Figure 1-27: OBW1-9

Supplementary stencils may also be placed at the end of a block, to warn cyclists not to enter a bike lane against traffic.

Additional stencils may be placed on long sections of roadway with no intersections. A rule of thumb for appropriate spacing is: multiply designated travel speed by 40. For example, in a 35 MPH speed zone, stencils may be placed approximately every 1400 feet.

Placing stencils outside where motor vehicles are expected to cross a bike lane, such as driveways and the area immediately after an intersection will help reduce maintenance costs, as vehicles won't drive over the stencils repeatedly.

Figure 1-28: Standard bike stencil

### Intersections

Bike lanes should be striped to a marked crosswalk or a point where turning vehicles would normally cross them.

Bike lanes are not normally striped through intersections; however, it may be appropriate to do so where extra guidance is needed; in this case, they may be marked with 8 inches wide dotted lines, to guide bicyclists through a long undefined area or to alert turning motorists of the presence of bicycle traffic.

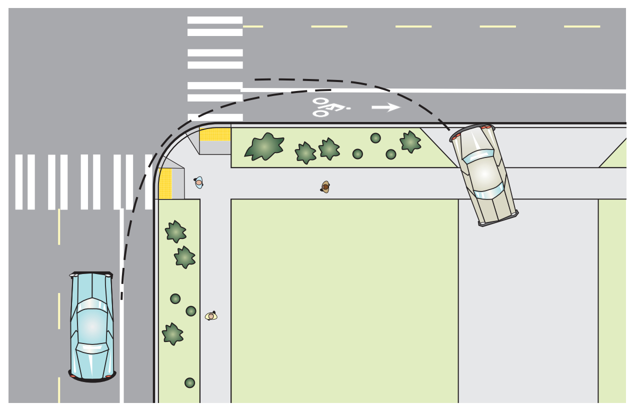


Figure 1-29 : Bike stencil placed out of wheel path

### Right Turn Lanes at Intersections

The through bike lane to the left of a right-turn lane must be striped with two 8 inches stripes and connected to the preceding bike lane with a dotted line (8 inches x 2 feet on 8 feet centers [6 feet gaps]). This lets turning motorists cross the bike lane. A stencil must be placed at the beginning of the through bike lane.

Sign R4-4, BEGIN RIGHT TURN LANE, YIELD TO BIKES, may be placed at the beginning of the taper in areas where a through bike lane may not be expected. For example, on sections of roadway where bike lanes have been added where there weren't any previously.


*Figure 1-30: R4-4*

### Reflectors

Reflectors and raised markings in bike lanes are discouraged as they can deflect a bicycle wheel, causing the cyclist to lose control. If pavement markers are needed for motorists, they should be installed on the motorist's side of the bike lane stripe, and have beveled edges.

## Special use signs

### Railroad Crossing

Where a shared roadway, shoulder bikeway, bike lane or shared-use path crosses a railway at an unfavorable crossing angle, or if the crossing surface is rough or slippery, warning signs OBW8-19R and OBW8-19L should be used.

*Figure 1-31: OBW8-19L*

### Sidewalk Users

Where bicyclists are allowed to use sidewalks, and the sidewalks are too narrow for safe riding (usually on a bridge), sign OBR10-13 may be used to encourage cyclists to walk.

### Bicycle Use of Push-Buttons

Where it is recommended that bicyclists use a push-button to cross an intersection (usually where a shared-use path crosses a roadway at a signalized intersection), the following signs should be used.


*Figure 1-32: OBR10-13*


*Figure 1-33: R10-26*

### Bike Stencils at Intersections

Many traffic lights are actuated by wire loops placed under the surface of the roadway. An electrical current passes through these loops, creating an electro-magnetic field. When a motor vehicle stops over them, the vehicle's metal disrupts the electro-magnetic field, sending a signal to the traffic controller that a vehicle is waiting for the light turn. Many bicycles don't contain enough conductive metal (steel or aluminum) to trigger the signal, causing frustration.

Figure 1-34: Bike symbol for loop detection placement

To help bicyclists trigger a signal, stencils placed over the most sensitive area of the loop detector indicate to cyclists where to place their bicycles for maximum sensitivity.

### Tunnels & Bridges

Where substantial bicycle traffic is expected in a narrow tunnel, the signs OBR10-10 and OBW1-8 may be used; it can be adapted for use on long narrow bridges, especially where there are sight distance constraints.

The push-button sign should be placed at a location that allows cyclists to proceed at a normal speed and enter the tunnel as lights begin to flash. The duration timing of the flashing lights should be based on normal bicycle travel speed, plus an extra margin of safety (though leaving the flashing lights on for too long may render them ineffective if motorists enter the tunnel and cyclists are no longer present).

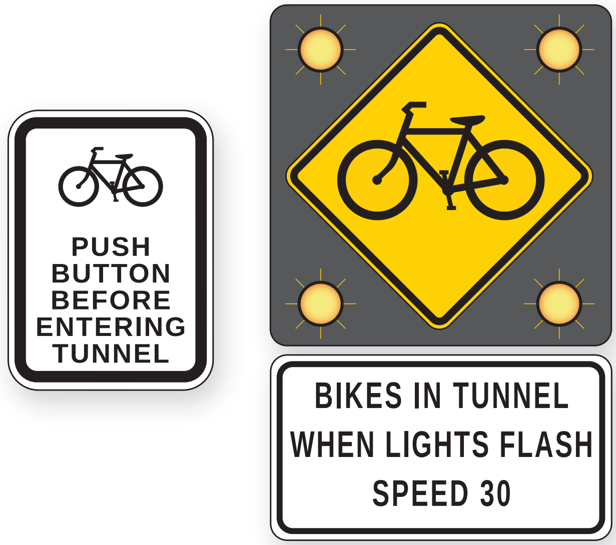



Figure 1-35: OBR 10-10 and OBW 1-8

### Touring Routes

Special signs have been created to guide cyclists along state and national touring routes, such as the Oregon Coast Bike Route, Oregon Scenic Bikeways and US National Numbered Bike routes:


Figure 1-36: OBD 11-3

These signs should be used sparingly, mainly at intersections (with right or left turn arrows) to guide cyclists along the route.


Figure 1-37: OBM 1-8

### Bicycle Races and Events

For a complete description of measures to be taken for bicycle races and events, please consult the "Guidelines for Administration of Bicycle Racing on Oregon Roads." *http://www.oregon.gov/ODOT/HWY/BIKEPED/docs/bikerace.pdf?ga=t*

Sign design specifics can be found in the ODOT Sign Policy and Guidelines, Chapters 6 and 8: *http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/sign_policy.shtml*

For events routed over county and city roadways consult with the local roadway authorities for their requirements.

### Temporary Work Zones

Construction and other temporary work zones should provide safe passage for bicyclists. ODOT Sign Policy and Guidelines, Chapters 6 and 8 (*http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/sign_policy.shtml*) as well as ODOT/APWA Unique Specifications Section 00225 (*http://www.oregon.gov/ODOT/HWY/SPECS/unique.shtml#Part_00200*) contain route and sign guidelines for directing bicyclists thru temporary work zones.


*Bike lane in temporary work zone*

## Innovative Designs

These concepts are presented as information, to help ODOT, cities and counties with new solutions to common problems. This compendium is provided to encourage creative thinking. Implementation will require more information than is available herein. More information on these facilities can be found in the following guides:

- NACTO (National Association of City Transportation Officials) Urban Bikeway Design Guide: *http://nacto.org/cities-for-cycling/design-guide/*
- Portland (Oregon) Bicycle Master Plan 2030 Bikeway Facility Design Guide: *http://www.portlandonline.com/transportation/index.cfm?a=289122&c=44597*
  See Appendix D under Supplemental Documents

### Advisory Bike Lanes

Advisory bike lanes are delineated with skip stripe bike lane markings. They are used on low volume, one and two lane roadways where the motor vehicle lanes are not wide enough to allow two cars to pass each other. When there is oncoming traffic the motor vehicle driver must pull into the advisory bicycle lane to pass. The center line on the roadway is omitted. They may require legislative action for implementation.

*Advisory Bike Lane*

## Bike Box

The bike box is a signalized intersection traffic control devise used to prevent the right-hook crash. Painted across the entire curb side lane the bike box gives bicyclists priority by positioning them in advance of motor vehicle traffic during the red signal phase. Once the light turns green bicyclists proceed across the intersection to the far side bike lane. The bike lane functions normally during the green phase. Right on red must be prohibited when using the bike box.

*Bike Box*

## Bike Left turn Lane

Bike left turn lanes are used when a bicycle boulevard or other signed bike route continues thru an offset intersection.

*Bike left turn lane*

## Bike Stair Channel

A bike stair channel assists bicyclists using stairs by providing a space in which to insert the bicycle wheels so that a bicycle may be rolled up or down a staircase.

*Stair Channel*

## Bike Passing Lane

When bicycle volumes warrant, a bicycle passing lane provides passing opportunities for higher speed bicyclists.

*Bike passing lane*

## Bicycle Signal

A bicycle traffic signal can be used in conjunction with a bicycle exclusive phase. This can be helpful where high volume motor vehicle turn movements conflict with the thru bike lane.

*Bike Signal*

## Bike Friendly Transit Stop

Routing bicyclists to the rear of a transit stop can help alleviate conflicts.

*Bicycle lane to rear of transit stop*

## Buffered Bike Lane

Buffered bike lanes provide additional separation from the motor vehicle traffic and/or parking lane, increasing bicyclist comfort.

*Buffered Bike lane*

## Choker/Separator

Used to calm and discourage thru motor vehicle traffic on bicycle boulevards, the choker/separator segregates traffic at non-signalized intersections.

*Choker/Separator*

## Cycle Track

A cycle track is a bike lane with a physical barrier between the bike and motor vehicle travel lanes, such as a curb or parking lanes. Cycle tracks provide a very high level of bicyclist comfort. Cycle tracks must “rejoin” the motor vehicle travel lanes at signalized intersections. Cycle tracks may require a two stage left turn for bicyclists. Cycle tracks are attractive to bicyclists less comfortable in on-street bike lanes.

*Cycle Track*

## Floating Bike Lane

A floating bike lane is a bike lane coincident with the parking lane during peak hours. During peak hours parking is prohibited. Parking is allowed in off peak hours – when bicyclists must use the motor vehicle travel lane.

## Green Wave

The green wave was developed in Copenhagen, Denmark. It is a signal timing technique that when partnered with bike lanes or a cycle track, gives priority to thru bicycle travel.

## Raised bike lanes

Normally, bike lanes are an integral portion of the roadway and are delineated from motor vehicle lanes with painted stripes. Though most bicyclists ride on these facilities comfortably, others prefer more positive separation; but separated paths are not practical in most urban settings.

Raised bike lanes incorporate the convenience of riding on the street with some physical separation, with these advantages:

- Motorists know they are straying from the travel way when they feel the slight bump created by the curb;
- Mountable curb allows motorists to make turns into and out of driveways;
- Mountable curb allows cyclists to enter or leave the bike lane (for turning left, overtaking another cyclist etc.); and
- Novice bicyclists are more likely to ride in the bike lane, leaving the sidewalk for pedestrians.

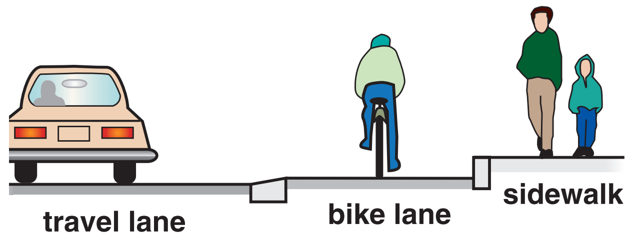



*Figure 1-38: Raised bike lane*

An effective design provides a gentle (4:1) slope, with no lip, so a bicycle tire is not caught during crossing maneuvers. Using concrete curbs in an asphalt roadway increases the visibility of the bike lane stripe. The raised bike lane drains to the roadway, not the curb or sidewalk; this requires drainage inlets in the travel lanes. The raised bike lane is dropped prior to intersections, where the roadway surfacing is uniform. Raised bike lanes cost more to construct, as the travel lanes and bike lanes must be paved separately and a narrow paving machine is required for paving the bike lane. The additional costs may be mitigated by reduced long-term maintenance costs:

- The bike lane portion receives less wear and tear than the motor vehicle travel lanes;
- The bike lane accumulates less debris, requiring less frequent sweeping; and
- The bike lane stripe doesn't need frequent repainting.

*Notes:*

- *On roads with parking, the bike lane should be placed between the travel lanes and parked cars, elevating the parking lane.*

- *Raised bike lanes must include the standard stencils and 8 inches white stripe. For better visibility of the 8 inches stripe, it should be placed entirely on the lower surface.*

Raised bike lane

### Skinny Street

A skinny street is a type of shared travel lane. By narrowing the roadway motor vehicle travel speeds are reduced.

Skinny Street

### Woonerf

A woonerf, developed in The Netherlands, is designed for extremely low motor vehicle travel speeds. When MV travel speeds are reduced below 20 miles per hour, bicyclists, pedestrians and motor vehicle traffic can share the same space.

Woonerf

## Practices to be Avoided

The Oregon Department of Transportation has 35 years of experience designing bikeways, and has also learned from local city and county experiences; some practices have proven to be poor ones.

#### Sidewalk Bikeways

Some early bikeway plans designated sidewalks for bicyclist use. While in rare instances this may be necessary (such as on narrow bridges), or acceptable for use by children, in most cases it should be avoided. Most cities ban bicyclists from sidewalks in business districts.

Cyclists are safer when they function on the roadway as vehicle operators, rather than as pedestrians. Sidewalks are not suited for cycling for several reasons:

- Cyclists face conflicts with pedestrians;
- There are often utility poles, sign posts, benches, etc. placed in sidewalks;
- Bicyclists face conflicts with motor vehicles at driveways, alleys and intersections: a cyclist on a sidewalk is generally not visible to motorists and emerges unexpectedly. This is especially true of cyclists who ride against the flow of adjacent motor vehicle traffic: drivers do not expect cyclists coming from this direction; and

- Bicyclists are put into awkward situations at intersections where they cannot safely act like a vehicle operator but are not in the pedestrian flow either, creating confusion for other road users.

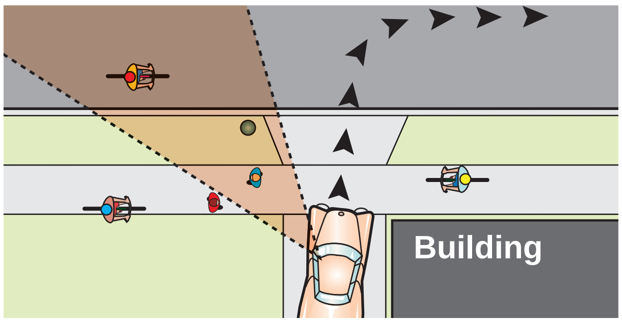



*Figure 1-39: Conflicts with sidewalk riding*

Where width constraints do not leave room for bikeways, solutions should be sought to accommodate both modes (e.g. narrowing travel lanes). In some urban situations, preference may be given to accommodating pedestrians. Sidewalks should not be signed for bicycle use - the choice should be left to the users.

There are circumstances where it may be advisable to allow bicyclists to ride on a sidewalk: on long narrow bridges with high traffic volumes. This can help cyclists if the bridge sidewalks are wide enough for bicycle use (minimum 5 feet). Ramps should be built to provide cyclists access to the bridge sidewalks; signs should be placed advising cyclists to walk their bikes on the sidewalk if it's too narrow for riding.

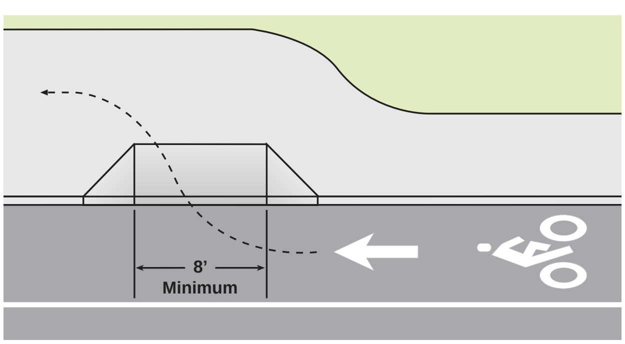



*Figure 1-40: Ramp allows bicycle to access sidewalk on bridge*

### Extruded Curbs

These create an undesirable condition when used to separate motor vehicles from cyclists: cyclists may hit the curb, lose control and fall onto the roadway. At night, the curbs cast shadows on the lane, reducing the bicyclist's visibility of the surface. Extruded curbs are often hit by motor vehicles, causing them to break and scatter loose pieces onto the surface. They make bikeways difficult to maintain as debris accumulates.

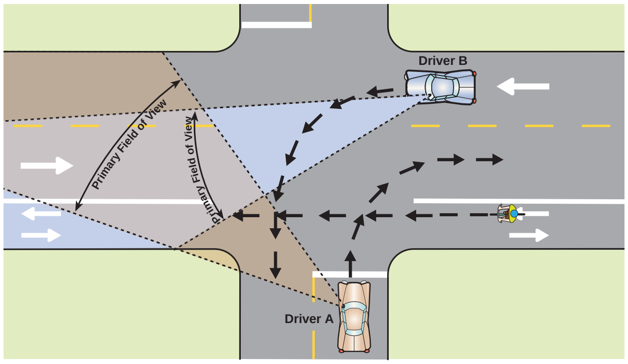
### Reflectors & Raised Pavement Markers

These can deflect a bicycle wheel, causing cyclists to lose control. If pavement markers are needed for motorists, they should be installed on the motorist's side of the stripe, and have a beveled front edge.

### Two-way Bike Lane

This creates a dangerous condition for bicyclists. It encourages riding against traffic, causing several problems:

- At intersections and driveways, “wrong way” riders approach from a direction where they are not visible to motorists;
- Bicyclists closest to the motor vehicle lane have opposing motor vehicle traffic on one side and opposing bicycle traffic on the other; and
- Bicyclists are put into awkward positions when transitioning back to standard bikeways.




Right turning driver A is looking for traffic on the left; Left turning driver B is looking for traffic ahead; In both cases, a wrongway bicyclist is not in the drivers main field of vision.

*Figure 1-41: Problems with two-way bike lanes*

A two-way bike lane on one side of the road is sometimes proposed in areas where there is insufficient room for two minimum width bike lanes. If constraints allow widening on only one side of the road, the centerline stripe may be shifted to allow for adequate travel lanes and bike lanes on both sides.

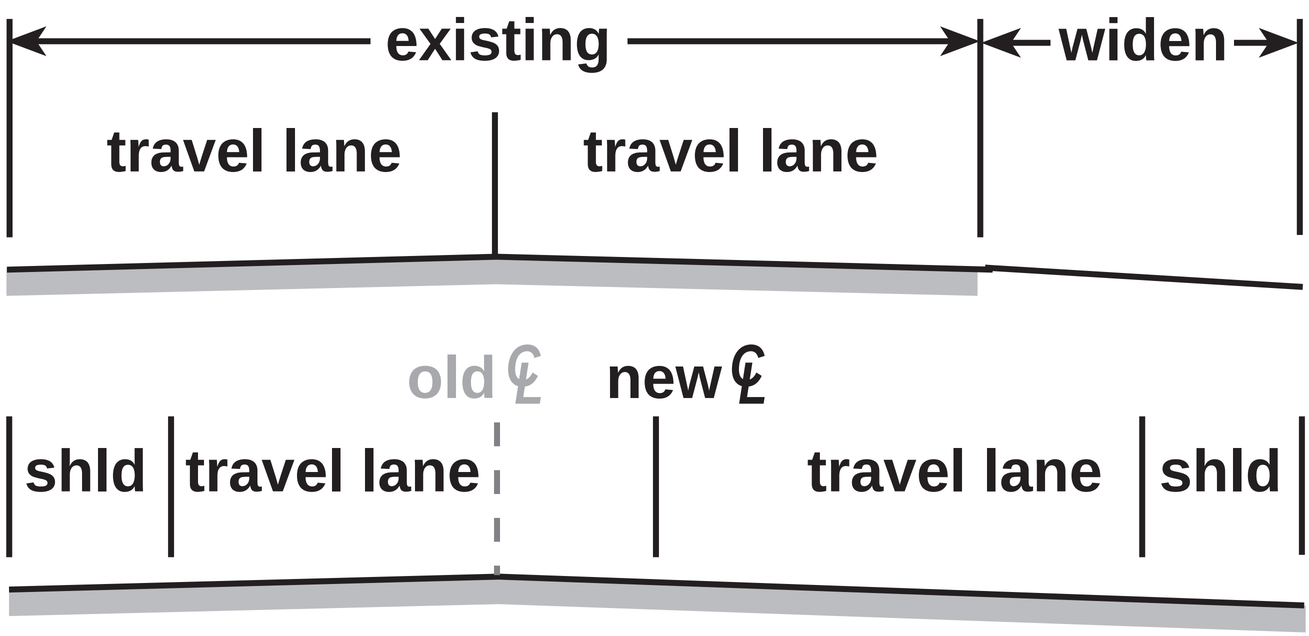



*Figure 1-42: Widening one side and moving center line results in proper bike lane placement*

### Continuous Right-Turn Lanes

This configuration is difficult for cyclists: riding against the curb puts them in conflict with right-turning cars, but riding to the left of the continuous right-turn lane puts them in conflict with cars merging in and out of the right-turn lane.

Continuous right-turn lanes are rarely created intentionally; they happen as development occurs, and a deceleration lane is provided for each new access. If the access points are too close together, the deceleration lanes merge into one continuous lane. The best solution is to implement an access management strategy to consolidate accesses and add short deceleration lanes only where warranted. Then a continuous through bike lane can be striped to the left of the deceleration lanes.

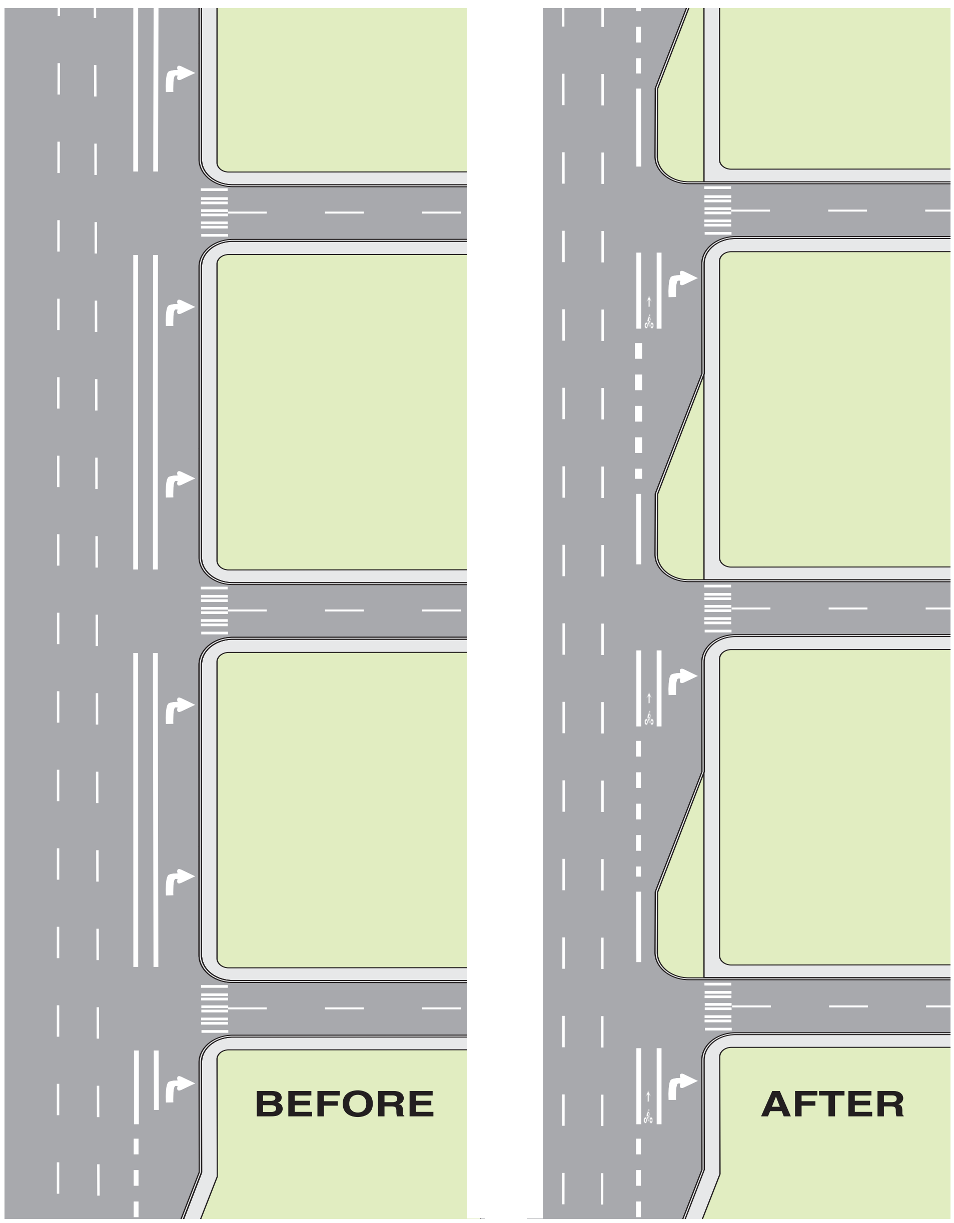
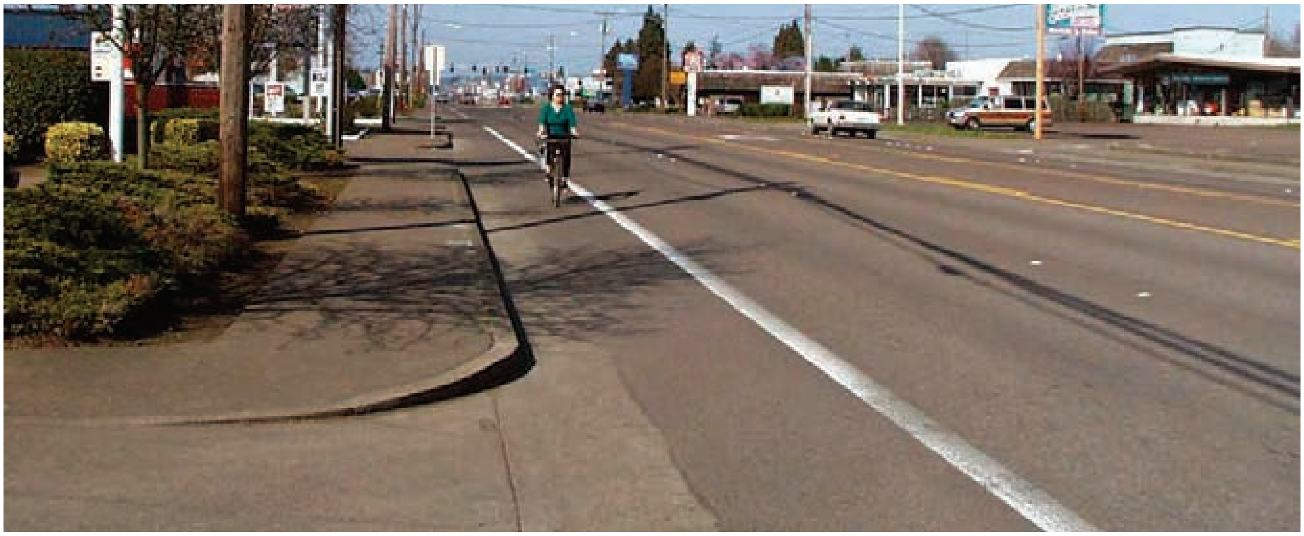



*Figure 1-43: Continuous right turn lane reconfigured*

# Chapter 2: Restriping Roads With Bike Lanes (Road Diets)



*Bike lane restriped by narrowing travel lanes on commercial arterial*

## Introduction

Bike lanes generally serve bicyclists and motorists well on busy roadways in urban areas, but many urban roadways were built without bike lanes and often act as deterrents to bicycle travel. Bike lanes can be retrofitted onto existing urban roadways by:

1. Marking and signing existing shoulders as bike lanes;
2. Widening the roadway to add bike lanes; and
3. Restriping the existing roadway to add bike lanes.

In many cases, altering the existing curb-to-curb width is costly or impractical. Restriping the roadway to add bike lanes is a practical approach. Restriping existing roadways is often referred to as a “road diet.” Restriping has benefits for all users, not just cyclists.

These guidelines illustrate how a roadway can be restriped for bike lanes, without negatively affecting and often enhancing the safety and operation of the roadway. Sample travel lane widths are within acceptable ODOT & AASHTO minimums. In ODOT designated Special Transportation Districts and other urban settings where speeds are lower, the need for wide travel lanes decreases.

It is important to use good judgment, and to consider context. Each project should be approved by a traffic and/or roadway engineer to ensure that capacity and safety are not compromised. ORS 366.215 prohibits reducing capacity on certain freight routes. Exceptions to this statute are allowed if safety or access considerations require the reduction. An exception may also be granted by the Oregon Transportation Commission if it is in the best interest of the state and freight movement is not unreasonably impeded.

The examples given are not the only acceptable way to restripe a roadway. It is not always necessary to use dimensions in whole feet increments. For example, with 32 feet available, 10.5 feet travel lanes with 5.5 feet bike lanes may work better in some cases than 11 feet travel lanes with 5 feet bike lanes, or 10 feet travel lanes with 6 feet bike lanes.

# Reduce Lane Widths

## Narrow Travel Lanes

Commonly used lane widths are: 14 feet center turn lanes, 12 feet travel lanes, 6 feet bike lanes and 8 feet parking lanes; under many conditions these can be narrowed to:

- 25 MPH or less: lanes can be reduced to 10 feet or 11 feet.
- 30 to 40 MPH: 11 feet travel lanes and 12 feet center turn lanes are acceptable, even desirable.
- 45 MPH or greater: 12 feet outside travel lane and a 14 feet center turn lane if there are high truck volumes.

Dimensions should take into account the combination of speeds, volumes, trucks, context, and desired outcome. On state highways, the above dimensions may only be applied if a design exception is approved where HDM standards are not met.

*5 lane roadway with wide lanes, no bike lanes*

*5 lane roadway with bike lanes, narrowed motor vehicle lanes*

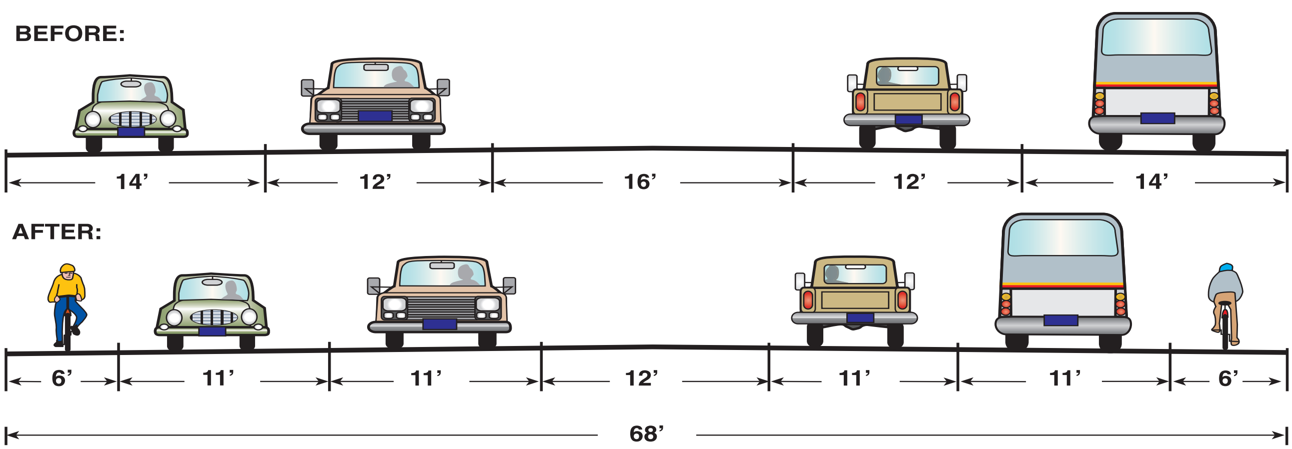



*Figure 2-1: Bike lanes added by narrowing travel lanes*

# Modify Parking

## Reduce on-street parking

On-street parking is usually beneficial to businesses and pedestrians. On-street parking helps keep traditional street-oriented businesses viable, provides a buffer for pedestrians, and helps keep traffic speeds down. Removing parking for bike lanes requires careful negotiation with the affected businesses and residents. Before making a proposal, a parking study should be conducted that includes:

- Counting the number of businesses/ residences and the availability of both on-street and off-street parking;
- Estimating use and occupancy characteristics;

- Selecting which side would be less affected by removal (usually the side with fewer residences or businesses);
- Replacing on-street parking with parking bays for residents or businesses with no other options;
- Proposing parking management strategies that increase the supply of parking when and where it's most needed, such as:
  - Allowing parking for church or school activities on adjacent lots during services or special events;
  - Shared use by businesses and institutions, or
  - Prohibiting on-street parking by employees;
- Evaluating crossing conditions for pedestrians.

The fear of losing potential customers is an important reason to retain on-street parking. Many cities have ordinances prohibiting employees from parking on the street. This increases the number of available parking spaces for customers, even if the total number of parking spaces is reduced. One parking place occupied by an employee for eight hours is the equivalent of 16 customers parking for half an hour, or 32 customers parking for 15 minutes, etc.

## Remove Parking on One Side

On most streets with parking on both sides, removal of all on-street parking is not necessary: removing parking from one side creates enough space for two bike lanes, with some additional lane narrowing. Parking may be needed on only one side to accommodate residences and/or businesses with no off-street parking.

*Notes:*

1. It is not always necessary to retain parking on the same side of the road through an entire corridor.

2. Education and enforcement may be needed for a period of time after parking has been removed in the space dedicated to a bike lane, to prevent motorists from parking in the new bike lanes.

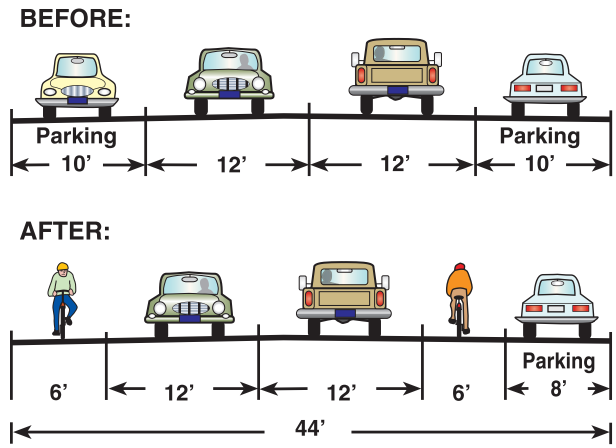



*Figure 2-2: Parking removed from one side*

*Parking removed from one side to add bike lane*

## Change From Diagonal to Parallel Parking

Changing to parallel parking on one side only is usually sufficient; this reduces total parking availability of a street segment by less than one-fourth.

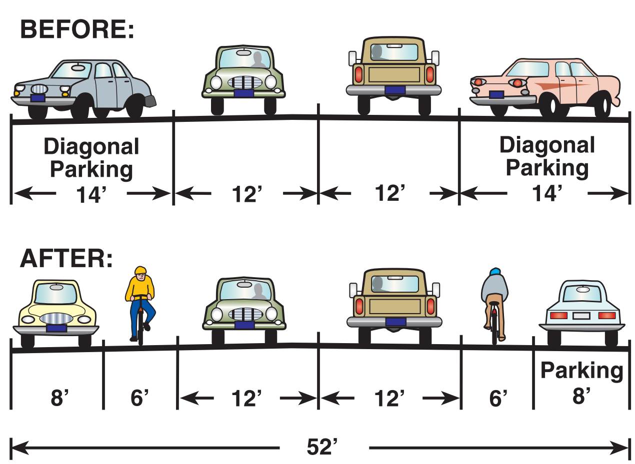



*Figure 2-3: Restripe from diagonal to parallel parking*

## Narrow Parking Lanes

Parking can be narrowed to 7 feet, particularly in areas with low truck parking volumes. On a one-way street, only one bike lane needs to be provided, so narrowing both parking lanes a little bit creates enough room for one bike lane.

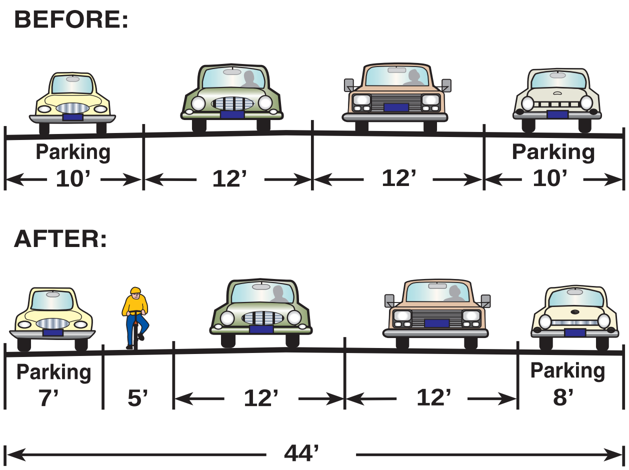



*Figure 2-4: Bike lane added by narrowing parking*

*Bike lanes added by narrowing parking lane*

## Replacing Lost Parking

Where all of the above possibilities have been pursued, and residential or business parking losses cannot be sustained, innovative ideas should be considered to provide parking, such as:

- Increasing parking supply on side streets; or
- Creating parking bays by using a portion of a planting strip, where available.

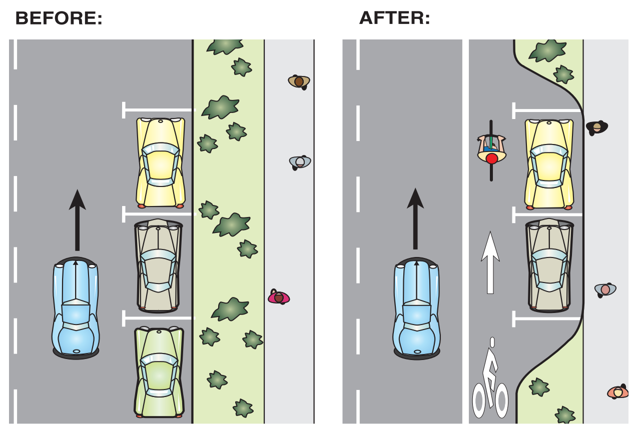



*Figure 2-5: Parking bays*

*Parking bay*

## Road Diets: Reduced Number Of Travel Lanes

Many roads were built wider than needed to accommodate existing or projected traffic volumes, or traffic conditions have changed since the road was built, and the number of travel lanes can be reduced. This concept is generally referred to as a “road diet.” In most cases the road diet results in enough space to stripe bike lanes. This chapter focuses on road diets and bike lanes, but road diets have safety, operational and livability benefits for motorists and pedestrians.

In all cases a traffic study must be conducted to ensure the resulting roadway will carry the traffic at an acceptable level of service. In many cases the road carries as much traffic with fewer lanes, and performs better when one considers issues that concern residents, business owners, bicyclists, pedestrians and others who use the roadway for a variety or reasons.

The most common road diet takes a 4-lane undivided highway and redistributes the roadway to one travel lane in each direction, a center turn lane and two bike lanes. The safety benefits of the 4 to 3 lane road diet include:

- Fewer rear-end crashes: motorists wait to make a left turn in a dedicated turn lane, not in a through lane;
- Fewer sideswipe crashes: motorists no longer swerve around a vehicle waiting to turn left in a through lane;
- Fewer left turn crashes: turning motorists face only one lane of oncoming traffic;
- Reduced speeds;
- Easier and safer pedestrian crossings, especially with a median island in the center turn lane: pedestrians cross only one lane at a time instead of all 4 lanes at once; and
- Elimination of multiple threat crash.

Operational benefits of the 4 to 3 lane road diet include:

- Fewer delays from traffic stacked behind a car waiting to turn left;
- Easier to negotiate right turns, as the curb lane is offset from the curb; and
- Higher carrying capacity where many left turns obstruct the inside lane on a 4-lane section.

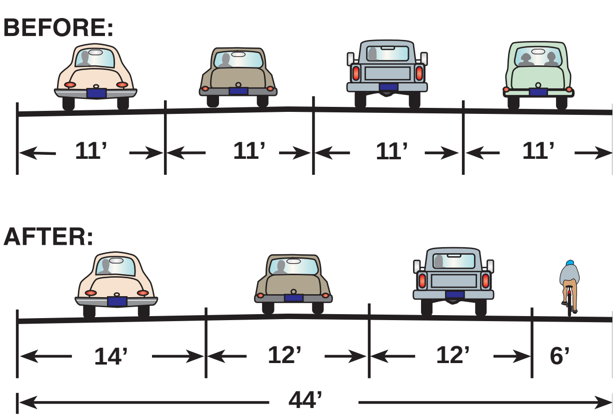



*Figure 2-6: Road Diet – 4 motor vehicle lanes becomes 2 bike lanes and 3 motor vehicle lanes*

*4 lane undivided roadway*

*Restriped with bike lanes center turn lane and pedestrian crossing*

The livability benefits of a road diet include:

- Greater separation from moving traffic for pedestrians;
- Room for street furniture and landscaping; and
- More people using bicycles for transportation.

*Road diet created room for median pedestrian refuge island*

## One-way couplets

One-way couplets are good lane-reduction candidates if they have more travel lanes in one direction than necessary for the traffic volumes. For example, a 4-lane one-way street can be reduced to 3 lanes and a bike lane. Since only one bike lane is needed on a one-way street, removing a travel lane can free up enough room for other features such as on-street parking or wider sidewalks. Both legs of a couplet must be treated equally, so there is a bike lane in each direction.

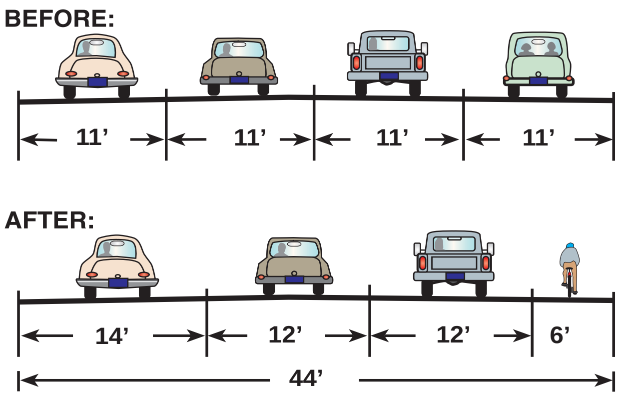



*Figure 2-7: Motor vehicle travel lane removed from 4-lane, one way street*


*Removing a travel lane created room for a bike lane, curb extension and on street parking*

## Unbalanced Flow

On streets with higher traffic volumes in one direction than the other, one direction of travel can have one less travel lane than the other side. For example, a 4-lane undivided roadway can be restriped with 2 lanes in one direction, one lane in the other, and 2 bike lanes.

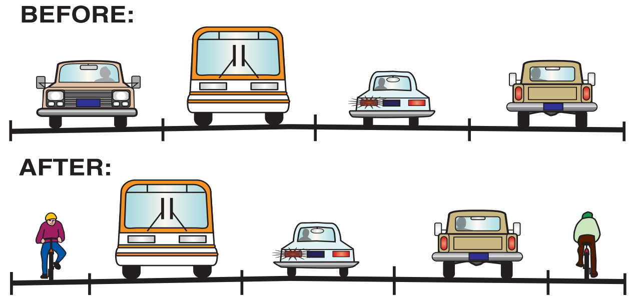



*Figure 2-8: 4-lane, two way street restriped with 2 lanes in one direction, 1 in the other and bike lanes*

## Pavement Conditions

Restriping a roadway with bike lanes will encourage more people to ride their bikes there; the expectation of a good riding experience must be met, and part of that experience is a good riding surface. If this expectation is not met, unsafe conditions and frustration can lead to opposition to more bike lanes. Improvements at the outer edge of the roadway should be made prior to bike lane restriping, including:

- Ensuring the surface is smooth and in good condition;
- Raising existing drainage grates, manhole and utility covers flush to the pavement; and
- Removing or relocating obstructions away from the edge of roadway to gain some useable width. Obstructions can include guardrail, utility poles and sign posts.

The best time to restripe a roadway is after a pavement overlay project, for two reasons:

- The new pavement offers a blank template; and
- Obliterating existing striping creates problems: the old stripes can show up on rainy days or at night when cars have their headlights on. Grinding out old lane lines can leave grooves deep enough to be a hazard to cyclists.

*Bike lanes striped on new pavement show up well*

## Width Constraints

Not all existing roadways allow bike lanes to be retrofitted for an entire corridor. Unique and creative solutions will have to be found to ensure bikeway continuity in constrained areas:

- Width restrictions may only allow for a wide curb lane to accommodate bicycles and motor vehicles.
- Where no possible extra width is obtainable, another technique is to slow traffic speeds so shared roadway conditions are acceptable.
- If the constraint is more than a few blocks, an alternate route may have to be improved for cycling; the alternate route must provide access to the destinations served by the thoroughfare considered for restriping.

Bike lanes must resume where the restriction ends. It is important that every effort be made to ensure bike lane continuity. Practices such as directing bicyclists onto sidewalks or other unsuitable streets should be avoided, as they may introduce unsafe conditions.

## Additional Benefits

Restriping roadways for bike lanes has benefits over and beyond those for bicyclists. Drivers and pedestrians also benefit when motor vehicle travel lanes are moved away from the curb:

Benefits for motorists include:

- Extended pavement life, as traffic is no longer driving in the same well-worn ruts.
- Safety, as travel lanes are offset from curbs, and lanes are better defined, which can improve sight distance and increase the effective turning radius at intersections and driveways. See discussion on road diets for safety benefits of reducing the number of motor vehicle travel lanes.

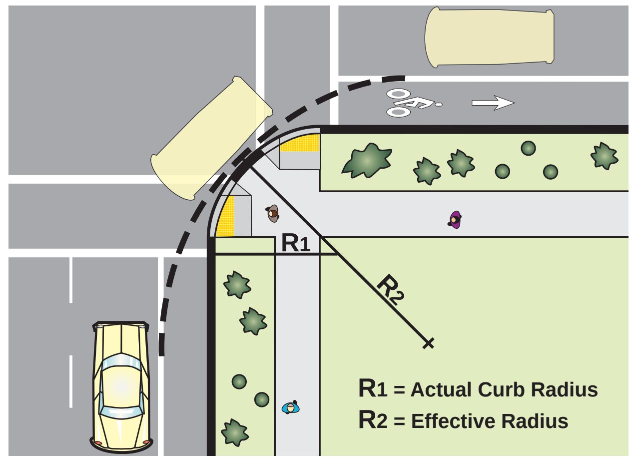



*Figure 2-9: Motor vehicle travel lane offset by bike lane results in larger effective turn radius*

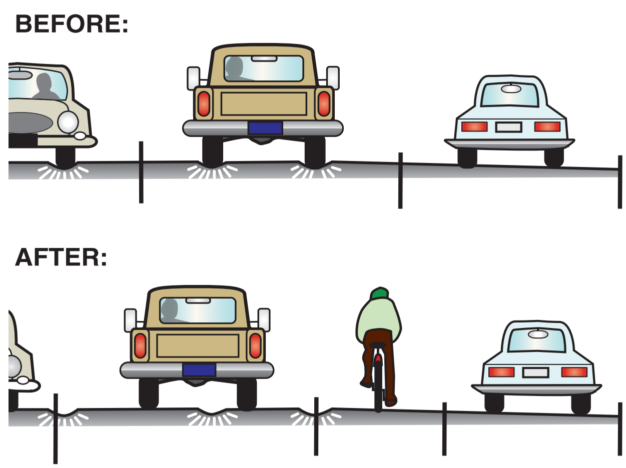



*Figure 2-10: Restriping offsets travel lanes reducing wear and tear*

Benefits for pedestrians include:

- Greater separation from traffic in the absence of on-street parking or a planter strip, increasing comfort and safety. This is important to young children walking, playing or riding their bikes on curbside sidewalks.

- An area for people in wheelchairs to travel where there are no sidewalks, or where sidewalks are in poor repair or do not meet ADA standards.
- Reduced splash from vehicles driving through puddles; in dry climates, less dust raised by passing vehicles, as they drive further from unpaved surfaces.
- The possibility of planting street trees, as the roots are not immediately under travel lanes.

## Bike Lane Widths

The standard width for a bike lane is 6 feet. While it is important to maintain standards for bicycle facilities, there may be circumstances where restrictions don't allow full standards. Minimum bike lane widths are:

- 5 feet against a curb or adjacent to a parking lane. A 4.5 foot curbed bike lane may be allowable where there are very severe physical constraints.
- 4 feet on uncurbed shoulders.

*Bike lane provides minimal buffer for pedestrians*

# CHAPTER 3: BICYCLE PARKING

*Well placed bicycle parking*

## Introduction

Secure bicycle parking provided at likely destinations is an integral part of a bikeway network. Bicycle thefts are common and lack of secure parking is often cited as a reason people hesitate to ride a bicycle to certain destinations. The same consideration should be given to bicyclists as to motorists, who expect convenient and secure parking at all destinations. 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.

*Upside down U or staple rack accommodates two bicycles*

Bicycle parking facilities are generally grouped into 2 classes:

- **Long Term:** Provides complete security and protection from weather. It is intended for situations where the bicycle is left unattended for long periods of time: apartments, condominiums, schools, places of employment and transit stops. These are usually lockers, cages or rooms in buildings, providing real security for the bicycle (with its easily removed components) and accessories (lights, pump, tools and bags).
- **Short Term:** Provides a means of locking the bicycle frame and at least the front wheel, but does not provide security for accessories, or weather protection unless covered. It is for parking where the bicycle is left for a short period of time and is visible and convenient to the building entrance.

The following recommendations are presented to help cities and counties develop local bicycle parking ordinances.

*Bike racks can be street art*

# Recommended Standards

## Dimensions

The recommended dimensions ensure that bicycles can be securely locked without undue inconvenience and will be reasonably safeguarded from theft as well as intentional or accidental damage.

- Bicycle parking spaces should be at least 6 feet long and 3 feet wide, and overhead clearance in covered spaces should be at least 7 feet.
- A 6 feet aisle for bicycle maneuvering should be provided and maintained beside or between each row of bicycle parking.
- Bicycle racks or lockers should be securely anchored to the surface or a structure.

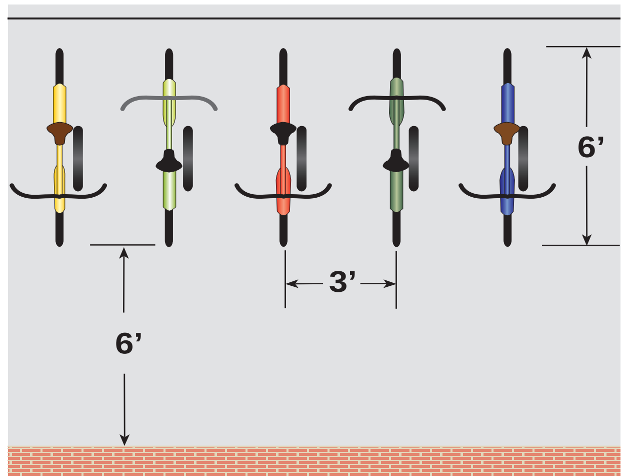



*Figure 3-1: Recommended bicycle parking dimensions*

## Covered Parking

Pacific Northwest winters have mild temperatures and periods of intermittent rain. Many short trips can be made by bicycle without getting wet; however, a rider might hesitate to leave a bicycle exposed to the weather if it’s left unattended for a long time.

Covered parking is necessary for long-term parking (mostly residential and employee uses). For customers, visitors and other occasional users, covered parking is also beneficial. Covered spaces can be roof overhangs, awnings, lockers or bicycle storage spaces within buildings.

Covered parking needs to be visible for security, unless supplied as storage within a building. Covering should extend 2 feet beyond the parking area, to prevent cross-winds from blowing rain onto bicycles.

- Bicycle parking for residential, school and industrial uses should be covered.
- 50% of bicycle parking for commercial uses should be covered.

- Where motor vehicle parking is covered, bicycle parking should also be covered.

Where there are 10 or more bicycle parking spaces, at least 50% of the bicycle parking spaces should be covered.

*Covered bike parking*

## Location

Bicycle parking should be located in well lit, secure locations within 50 feet of the main entrance to a building, but not further from the entrance than the closest automobile parking space; and in no case further than 50 feet from an entrance where several entrances are involved.

The effectiveness of bicycle parking is often determined by location. To reduce theft, a highly visible location with much pedestrian traffic is preferable to obscure and dark corners, even if the more visible location is more distant. Because of its smaller size, the bicycle can be parked closer to the rider's destination than a car.

Racks near entrances should be located so there are no conflicts with pedestrians. Curb cuts near the rack location discourage users from riding on the sidewalk to access the racks.

Many sites need two types of bicycle parking: short-term for customers (up front); and long-term (covered) for employees, which may be placed further away from the main entrance.

Separating bicycle from car parking by a physical barrier or sufficient space protects bicycles from damage by cars.

Bicycle parking provided in the public right-of-way should allow sufficient passage for pedestrians (6 feet).

*Bike racks placed out of pedestrian zone*

(Bicycle parking may be provided within the public right-of-way in areas without building setbacks, subject to approval of local officials and provided it meets the other requirements for bicycle parking.)

In Central Business Districts, simple racks placed along the sidewalks serve bicyclists riding to various locations along a commercial street. They should be placed in the furniture or the frontage zone, so they do not interfere with pedestrians. There should be several per block: smaller bicycle parking areas are preferable to one large centralized area both for convenience in access and greater security.

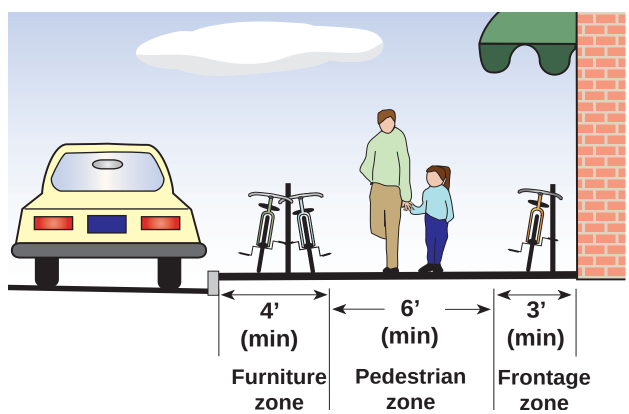



*Figure 2-2: Bike parking in furniture zone in central business district*

Covered bike parking on curb extension

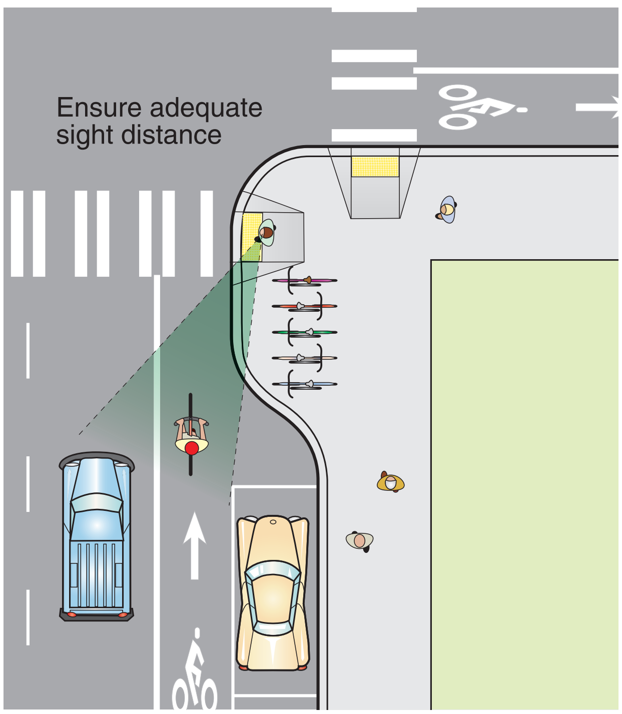



Figure 3-3: Bike parking on curb extension

## Bicycle parking on curb extensions

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.

## On-street bicycle parking

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.

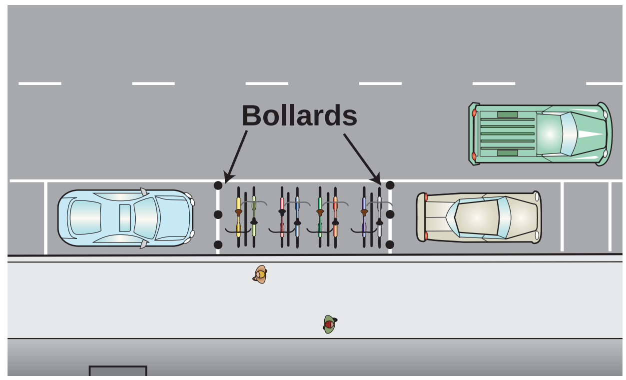



Figure 3-4: Protected on street bike corral

On-street bike parking

Bicycle parking may also be provided inside a building in secure and accessible locations. This provides a high degree of security and protection, at the expense of some convenience. Dedicated rooms with card locks are very effective. Locating a room close to changing and showering facilities enhances its attractiveness.

## Number of Spaces

See Table 3.3.400 in the model land use and development codes developed by the Transportation and Growth Management program: *http://www.oregon.gov/LCD/TGM/docs/modelCode05/pdf/art3.pdf.* The TGM recommendations are based on specific and easily measurable criteria; e.g. size of buildings, number of residential units, number of classrooms, etc.

Combined parking could be allowed in areas of concentrated small businesses, such as downtowns and business parks. Publicly provided bicycle parking could also be used.

For park-and-ride lots, requirements need to relate the number of bicycle parking spaces to the probable service area (e.g. the number of residents within a three-mile radius of a facility.)

*Secure bicycle parking in basement room*

The amount, location and usage of bicycle parking should be monitored and adjusted to ensure that there is an adequate supply. If bicycle use increases, the need for bicycle parking may increase above that specified when facilities are constructed. Local jurisdictions may have to require additional bicycle parking to meet the demand.

Employment and retail centers should voluntarily provide additional parking to satisfy the demands of customers and employees.

## Signing

Directional signs are needed to guide cyclists if the bicycle parking locations are not visible from building entrances or transit stops. Instructional signs may be needed if the design of bicycle racks isn't readily recognized as bike parking, such as art racks.

But for security reasons, it’s better not to sign long-term employee parking within a building, to avoid bringing bicycles to the attention of potential thieves.

## Other Recommendations

Long-term bicycle parking spaces should be provided at no cost, or with only a nominal charge for key deposits, etc. Residential parking spaces should be available to residents as part of rental or ownership contracts. This does not preclude the operation of private for-profit bicycle parking businesses.

Short-term bicycle parking should be available near the building entrances of all land uses, and should be free.

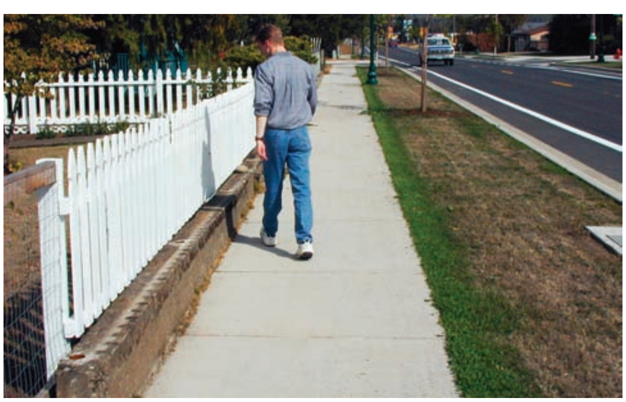
# CHAPTER 4: WALKWAYS


*A successful Central Business District depends on good sidewalks*

## Types of Walkways

Pedestrian facilities include sidewalks, traffic signals, crosswalks, refuge islands, pedestrian-scale illumination and benches. Walkways include:

- SIDEWALKS, located along roadways, separated with a curb and/or planting strip or swale, have a hard, smooth surface. Sidewalks in residential areas are sometimes used by bicyclists, but cities may ban bicycle riding on sidewalks.



*Sidewalks serve pedestrians in urban and suburb contexts*

- PATHS, typically used by pedestrians, cyclists, skaters and joggers (shared-use). It is not realistic to plan and design a path for exclusive pedestrian use, as others will be attracted to the facility. Paths may be unpaved (packed gravel) if they are smooth and firm enough to meet ADA requirements. See Chapter 7 for path design guidelines.


*Paths serve pedestrians in many contexts*

- SHOULDERS, which serve pedestrians in many rural areas. The ODOT-recommended shoulder widths are usually adequate to accommodate pedestrians. In rural areas where population densities are too low to justify sidewalks, shoulders should be:

- Wide enough (6 feet) to accommodate pedestrian and bicycle traffic.

See shoulder width table in Chapter 1 for shoulder width guidelines.

*Shoulders serve pedestrians in rural areas*

# Standards

## Sidewalks

## The Sidewalk Zone System

The best way to achieve the goal of a clear walking area is to design sidewalks using the zone system. Each zone is a distinct sidewalk area; the 4 zones are:

1. The curb zone;
2. The furniture (or planter) zone;
3. The pedestrian (or walking) zone; and
4. 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. 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 furniture or frontage zones. Separation from the roadway also places pedestrians further from traffic, increasing comfort and security.

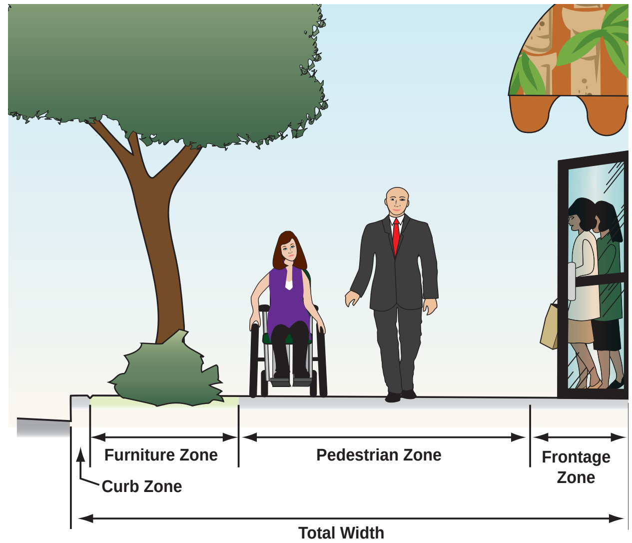



*Figure 4-1: The sidewalk zone system, urban context*

### The Curb Zone:

Most urban streets with sidewalks are typically curbed. A vertical (barrier) curb channelizes drainage and prevents people from parking their cars on the sidewalk. Mountable curbs are not recommended on urban streets, as they make it easier for drivers to park on the sidewalk. The curb zone is also where a sidewalk transitions to the street at a crosswalk or intersection; the design of the gutter pan (apron) is critical for ADA access standards.

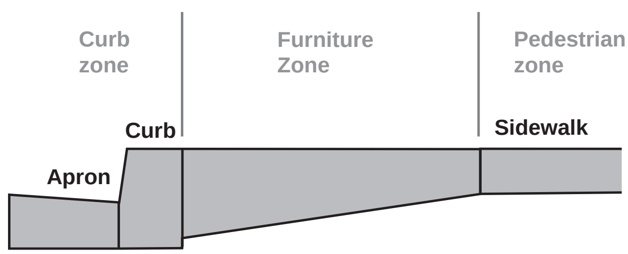



*Figure 4-2: The curb zones transitions from the street to the sidewalk*

### The Furniture Zone:

The furniture zone is located between the curb and pedestrian zones and can be paved or landscaped. When landscaped it is referred to as the funiture zone. It's easier to meet ADA sidewalk requirements with separated sidewalks. The furniture zone has many functions:

- Pedestrians are separated from traffic, increasing a walker's sense of security and comfort;
- Street furniture and obstructions (bicycle parking, poles, posts, mailboxes, parking meters, fire hydrants, etc.) can be placed out of the walking zone (these objects should not reduce visibility of pedestrians, bicyclists and signs);
- Room for street trees and other landscaping (plants should be selected that require little maintenance and watering; roots should not buckle sidewalks);
- The sidewalk can stay level across driveways;
- Ramps can be placed correctly: sidewalks, curb cuts and crosswalks line up at intersections; and
- Improved drainage: decreased runoff water, decreasing overall drainage requirements; prevents water in puddles from splashing onto pedestrians; creates a place to store snow removal during the winter.

The curb zone and furniture zone should be 5 feet wide or more. Narrower furniture zones (2 feet min) offer some of the advantages listed above. Where constraints preclude the use of the same width throughout a project, the furniture zone can be interrupted and resumed where the constraint ends.

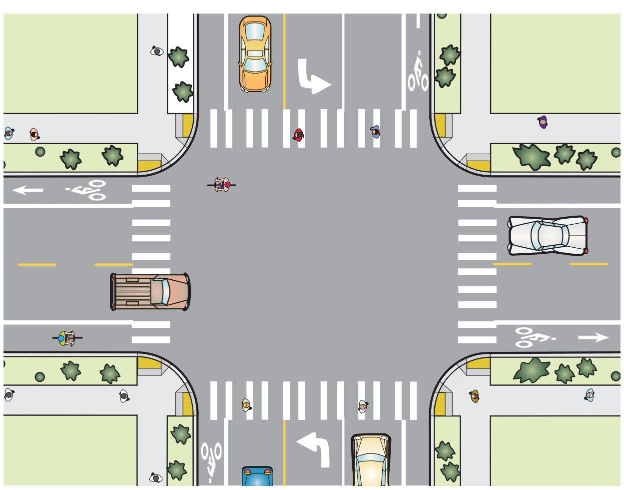


*Figure 4-3: Separated sidewalks facilitate ramp and crosswalk alignment*

*A well organized furniture zone leaves the pedestrian zone clear of obstacles*

### The Pedestrian Zone:

This is where people walk. All planning, design and construction documents should clearly state the walking zone dimension is to be clear of all obstructions. The ODOT standard pedestrian zone width is 6 feet. This width allows two people (including wheelchair users) to walk side by side, or to pass each other comfortably. It also allows two pedestrians to pass a third person without leaving the sidewalk. Where it can be justified and deemed appropriate, the minimum width may be 5 feet, such as on local streets, with adequate separation from the roadway. At no point should the pedestrian zone be less than 4 feet wide at pinch points such as around poles.

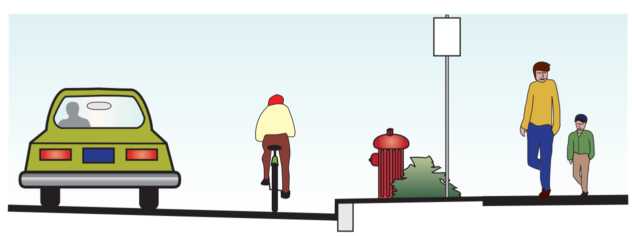


*Figure 4-4: Separated sidewalk is free of obstructions*

Clearance to vertical obstructions (signs, tree limbs, etc.) must be at least 7 feet.

*5 foot sidewalk is uncomfortably narrow*

*Sidewalk widened to 6 feet*

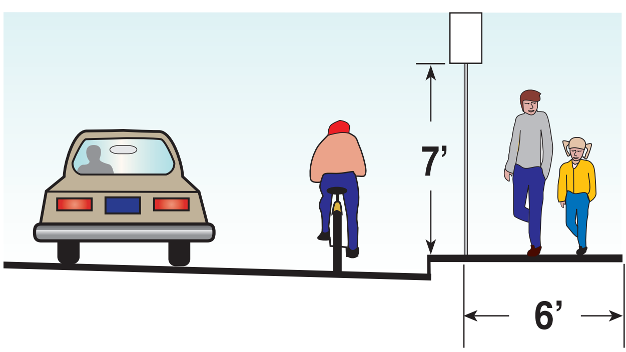



*Figure 4-5: Sidewalk clearances*

The pedestrian zone should be straight, or parallel to the adjacent road when the road naturally curves. Attempts to create meandering sidewalks 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 sidewalk 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 4-6: The furniture zone may be eliminated or reduced at pinch points*

*Furniture zone eliminated at pinch point*

Cars parked perpendicular or diagonally to sidewalks can reduce the sidewalk width if there is excessive overhang. Wheel stops should be used to prevent narrowing the usable sidewalk width.

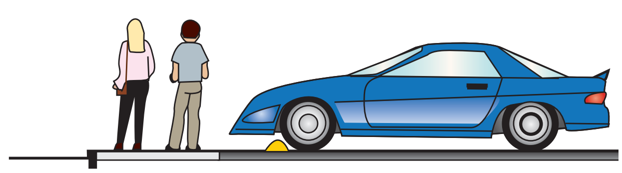


*Figure 4-7: Wheel stops reduce sidewalk encroachment*

*Wheel stops prevent sidewalk encroachment*

Sidewalks must not be placed directly adjacent to a high-speed travel lane (45 MPH and above); they should be buffered with a planting strip, a parking lane or a bike lane. In the absence of any separation, sidewalks 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 walking space and provides 2 feet shy distance from high speed motor vehicle traffic.

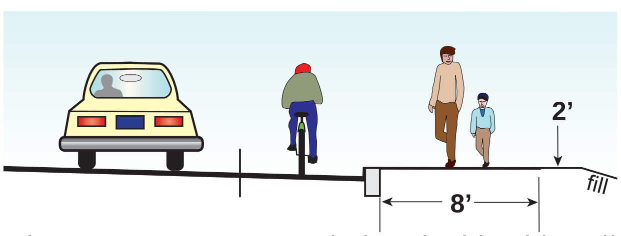



*Figure 4-8: Recommended curb side sidewalk dimensions*

*Sidewalk with no buffer*

Greater sidewalk widths are needed in high pedestrian use areas, such as central business districts, where 10 feet is considered necessary, as the sidewalks are often also used for sidewalk cafés, street furniture, etc. 12 feet to 14 feet sidewalks or greater are common in Central Business Districts.

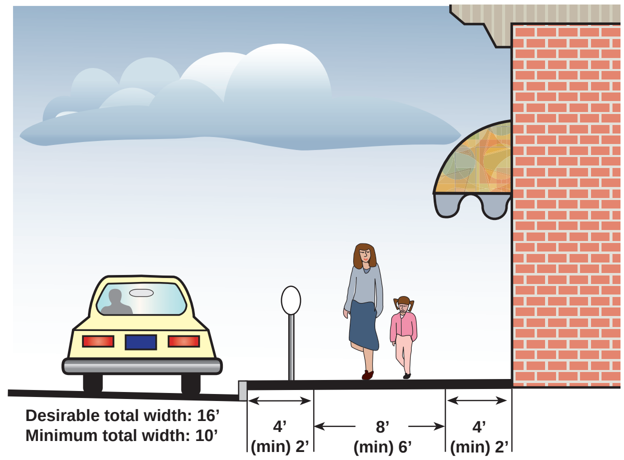



*Figure 4-9: Recommended Central Business District sidewalk dimensions*

*Central business districts require wider sidewalks*

The surface should be smooth and uniform. When a sidewalk is paved out to the curb, it is beneficial to make a surface distinction between the walking area and the buffer strip; this helps ensure obstacles are placed out of the walking area.

### The Frontage Zone:

The frontage zone is located between the pedestrian zone and the right-of-way. It is where sandwich boards, bike racks and other street furniture are placed; it is used by window shoppers, it's where people enter and exit buildings.

*A generous frontage zone with seating and bus shelter*

The recommended width is 2 feet or greater. An absolute minimum of 1 foot is needed for practical purposes, for example to ensure that adjacent property owners don't erect a fence at the back of walk, or for maintenance personnel to make sidewalk repairs. A 2 foot shy distance is needed from vertical barriers such as buildings, sound walls, retaining walls and fences.

In Central Business Districts the frontage zone should be 4 feet or wider to provide space for merchandise, sidewalk cafés, and opening doors.

*Note: ADA requires that "objects protruding from walls (e.g. signs, fixtures, telephones, canopies) with their leading edge between 27 inches and 80 inches above the finished sidewalk shall protrude no more than 4 inches into any portion of the public sidewalk." (ADAAG 14.2.2)*


*Frontage zone used for decorative planters*

## Sidewalks without Curb & Gutter

Most sidewalks are separated from the roadway with curbs, which channelize drainage and provide positive separation from traffic.
But curb and gutter can add substantially to sidewalk costs. Where sidewalks are needed, but the high cost of curb and drainage cannot be justified, or where curbs don't fit the character of the street, sidewalks may be constructed without curb and drainage.

### Sidewalks behind the ditch

On roads with a rural character, where drainage is provided with an open ditch, and where there is sufficient room, sidewalks may be placed behind the ditch.

The sidewalk should be built to the same width as curbed sidewalks: 6 feet (5 feet min). Gravel driveways should be paved 15 feet back from the sidewalk to avoid debris accumulation.

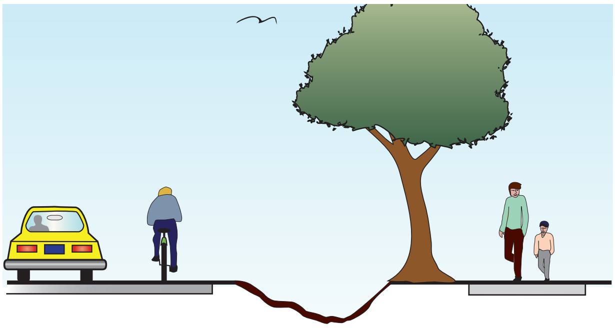


Figure 4-10: Sidewalk behind ditch or swale

Sidewalk behind swale

## Bridges

Sidewalks should always be provided on both sides of bridges where pedestrian use can be expected. The minimum width for sidewalks on bridges is 7 feet, to account for two shy distances: from traffic, and from the 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. The bridge sidewalk must not be narrower than the approach sidewalk. Sidewalks on bridges with design speeds greater than 40 MPH require a vehicle barrier at the curb line.

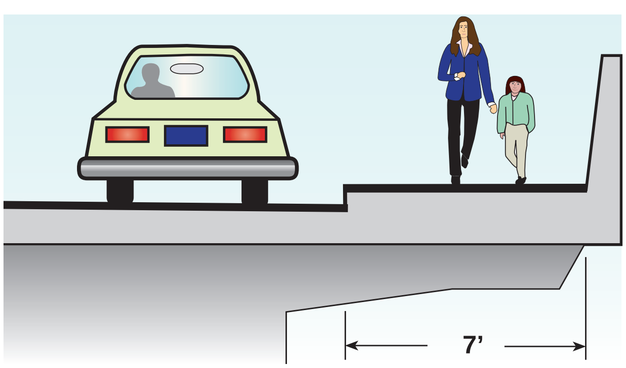



Figure 4-11: Minimum bridge sidewalk width

Barrier curb

## Surfacing

The preferred material for sidewalks is Portland Cement Concrete (PCC), which provides a smooth, durable finish that is easy to grade. Asphaltic Concrete (A/C) may be used if it can be finished to the same surface smoothness as PCC. A/C is susceptible to breakup by vegetation and has a shorter life expectancy than PCC.

Brick pavers can provide an aesthetically pleasing effect if the following concerns are addressed:

- They should be laid to a great degree of smoothness;
- They should not have beveled edges;
- The surface must be slip-resistant when wet; and
- Long-term maintenance costs should be considered.

Ornamental landscape pavers (often beveled or "pillowed") should not be used as the primary walking surface; they can be used for aesthetics in the furniture and frontage zones. Sidewalks embellishments can also be achieved by treating concrete with dyes or with decorative scoring.

*Pavers require regular maintenance to meet ADA requirements*

### Thickness

Sidewalks with foot traffic only are normally constructed with 4 inches of PCC on top of a compacted base of crushed rock or sand.

At driveways or where the sidewalk can be expected to be driven on by maintenance vehicles 6 inches of PCC is required. Heavy vehicle traffic, such as garbage trucks and emergency vehicles may require 8 inches of PCC to avoid damage.

### Utility Vaults

Water meter covers, man holes and other utility vaults may be located within the pedestrian zone as long as they are smooth, slip resistant and do not have protruding hardware.

### Tree Well Grates

Likewise tree well grates traversable by wheelchairs can be located within the pedestrian zone; however, tree well grates are a hazard to high heel wearers so care should be taken to minimize the extent that tree well grates extend into the pedestrian zone.

*Wheelchair traversable tree grates may extend into pedestrian zone*

### Pedestrian Rail

Pedestrian rail should be provided where the sidewalk abuts a steep slope or hazard. The need for pedestrian rail can be eliminated with a shallow slope and soft surface, such as grass.

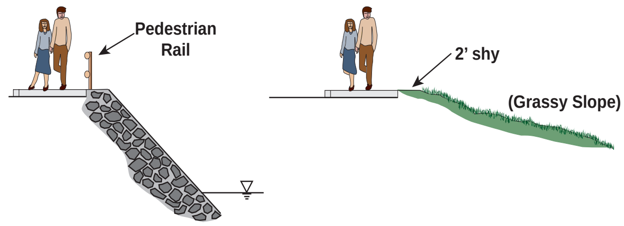



*Figure 4-12: Pedestrian rail should be used when a sidewalk abuts a serious hazard*

## Pervious sidewalk 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 sidewalks are usually separated from the roadway with a bio-swale. This 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 sidewalks surfaces must still meet smoothness standards: no more than ¼ inch height difference (ADA).

Sidewalks built out of conventional impervious materials (concrete) contribute little to runoff if they are separated form the roadway with a funiture zone: most of the precipitation that lands on the sidewalk can be absorbed by the native soil in the funiture zone.

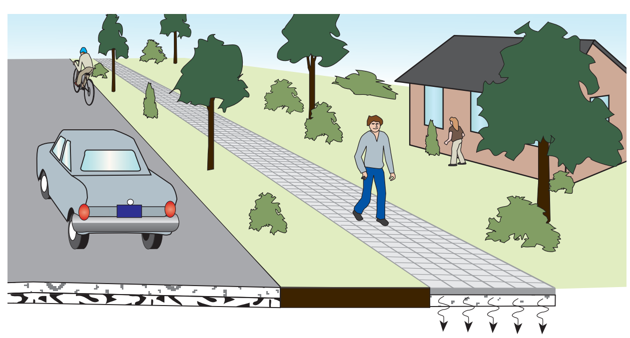


*Figure 4-13: Pervious sidewalk*

*Concrete mix design is critical in pervious sidewalk to avoid a rough surface*

## Railroad Crossings

Sidewalks crossing a railroad are not controlled by the warning gates/arms; they cross behind the gate/arm. The sidewalk width across the tracks should be the same as the approaching sidewalk, or wider.

OAR 741-120-0025 (3) states: “At crossings equipped with automatic protective devices, sidewalks shall be directed behind the devices at a distance of not less than 5 feet, as measured from the centerline of the signal mast to the nearest edge of the sidewalk.” Sidewalks at crossings equipped with automatic protective devices should be constructed as close to the roadway as possible so that users receive visual and auditory warnings of approaching trains. To this end, the far edge of the sidewalk should be no more than 10-12 feet from the centerline of the signal mast.

There is no mandate for sidewalks to cross tracks at 90º. When a sidewalk crosses tracks at a skew, it’s usually possible for people in wheelchairs to align themselves at a right angle within the width of a 6 foot sidewalk, even in most cases within a 5 foot sidewalk. Some people prefer to cross at a slight angle, so both casters don't hit the tracks at the same time. For this reason, the best practice is to widen the sidewalk at the grade crossing to allow the 4 foot square footprint of a wheelchair to align itself to cross tracks safely, regardless of the skew angle at the crossing. Curving the entire sidewalk to cross tracks at 90º is usually unnecessary.

Detectable warnings domes must be placed at the sidewalk/track interface, to alert pedestrians with vision impairments of the presence of tracks.

*Railroad Crossing*

# Paths

## Unpaved Paths

In general, the standard width of an unpaved path is the same as for sidewalks. An unpaved path should not be constructed in lieu of a sidewalk.

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: they are usually inexpensive and easy to grade (this should be done in the summer, when the heat helps pack and bind the grindings).

## Paved Paths

See Chapter 7 for standards for shared-use paths.

## Transit Stop Connections

Transit depends on walking to function well; most transit users walk to and from transit stops. The sidewalk network supports transit by providing walkways to bring people to and from transit stops, and by providing safe and convenient crossings at transit stops. Since there is an element of risk in crossing busy streets, safety improvements must be made at transit stops.

The safety of pedestrians can also be enhanced using a variety of transit operation improvements, usually implemented by the transit agency, in cooperation with the road authority: consolidate, relocate or eliminate stops. Convenient access by passengers must remain at the forefront of all transit stop planning: simply eliminating stops because they are perceived as unsafe may not serve the needs of transit users. Best is to make access and crossing improvements at existing stops that serve passengers well, or relocating them to a safer and more accessible location within a reasonable walk.

Pedestrian crossing paired with transit stop

### Sidewalks

At transit stops, sidewalks or paths should be constructed to the nearest intersection or to the nearest section of existing sidewalk. It might 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 people waiting for a bus.

ADA requires an 8 foot by 5 foot landing pad at bus doors. To avoid the choppy effect this creates at bus stops on curbside sidewalks less than 8 feet wide, it is preferable to construct a continuous 8 foot wide sidewalk the length of the bus stop. The wider sidewalk allows passing pedestrians to get by people waiting for a bus.

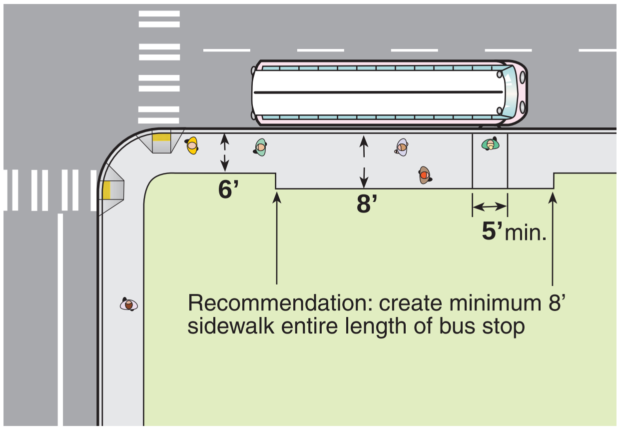



*Figure 4-14: Bus stop pad dimensions*

At stops in uncurbed areas, the shoulder should be 8 feet wide to provide a landing pad.

Bus stop with shelter in furniture zone

### Bus Shelters

A standard-size bus shelter requires a 6 feet x 10 feet pad, with the shelter offset at least 4 feet from the curb for wheelchair clearance. The adjacent sidewalk must still have a 4 feet clear-zone (6 feet preferred) behind or in front of the shelter for sidewalk traffic. Orientation of the shelter should take into account prevailing winter winds. Bike racks should be considered at bus stops in urban fringe areas.

These goals are easier to meet with separated sidewalks, as the shelter and bike racks can be placed in the furniture zone.

*Each transit agency may have its own standards for bus shelter pads; walkway construction should be coordinated with local transit agencies to ensure compatibility.*

Bus shelter improves transit experience

## Bus Pullouts

Where high motor vehicle traffic volumes warrant a bus pullout at an intersection, a far-side location is preferred. The needs of passengers boarding or exiting a bus should not conflict with the needs of pedestrians and bicyclists moving through the area. The curb at the corner should not be recessed, as this creates the illusion of an acceleration lane for right-tuning motorists. Placing a curb extension at the corner in line with the rest of the curb helps pedestrian crossing movements, prevents motorists from entering the bus pullout area and reduces conflicts with through bicyclists.

Each pullout should be designed to meet roadway conditions and bus characteristics. The bus pad should be constructed with concrete pavement to avoid heaving, as buses slow to a stop in the pullout.

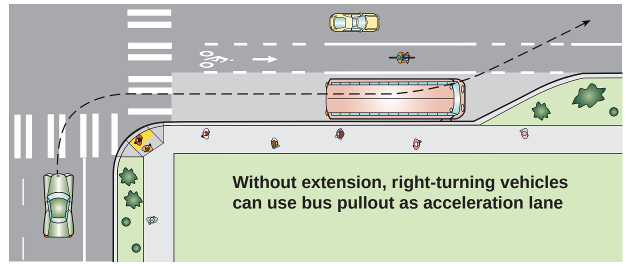



Figure 4-15: Bus pullout at corner adversely impacts traffic

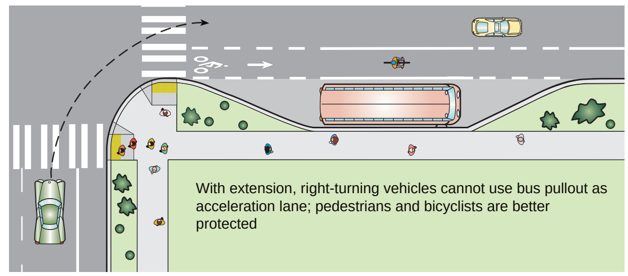



Figure 4-16: Bus pullout with curb extension

Bus pull out

## Bus curb extensions

On streets with parking, curb extension bus stops benefit passengers who can board or dismount the bus directly without stepping onto the street. This also makes it easier for passengers with disabilities to board the bus, as it pulls up right next to the curb. The curb extension provides room for a shelter. Curb extensions require a bus to stop in the travel lane; the added delay to motorists is offset by reduced:

1. Dwell time (passengers can board the bus faster); and
2. The bus's ability to accelerate immediately, without waiting to merge back into traffic.

These two advantages are substantial improvements to transit operations.

A curb extension bus stop may also increase on street parking. The amount of yellow curb required for bus ingress and egress can be greater than the length of a curb extension bus stop.

For a more thorough discussion of designing for transit, please consult the Highway Design Manual.

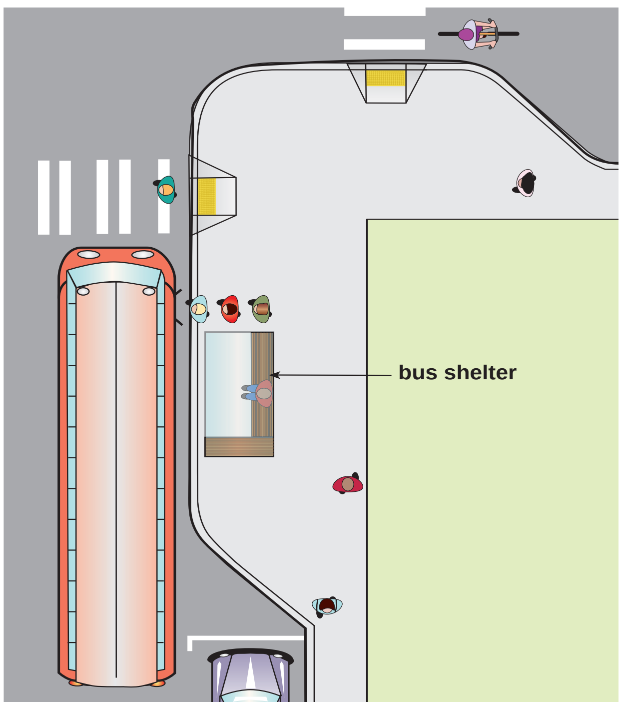



*Figure 4-17: Curb extension bus stop*

*Curb extension bus stop reduces bus dwell time*

## Transit Stop Crossings

Chapter 5 and 6 discuss street crossings and intersection design; all of the techniques described there can be used to help people cross the street safely and conveniently when accessing or leaving a bus stop. The safety of pedestrians crossing streets to access transit can also be enhanced by using a variety of transit operation improvements. These are usually implemented by the transit agency in cooperation with the road authority, and include consolidating, relocating and eliminating stops.

When a transit stop is located midblock, a single crossing should be provided to serve both directions of bus travel; if a crosswalk is marked, it should be behind the bus stop, so:

- Pedestrians cross behind the bus, where they can see traffic (crossing in front of a bus blocks visibility);
- The bus driver can accelerate as soon as passengers have left the bus; and
- The driver won't accidentally hit a pedestrian crossing in front of the bus.

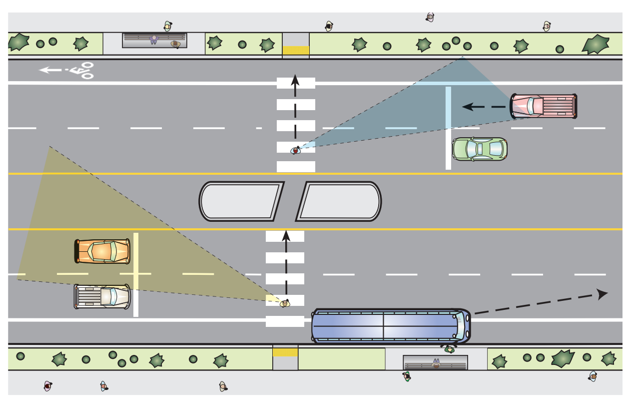


*Figure 4-18: One crossing serves bus stop in both directions*

For a variety of operational reasons, at intersections, farside stops are usually preferred. One advantage is that pedestrians cross in back of the bus. However, transit operators often must place stops nearside, for reasons such as a concentration of users at a nearside corner, or because the bus route makes a right turn at that intersection. In all cases the safety and convenience of pedestrians must be a high priority.

*Pedestrian crossing to rear of transit stop*

## Accommodating People with Disabilities

The Americans with Disabilities Act (ADA) requires that transportation facilities accommodate the disabled. For most practical purposes, pedestrians with mobility and vision impairments need greater attention. The essential ADA requirement is to create a pedestrian access route to link community destinations. Within the public right-of-way, sidewalks are considered the pedestrian access route, as well as crosswalks, pedestrian refuge islands, traffic signals and other pedestrian features. Minor improvements can greatly improve accessibility. ODOT sidewalk standards meet or exceed minimum ADA requirements.

*Note: at the time of publication, the Access Board has not finalized the Americans with Disabilities Act Accessibility Guidelines for the Public Rights-of-Way (PROWAG). (The ADA Accessibility Guidelines [ADAAG] pertain primarily to buildings and building sites.) FHWA's September 12, 2006 memo addresses compliance with the ADA and states, "Sidewalks and street crossings generally should use the guidelines the Access Board is proposing for public rights-of way" i.e. PROWAG.*

PROWAG and ODOT Standard Drawings should be used to construct curb cuts, driveways, accessible signals and other facilities designed for pedestrians with disabilities.

The US Access Board website has the latest guidelines: *http://www.access-board.gov/prowac/draft.htm*

The Oregon DOT Bicycle and Pedestrian program website has links to ODOT's standard drawings: *http://www.oregon.gov/ODOT/HWY/BIKEPED/*

The purpose of this section is to provide general guidance; please refer to the standard drawings for construction details.

It is much easier to meet the ADA requirements with separated sidewalks for several reasons:

- Obstacles such as poles can be placed in the furniture zone;
- Driveway aprons and curb ramps can be placed in the furniture zone, leaving the sidewalk level; and
- Sidewalks, curb cuts and crosswalks line up better at intersections.

These and others are reasons why separated sidewalks should always be the design of choice.

### Width

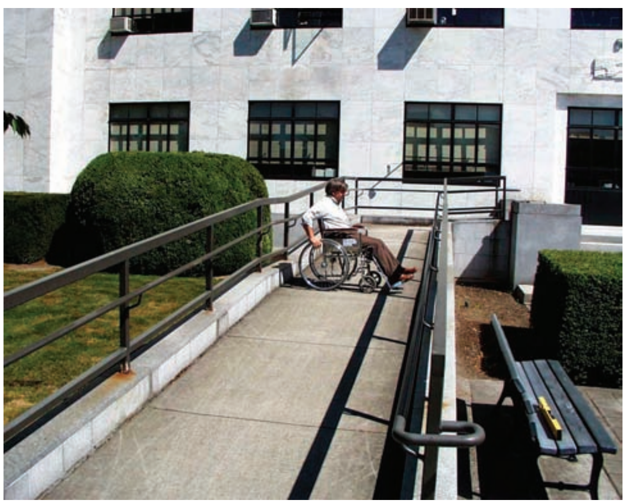
The 6 foot standard sidewalk width exceeds the ADA minimum passage requirements. The ADA required pedestrian access route is minimally 4 feet wide with 7 feet vertical clearance. Pinch points, such as at poles or other obstructions must comply with this requirement. **The ADA minimum clearance width is not an acceptable continuous sidewalk width.**

### Grades

Grade standards pertain mostly to separated paths on independent alignments and curb ramps. Where sidewalks are directly adjacent to a roadway, they may follow the grade of the roadway.

ADA requires that the grade of building access ramps and separated pathways not exceed 5%. A maximum grade of 12:1 (8.33%) is acceptable for a rise of no more than 2.5 feet if a 5 foot long level landing is provided after each 2.5 foot rise.

While this may be suitable for short distances, such as a ramp to the entrance of a building, a 12:1 slope followed by a level landing over a long distance creates a choppy effect that is difficult to construct. The overall grade achieved by a configuration of three consecutive rises of 2.5 feet with 5 feet landings in between and at each end is 7.1%. It may be preferable to extend the length of the facility to achieve a constant 5% grade.



*Level landing provides resting area*

Continuous sidewalk should also be constructed in accordance with the above guidelines. Where terrain is a challenge, sidewalks adjacent to a roadway may be constructed at the same grade as the roadway, but not steeper. Occasional level rest areas are recommended and care must be taken to address slopes at street crossings.

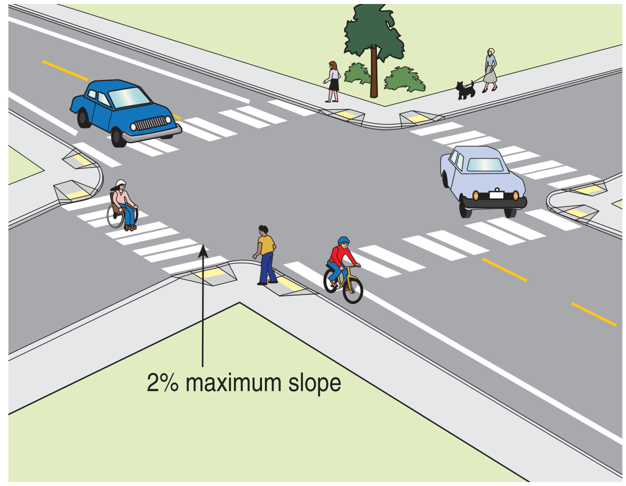



*Figure 4-20: Crosswalks maintained at 2% cross slope in steep terrain*

## Cross-Slope

The maximum allowable cross-slope (needed for drainage) for the pedestrian access route portion of a walkway is 2%. Across driveways, curb ramps and road approaches (in crosswalks, marked or unmarked), a 4 foot minimum wide area must be maintained at 2%.

The most frequent interruptions to the level pedestrian access route are at driveways. To facilitate wheelchair movement at driveways, the following techniques prevent an exaggerated warp and cross-slope:

- A furniture zone allows sidewalks to remain level, with the driveway grade change occurring in the furniture zone.
- Reducing the number of accesses reduces the number grade conflicts.

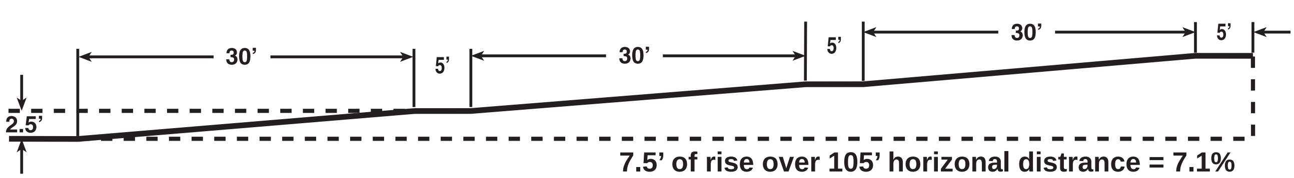



*Figure 4-19: Grade guideline for building access ramps and separated pathways*

Steep cross slope (4%) is difficult to traverse in a wheelchair

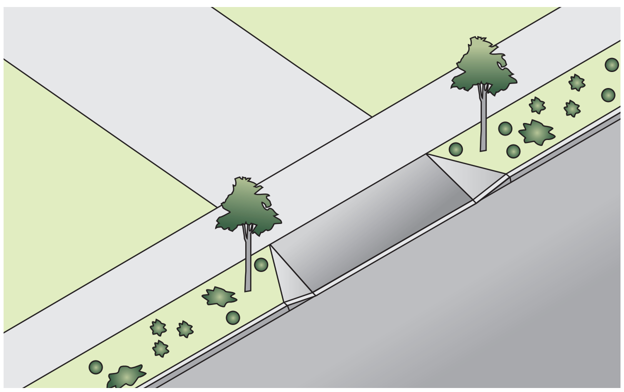


Figure 4-21: Furniture zone maintains sidewalk continuity

Separated sidewalk stays level at driveways and is free of obstacles

Where constraints don't allow a furniture zone, wrapping the sidewalk around driveway entrances has a similar effect. Wide sidewalks have enough room to avoid excessively steep driveway slopes; the overall width must be sufficient to avoid an abrupt driveway slope.

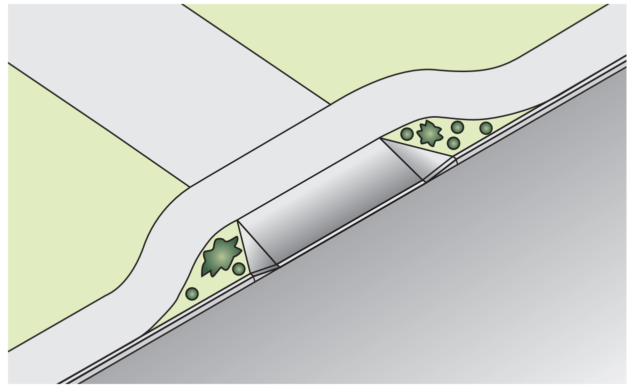


Figure 4-22: Curb tight sidewalk wraps to the back of driveway

Sidewalk is kept level at driveway

When constraints allow for only minimal sidewalks behind the curb, dipping the entire sidewalk at approaches keeps the cross-slope at a constant grade. This requires pedestrians to go up and down at every driveway, in a roller coaster manner and may create drainage problems on and behind the sidewalk.

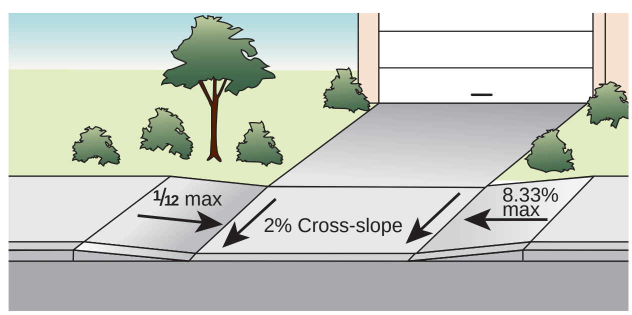



Figure 4-23: Entire sidewalk dips at driveway, but beware the roller coaster effect

*Lowering the entire sidewalk should be a last resort*

There are a number of variations on the above themes: partially lowering the sidewalk, wrapping the sidewalk around the driveway and partially lowering it, etc. Care should always be taken to keep the sidewalk as level as possible and to reduce out of direction travel.

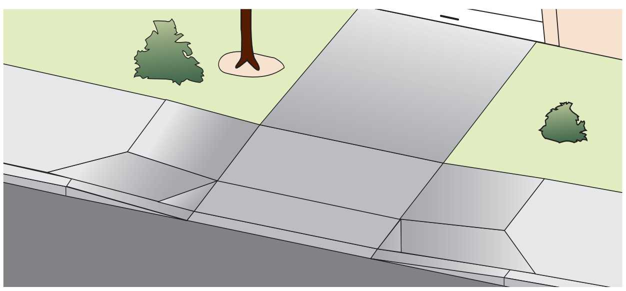


*Figure 4-24: Partially lowered sidewalk at driveway*

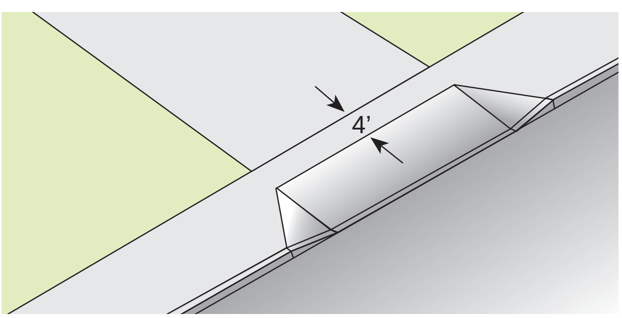



*Figure 4-25: Minimum pedestrian access route maintained level at driveway*

*Wide sidewalk accommodates driveway and keeps pedestrian access route level*

The other instance where cross-slope can be a concern is on older sidewalks adjacent to buildings. It's not uncommon for the street, the sidewalks and the buildings to have settled over time, at different rates. The sidewalk cross-slope often greatly exceeds 2% in these circumstances. The mitigation measures need only apply to the pedestrian zone, not the furniture or frontage zones; these two zones can be used to make up for the excessive cross-slope.

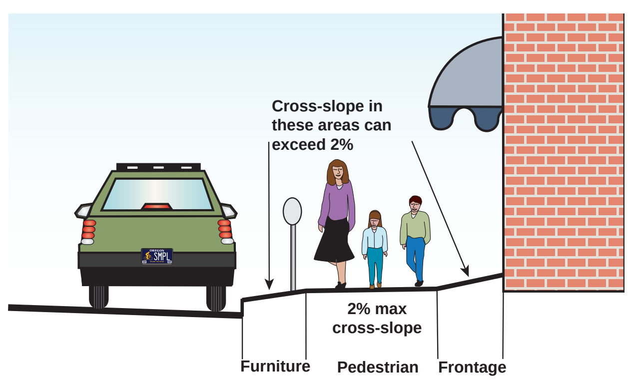



*Figure 4-26: Steeper cross slopes in furniture and frontage zones keep pedestrian zone level*

*Furniture zone accommodates needed grade changes, keeping pedestrian zone level*

## Ramps

ADA recommends two ramps per corner at intersections for new construction, as a single diagonal ramp may direct users into the travel way. A single ramp is allowable on retrofit projects where circumstances prohibit the installation of two ramps; however, in most cases two ramps can and should be accommodated even on retrofit projects. A 4 foot wide passage with a maximum cross slope of 2% must be maintained behind ramps.

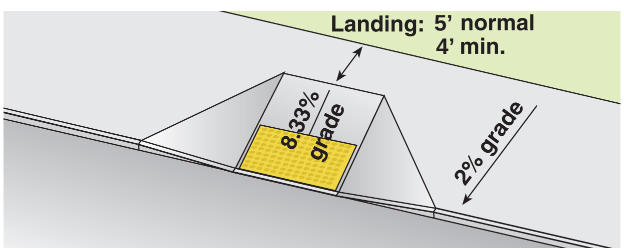



*Figure 4-27: "Standard" ramp*

*"Standard" curb ramp*

## Ramp Types

The ramp shown in Figure 4-27 works when there is a furniture zone, curb extension, or wide sidewalk; there are many situations in which this design will not work, particularly for narrow curbside sidewalks. The following ramp styles also meet ADA curb ramp requirements.

### Parallel ramp

To be used on narrow curbside sidewalks.

**Advantages:**

- Easy to construct; and
- Ramp is full width of sidewalk.

**Disadvantages:**

- All pedestrians must go down and up ramp; and
- May cause drainage problems.

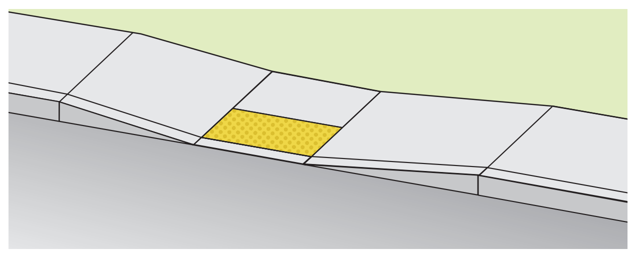


*Figure 4-28: Parallel curb ramp*

*Parallel curb ramp*

### Perpendicular ramp

To be used on separated sidewalks (with furniture zone/landscaped buffer).

**Advantages:**

- Easy to construct;
- Ramp may be full width of sidewalk or crosswalk;

- Pedestrians not using ramp may bypass it; and
- Minimizes impact on landscape area.

**Disadvantage:**
- Cannot be used in narrow rights-of-way.

***Note:*** *Wings are required only when furniture zone is traversable, (i.e. when it is paved).*

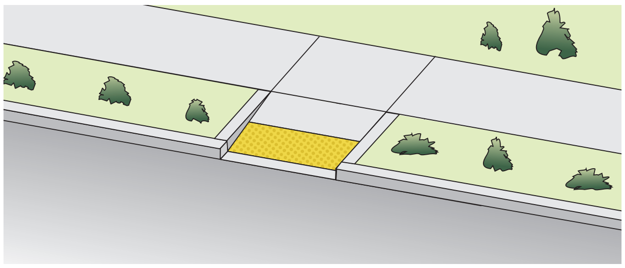


*Figure 4-29: Perpendicular ramp*

*Perpendicular Curb Ramp*

## Perpendicular ramp with one flare

To be used on wide curbside sidewalks where an obstacle prevents construction of a flare.

**Advantage:**
- Avoids having to construct flare.

**Disadvantage:**
- Requires special forming.

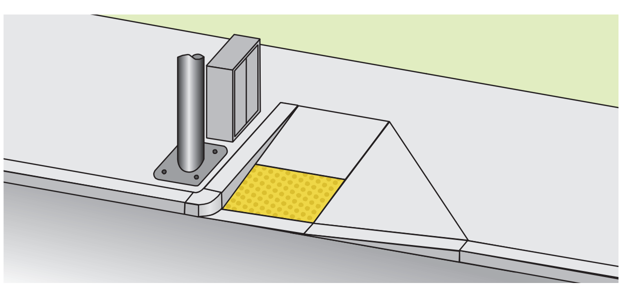


*Figure 4-30: Perpendicular ramp with one flare*

*Curb ramp with one flare*

## Combination ramp

To be used on sidewalks where circumstances prevent construction of standard or parallel ramps.

**Advantage:**
- Can be used in constrained areas with difficult grades.

**Disadvantage:**
- Requires special forming.

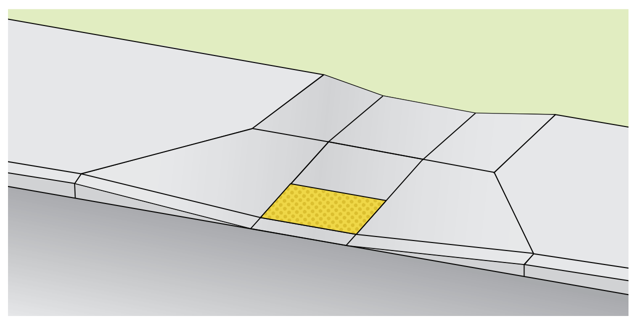


*Figure 4-31: Combination curb ramp*

*Combination curb ramp*

## Ramp Placement

Placement of the ramp within the intersection is crucial for safety and accessibility. Chapter 6, Intersection Design, covers ramp and crosswalk placement in greater detail; this section discusses the main issues that pertain to accessibility. These rules should be followed:

- Ramps must be wholly contained within the crosswalk lines (flares may fall outside the crosswalk);
- Two ramps per corner should be provided, where feasible;
- Ramps should be placed as close to the intersection as possible; this is made easier by keeping the curb radius tight, and the curb height between two adjacent ramps to no more than 3 inches; and
- Drainage grates should be provided upstream of ramps to prevent water ponding.

The following figures illustrate possible ramp placement scenarios:

## Separated sidewalks

Sidewalks with furniture zones make ramp placement very simple. Two perpendicular style ramps prolong the sidewalk down to the crosswalk; flares are not needed where the furniture zone is landscaped.

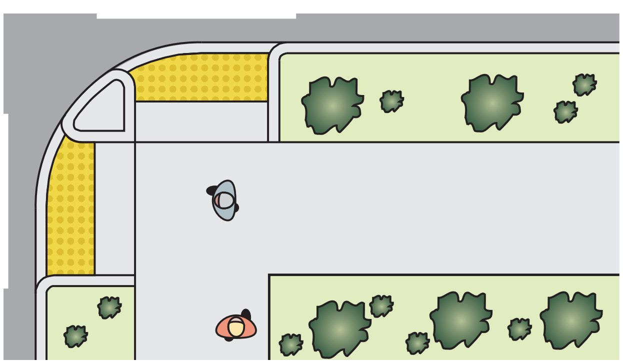


*Figure 4-32: Ramp placement, sidewalk with furniture zone*

*Ramp placement on separated sidewalk, NOTE: outside flares are not required.*

### Curb tight sidewalks

By their very nature curb tight sidewalks make placing two ramps difficult. On wide sidewalks with small corner radius (under 25 feet), two ramps can be placed close together.

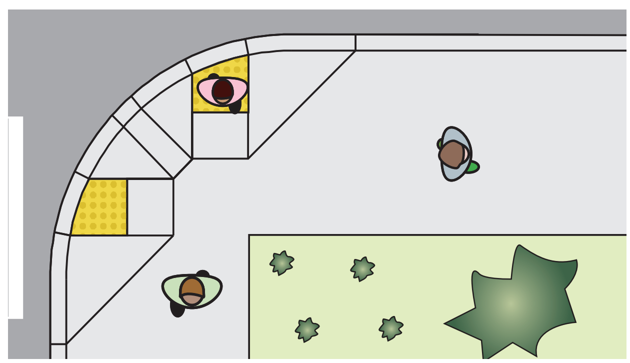


*Figure 4-33: Ramp placement on wide curbside sidewalk*

On larger radius curves, the ramps (and crosswalks) will be placed further apart. In this case, two parallel ramps work well on curbside sidewalks.

In both cases, limiting the curb height (3 inches min curb exposures) between the two ramps brings them closer together.

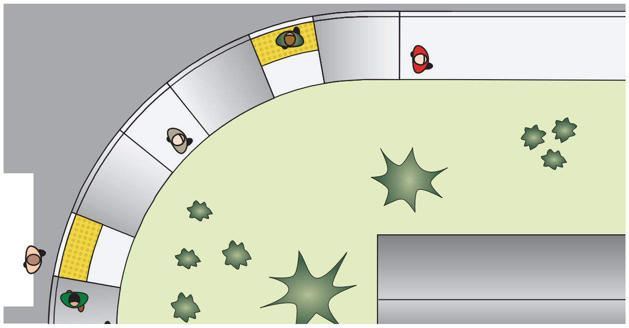


Figure 4-34: Ramp placement on narrow curb tight sidewalk

In constrained circumstances, such as against existing buildings, one ramp may be the only option. A 4 foot setback must be provided where the crosswalks meet, so a person using the ramps in a wheelchair can reorient himself in the crosswalk, not the travel lanes. This design is the least desirable, as people in wheelchairs must take a circuitous route to cross the street in either direction.

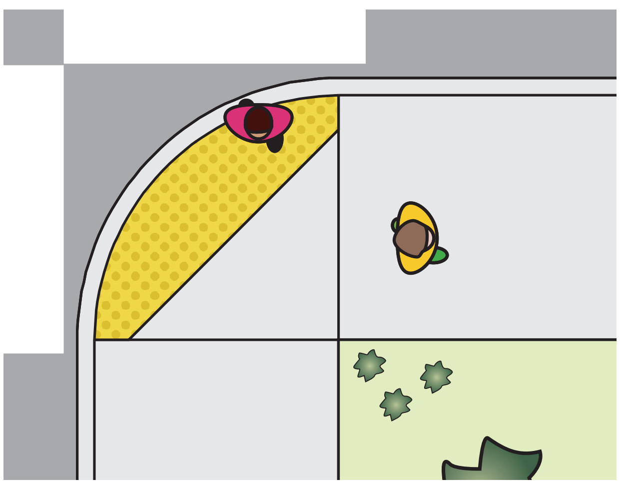


Figure 4-35: Single ramp placement on constrained sidewalk

In all cases, reducing the curb radius makes it easier to place ramps so they line up with the sidewalks and crosswalks.

## Ramp Elements

APWA/ODOT standard drawings and PROWAG, among other resources, provide detailed information on required ramp elements.

## Pedestrians with Visual Impairments

Sidewalks should be designed so people with vision impairments can find their way via a clear delineated edge, without hitting obstructions. Separated sidewalks satisfy this basic requirement. Sidewalks must be built with no protruding objects within the paved area; the specific requirements are:

- 80 inches minimum vertical clearance;
- No objects protruding from wall more than 4 inches at a height greater than 27 inches; and
- Any object protruding more than 4 inches at a height greater than 27 inches must be detectable with a curb or other detectable feature on the ground.

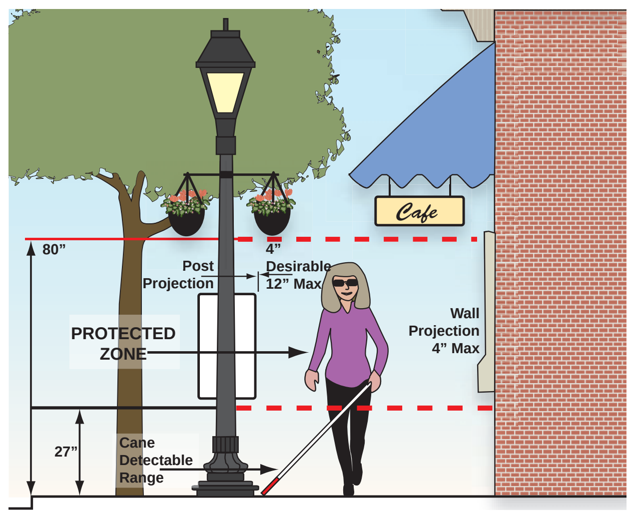



Figure 4-36: Blind pedestrian with clearances

Pedestrians with visual impairments must also be able to locate crosswalks and travel across streets at intersections. The visually impaired may have difficulty locating the crosswalks where the crossing points are not readily apparent, for example at a corner with a large radius or diagonal ramp. There are several techniques that enhance the environment for the vision-impaired:

- Keeping intersections tight and square to limit long and skewed crosswalks;

- Placing crosswalks in areas where they are expected (in line with ramps and sidewalks);
- Keeping crosswalks straight across the street;
- Providing accessible pedestrian signals; and
- Using detectable warnings at ramps to identify the transition from the sidewalk to the street.

These features are discussed in greater detail in Chapter 6, Intersections.

## Other Pedestrian Facilities

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 furniture or the frontage zones.

### Benches

People walking want to sit down and rest occasionally. In an urban setting, wide sidewalks, furniture zones and curb extensions provide opportunities for placing benches out of the walking zone.

*Bus shelter in furniture 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.

*Bench in furniture zone*

### 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.

*Awning shades sidewalk cafe*

### Landscaping

Landscaping can greatly enhance the aesthetic experience for pedestrians, making the walk less stressful or tiring. Landscaping can increase the effectiveness of a planting strip as 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:

- Plants should be adapted to the local climate and fit the context; they should survive without protection or intensive irrigation, and should require minimal maintenance, to reduce long-term costs.
- Plants must have growth patterns that do not obscure pedestrians from motor vehicles, especially at crossing locations, nor must they obscure signs.
- 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.
- Planting strips should be wide enough to accommodate plants grown to mature size.

*Landscaping provides 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.

## Other Considerations

### Driveways

Accesses to private property can be built as conventional driveways, or with designs that resemble street intersections. For pedestrian safety and comfort, the conventional driveway type is preferred, as motorists must slow down when crossing the driveway, and the right of way is clearly established, as motorists cross a sidewalk.

Intersection-type driveways can disadvantage pedestrians as motorists can negotiate the turn at faster speeds, and the right of way is not as clearly established, the driveway and roadway appear continuous.

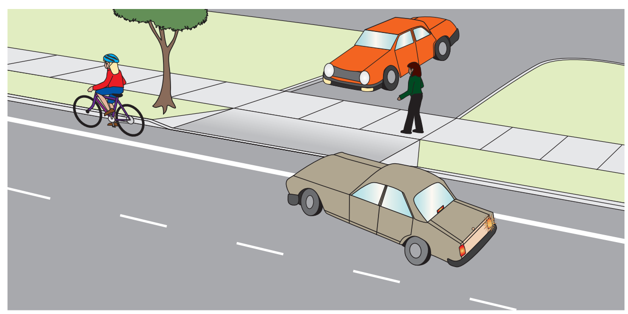


*Figure 4-37: Conventional driveway design*

*Dustpan style driveway approach improves pedestrian safety*

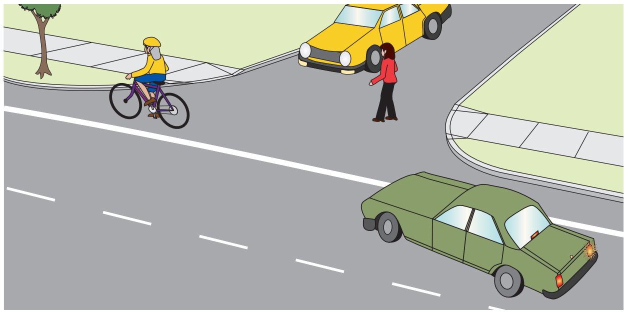


Figure 4-38: Intersection style driveway

Where an intersection-style driveway is used (such as to implement a "right-in, right-out" policy), the following techniques can be used to alleviate the above concerns:

- The street surface material should not carry across the driveway - rather, the sidewalk should carry across the driveway at sidewalk height, so motorists know they are entering a pedestrian area;
- The curb radius should be kept as tight as possible;
- Driveway widths should be the minimum needed to accommodate entering and exiting vehicles; and
- Where the volume of turning vehicles is high, right-turn channelization should be considered, to remove slower turning vehicles from the traffic flow, allowing them to stop for pedestrians. A traffic signal should be considered where the turning movements are very high.

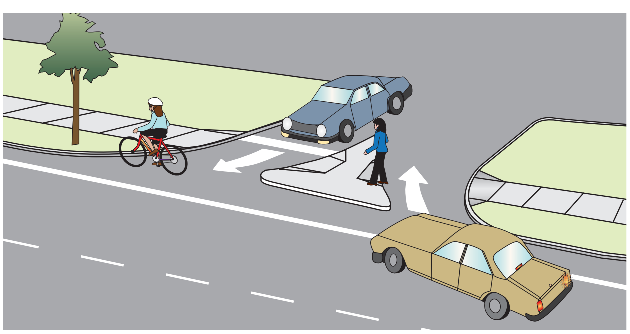


Figure 4-39: Right-in, right out driveway

Commercial right-in, right-out driveway. NOTE: truncated domes are used ONLY at commercial style driveways.

Commercial driveway with wrapped, level sidewalk and pork chop island

## Alleys

Alleys are often surfaced with the same paving material as the roadway, so drivers may not realize they are crossing a sidewalk when they exit an alley. Alleys present problems for pedestrians if they are not noticed by exiting drivers. Several measures can improve pedestrian visibility:

- Designing alleys like driveways, by continuing the sidewalk grade and surface design (texture and color) across the alley, so motorists know they are entering a pedestrian zone; and

- Placing stop signs or a speed hump before the front of a vehicle protrudes onto the sidewalk.

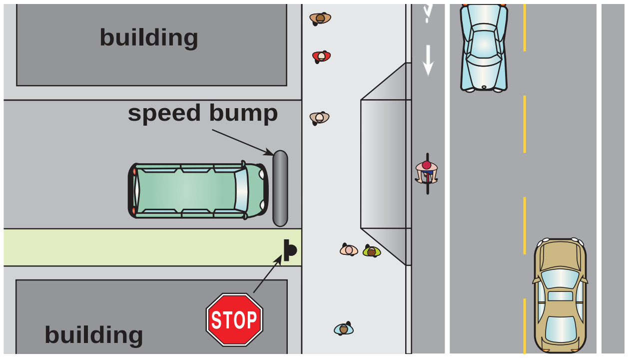



*Figure 4-40: Alley clearly crosses a sidewalk*

*Sidewalk thru alley entrance is kept level*

## 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.

### Directional/Wayfinding Signs

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 walking trips are short, and the pedestrian's line of sight is lower, so 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.

No standards have been developed yet for pedestrian directional signs. Signs should be unobtrusive, easy to read and aesthetic. This example gives distances in blocks; other measures could be average walking time. Distances in miles are not very meaningful to pedestrians.

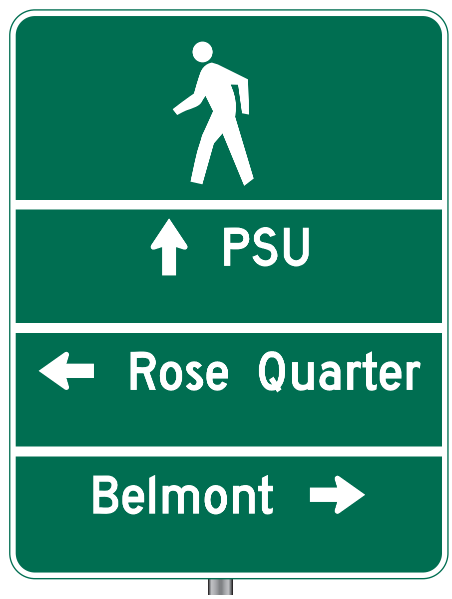



*Figure 4-41:D1-3b*

### Street Signs

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.

## Practices to be Avoided

### Meandering Sidewalks

Meandering sidewalks are used in several scenarios:

1. Sidewalks can meander to wrap around large obstacles, such as a mature tree or power pole.
2. Sidewalks can meander in topographically constrained areas, and follow the natural contours of the land.

Both these approaches are acceptable, even desirable. But sidewalks often meander with the intention of softening the look of a curbed urban street in a semi-rural or suburban environment. 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;
- Construction costs are higher, due to the need for special forms;
- Long-term maintenance costs are higher, as its more difficult to maintain a curved edge than a straight edge; and
- Once the novelty has worn off, meandering sidewalks 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.


*Meandering a sidewalk for no purpose should be avoided.*

# Chapter 5: Street Crossings

*A successful pedestrian network requires safe and convenient crossing opportunities*

## Introduction

Walkways along a road provide mobility, but a successful pedestrian network also requires safe and convenient street crossing opportunities. Wide roads carrying large traffic volumes can be obstacles to pedestrians who need access to destinations on the other side of the street. Pedestrians are less visible and less protected than motorists; well-designed roads take this into account.

*Many crossings occur midblock out of convenience*

Most pedestrian crashes occur when a pedestrian crosses a road, at intersections and other locations. Midblock crossings are a fact that planners and designers need to consider: people will take the shortest route to their destination. Prohibiting such movements is counter-productive if pedestrians continue to cross the road with no protection. It is better to design roadways that enable pedestrians to cross safely.

Safe street crossings also benefit transit users; in most cases access to or from a bus stop requires crossing a street. Many pedestrian crashes are associated with bus stops. See Chapter 4 "Transit Stop Crossings" for a discussion on transit planning and bus stop locations.

Safe street crossings also benefit motorists who park on one side of a street to access destinations across the street. Sidewalks and crossing opportunities allow drivers to park once and walk to several destinations.


Pedestrian crossings help shoppers access both sides of the street.

## Crosswalks Defined

Oregon law defines a crosswalk as the prolongation of a curb, sidewalk or shoulder across an intersection, whether it is marked or not. Outside an intersection, a crosswalk is created with markings on the road. See ORS 801.220 for the complete legal definition of a crosswalk.

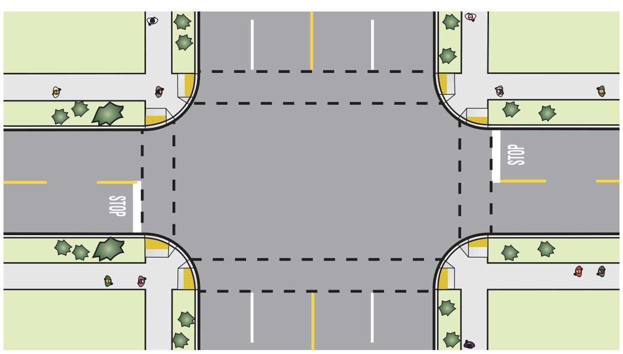



Figure 5-1: All legs of all street intersections are crosswalks, regardless of the presence of sidewalks, shoulder or other "pedestrian" facility

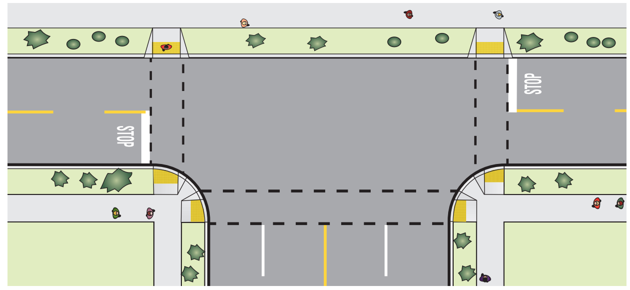



Figure 5-2: Crosswalks defined for T-Intersection

## Legal Crossings

"Jaywalking" is not a legally defined term in Oregon law. It does not mean crossing a street midblock. The Oregon Vehicle Code states that it is illegal for pedestrians to:

- Cross a street against a traffic signal;
- Cross the street outside of a crosswalk without yielding to vehicular traffic;
- Cross the street outside of a crosswalk at an intersection; and
- Proceed in a crosswalk in a manner that causes an immediate hazard to an approaching motor vehicle.

The right of way laws are:

- At non-signalized crosswalks, marked or unmarked, drivers stop and remain stopped for pedestrians (ORS 811.015, 017 and 028).
- At signalized crosswalks, when the pedestrians are proceeding in accordance with the traffic signal, drivers stop and remain stopped for pedestrians (ORS 811.028). Pedestrians are required to obey traffic signal indications (ORS 814.010).
- At other locations, crossing is allowed, but pedestrians yield to vehicles (ORS 814.040). Some local jurisdictions have passed ordinances prohibiting crossings outside of

crosswalks between signalized intersections.

*Crossing the street is not a crime*

In many instances, a midblock crossing has fewer conflicts than a crossing at an intersection, as gaps in traffic are easier to judge; at intersections, there are additional conflicts with vehicles turning left and right into the pedestrian's path. On one-way streets the upstream side of the intersection has fewer conflicts; there is no turning traffic and the pedestrian need only find a gap in one direction of traffic.

Oregon's crosswalk laws provide a buffer of safety for pedestrians on the roadway. When turning at a traffic signal, drivers must stop and remain stopped for pedestrians until they have cleared the lane into which their vehicle is turning and at least 6 feet of the next lane. At any other crosswalk drivers must stop and remain stopped for pedestrians until they have cleared the lane in which they are traveling or turning and the next lane.

## Planning and Design Issues that Affect Crossings

Safe and convenient pedestrian crossings must be considered when planning and designing urban and suburban roadways. The following issues should be addressed when seeking solutions to specific problems:

## Level of Service (LOS), Speed & Appropriate Design Standards

Appropriate design standards take into account the needs of all users. Pedestrian access and mobility should be considered when determining the desirable LOS and speed for a roadway. In some areas, pedestrian needs should be elevated above the needs of motorized traffic (e.g. downtown or near schools).

There is often an inverse relationship between traffic volumes and/or speeds and the ease of pedestrian crossing, which can lead to conflicting goals when determining priorities for a roadway:

- Some design features, such as raised medians, benefit all users;
- Some designs intended to increase motor vehicle traffic flow may reduce pedestrian crossing safety and opportunities (e.g. it is difficult for pedestrians to cross a large number of travel lanes); and
- Some designs that facilitate pedestrian crossings may reduce motor vehicle capacity (e.g. pedestrian signals).

In many cases actual travel speeds are higher than is appropriate for the adjacent land use, and improvements to facilitate pedestrian crossings may help reduce traffic speeds to desirable and legal limits. These include refuge islands and curb extensions. Many residential streets carry faster-moving traffic than the street is designed to carry. The design of a road should not encourage excessive speeds; even a major street can be treated for pedestrian safety without degrading capacity.

*A wide, multi-lane street built for motor vehicle capacity is difficult to cross*

## Land Use

As the number and density of pedestrian-accessible origin and destination points along a road increases, so does the demand for pedestrian crossings. On corridors with concentrated nodes of activity, special crossing treatments are easier to justify at locations where crossings will likely occur. Examples include apartment complexes, senior citizen centers, schools, parks, shopping areas, libraries, hospitals and other public or institutional uses. On corridors with scattered development and residences, it is difficult to predict where crossings may occur.

Planners and transportation officials must work together to ensure that land use is compatible with the roadway design, and vice versa.

*It is difficult to determine where pedestrians will cross on auto oriented streets with diffuse destinations*

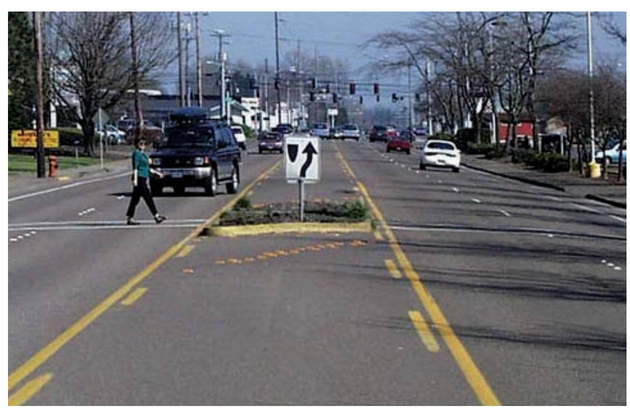
## Transit Stops

Most transit users will have to cross the road to access a transit stop on one leg of their trip. Coordination between public transit agencies and transportation designers is essential to ensure safe pedestrian crossings. By coordinating land use, roadway design and transit stops, passengers will be more secure when boarding or leaving a bus, and walking to or from their destination at either end of the transit trip. See Chapter 4 “Transit Stop Crossings” for a discussion on transit planning and bus stop locations.

## Signal Spacing

Signalized intersections may be the preferred pedestrian crossing points at peak traffic hours; other crossing opportunities close to signalized intersections benefit from a “platooning” effect, as traffic signals create gaps in traffic. The effect decreases:

- As the distance from the signalized intersections increases;
- As traffic volumes increase; or
- If poor access management allows vehicles to continually enter the roadway between signals.



*Traffic signal in distance creates adequate gaps for pedestrians to cross street*

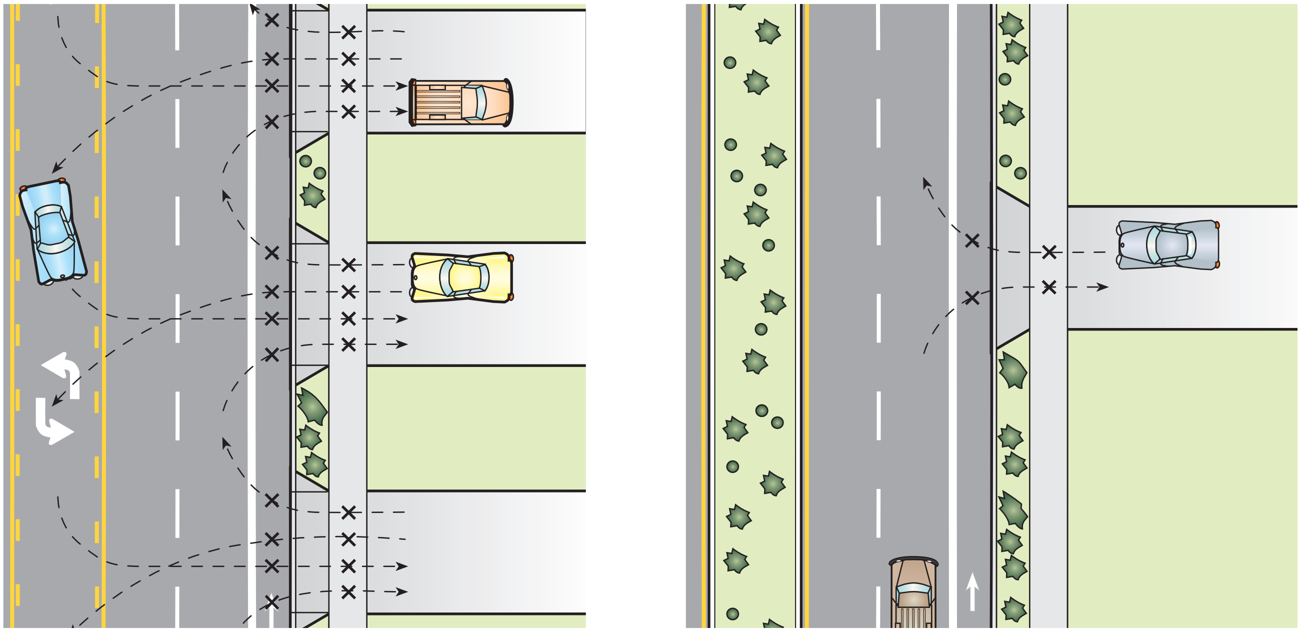


*Figure 5-3: Access management techniques such as raised medians and consolidated driveways reduce conflict points*

## Access Management

Many uncontrolled accesses to a busy road decrease pedestrian crossing opportunities and increase risk: when a gap is created in the traffic stream, motorists entering the road from driveways fill the gap, making it hard for the pedestrian to cross.

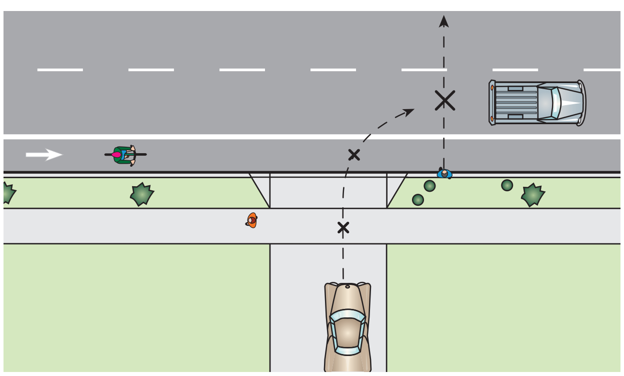


*Figure 5-4: Driver and pedestrian waiting for same gap are in conflict when the gap opens up*

A well designed raised median or island benefits pedestrians: it provides a refuge, and allows them to cross one direction of traffic at a time (pedestrians seeking refuge in a center turn lane are unprotected). However, arbitrarily eliminating road connections and signals also eliminates potential pedestrian crossing opportunities and increases risk.

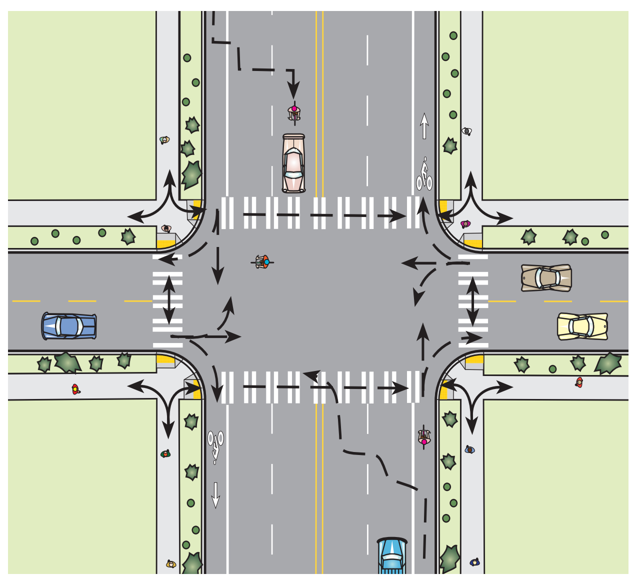


*Figure 5-5: Intersection with all turn and crossing movements*

Creating an urban expressway can increase traffic speeds and volumes. Concrete barriers placed down the middle of the road (rather than a raised median) effectively prohibit pedestrian crossings.

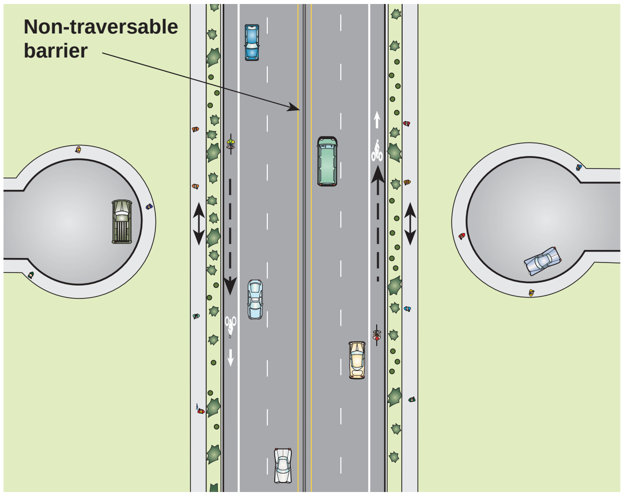



*Figure 5-6: Severed streets and non-traversable barrier reduce pedestrian travel options*

## Out-of-Distance Travel

Though some crossing solutions appear to offer greater safety, such as traffic signals or overcrossings and undercrossings, excessive added travel distance will discourage pedestrians who want to take a more direct route; they may end up making unsafe crossings. A crossing such as a traffic signal or grade-separated structure must offer obvious advantages.

## Midblock vs. Intersection Crossings

The Oregon Vehicle Code allows pedestrians to cross midblock outside of a crosswalk, but they must yield to motor vehicles (ORS 814.040).

Intersections are recognized by road users as areas where conflicts may occur, and prudent drivers proceed cautiously though intersections, expecting the unexpected. This is cited as a reason to encourage pedestrians to cross at intersections rather than midblock.

But the increased number of conflicts at intersections can also make pedestrians more vulnerable, as both pedestrians and drivers have to be on the lookout for conflicts coming from several directions at once: pedestrians have to watch for drivers making turns and right turning vehicles approach the pedestrian from behind, and drivers are also looking for multiple motor vehicle conflicts. This can cause a situation where both pedestrians and drivers are not aware of each other's intentions. Pedestrians are particularly vulnerable at signalized intersections where left and right turns are concurrent with the pedestrian walk phase.

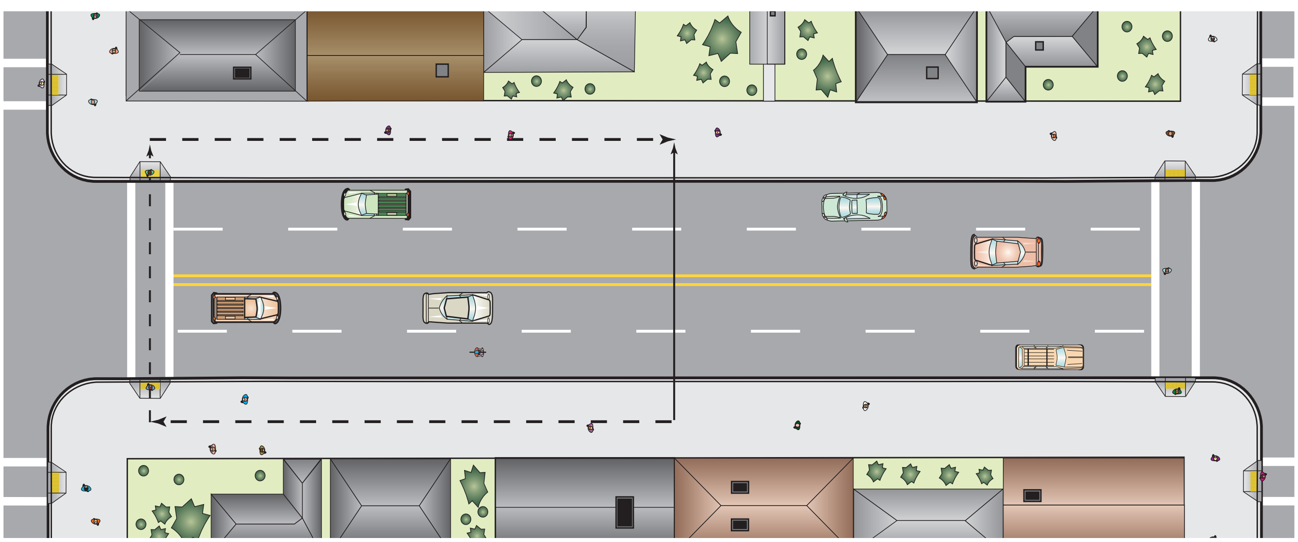


*Figure 5-7: Most pedestrians will cross midblock rather than walk to a signalized intersection*

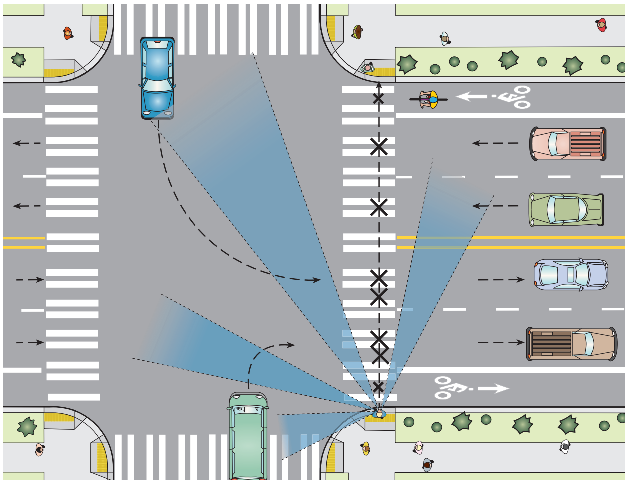


Figure 5-8: Conflicts at intersections are many

At midblock locations, the pedestrian has to look only for traffic on the roadway, and the driver is generally looking straight ahead, at the potential crossing point.

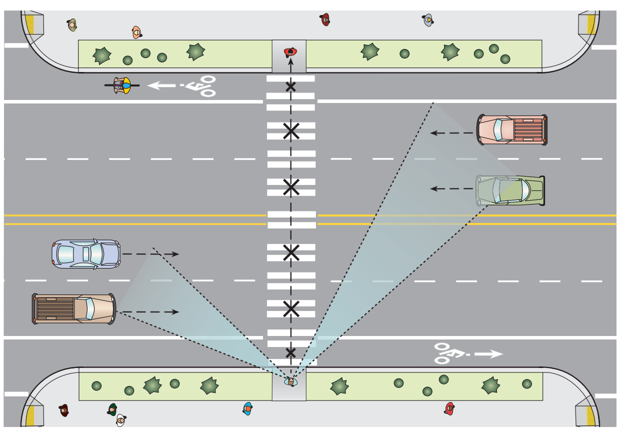


Figure 5-9: Conflicts at midblock crossings may be fewer

A raised median allows pedestrians to cross midblock more easily; they still must yield to motor vehicles. Marking a crosswalk at a midblock location reverses the right of way, as drivers must yield to pedestrians. Midblock crosswalks are established by the appropriate road authority, and must be approved by the State Traffic Engineer on State Highways.

### Maintenance

The effectiveness of a design will be lost if maintenance is excessively difficult or expensive. Forethought must be given to the practicality of future maintenance. Facilities will be effective over time only if they are in good repair. Examples of design features to avoid include:

- Vegetation that can obscure pedestrians;
- Restricted areas that cannot accommodate sweepers or other power equipment; and
- Remote areas requiring hand sweeping.

## Crossing Solutions

To increase pedestrian crossing opportunities and safety, two approaches can be considered:

1. Designing roads that are inherently easier and safer to cross by incorporating design features such as raised medians, or cross-section elements that slow traffic down or reduce the total roadway width; or

2. Constructing actual pedestrian crossings with features such as refuge islands, pedestrian-activated signals, curb extensions, marked crosswalks, etc.

These solutions are listed in order of complexity and cost; there is no implied preference. No one solution is applicable in all situations, as the issues will usually overlap on any given section of road. In most cases, a combination of measures will be needed to improve pedestrian crossing opportunities and safety. Guidance on crossing treatments on state highways can be found in the ODOT Traffic Manual. The Federal Highway Administration (FHWA) and the National Cooperative Highway Research Program (NCHRP) publish research on pedestrian traffic and are good resources for the latest information on pedestrian crossing treatments.

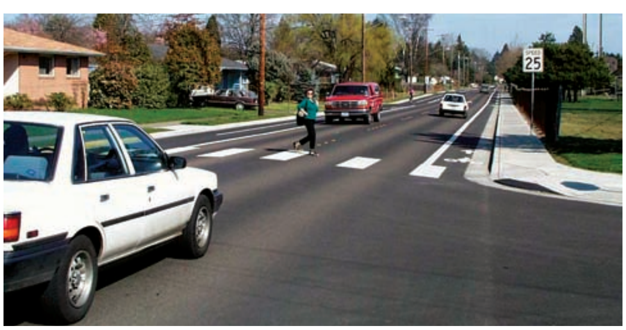
## Crosswalks

The two primary purposes of crosswalks are to indicate to pedestrians a desirable place to cross, and to indicate to drivers where to expect pedestrians to cross. Any marked crosswalk must fulfill these two goals before discussing the relative safety of marked crosswalks.

There is considerable debate concerning the utility and safety of crosswalks. Recent studies have indicated that a marked crosswalk alone is not enough to improve safety of pedestrians crossing busy, multi-lane roads. The latest research on this subject is available in the report "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines FHWA-RD-01-075": *http://www.tfhrc.gov/safety/pubs/04100/04100.pdf*

The basic conclusions are:

- On lower volume/lower speed roads (under 12,000 ADT/ 35 MPH), marking a crosswalk is not associated with increased risk to pedestrians. On multi-lane roads with ADT over 12,000 or speeds over 35 MPH, marking a crosswalk is not sufficient; additional measures such as median islands, curb extensions, illumination and advance stop bars are recommended. At very high traffic volumes and speeds, a signal or grade-separation should be considered.
- A traffic study will determine if a marked crosswalk is appropriate. This is usually in locations that are likely to receive high use, based on adjacent land use.




*Painted crosswalk on two lane roadway is appropriate*


*Good pedestrian crossings on multilane roadways require more than just paint*

Crosswalks should be marked at all legs of signalized intersections. The decision to close a crossing must take into consideration the safety and convenience of pedestrians. Closing crosswalks usually forces pedestrians to cross three legs of an intersection to reach the opposite corner, which is inconvenient and exposes them to more traffic conflicts (see Chapter 6 Intersections for more detail).

If motor vehicle stopping compliance at a crosswalk is low, some possible problems include:

- Enforcement: more rigorous enforcement of traffic laws is needed for motorists to understand that it is their duty to yield to pedestrians in a crosswalk, marked or unmarked;
- Location: marked crosswalks must be placed in locations where they are visible (avoid the crest of a vertical curve, for example) and where obstructions such as poles do not affect sight lines;
- Traffic movement: turning vehicles at a nearby intersection or driveway can compromise the crosswalk; and
- Users: some people need extra help crossing a street and crosswalks alone may not be sufficient; for example, young children and elderly pedestrians may need the positive control provided by signals or adult crossing guards.

## Crosswalk Striping

Crosswalks should be 10 feet wide, or the width of the approaching sidewalk if it is greater.

The standard in many jurisdictions has been two parallel white lines. The staggered continental crosswalk is more effective because it is more visible to drivers and helps pedestrians with vision impairments locate the crosswalk. And since stripes are placed outside of the wheel tracks, it also reduces long-term maintenance costs due to less wear and tear – they don't need to be repainted as often. Staggered continental crosswalks are recommended at midblock crossings and at intersections not controlled by a stop sign or traffic signal. Signalized intersections may be marked with two parallel lines.

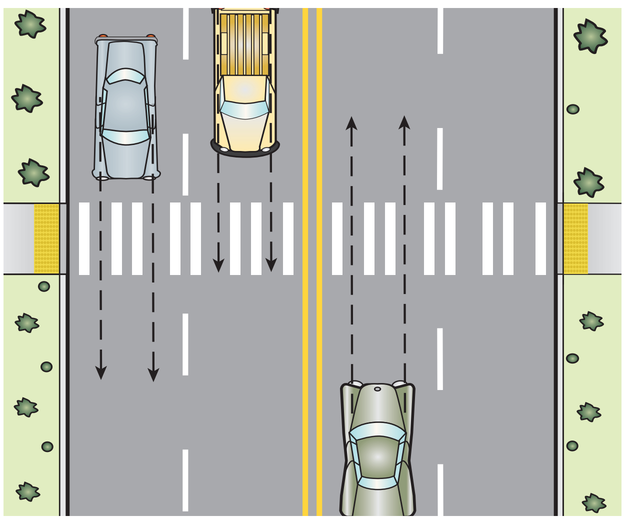


*Figure 5-10: Staggered continental crosswalk markings*

*Staggering markings place stripes out of wheel paths*

## Advance Stop Lines

One of the main crash types at marked crosswalks on multi-lane roads is the multiple threat crash. This occurs when a driver in the curb lane stops to let a pedestrian cross, but too close to the crosswalk, masking visibility of the pedestrian and the adjacent travel lane. A motorist proceeding in the adjacent lane doesn't notice the first car has stopped to let a pedestrian cross. The pedestrian doesn't see the other car coming and continues to cross, which can result in a high-speed, fatal or severe injury crash.

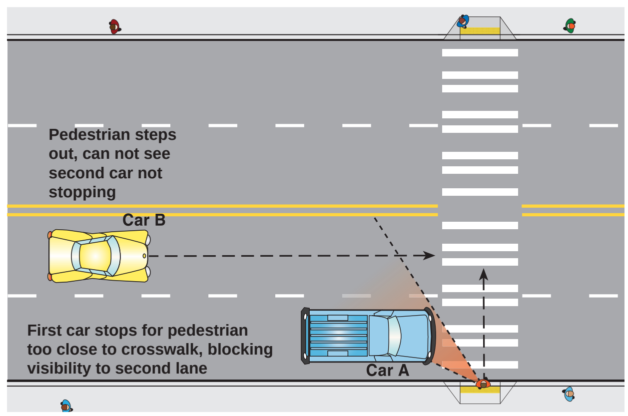



*Figure 5-11: Multiple threat crash occurs when Car B does not yield to pedestrian*

The likelihood of a multiple-threat crash is greatly reduced with an advance stop line placed 20 feet–50 feet ahead of the crosswalk. This encourages drivers to stop back far enough so a pedestrian can see if a second motor vehicle is not stopping, and take evasive action. Advance stop bars are recommended at midblock crosswalks and at uncontrolled intersections on multi-lane roads.

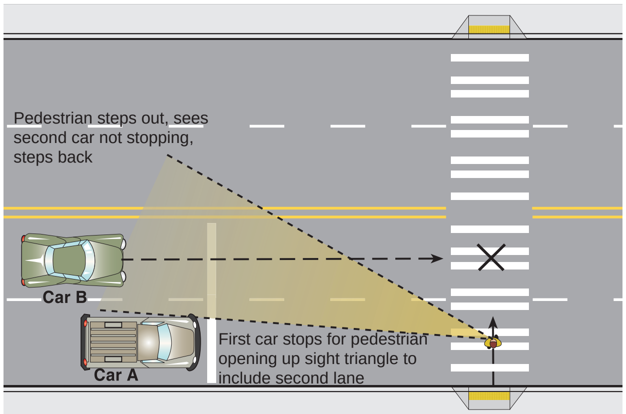



*Figure 5-12: An advance stop bar allows a pedestrian to see that Car B has not stopped*

The advance stop line should be supplemented with signs to alert drivers where to stop for pedestrians. At least one sign should be placed on the right; a second sign may be placed on a median island.


*Figure 5-13: Sign R1-5c are placed adjacent to the stop bar*

## Signs

Pedestrian Crossing signs should be used at locations where a crossing is not normally encountered. This is usually at mid-block locations, isolated crosswalks and where the adjacent land use is likely to generate a fairly high number of crossings, such as at transit stops.

Sign W11-2 should be used in advance of crossings or areas of high pedestrian use; sign W11-2 may be supplemented with the plaque W16-7p at a crosswalk.

*Figure 5-14: Signs W11-2 and W16-7p*


*Pedestrian crossing signs*

## Textured & Colored Crosswalks

Textured crossings, using bricks or pavers, are often assumed to be more visible to drivers; there is also speculation they raise drivers' awareness through increased noise and vibration. Experience has shown that textured/colored crosswalks fade quickly and are less visible to drivers than conventional white markings, especially in the dark or in adverse weather. The texture increases vibration for pedestrians using wheelchairs or walkers, slowing them down as they cross the road.

*Textured crosswalk, pedestrian view point*

*Drivers view of same crosswalk*

Where coloring and/or texturing is used, the area where pedestrians cross must be smooth, and white lines must be used to demark the crosswalk.

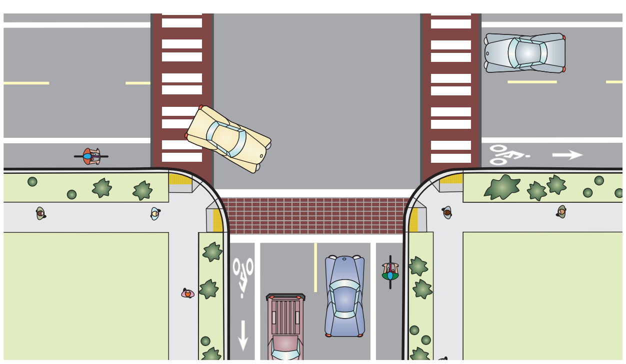


*Figure 5-15: Textured crosswalk supplemented with white lines*

*Textured crosswalk with supplemental white markings*

Coloring the pavement surrounding the crosswalk can increase visibility by increasing contrast. Conventional striped crosswalks are set in the colored area. Decorative crosswalk markings are not recommended. They are not visible to drivers and experience has shown that they do not last as long as standard white pavement marking materials.

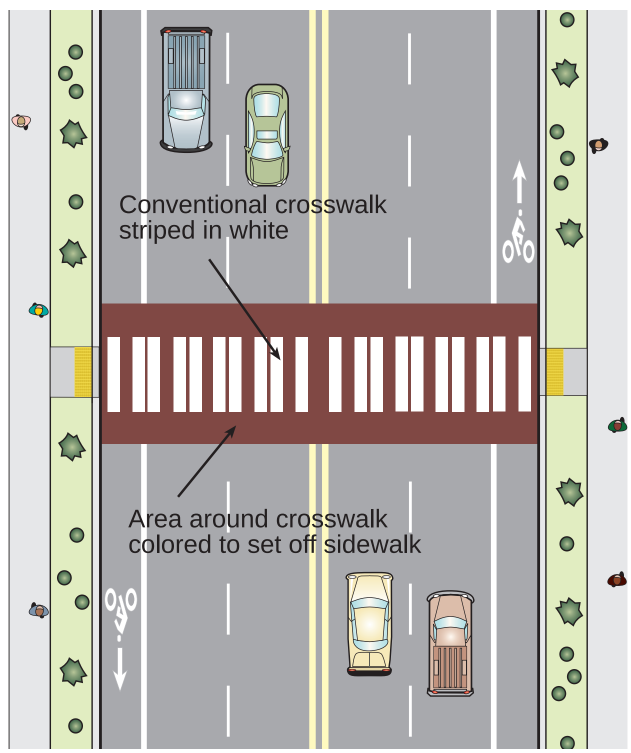
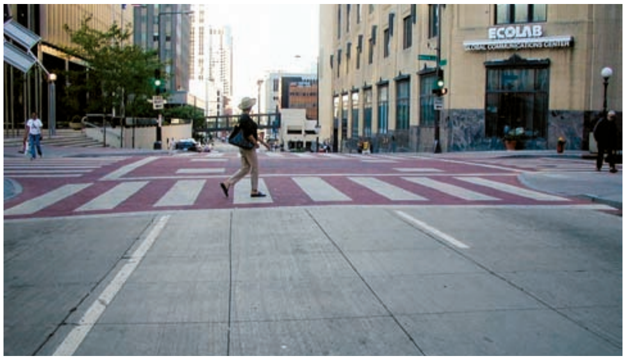



*Figure 5-16: White crosswalk inset into colored pavement*




*White markings inset into colored pavement*

## Illumination

Pedestrians are disproportionately hit at night. Many crossing sites are not well lit. Providing illumination or improving existing lighting can increase nighttime safety at intersections and midblock crossings, increasing awareness by motorists.

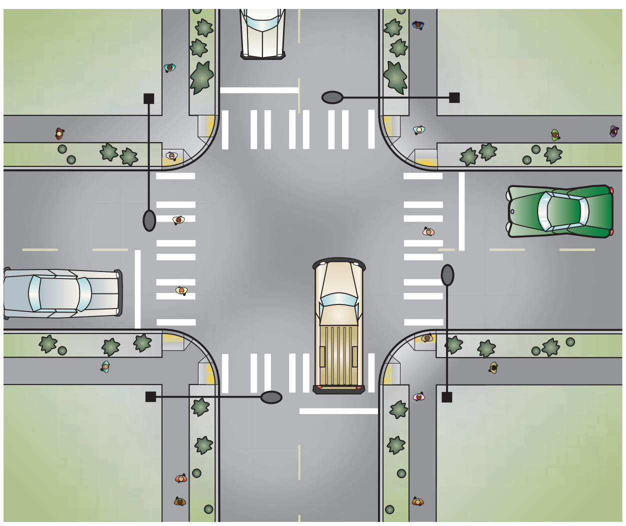


*Figure 5-17: Proper illumination makes pedestrians crossing the street more visible*

The vertical surface of the pedestrian should be lit. Lighting placed directly over a crosswalk illuminates the tops of the pedestrians' head, only. For guidance on crosswalk illumination see Informational Report on *Lighting Design for Midblock Crosswalks*, FHWA-HRT-08-053.

## Raised Medians & Refuge Islands

These should be considered the first option on multi-lane, two way roads. On busy highways, it can take a long time to find a gap that allows a person to cross four or more lanes of traffic in both directions. A median allows a pedestrian to cross only one direction of traffic at a time, making it much easier to find and correctly identify acceptable gaps. The crossing task is greatly simplified: the pedestrian simply looks left, waits for an acceptable gap, crosses to the median island, then looks right, and seeks a second gap. Pedestrians are less likely to take risks and try to dash all the way across if they know they only need to cross halfway.

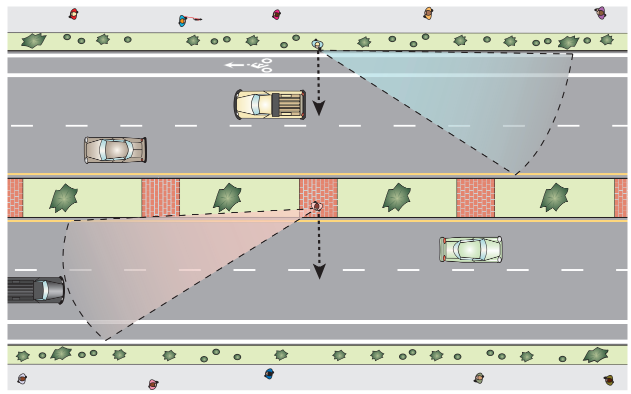


*Figure 5-18: Median allows pedestrian to cross one half of the roadway at a time*

To provide a usable pedestrian refuge, raised medians should be constructed with a curb no higher than used for sidewalks (6 inches-7 inches). The surface of the median should be level and smooth. If the median is landscaped, flat paved areas should be placed occasionally to provide a place to stand and wait.

When a raised median is designed for access control, with pedestrian crossings in mind, there is usually no need to mark crosswalks or provide curb cuts; it is a feature that simply allows pedestrians to cross more easily, as the law allows, as long as pedestrians yield to traffic. Marking crosswalks reverses the yield rules, and should only be considered at specific locations where a lot of concentrated crossings are expected; curb ramps and cut-throughs need to be provided where a crosswalk is marked. Midblock crosswalks are established by the appropriate road authority, and must be approved by the State Traffic Engineer on State Highways. Curb ramps or cut throughs must also be provided at all marked crosswalks and intersections. Consult the ODOT Traffic Manual for information on marking crosswalks on State Highways.

Where it is not possible to provide a continuous raised median, refuge islands can be provided across from high pedestrian generators such as schools, park entrances, libraries, parking lots, transit stops, etc. If a raised island is placed midblock, with curb cuts and other obvious pedestrian features, a crosswalk should be marked, as the added treatments indicate to pedestrians “this is a place to cross.”

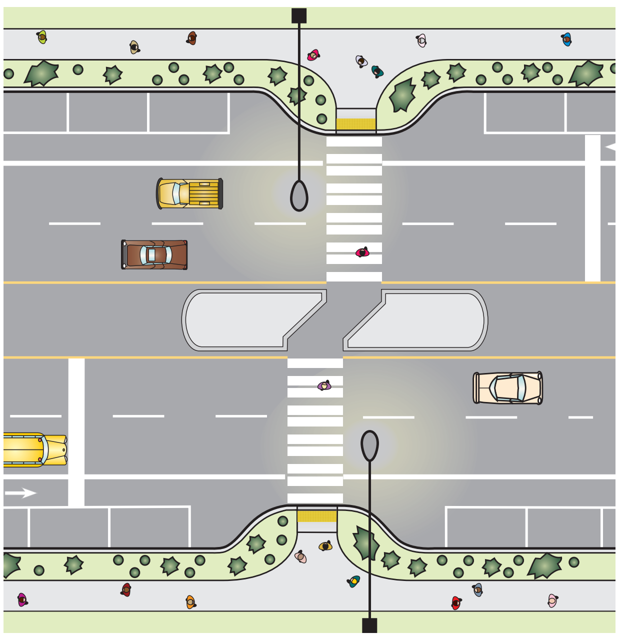


*Figure 5-19: Midblock island with high visibility crosswalks, advanced stop lines, illumination and angles cut through*

Refuge islands should be made as big as possible, so they are visible to drivers. Other ways to increase visibility include painting the curb yellow, providing landscaping (but not so high as to obscure pedestrians) and signing.

Cut-throughs should be at least 5 feet wide. Cut-throughs are preferred over ramps, as most islands are not large enough to comfortably fit two ramps and a 4-foot level landing between the ramps as required by ADA. One technique to increase the likelihood a pedestrian will look at oncoming traffic in the second half of the crossing is to skew the cut-through to the right, forcing pedestrians to face oncoming traffic as they traverse the island. A 2-foot section of right-angled curb should be provided at each end to provide guidance for the blind.

In most instances, the width of a raised median or refuge island is the width of the center turn-lane, minus the minimum shy distance on each side. Minimum acceptable width for a median refuge island is 6 feet.

*Median island provides mid-street refuge for pedestrians*

The preferred location for a raised island, based on pedestrian demand, may conflict with vehicular turning movements if driveway accesses are present at that location. Careful negotiation with property owners may be required to ensure placement of island meets the intended goal of improved pedestrian crossings, while taking into account vehicular movements. Moving an island away from the desired crossing location may be a solution, but can be counter-productive if it’s too far, as pedestrians will not use it and cross at the desired location with no island. Another option is to keep the island where needed for pedestrians, and move the driveways to allow turns to occur. On streets with diffuse crossing generators, judicious placement of high quality pedestrian crossings along the corridor can help to concentrate pedestrian crossings at the improved locations, improving roadway operations and safety. Paring improved pedestrian crossings with transit stops is a natural choice.

## Curb Extensions

Also known as bulbouts, bumpouts, neckdowns or chokers, curb extensions should be considered at all intersections where on-street parking is allowed. Curb extensions reduce the crossing distance on streets with on-street parking. Other advantages include:

- Better visibility: pedestrians can see approaching motorists and drivers can see pedestrians waiting to cross.
- Increased yielding by drivers: pedestrians standing on a curb extension are more visible, and their intent to cross the street is more obvious.
- Traffic-calming: the roadway appears narrower to drivers, even in the absence of cars parked on the street. This effect is increased when the curb extension includes features such as landscaping and street furniture, and the parking area is paved in concrete or pavers, making the road look narrower to drivers when no cars are parked.
- Slower-speed right-turns: a curb extension prevents right-turning motorists from “cutting the corner.”
- Street furniture (newspaper boxes, poles, bicycle parking, street trees, etc.) can be placed in the curb extension, outside of the pedestrian zone, as long as they don’t obscure pedestrians waiting to cross.
- Additional on-street parking: curb extensions improve visibility, allowing parking to be located closer to crosswalks.

Other techniques to increase the supply of on-street parking include:

- Carefully inventorying existing parking spots, and finding ways to increase supply by restriping.
- Moving fire hydrants from the sidewalk to the curb extension.
- Curb extensions can be elongated to serve as bus stops, reducing bus dwell time for on and off loading of passangers.

*Pedestrians waiting where curb extension could be*

Reducing the pedestrian crossing distance improves signal timing if the pedestrian phase controls the signal. The time saved is substantial when two corners can be treated with curb extensions. (The speed normally used for calculating pedestrian crossing time is 3.5 ft/sec). Non-signalized intersections also benefit from curb extensions: reducing the time pedestrians are in a crosswalk improves pedestrian safety and vehicle movement.

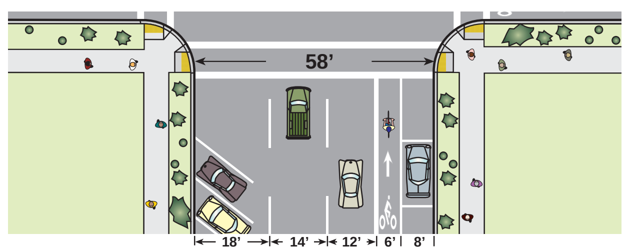



*Figure 5-20: Crossing distance without curb extensions*

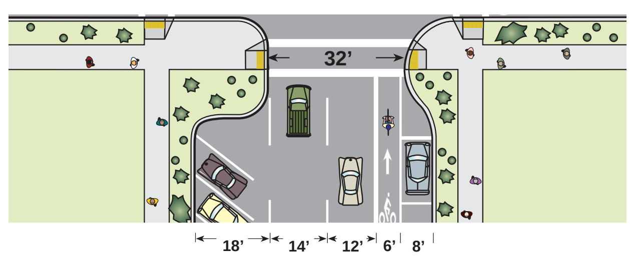



*Figure 5-21: Crossing distance with curb extensions*

At midblock crossings, curb extensions may be considered where there is on-street parking and there are pedestrian generators on both sides of the road. Combined with refuge islands, they greatly increase the ability of a pedestrian to safely cross a street.

*Motorist yields to pedestrians at curb extension*


*Curb extension provides room for bike parking*

In general, **curb extensions should extend the full width of the parking lane**, to increase visibility, but no more: on streets with existing or planned bike lanes, the curb extension should not extend into the bike lane.

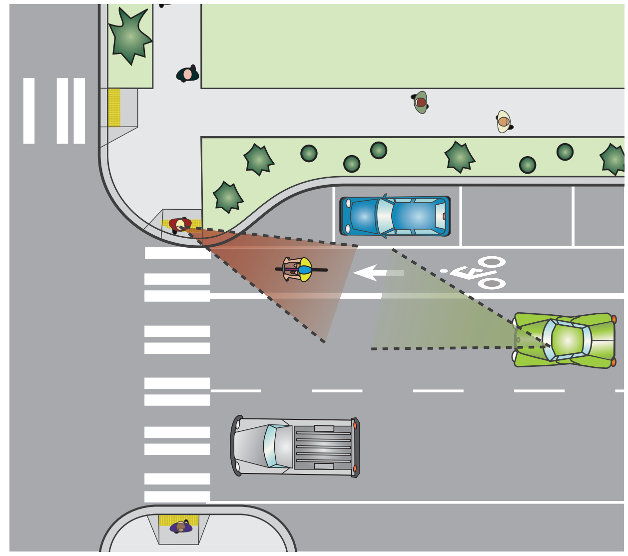


*Figure 5-22: Curb extensions improve visibility of and by the pedestrian*

Retrofitting curb extensions onto existing roadways often creates design challenges, as the existing sidewalk grade usually slopes at 2% toward the roadway, and the roadways slopes towards the sidewalk. A curb extension usually cannot carry the sidewalk grade out an additional 7 or 8 feet; this reduces curb exposure to below acceptable height. On retrofits, the slope of the curb extension is often reversed, following the grade of the roadway. This creates a slight valley in the curb extension. This is usually not a problem if a slight grade is created to drain standing water away.

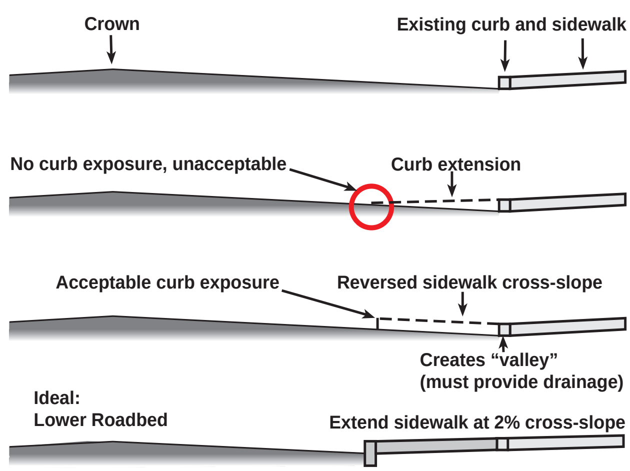



*Figure 5-23: Curb extension retrofit issues*

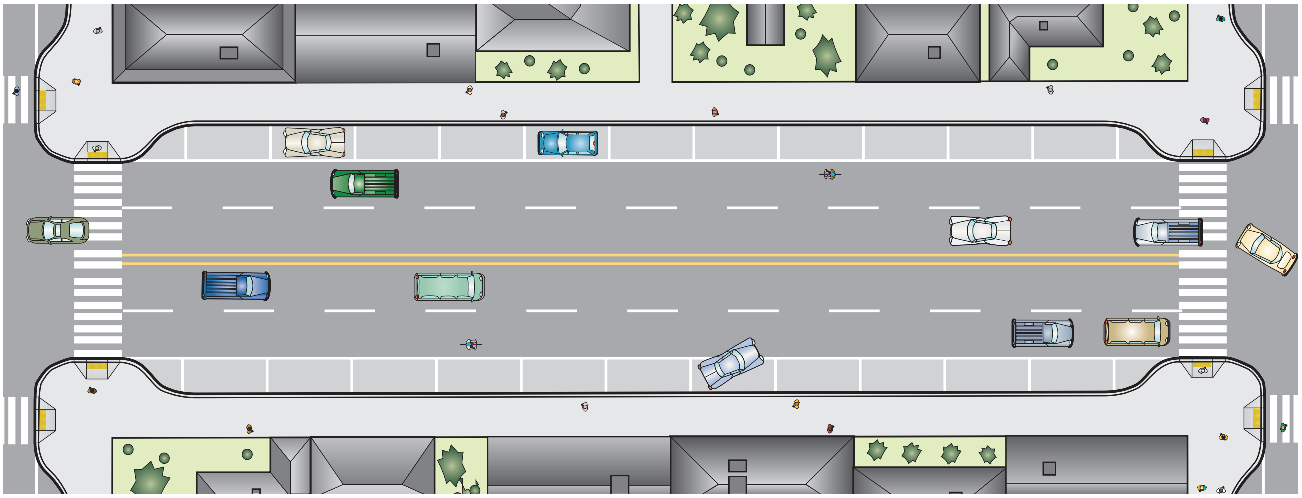


*Figure 5-24: Roadway designed with curb extensions and integrated parking lanes*

Solutions include slotted drains between the old curb and the extension, or placing new drains at each end of the extensions.

On new construction projects, or when the roadway and sidewalks are completely rebuilt, there is an opportunity to slope sidewalks and curb extensions correctly: a constant 2% across the sidewalk and curb extension towards the roadway. This creates parking bays that also slope at 2% towards the roadway, requiring a valley drain between the travel lanes and the parking area. Paving the parking area in concrete or pavers makes the road look narrower to drivers when no cars are parked, adding a traffic-calming element to this design.

*Slotted drain at retrofit curb extension*

## Pedestrian Signals

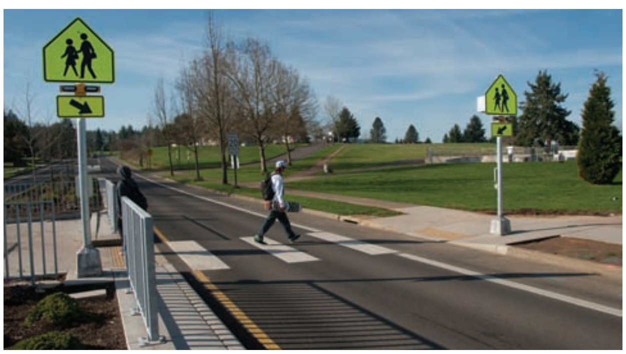
A pedestrian-activated signal may be warranted where the expected number of people needing to cross a roadway at a particular location is significant and/or if it is difficult for pedestrians to find an adequate gap. Refer to the MUTCD for pedestrian signal warrants. Sight-distance must be adequate to ensure that motorists will see the light in time to stop. Advance warning signs should be installed on the approaching roadway. Signals provided for pedestrians should have the most up-to-date accessible features.

Wherever possible, the response for pedestrians should be “hot.” The signal should turn yellow then red for traffic as soon as a pedestrian pushes the button. This will encourage pedestrians to comply with the signal. If there is a substantially delayed response after a pedestrian pushes the button, the pedestrian will often seek a gap and cross against the light. Then when the light does turn red for motorists, the pedestrian is gone, increasing motorist frustration, as they don’t understand why they were required to stop.

Curb extensions and raised medians increase the effectiveness of pedestrian signals, reduce crossing times and decrease motor vehicle delay.

## Rectangular Rapid Flashing Beacon (RRFB)

The Rectangular Rapid Flashing Beacon or RRFB is a pedestrian activated flashing warning beacon used to supplement pedestrian or school crossing signs at uncontrolled crosswalks. FHWA Interim Approval dated July 16, 2008 should be consulted for implementation details. The RRFB has proven to be very effective in improving stopping compliance at uncontrolled and mid-block crosswalks. In Oregon, the convention is to not provide any indication to the pedestrian about the flasher status, so that the pedestrian responds to changes in traffic, not the flasher. The RRFB should be paired with the advance stop bar on multi-lane roadways. Effectiveness improves with installation of a flasher on at the edge of the roadway and in a median.



*Rapid rectangular flashing beacon*

## Two-Step Pedestrian Signal

On busy roads, stopping all traffic long enough to let a pedestrian cross may cause undue delay if the pedestrian signal is activated frequently at peak periods. A two-step pedestrian signal minimizes delay to motor vehicle traffic while allowing pedestrians to cross conveniently. This requires a median refuge island to break the crossing into two distinct parts. Each signal is independently controlled – essentially creating two pedestrian signals across two one-way streets:

- Phase 1: pedestrian pushes button to stop traffic in one direction; traffic stops and pedestrian crosses to median island; traffic in opposite direction is not stopped and continues to travel, uninterrupted.
- At the end of phase 1, traffic in the first direction resumes; pedestrian walks towards second crossing, which is offset to the right.
- Phase 2: pedestrian pushes button in island and stops traffic in other direction; when pedestrian has finished the second crossing, traffic resumes in the second direction.

Pedestrians must be made to walk against on-coming traffic, so they can see it hasn't stopped; pedestrians need to push the second button (a pedestrian push button on island is required). This offset also makes it possible to orient the pedestrian signals to just half the roadway, so pedestrians don't get a mixed message from a pedestrian head that is in their line of sight, but not intended for their half of the roadway.

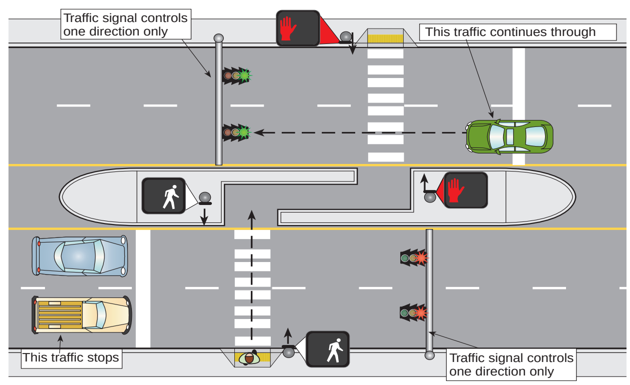



*Figure 5-25: 2-step signal: pedestrian activates signal to stop near side traffic*

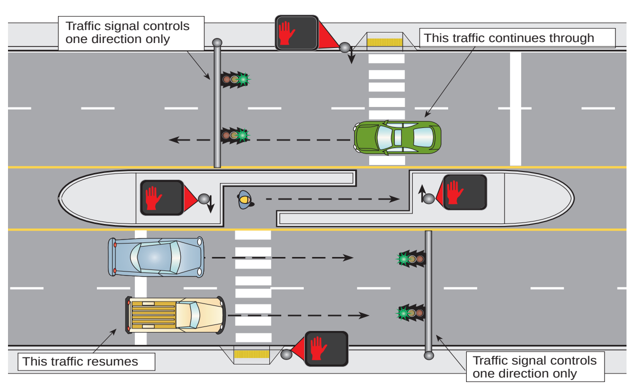



*Figure 5-26: 2-step signal: pedestrian proceeds to far side crossing facing traffic*

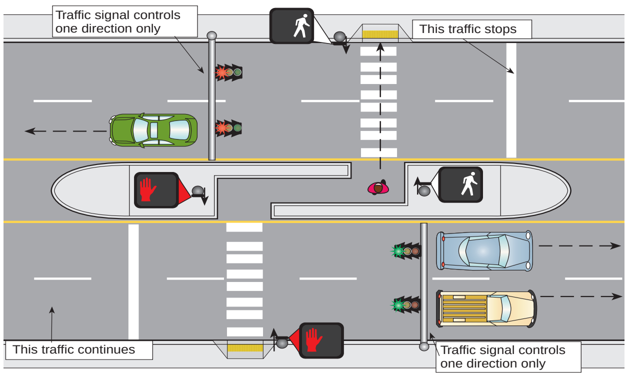



*Figure 5-27: 2-step signal: pedestrian activates push button to stop far side traffic*

## Overcrossings and Undercrossings

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 grade-separated 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.

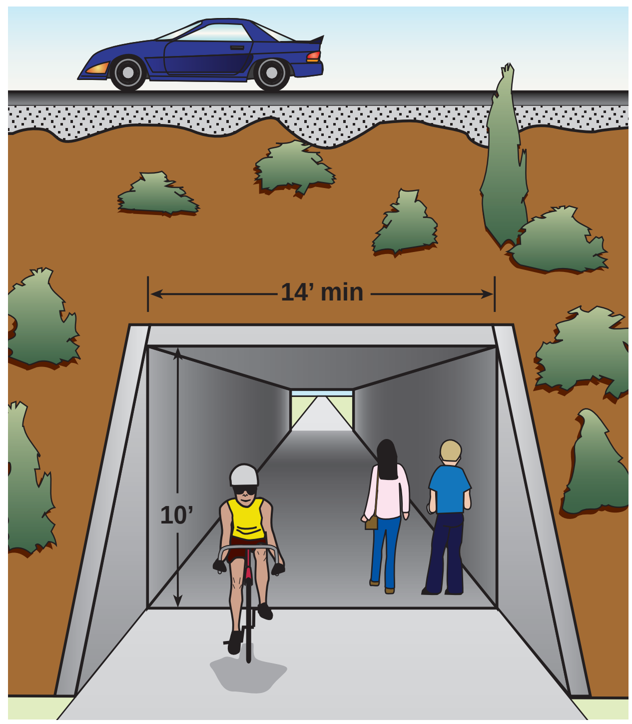



*Figure 5-30: Undercrossing of elevated roadway*

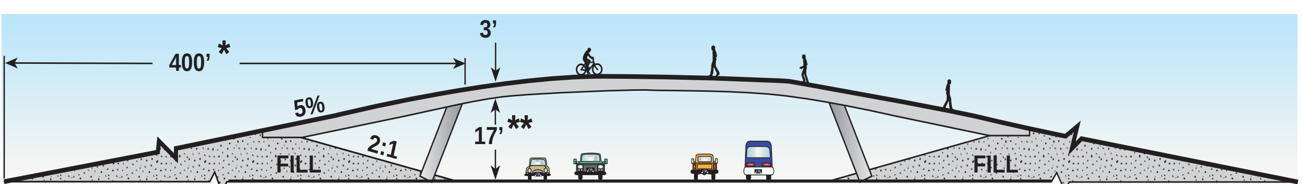



*Figure 5-28: Pedestrian overcrossing adds a lot of travel distance when raised above a roadway*

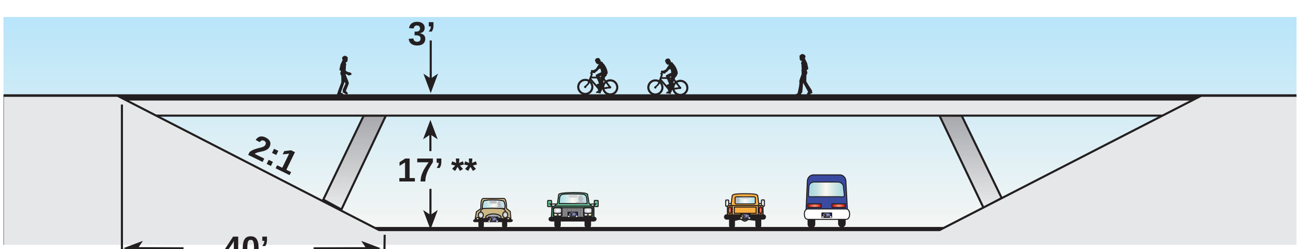



*Figure 5-29: Pedestrian overcrossing reduces travel distance when roadway is lowered*

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.

*Pedestrian undercrossing is open and inviting*

See Chapter 7 Shared-use paths for a more complete discussion on the design of bridges and undercrossings.

## Other Innovative Designs

*These concepts are presented as information, to help ODOT, cities and counties to come up with new solutions to street-crossing problems.*

### Raised Crosswalks

Raised crosswalks can render the crossing more visible, especially if the beveled edge is textured and colored. Texturing or coloring the crosswalk portion is not recommended, as this area is less visible and texture can slow pedestrians as they cross. Raised crosswalks also act as speed humps and may be used in areas where excessive speeds are a problem.

The physical design of a raised crosswalk is the same as that of a speed table. The height should be the full height of the curb, so pedestrians can transition from the sidewalk to the crossing seamlessly; the incline of the beveled portion is a function of design speed and design vehicle.

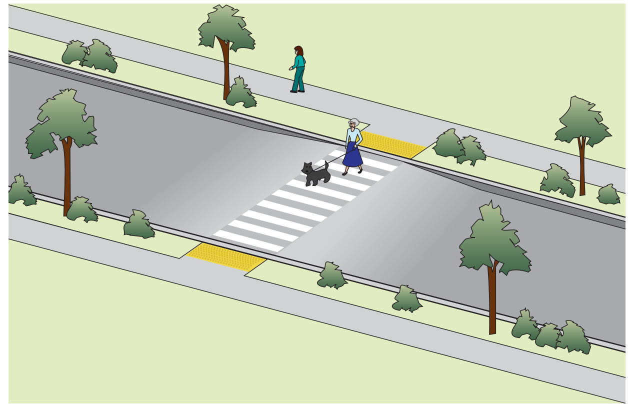


*Figure 5-31: Raised crosswalk acts as speed hump*

*Raised crosswalk*

### Pedestrian Beacon

The Pedestrian Hybrid Beacon, also known as the “Hawk,” is a new form of traffic control in the 2009 MUTCD. Primarily intended for use on wide, mid- to high-speed multi-lane roadways with few crossing opportunities, at midblock locations, or minor intersections. On multi-lane roadways, an advance stop line should be provided to reduce the risk of a multiple-threat crash.

*Pedestrian hybrid beacon or HAWK*

Their primary purposes are to create gaps in motor vehicle traffic to let pedestrians cross without unduly adding delay. This is accomplished by using a beacon with yellow and red indicators, rather than a full green-yellow-red traffic signal. The main characteristics of a Pedestrian Beacon are:

- At rest, drivers see a dark (unlit) Beacon Head;
- At rest, pedestrians see a conventional pedestrian head indicator, set on the steady red hand (DON'T WALK), and a conventional pedestrian push button; and
- The beacon begins its sequence only after a pedestrian pushes the push button.

The sequence is as follows:

1. At rest, blank for drivers, DON'T WALK for pedestrians.
2. Pedestrian pushes button, starts the flashing yellow beacon; pedestrian indicator is still steady red hand.
3. Flashing yellow turns to steady yellow; pedestrian indicator is still steady red hand.
4. Beacon turns steady red; pedestrian indicator is steady white walking figure.
5. Beacon turns flashing/alternating red (wig-wag); pedestrian indicator turns to flashing red hand.
6. Beacon turns off and rests at blank; pedestrian indicator rests on steady red hand (Don't Walk).
7. Phase 5 is timed for a standard pedestrian crossing time of 3.5 ft/sec. The alternately flashing red wigwag indicates to drivers they may proceed after stopping and yielding to pedestrians; this shortens delay considerably.

The guidelines for pedestrian beacons identify when they can be installed at locations where full signal warrants may not be met. Consult the 2009 MUTCD for a full description of the pedestrian hybrid beacon.

# Chapter 6: Intersections

*Large multi-lane intersections pose particular challenges for pedestrians and bicyclists, but solutions exist*

## Introduction

Most conflicts between roadway users occur at intersections, where travelers cross each other's path. Good intersection design indicates to those approaching the intersection what they must do and who yields to whom. Pedestrians' and bicyclists' movements are complicated by their lesser size and visibility.

This chapter is divided into intersection designs for bicyclists, intersection designs for pedestrians, and intersection and interchange designs for both pedestrians and bicyclists. These basic principles apply to all users:

- Unusual and unexpected conflicts should be avoided.
- Good intersection designs are compact.
- Simple right angle intersections are best for bicycle and pedestrian movement. The problems are more complex at skewed and multi-legged intersections.
- Free-flowing movements should be avoided.
- Access management practices should be used to remove additional conflict points near the intersection.
- Signal timing should not hinder bicycle or foot traffic with overly long waits or insufficient crossing times.

## Bicyclists

These basic principles apply to bicyclists:

- Good design creates a path for bicyclists that is direct, logical and close to the path of motor vehicle traffic; only in rare cases should they proceed through intersections as pedestrians.
- Bicyclists should be visible and their movements should be predictable.
- Bike lanes should be striped to a marked crosswalk or a point where turning vehicles would normally cross them. The lanes should resume at the other side of the intersection. The bike lane stripe may be dashed prior to the crosswalk to indicate a potential conflict point to both bicyclists and drivers.

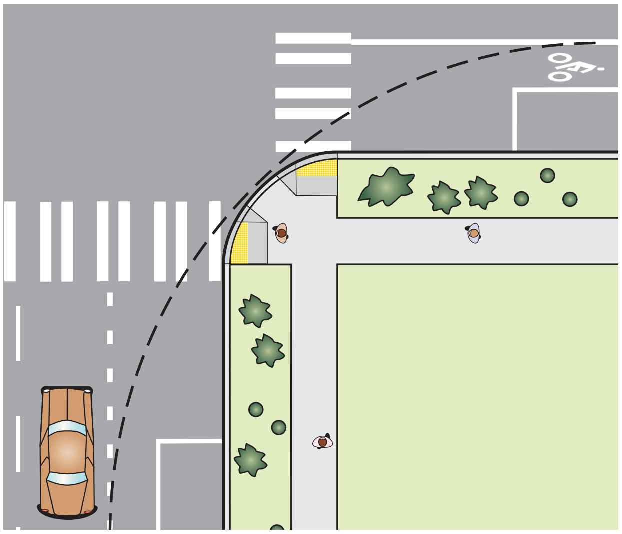


*Figure 6-1: Dashing bike lane prior to intersection warns motorists and bicyclists of potential conflict*

## Right-Turn Lanes

Right-turn lanes should be used only where warranted by a traffic study, as they present these problems for cyclists:

- Right-turning cars and through bicyclists cross paths; and
- Right-turns are made easier, which may cause inattentive drivers to not notice bicyclists on their right.

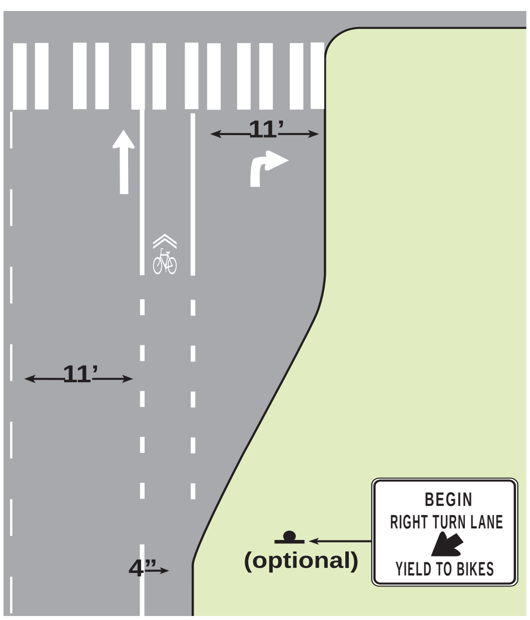



*Figure 6-2: Standard right turn lane with through bike lane*

The design shown above makes through bicyclists and right-turning motor vehicles cross prior to the intersection, with these advantages:

- This conflict occurs away from other conflicts at the intersection;
- The difference in speeds enables a motor vehicle driver to pass a bicyclist rather than ride side-by-side; and
- Bicyclists follow the rules of the road: through bicyclists proceed to the left of right-turning vehicles.

This design should also be used where there are currently no bike lanes approaching or beyond the intersection, for these reasons:

- This design enables bicyclists and drivers to position themselves correctly; and
- When the roadway is striped with bike lanes in the future, the intersections are already designed correctly.

## Other Right-Turn Lane Designs

Not all intersections have an exclusive right-turn lane. A bike lane to the left of right turning cars should still be provided if right turn movements are heavy.

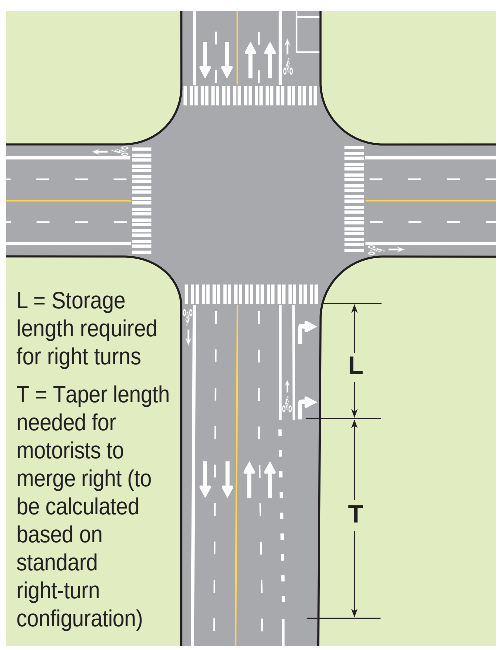



*Figure 6-3: Right-turn lane developed by dropping parking lane*

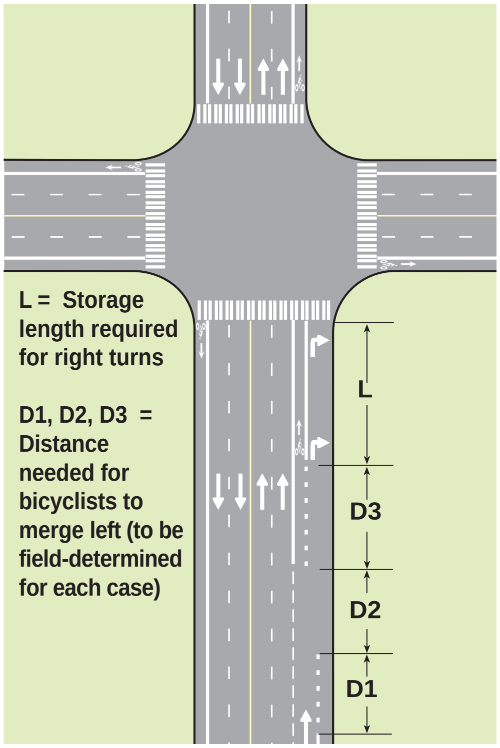



Figure 6-4: Right turn lane developed by dropping a lane

*Note: This is a difficult movement for bicyclists as they must merge left and find a gap in the traffic stream.*

On bike lane retrofit projects, where there is insufficient room to mark a minimum (4-foot) bike lane to the left of the right-turn lane, a right-turn lane may be marked and signed as a shared-use lane, to encourage through cyclists to occupy the left portion of the turn lane. This is most successful on slow-speed streets.

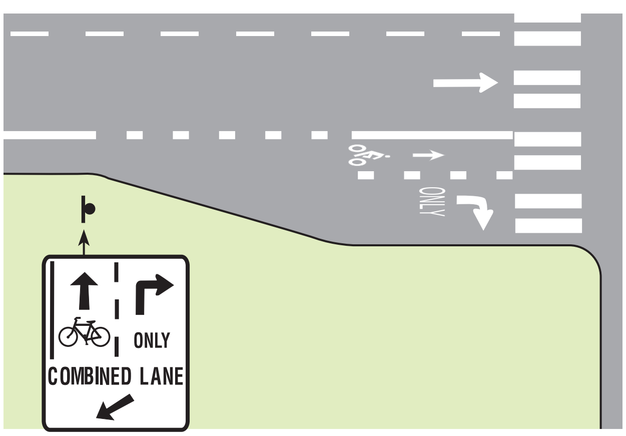



Figure 6-5: Combined right turn lane and thru bike lane


Combined right turn lane and thru bike lane

## Exceptions

### Heavy Right Turns

If the major traffic movement at an intersection is to the right, and the straight through move leads to a minor side street, the bike lane may be placed on the right if most cyclists are turning right. This often occurs where a highway winds through town and is routed over local streets.

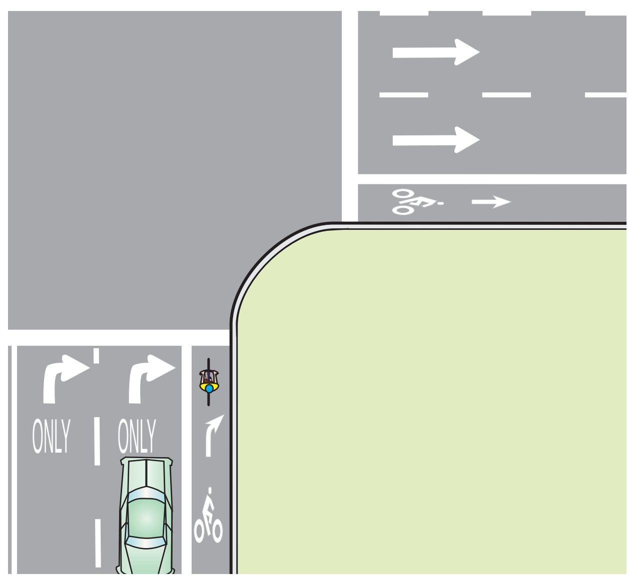



Figure 6-6: Right bike lane follows traffic flow

### Tee Intersections

At a T-intersection, if the traffic split is approximately 50% turning right and 50% turning left, the bike lane should be dropped prior to the lane split so cyclists can position themselves in the correct lane; where traffic volumes are very high, a left- and right-turn bike lane should be considered.

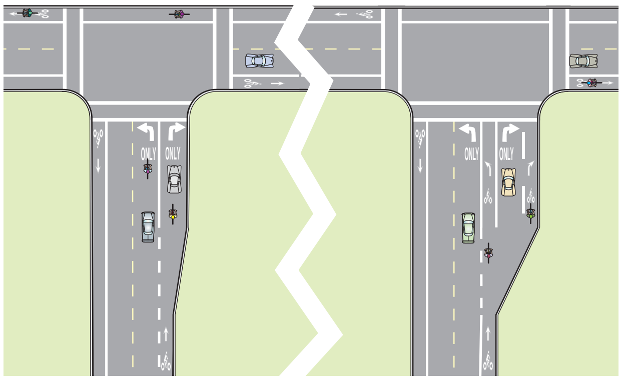



*Figure 6-7: Bike lane at T-intersection*

### Signals

Traffic signals are timed to accommodate smooth motor vehicle flows at a desired operational speed. In urban areas, this ranges from 15 to 45 MPH. These speeds are higher than typical bicycling speeds: 10 to 20 MPH.

Signal timing can create difficulties for bicyclists trying to maintain a constant speed. They may be able to get through two or three lights, then have to stop and wait, to start over again. This can tempt bicyclists to get a jump on a light or to run red lights out of frustration or to take advantage of their momentum.

Where bicycle use is high, signal timing should take into account the convenience of bicyclists. For example, the traffic signals in downtown Portland, Oregon are timed between 12 and 16 MPH, allowing bicyclists to ride with motor vehicle traffic.

In Copenhagen, Denmark, they have adopted the “Green Wave”. Green Wave signals are timed for bicycle travel speed, minimizing stopping.

On signals that function “on-call” (with loop detectors), these improvements can be made to;

- Placing loop detectors in bike lanes to prolong green phase when a bicyclist is passing through (the yellow phase may not allow enough time for a cyclist to cross a wide intersection);
- Increasing the sensitivity of existing loop detectors in bike lanes;
- Painting stencils to indicate to cyclists the most sensitive area of the loop; and
- Placing push-buttons close to the roadway where a bicyclist can reach them without dismounting.

*Stencil indicates where to position bicycle over loop detector to trip signal*

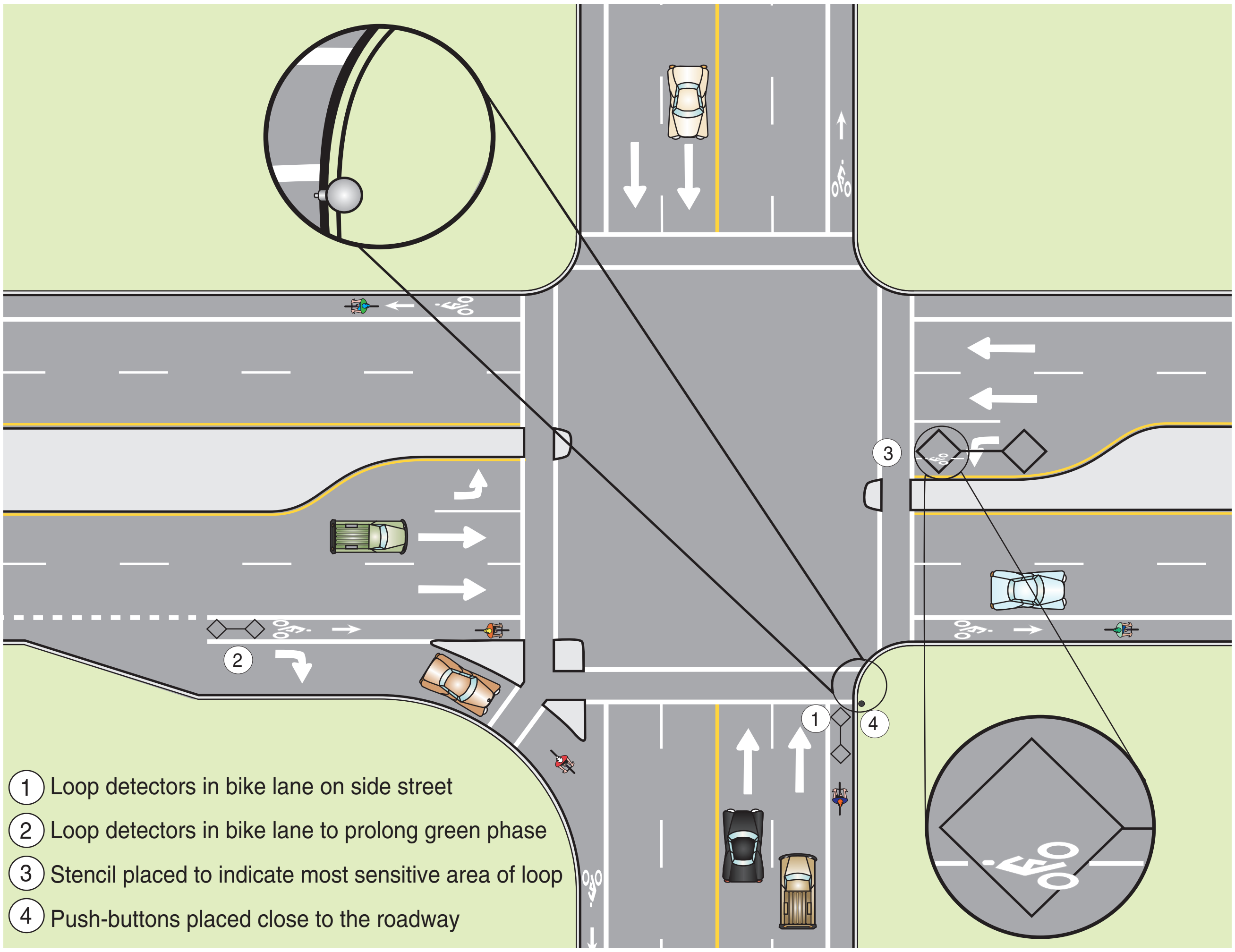



*Figure 6-8: Intersection sensitive to bicycles*

## Pedestrians

Basic principles of intersection design for pedestrians:

- All legs of an intersection should be open to pedestrians;
  - ➢ If a crosswalk is closed for safety or capacity reasons, and there are pedestrian destinations at the closed crosswalk, every effort should be made to mitigate the closure justification and reopen the crosswalk. ORS 810.080 requires a physical barrier. Refer to the ODOT Traffic Manual for ODOT's policy on crosswalk closure.
- The pedestrian's path of travel should be direct, with minimal out-of-direction travel, and obvious to drivers;
- Pedestrians should not have to cross too many travel lanes without a refuge island available; and
- Pedestrian refuge islands should be used to decrease crossing distances and separate conflicts.

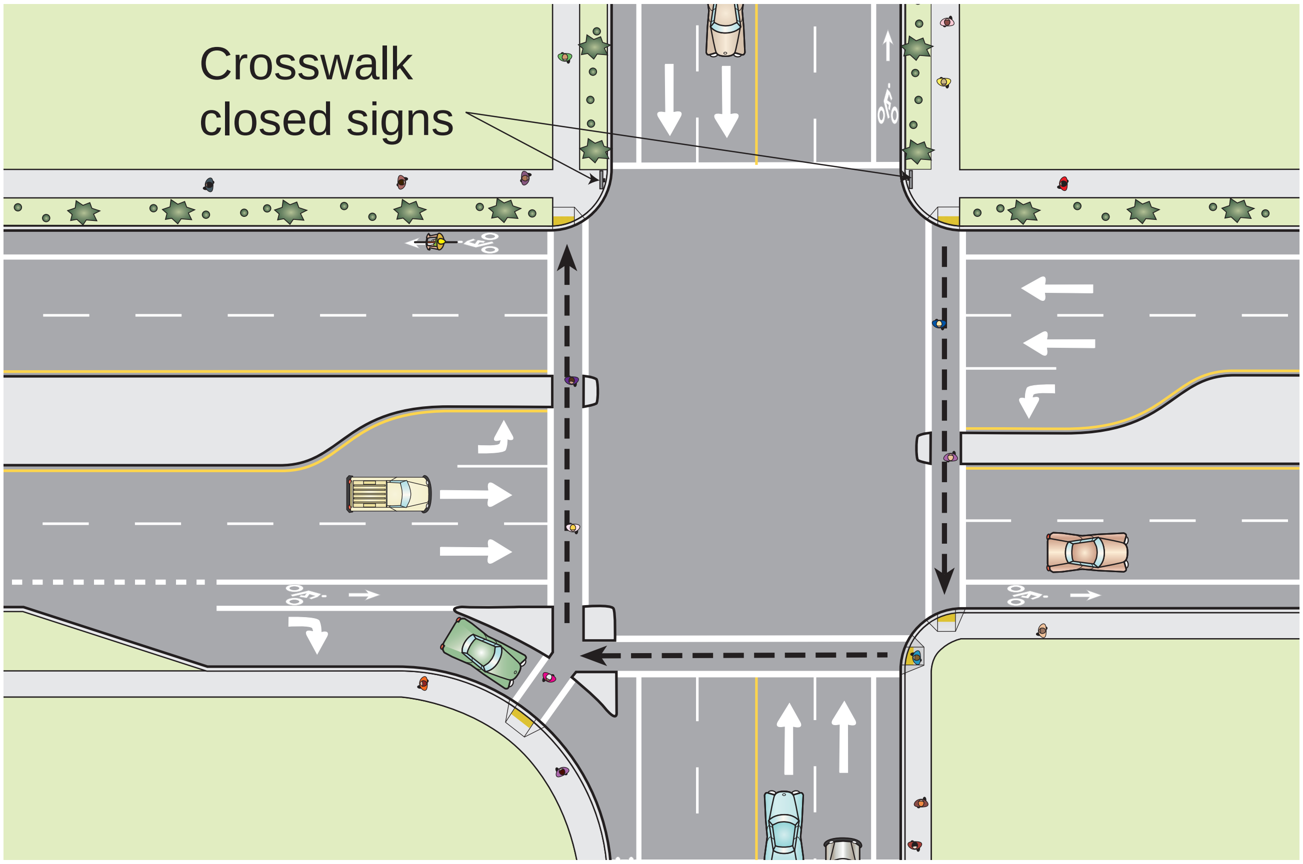



*Figure 6-9: Closed crosswalk forces pedestrians to cross three streets instead of one*

## Minimizing crosswalk length

Crosswalks should be kept as short as possible. This can be achieved by:

- Making the radius of a corner as small as needed to accommodate design vehicles. The effective turning radius takes into account parking and bike lanes. The radius can be very tight on one-way streets where no turn movements are allowed at a corner;
- Using curb extensions on streets with on-street parking, as they make pedestrians more visible to motorists. At signalized intersections, they improve signal timing by reducing the time needed for the pedestrian phase;
- Using islands to interrupt long crosswalks; and
- Lining up curb cuts with the crosswalk.

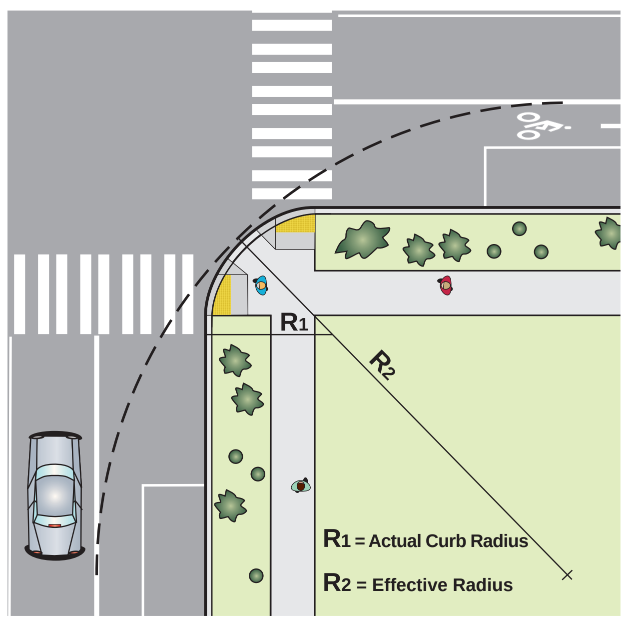



*Figure 6-10: Effective vs. actual corner radius*

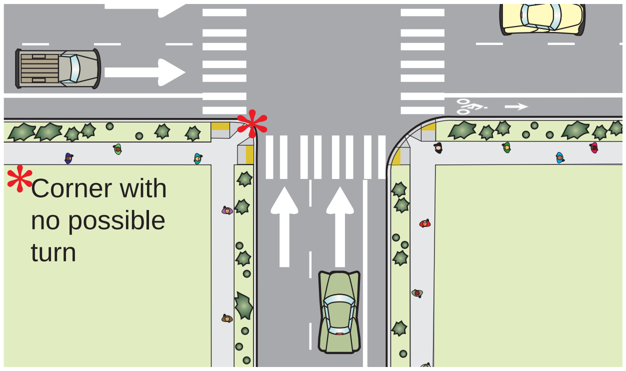



*Figure 6-11: Corner with no turns can have tight radius*

### Truck Turning

Truck movements are an important consideration of roadway design. The needs of trucks must be balanced with the impact to pedestrians and bicyclists. In many instances prudent roadway design accommodates but does not design for trucks. Accommodation refers to the physical ability of a large vehicle to make the required turn movements: allowing large trucks to turn into the far travel lane or encroach on the bike lane, for example. This is often preferable to designing for the largest vehicle and negatively impacting curb radii, crosswalk alignment, curb ramp placement and other elements of the bicycling and walking networks.

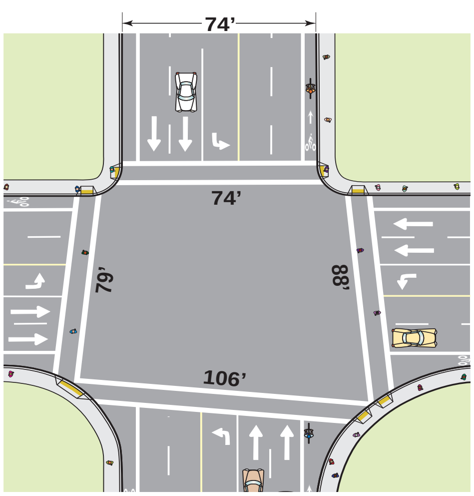



*Figure 6-12: Large curb radius design impacts crossing distances, crosswalk alignment and facilitates high speed motor vehicle turns*

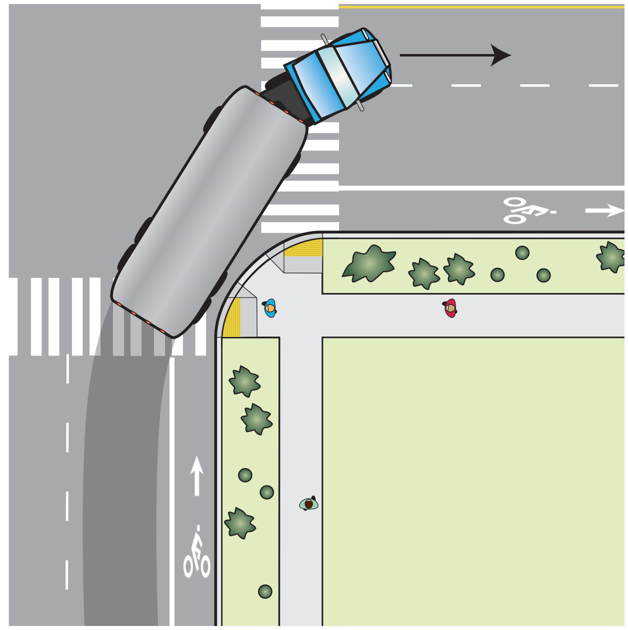


*Figure 6-13: Large vehicles can be accommodated*


*Truck negotiating turn*

## Crosswalk Placement

There are many situations where it is difficult to determine the best location for a crosswalk, often because of skews, large radii or other complicating factors. There are three ways to approach the problem:

1. Place the crosswalk in a direct line with the pedestrians' line of travel as they approach the intersection;

2. Place the crosswalk where the distance across the roadway is shortest; or

3. Place the crosswalk midway between the above two locations.

The first two approaches can yield undesirable results: the shortest distance is often in a location too far from the intersection to be obvious to drivers and pedestrians; the most direct route often creates a long crosswalk. Sometimes the best crosswalk placement is to split the difference between these two extremes, locating the crosswalk where it is visible to drivers and used by pedestrians.

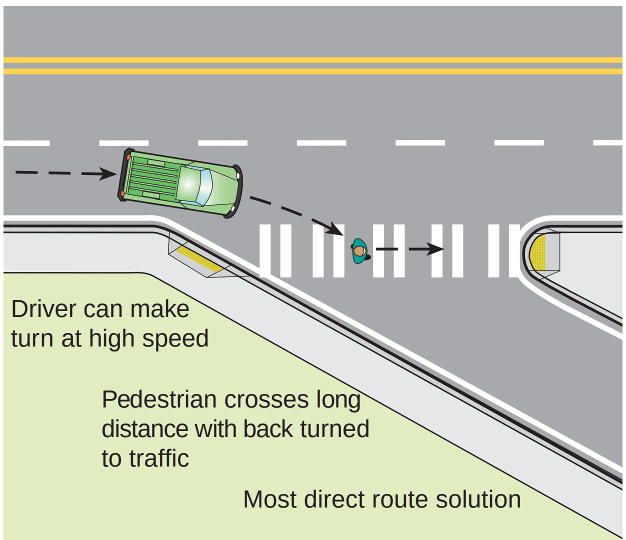



*Figure 6-14: Crosswalk placed at most direct route*

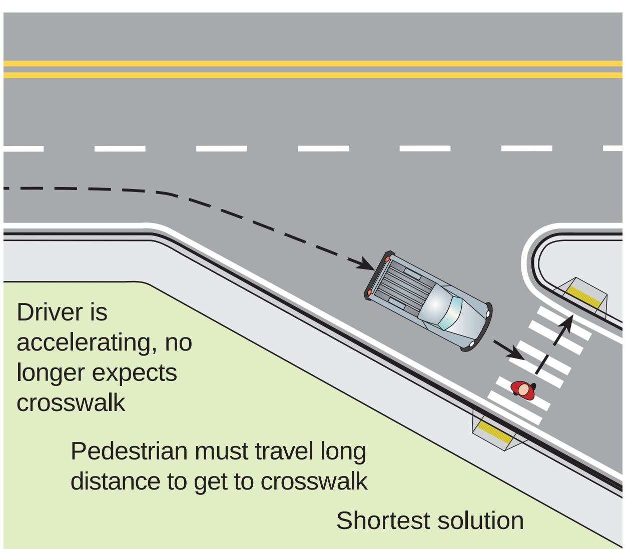



*Figure 6-15: Crosswalk placed at shortest crossing point*

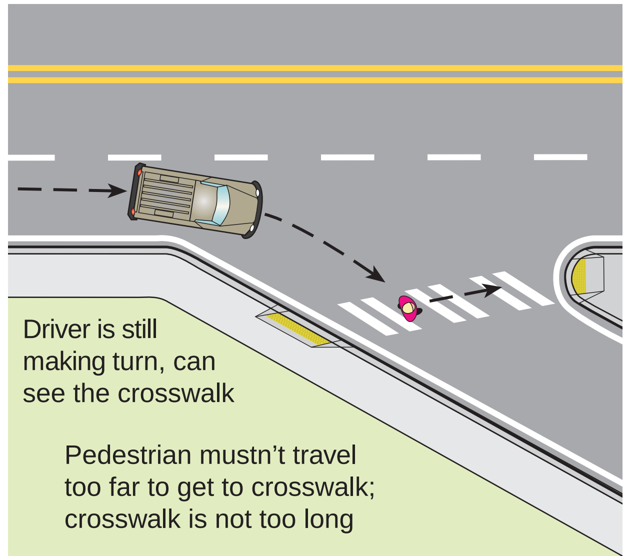



*Figure 6-16: Crosswalk placed midway between direct and shortest routes*

## Crosswalk Markings/Materials

See Chapter 5 for information on crosswalk striping, colors and texture.

## Pedestrian Signal Head Placement

All signalized intersections should have pedestrian signal heads; they should be clearly visible, placed within, or at least close to the crosswalk they control, at a height of 7 to 10 feet, so pedestrians can see them.


*Pedestrian signal head in line with crosswalk*

## Push Button Placement

At signalized intersections, where pedestrian pushbuttons are necessary, they should be clearly visible and be placed close to the level landing at the top of curb ramps. The pushbuttons should be within 10 feet of the curb, 5 feet of the prolongation of the crosswalk, and mounted on a pole or pedestal adjacent to the crosswalk they control at a height of 42 inches. In most cases a separate pedestal is needed to fulfill these requirements; mounting two pushbuttons on one pole rarely satisfies these requirements.

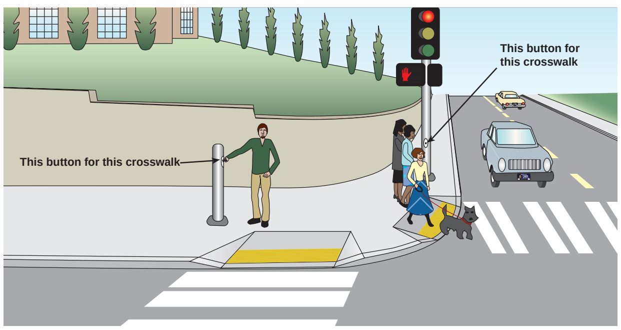
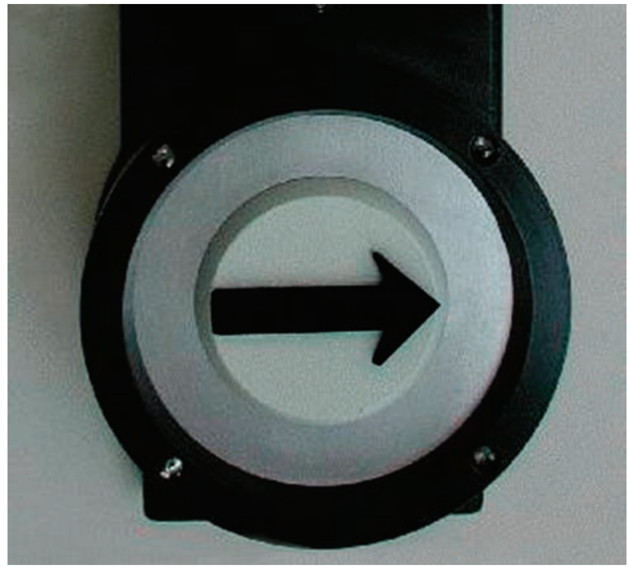



*Figure 6-17: Proper pedestrian push button placement*

*Pushbutton placed and aligned for the visually impaired*

Pushbuttons should be equipped with the most up-to-date accessibility features (vibro-tactile, audible).



*Tactile pedestrian push button*

Push buttons should not be used in high pedestrian use environments, such as a central business district, where the pedestrian phase should be recalled at every signal cycle.

## Islands & Refuges

A median island at an intersection helps pedestrians who cannot cross all the way at one time. Islands must be at least 6 feet wide, preferably 8 feet or more, and large enough to provide refuge for several pedestrians waiting at once. For wheelchair accessibility, it is preferable to provide at-grade cuts rather than ramps.

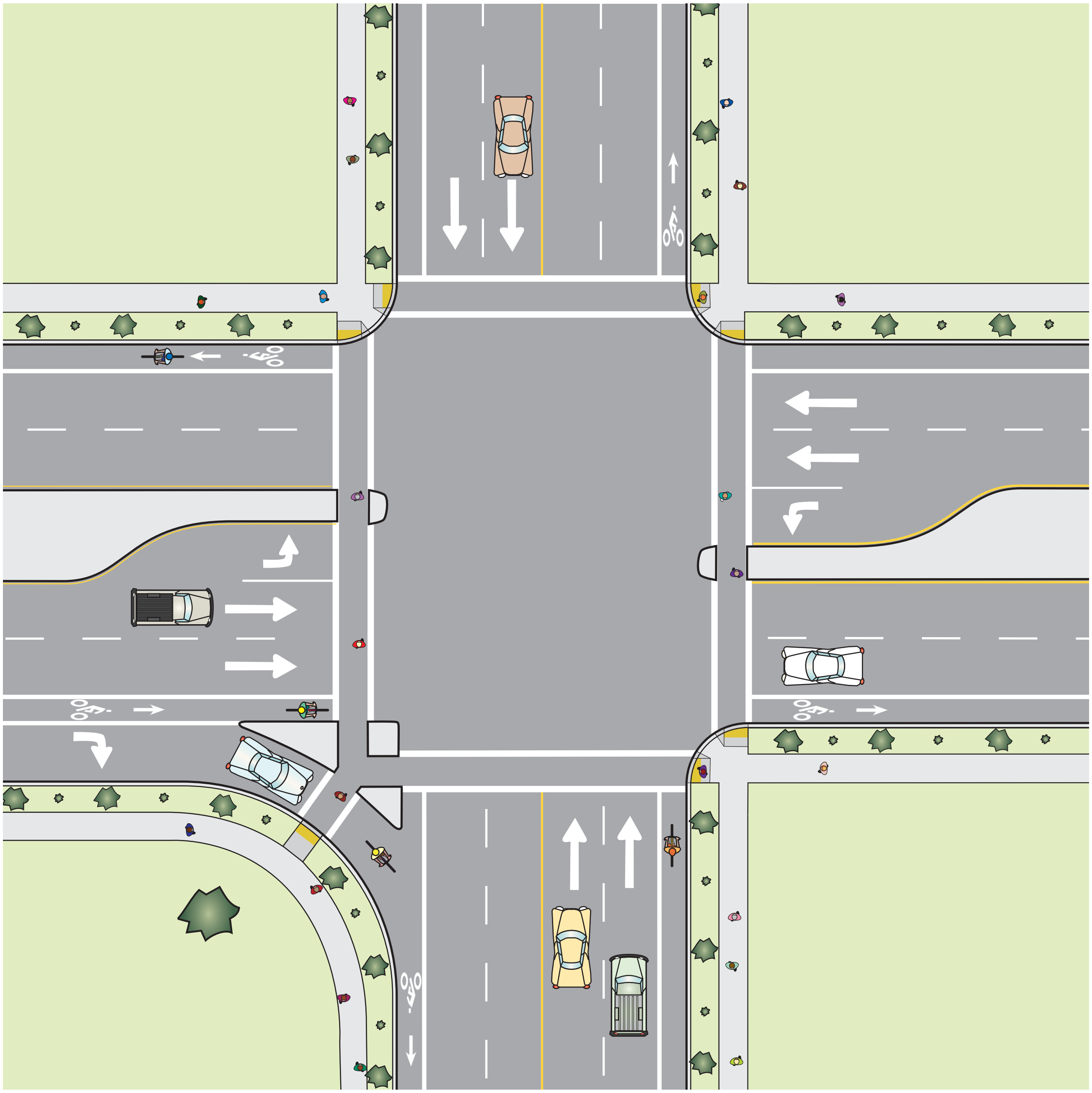


*Figure 6-18: Pedestrian refuge island and medians helps separate conflicts and assists pedestrian crossings at large intersections*

*Cut thru pedestrian island*

Right-turn lanes should be used only where warranted by a traffic study, as they present problems for pedestrians:

- The additional lane width adds to the pedestrian crossing distance;
- They can add confusion to pedestrians with vision impairments, as right-turning vehicles mask the sound of stop-and-go through traffic; and
- Right-turn moves are made easier for motorists, which may cause inattentive drivers to not notice crossing pedestrians.

Once the decision has been made to provide a right-turn lane, placing a raised island between the through lanes and the right turn lane benefits pedestrians as they:

- Allow pedestrians to cross fewer lanes at a time;
- Allow motorists and pedestrians to judge conflicts separately;
- Provide a refuge so that slower pedestrians can wait for a break in traffic;
- Reduce the total crossing distance (which provides signal timing benefits); and
- Provide an opportunity to place accessible pedestrian push-buttons.

The design of right-turn lane channelization islands is critical to pedestrian and driver safety:

- The angle of approach of right-turning cars must be such that the crossing pedestrian is clearly visible;
- The crosswalk across the right-turn-lane should be placed one car length back, allowing a driver to proceed to the intersection proper after having dealt with the potential pedestrian conflict at the crosswalk. This is accomplished by creating an island that is roughly twice as long as it is wide.
- The cut-throughs within the island must line up with the crosswalks.

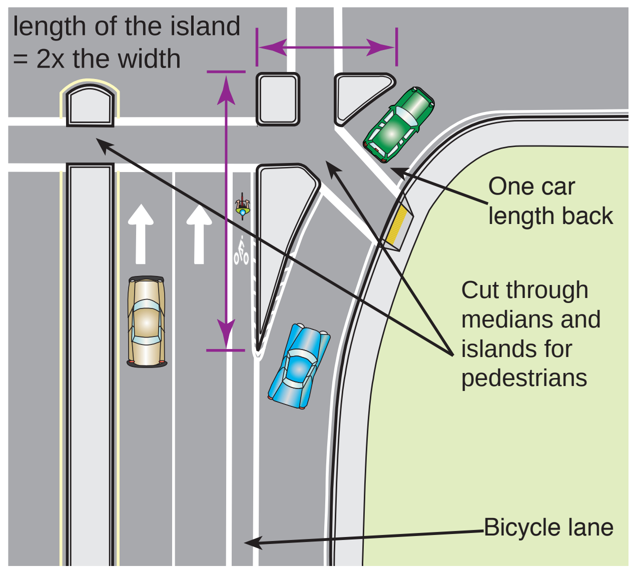



*Figure 6-19: Pedestrian refuge island at right turn slip lane*

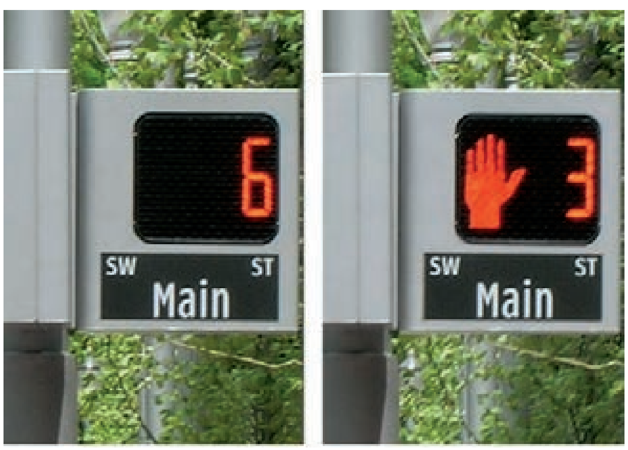
## Signals

Traffic signals are timed to accommodate smooth motor vehicle flows at a desired operational speed. In urban areas, this ranges from 15 to 45 MPH. These speeds are higher than typical walking speeds.

Signal timing can create difficulties for pedestrians trying to maintain a constant walking speed. They may be able to get through one or two signals, then have to stop, wait, and start over again. This tempts pedestrians to walk against the light out of frustration. Where pedestrian use is high, signal timing should take into account the pedestrian convenience. Signal improvements for pedestrian mobility include:

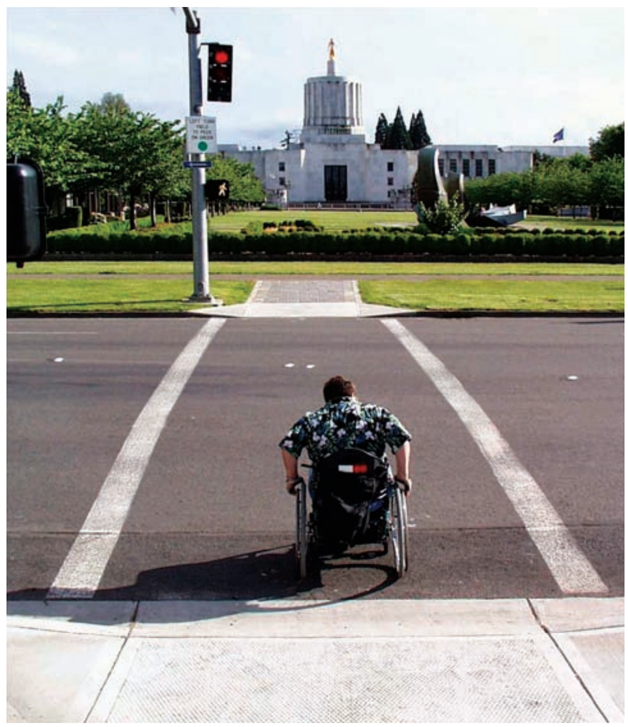
- Incorporating a pedestrian phase in the signal sequence (on recall), rather than on-demand, in locations with high pedestrian use;
- Using short signal cycles to limit the time a pedestrian has to wait;
- Placing pedestrian push-buttons where they're easy to reach, next to the sidewalk, with a clear indication as to which signal the button activates (this will improve operations, as many pedestrians push all buttons to ensure that they hit the right one); and
- Motion detectors (video/infrared/ microwave) that calls for a pedestrian phase when a pedestrian waits.

Signalized intersections also present many potential conflicts; pedestrians are particularly vulnerable when the walk phase is concurrent with the vehicular turn movements, especially left turns. The latter account for the greatest number of pedestrian crashes at signalized intersections. Signal improvements for pedestrian safety include:




*Countdown pedestrian signal head*

- Pedestrian countdown signals: let pedestrians know how much time is left to cross; this has proven effective at reducing conflicts between turning vehicles and pedestrians still in the crosswalk at the end of the crossing phase.
- A longer all-red phase: this can prevent conflicts with vehicles entering the intersection on the tail end of a yellow light and not making it to the far crosswalk before it turns to the steady walk phase for the pedestrian.
- The Leading Pedestrian Interval: (LPI) gives pedestrians a 2-5 second head start before the concurrent vehicle phase turns green; this helps reduce conflicts with pedestrians and turning vehicles, as pedestrians enter and occupy the crosswalk before turning vehicles get there. Accessible Pedestrian Signal features are essential, so pedestrians with vision impairments know when the walk indicator has come on for them.



*LPI: Pedestrian phase precedes motor vehicle green phase by a few seconds*

- Protected left turns: This virtually eliminates left-turn conflicts, as the walk phase is not concurrent with left-turning vehicular movements.

## Issues for Pedestrians and Bicyclists

### Skewed Intersections

Skewed intersections are generally undesirable and introduce complications for bicyclists and pedestrians:

- Bicyclists and pedestrians approaching from an acute angle are not very visible to motorists;
- The crosswalks are longer, which lengthens the pedestrian phase at a signalized intersection; and
- The path a bicyclist must follow may not be evident.

To alleviate these concerns, several options are available:

- Every reasonable effort should be made to design the intersection closer to a right angle;
- Pedestrian islands should be provided if the crossing distance is excessive; and
- Bike lanes may be striped with dashes, or colored, to guide bicyclists through a long undefined area.

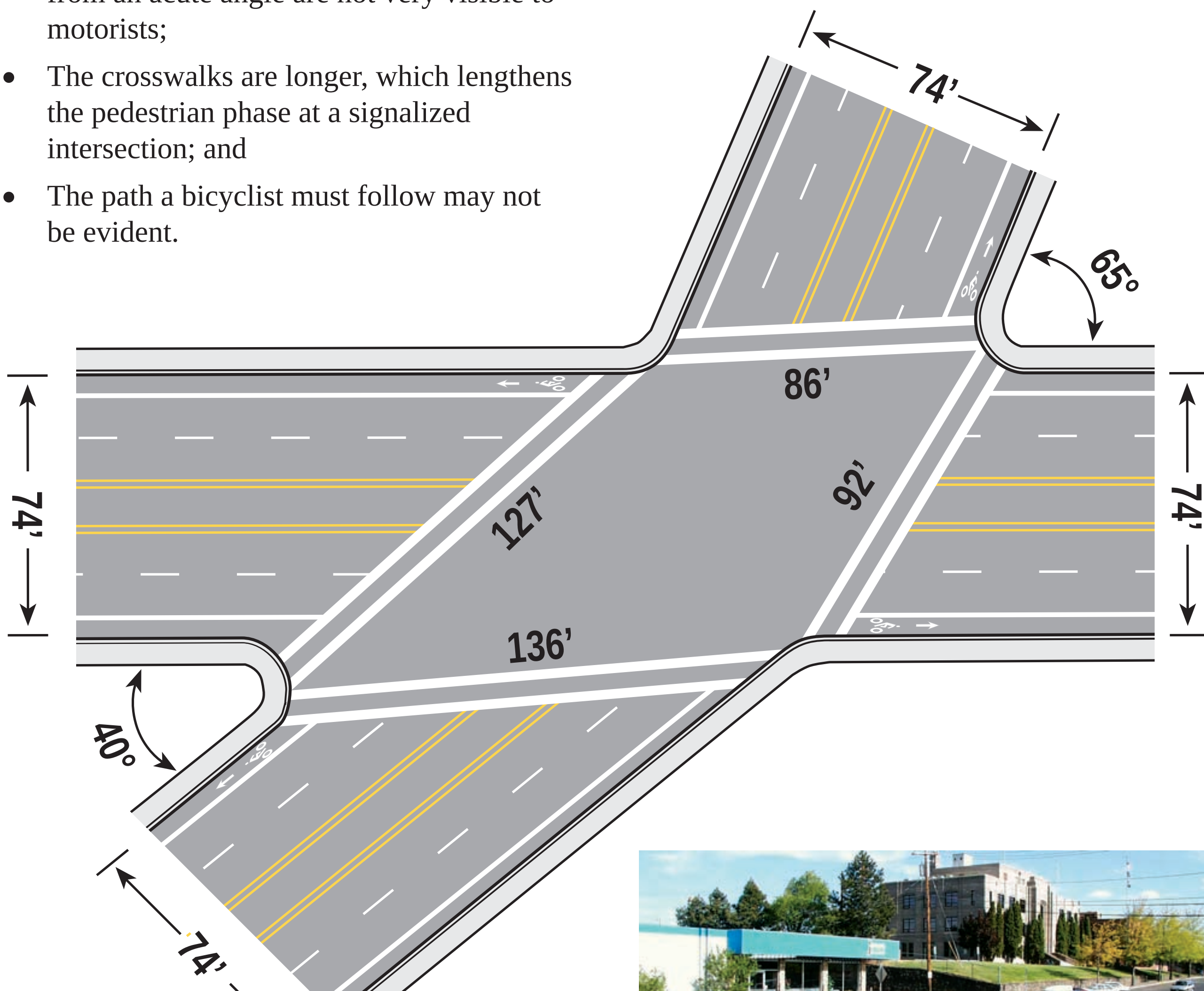



*Figure 6-20: Skewed intersection increases crossing distances*

*Skewed intersection results in long crosswalk and increased pedestrian exposure*

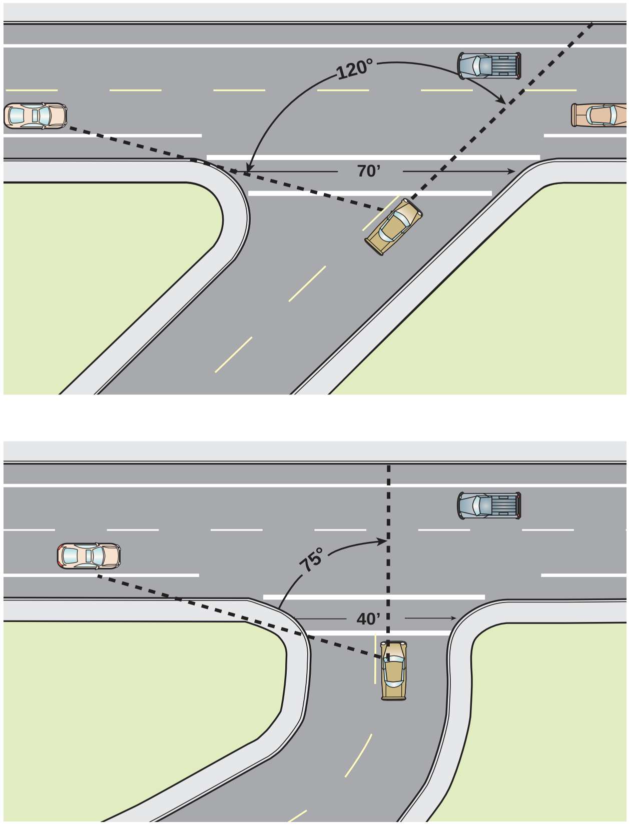



Figure 6-21: Squared intersection improves visibility

Formerly skewed intersection realigned to right-angle

Blue bike lane thru skewed intersection

## Multi-Leg Intersections

Multi-leg intersections are generally undesirable and introduce complications for bicyclists and pedestrians:

- Multiple conflict points are created as motor vehicles arrive from several directions;
- The visibility of cyclists and pedestrians is poor as they are not seen by many approaching vehicles;
- The unpredictability of motorists, cyclists and pedestrians is increased;
- Pedestrians and bicyclists must cross more lanes of traffic and the total crossing distance is great; and
- At least one leg will be skewed.

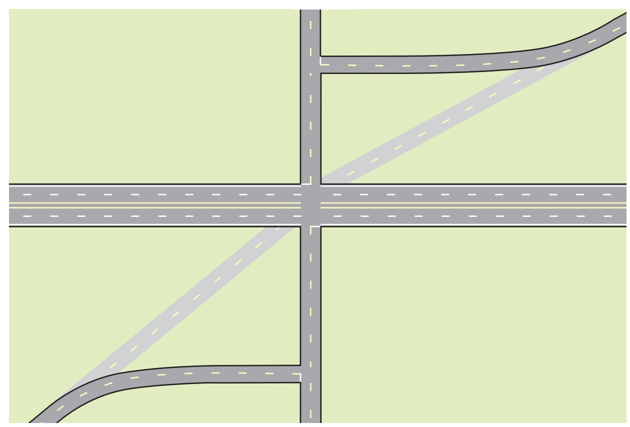


Figure 6-22: Muti-legged intersection reconfigured

To alleviate these concerns, several options are available:

- Every reasonable effort should be made to design the intersection so that only two roads cross at a given point. This is accomplished by removing one or more legs from the major intersection and creating a minor intersection further downstream;
- One or more of the approach roads can be closed to motor vehicle traffic;
- Innovative designs such as roundabouts should be considered at complex intersections;

- Pedestrian islands should be created if the crossing distance is excessive; and
- Bike lanes may be striped with dashes, or colored, to guide bicyclists through a long undefined area.

## Dual Right-Turn Lanes

This situation is particularly difficult for bicyclists and pedestrians. Warrants for dual turn lanes should be used to ensure that they are provided only if absolutely necessary. The design for simple right-turn lanes allows bicyclists and motorists to cross paths in a predictable manner, but the addition of a lane from which cars may also turn adds complexity: some drivers make a last minute decision to turn right from the second turn lane without signaling, catching bicyclists and pedestrians unaware and higher speed turns are facilitated.

Users should be guided to areas where movements are more predictable, so bicyclists, pedestrians and motorists can tackle one conflict at a time, in a predictable manner.

Four possible ways to mitigate for the effect of dual right-turn lanes are:

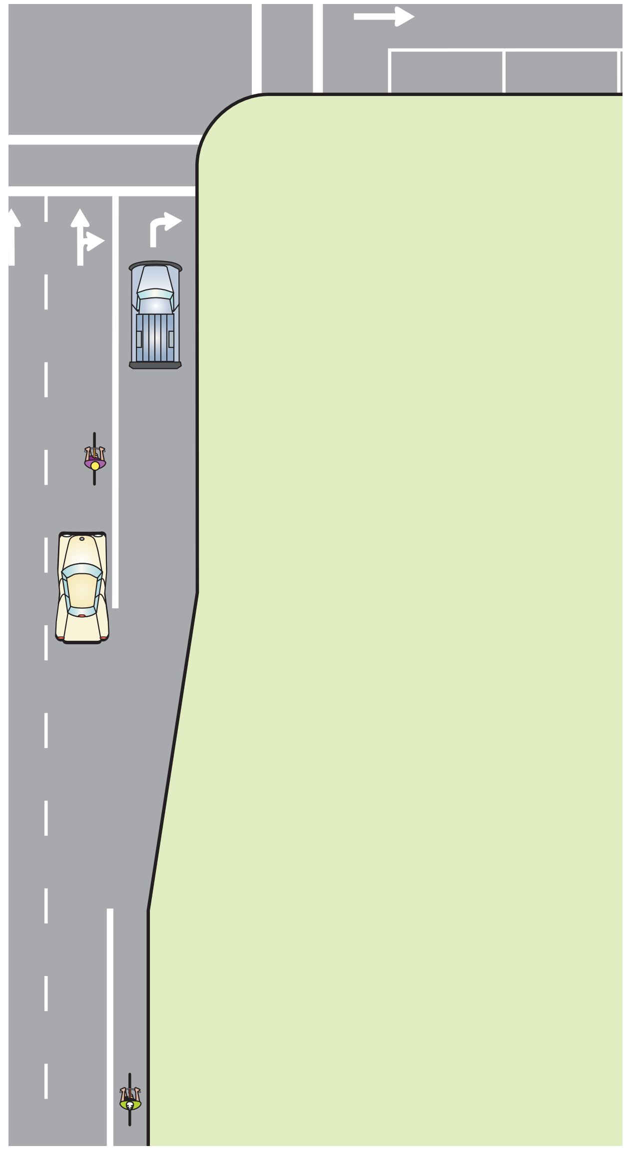


*Figure 6-23: Option 1 - Drop bike lane prior to intersection*

1. This design allows cyclists to choose a path themselves by dropping the bike lane prior to the intersection (this is the AASHTO recommendation).

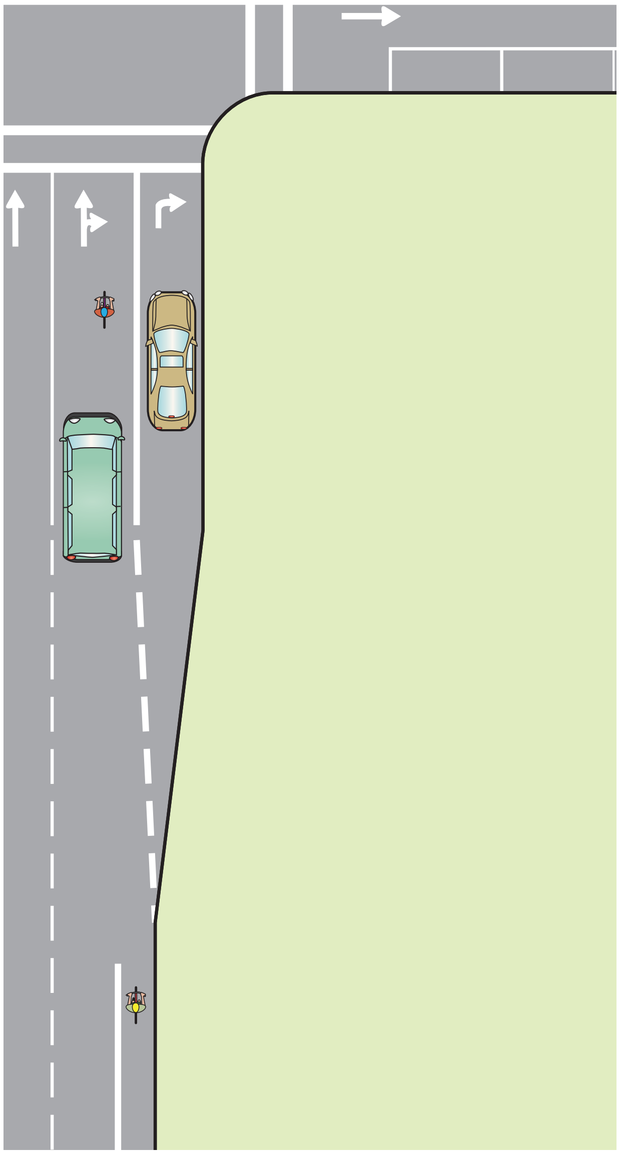


Figure 6-24: Option 2 – Encourages bicyclist to take thru-right lane

2. This design encourages cyclists to share the optional through/right-turn lane with motorists.

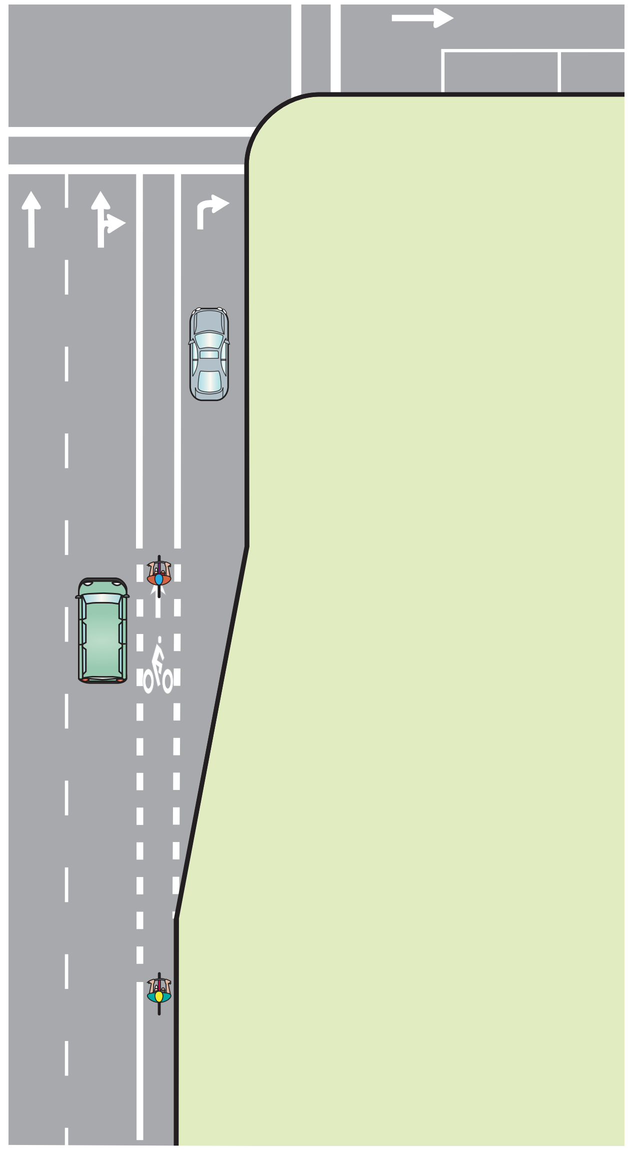


Figure 6-25: Option 3 - Preserves dedicated bike lane

3. This design guides cyclists up to the intersection in a dedicated bike lane.

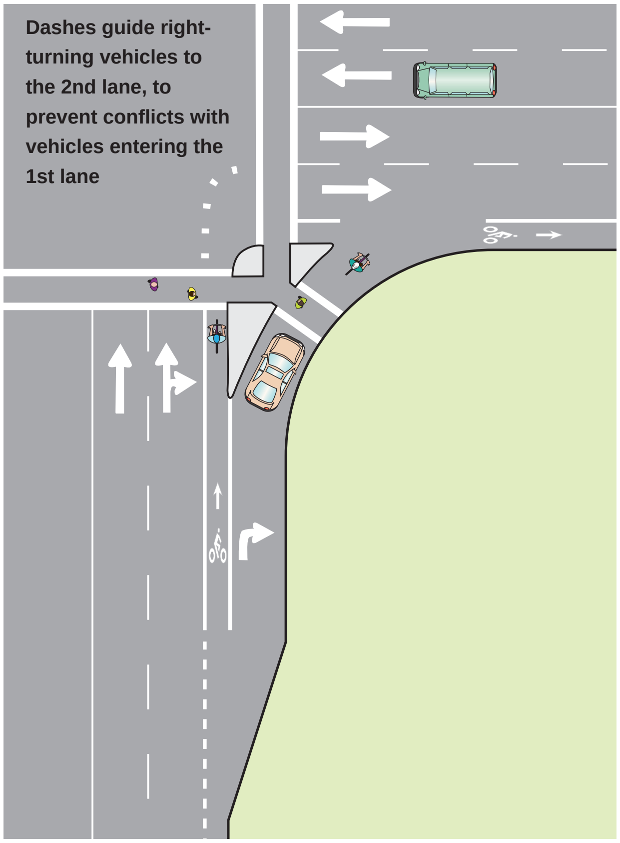



*Figure 6-26: Option 4 – Addition of pedestrian island*

4. This design places an island between the right-turn lane and the optional through/ right turn lane. This creates a more conventional intersection, separating the conflicts. This design is also better for pedestrians, as the island provides a refuge.

Engineering judgment should be used to determine which design is most appropriate for the situation.

## Modern Roundabouts

A roundabout is a type of intersection commonly used around the world; roundabouts are now gaining acceptance in this country. Modern roundabouts should not be confused with small traffic-calming circles or large rotaries, which are often signalized. Early roundabout designs were often unsuccessful for several reasons, mainly:

- They were too small (creating difficulties for trucks);
- They were too large (encouraging high speeds);
- The right of way was not clearly defined (causing confusion and collisions); or
- Pedestrians were allowed access to the middle of the roundabout.

Modern roundabouts have several distinctive features:

- Deflection which forces slow motor vehicle traffic speeds, but that allows movement by trucks;
- A landscaped visual obstruction that obscures the driver's view of the road ahead, to discourage users from entering the roundabout at high speeds;
- Clearly established right of way: drivers entering the roundabout yield to drivers already in the roundabout;
- Splitter islands, to force drivers to turn right, and to provide a refuge for pedestrians; and
- No pedestrian access to the center island, which should not contain attractions.

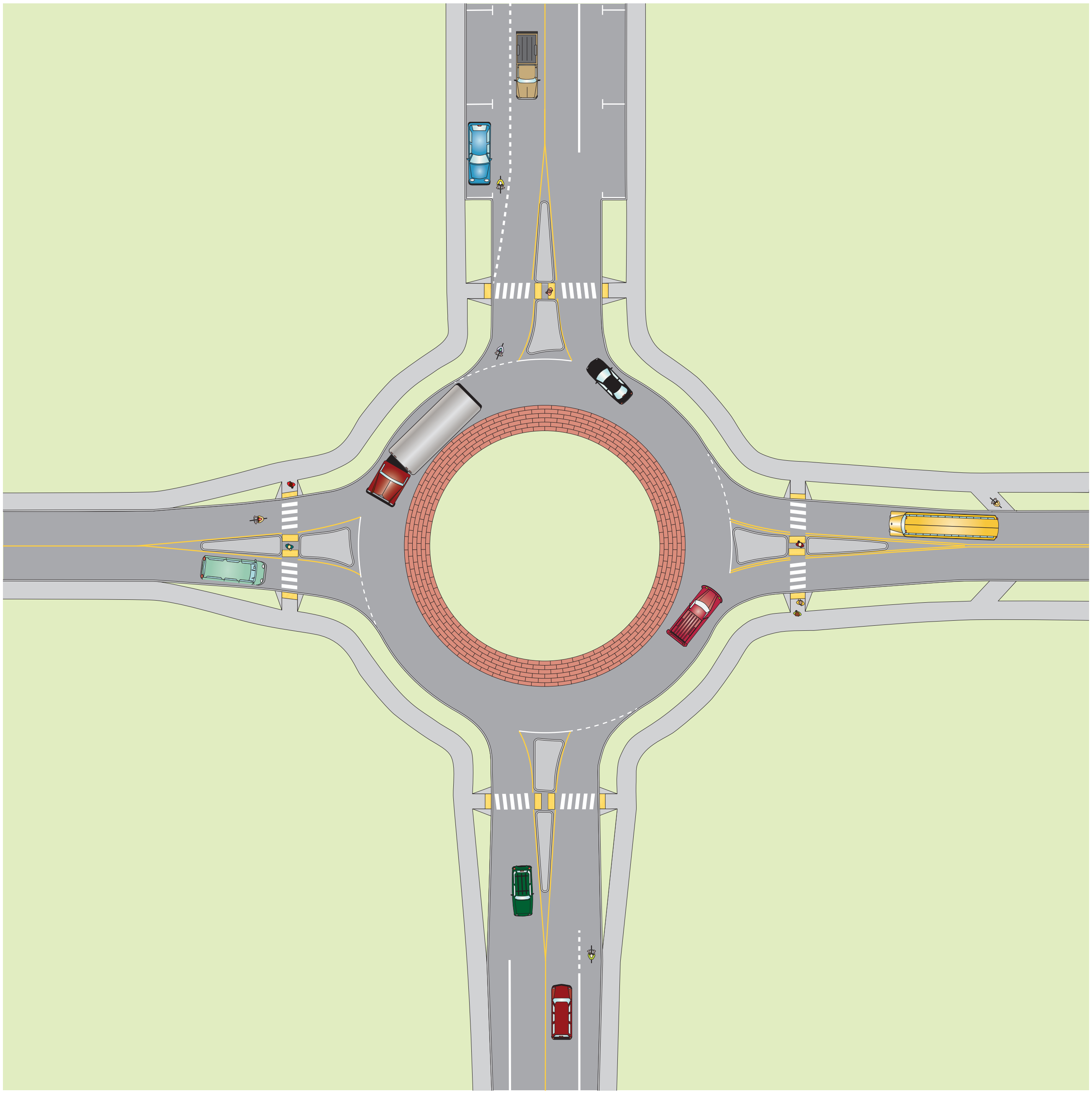


*Figure 6-27: Modern roundabout*

*Modern roundabout in suburban context*

One major advantage of roundabouts is the reduced need for additional travel lanes (signals create stop-and-go conditions, resulting in a need for extra travel lanes to handle capacity at intersections). Other advantages include:

- Reduced crash rates;
- Reduced severity of injuries (due to slower speeds);
- Reduced long-term costs (compared to traffic signals, which require electrical power); and
- Reduced liability by transportation agencies (there are no signals to fail).

*Pedestrian crossing to splitter island at roundabout*

Advantages of roundabouts for bicyclists and pedestrians:

- The reduced need for travel lanes enables the right-of-way to be used for bicycle and pedestrian facilities;
- Pedestrians have to cross only one or two lanes of traffic at a time, in clearly marked crosswalks;
- Motor vehicle operators negotiate the intersection at speeds closer to that of bicyclists; and
- Improved midblock crossing opportunities if the number of travel lanes can be reduced.

*Bicyclist in circulating roadway at roundabout*

Disadvantages for pedestrians and bicyclists:

Even though drivers must yield to pedestrians in crosswalks, this doesn’t always happen; the absence of signals may have the following consequences:

- Traffic flowing more evenly may reduce pedestrian crossing opportunities as fewer gaps are created;
- Pedestrians with impaired vision may have difficulty finding traffic gaps, especially the blind who depend on traffic sounds to ensure traffic has stopped;
    - ➢ As mitigation, pedestrian signals can be added at special sites;
- Bicyclists must share the road and occupy a travel lane; by riding too far to the right,

they risk being cut off by vehicles leaving the roundabout in front of them; and

- Multi-lane roundabouts are more challenging, because it's harder to control speed through deflection; at low traffic volumes, a driver can enter from the outside lane, cut across the inside lane in the circulating roadway and exit at high speed from the outside lane.

<u>Roundabout designs for pedestrians and bicyclists:</u>

The following design principles help ensure roundabouts work well for pedestrians and bicyclists:

- Slow speeds provided by deflection, with constrained entries, narrow circulating roadway and truck apron;
- Simple, single lane, throughout;
- Well-defined pedestrian crossings, one car-length back from yield line;
- Splitter islands to allow pedestrians to cross one lane at a time; and
- Bike lane dropped on approaches to encourage cyclists to enter the roundabout with traffic and ride in the circulating roadway. The bike lane should be dropped about 30-50 feet prior to the entry lane crosswalk, and dashed for approximately 30 feet. A ramp should be provided where the dashes begin to allow cyclists to use the sidewalks and crosswalks to negotiate the roundabout, if they so prefer.

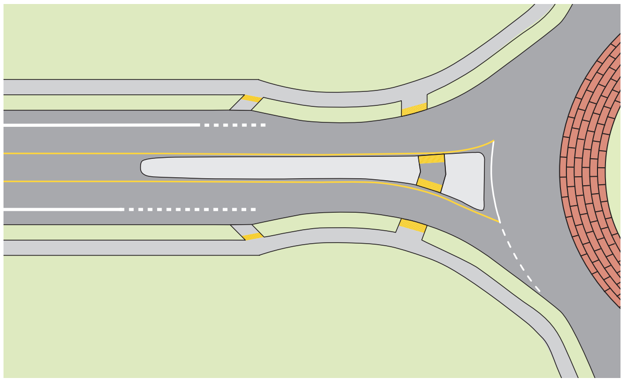


*Figure 6-28: Bicyclist exit ramp detail*

*Bicyclist using exit ramp to access sidewalk*

## Interchanges

### Introduction

Freeways in urban areas can present barriers to pedestrian and bicycle circulation. Interchanges can be obstacles to walking and bicycling if they are poorly designed. Pedestrians and bicyclists should be accommodated on the intersecting and parallel local roads and streets.

In rural areas, traffic volumes are usually low, little pedestrian use is expected, and recreational and touring bicyclists are usually experienced enough to make their way through an interchange. Shoulder widths through interchanges should be wide enough for bicycle and occasional pedestrian use. At interchanges with services such as restaurants, motels and stores, sidewalks, crosswalks and other pedestrian features are expected and should be provided.

In urban and suburban areas, pedestrians and bicyclists of all skill levels travel on the intersecting cross-streets. Well designed interchanges provide safe and convenient passage for non-motorized traffic.

To alleviate conflicts, more non-interchange crossings of freeways should be provided, with these advantages for bicyclists and pedestrians:

- Bicyclists and pedestrians can cross the freeway at locations where there are no conflicts with vehicles entering and exiting freeway ramps; and
- The additional crossings will relieve some motor vehicle traffic from the interchanges, making it easier for bicyclists and pedestrians who must cross at these locations.

## Basic Principles

The critical areas for pedestrian and bicyclist safety, access and convenience are at the freeway ramps, where freeway traffic interacts with local traffic. The interface between the ramps and the local cross-streets must be designed so drivers understand there will be conflicts, and they should reduce their speeds to appropriate urban speeds, for example from 65 to 25 MPH.

Designs that encourage high speed and/or free-flowing motor vehicle traffic movements are the most difficult for pedestrians and bicyclists to negotiate safely and comfortably. Conversely, designs that provide safe and convenient pedestrian and bicycle passage may require some slowing or stopping of motor vehicle traffic.

It is important to consider both convenience and safety when accommodating pedestrian and bicycle travel near interchanges. The issue of safety becomes moot if facilities are not used because of perceived inconvenience. The expected path of pedestrians and bicyclists must be obvious and logical, with minimal out-of-direction travel and grade changes.

All potential pedestrian and bicycle movements should be accommodated. Closing a crosswalk should only be considered as a last resort.

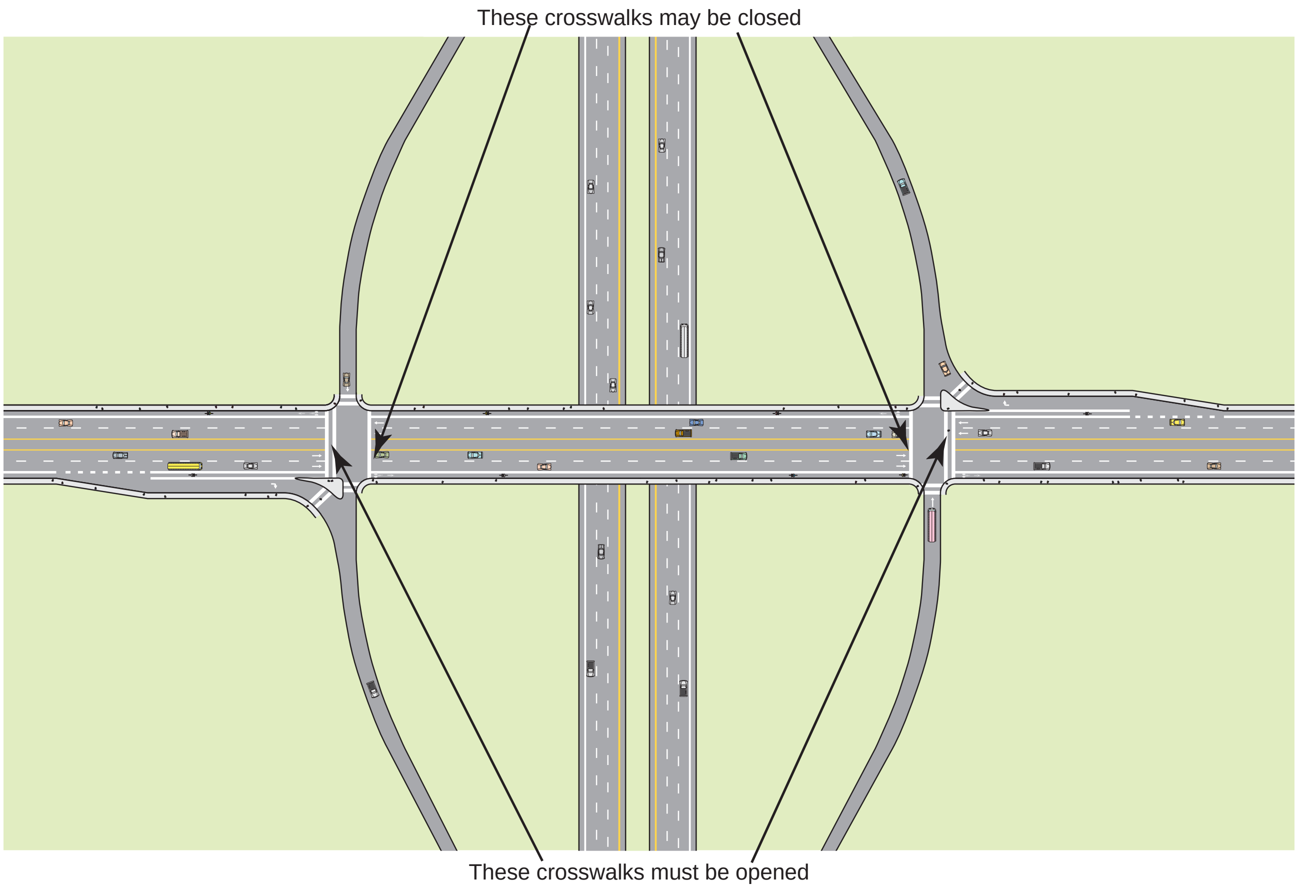



*Figure 6-29: Pedestrian and bicyclist accessible urban freeway interchange with right angle approaches*

However, the two crosswalks across the cross-street on the inside of the interchange may be closed, as there should be no pedestrian-accessible destinations within the interchange area; the two outer crosswalks must be open to facilitate crossings. Continuity of sidewalks and bike lanes must be provided to ensure linkage with existing facilities beyond the intersection.

In most urban and suburban settings, the appropriate pedestrian facilities are sidewalks, and the appropriate bicycle facilities are bike lanes. Sidewalks should be located on both sides of the intersecting local streets, and should be wide enough to facilitate two-way pedestrian travel. Pedestrians should have access to all 4 quadrants of the interchange, especially when destinations such as restaurants or mini-marts are present. Bike lanes must be placed on both sides of the roadway to allow bicyclists to ride with traffic. Higher design standards should be considered under these special circumstances:

- Sidewalks should be at least 8 feet wide when placed on only one side of the road, if sidewalks are not provided on the other side due to conflicts; this situation should be avoided if possible.
- Sidewalks should be at least 10 feet wide if they are intended for joint use by pedestrians and bicyclists; this situation should be avoided if possible.

## Guidelines

### At-Grade Crossings

Connecting access ramps to local streets at a right angle makes it easier for pedestrians, bicyclists and motorists; the intersection of the ramp and the street should follow the principles of good urban intersection design outlined earlier in this chapter. This interface should be designed as half a regular urban intersection, preferably signalized. The main advantages are:

- The distance that pedestrians and bicyclists must cross at the ramps is minimized;
- Signalized intersections stop traffic; and
- Visibility is enhanced.

Where large truck turning movements must be accommodated, compound curves reduce the distance for pedestrians at crosswalks.

The use of traffic islands can help create pedestrian refuges. Pedestrians won't have to cross too many lanes of traffic at once, which helps improve signal timing. Illumination ensures good nighttime visibility.

Interchanges that use a rural design create more difficult crossing movements for pedestrians and bicyclists, as motor vehicle speeds are higher and movements are less restricted. Configurations with free-flowing right turns and dual left- or right-turns are difficult for pedestrians and bicyclists to negotiate safely. They are particularly vulnerable where a high-speed ramp merges with a roadway.

If these configurations are unavoidable, mitigation measures should be sought. Special designs should be considered that allow pedestrians and bicyclists to cross ramps in locations with good visibility and where speeds are low.

## Grade-Separated Crossings

Grade separation should be considered where it is not possible to accommodate pedestrians and bicyclists at grade. Grade-separated facilities are expensive; they add out-of-direction travel and will not be used if the added distance is too great. This can create a potentially hazardous situation if pedestrians and bicyclists ignore the facility and try to negotiate the interchange at grade with no sidewalks, bike lanes or crosswalks.

A separated path provided on only one side of the interchange can lead to awkward crossing movements:

- Pedestrians must cross prior to the interchange (signs should be used to direct them at the nearest signalized crossing); and

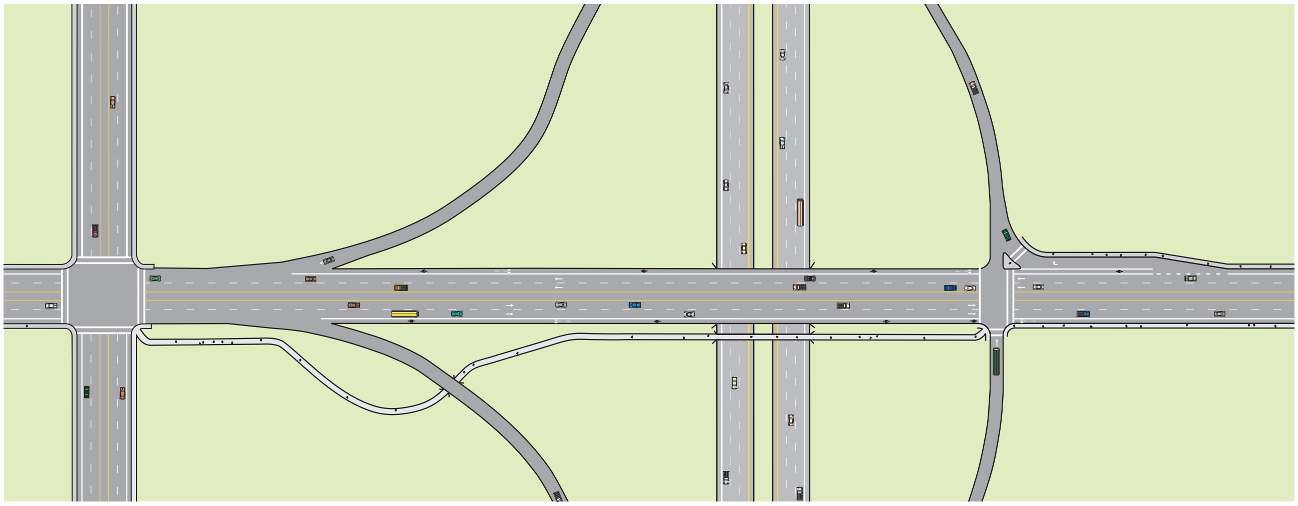


*Figure 6-30: Freeway interchange with separated pedestrian and bicyclist path to avoid high speed conflicts*

- Some bicyclists will be riding on a path facing traffic, creating difficulties when they must cross back to a bike lane or shoulder (clear directions must be given to guide bicyclists' movements when inconsistent with standard bicycle operation).

To ensure proper use by pedestrians and bicyclists, structures must be open, with good visibility - especially undercrossings. Opportunities to provide direct links to destination points should be sought if they offer less travel distance than following the roadway alignment.

## Single-Point Urban Interchange (SPUI)

The Single Point Urban Interchange is gaining favor for urban locations because of the reduced need for right-of-way. It can be made accessible to pedestrians and bicyclists by following these principles:

- Each vehicular movement should be clearly defined and controlled;
- Exit and entry ramps should be designed at close to right angles;
- Pedestrian crossings should be visible and easily identifiable;
- Pedestrians should not be required to cross more than one or two lanes at a time;
- Bicyclists should be able to proceed through the intersection in a straight line; and
- Motor vehicles merging to and from freeway on/off ramps should be required to yield to through cyclists.

The SPUI works reasonably well for pedestrians and bicyclists if the intersection is that of a local thoroughfare and a freeway; pedestrian and bicyclists need to be accommodated only on the cross-street, not the freeway. If a SPUI is used for the grade-separated intersection of two surface streets, which accommodate pedestrians and cyclists, then the SPUI design is not effective, as pedestrians and cyclists on one of the streets will be in a freeway-like environment, with free-flowing exiting and merging ramps.

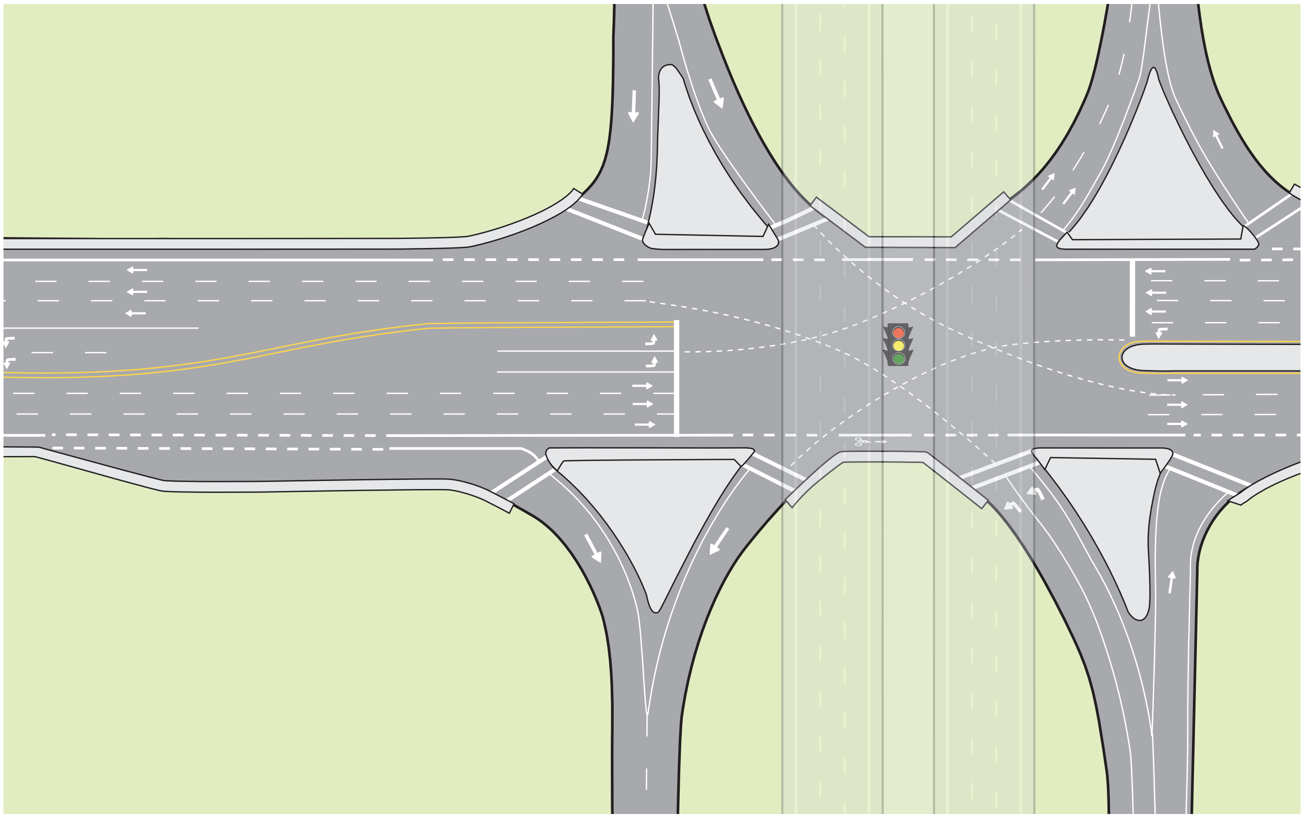


*Figure 6-31: Single Point Urban Interchange (SPUI) with pedestrian and bicyclist access*

## Merging & Exit Lanes

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.

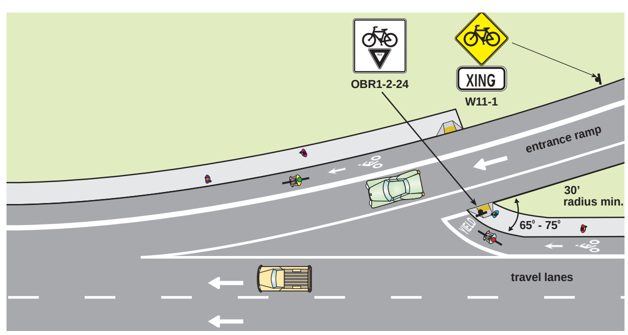



*Figure 6-32: Bicyclist crossing at high speed entrance ramp*

### 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.

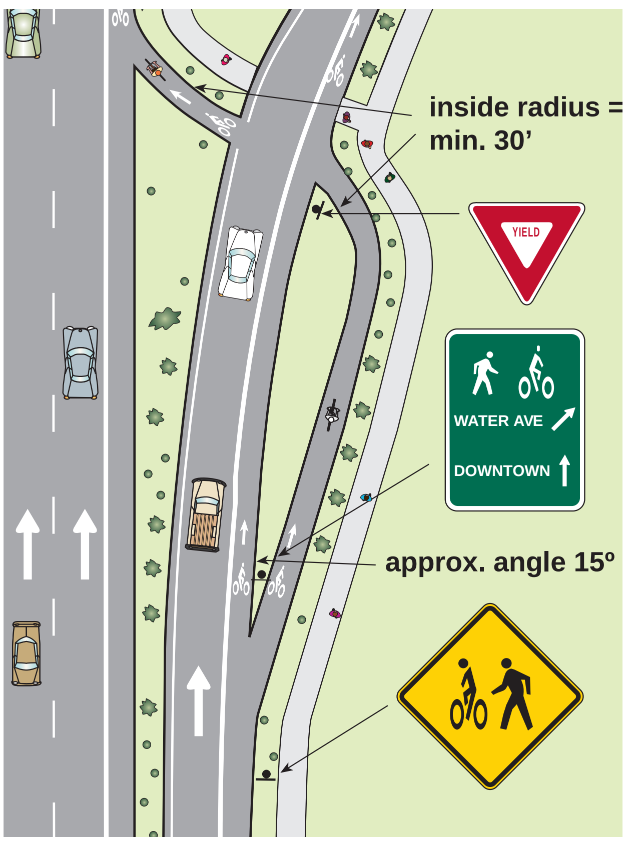



*Figure 6-33: Pedestrian and bicyclist crossing at high speed exit ramp*

## Other Innovative Designs

*These concepts are presented as information, to help ODOT, cities and counties to come up with new solutions to common intersection problems.*

### Bike Boxes

On streets with bike lanes and heavy bicycle use, there is often competition for space and time after a light has turned green at an intersection, as bicyclists, through and right-turning motorists try to proceed at the same time. The bike box reduces conflicts as cyclists can pull forward to the front of the queue when the light is red and motor vehicle traffic is stopped; they can then be the first to proceed when the light turns green. The bike box works best at intersections with no right turn on red and with high bicycle use, so drivers understand why they're being asked to hold back.

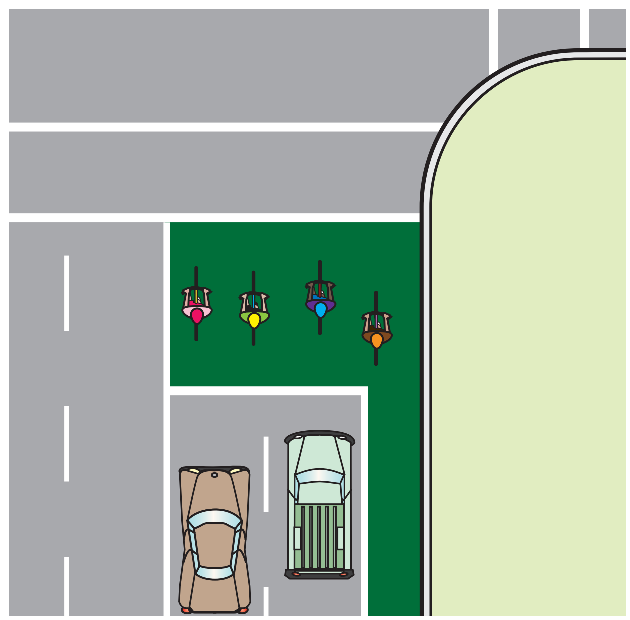


*Figure 6-34: Bike box*


*Bike box (bicyclists may continue straight)*

### Raised Intersections

Raised intersections take the raised crosswalk concept one step further. Motorists see that the area is not designed for rapid through movement; it is an area where pedestrians are to be expected. The driver must be cautious in approaching the intersection and be ready to yield the right of way to pedestrians.

As with raised crosswalks, the incline of the beveled portion is a function of design speed and design vehicle.

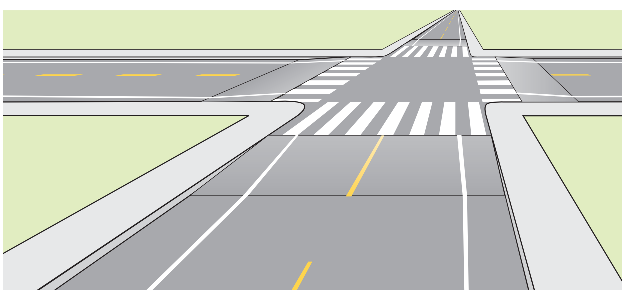


*Figure 6-35: Raised intersection*

Raised crosswalks and intersections have additional advantages:

- It is easier to meet certain ADA requirements, as the crosswalk is a natural extension of the sidewalk, with no change in grade, but they require detectable warnings to be detected by the visually-impaired; and
- Raised intersections can simplify drainage inlet placement, as all surface water will drain away from the intersection.

**Note:** *These treatments are more appropriate on low speed urban roads not high-speed thoroughfares, or on transit routes.*

*Raised intersection keeps crossing level with sidewalk*

# Chapter 7: Shared Use Paths

*Paths accommodate many users*

## Introduction

Originally called "bike paths," then "multi-use paths," shared-use paths are used by pedestrians, joggers, skaters, bicyclists and many others. Shared-use path planning and design must take into account the various skills and characteristics of these different users. Many inexperienced cyclists don't want to ride in traffic and may not ride on streets until they gain experience and confidence. A separated path provides a learning ground for bicyclists and can attract cyclists who prefer a more aesthetic experience.

Well planned and designed 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. Paths can serve both utilitarian and recreational cyclists.

The key components to successful paths include:

- Continuous separation from traffic, by locating paths along a river or a greenbelt such as a rail-to-trail conversion, with few street or driveway crossings; however, this must be balanced with:
- Frequent connections to land-uses, such as residential areas, shopping, schools and other destinations;
- Security: proximity to housing and businesses increases visibility (despite fears of some property owners, paths do not attract crime into adjacent neighborhoods); illumination helps provide a sense of security at night;
- Scenic qualities, offering an aesthetic experience that attracts cyclists and pedestrians;
- Well-designed street crossings, with measures such as signals or median refuge islands (paths directly adjacent to roadways are not recommended, as they tend to have many conflict points);

- Shorter trip lengths than the road network, with connections between dead-end streets or cul-de-sacs, or as short-cuts through open spaces;
- Good geometric design, by providing adequate width, grades, and curvature and avoiding problems such as poor drainage, blind corners and steep slopes;
- Good pavement design, including subgrade and base preparation, to ensure path longevity, good surface conditions and to reduce maintenance cost; and
- Proper maintenance: regular sweeping and repairs can prevent paths from falling into disrepair, with the subsequent increased liability and decreased use.

*Paths are used by many non-motorized modes*

## Shared Use Paths vs. Cycle Tracks

Shared use paths share many commonalities with cycle tracks. However, shared use paths differ from cycle tracks in important ways.

Similarities:

- Separation from traffic;
- Used by bicyclists; and
- Driveway/alley/side street conflicts must be addressed.

Differences:

- Shared use paths are used by many modes: bikers, walkers, joggers, skaters, etc;
- Cycle tracks are for exclusive bicyclist use;
- Share use paths are properly sited where driveways and side street conflicts are minimal;
- Shared use paths may or may not be adjacent to a roadway;
- Cycle tracks replace bike lanes;
- Shared use paths may compliment or supplement bike lanes;
- Shared use paths have two way, largely unregulated bicycle traffic; and
- Cycle tracks are most commonly one way, regulated bicycle traffic.

## Important Considerations

To ensure success, the following concerns must be addressed at the planning, design, construction and maintenance phases of path projects:

### Crossings

The number of at-grade crossings with streets or driveways should be limited; street crossings are one of the most important path design elements. At grade street crossings should be visible to drivers, with proper traffic control for path users and motorists. Where good quality street crossings cannot be obtained, crossings should be grade separated.

### Access

Limiting crossings must be balanced with providing access. To serve users well, a path must have frequent and convenient access to the street network. Access points that are spaced too far apart will require users to travel out of direction to access or leave the path. The path should terminate where it is easily accessible to and from the street system, (e.g. at a controlled intersection or at the end of a dead-end street). Terminating a path midblock on a busy thoroughfare, or at a busy intersection, is generally not recommended; if there is no alternative, a well-designed connection and

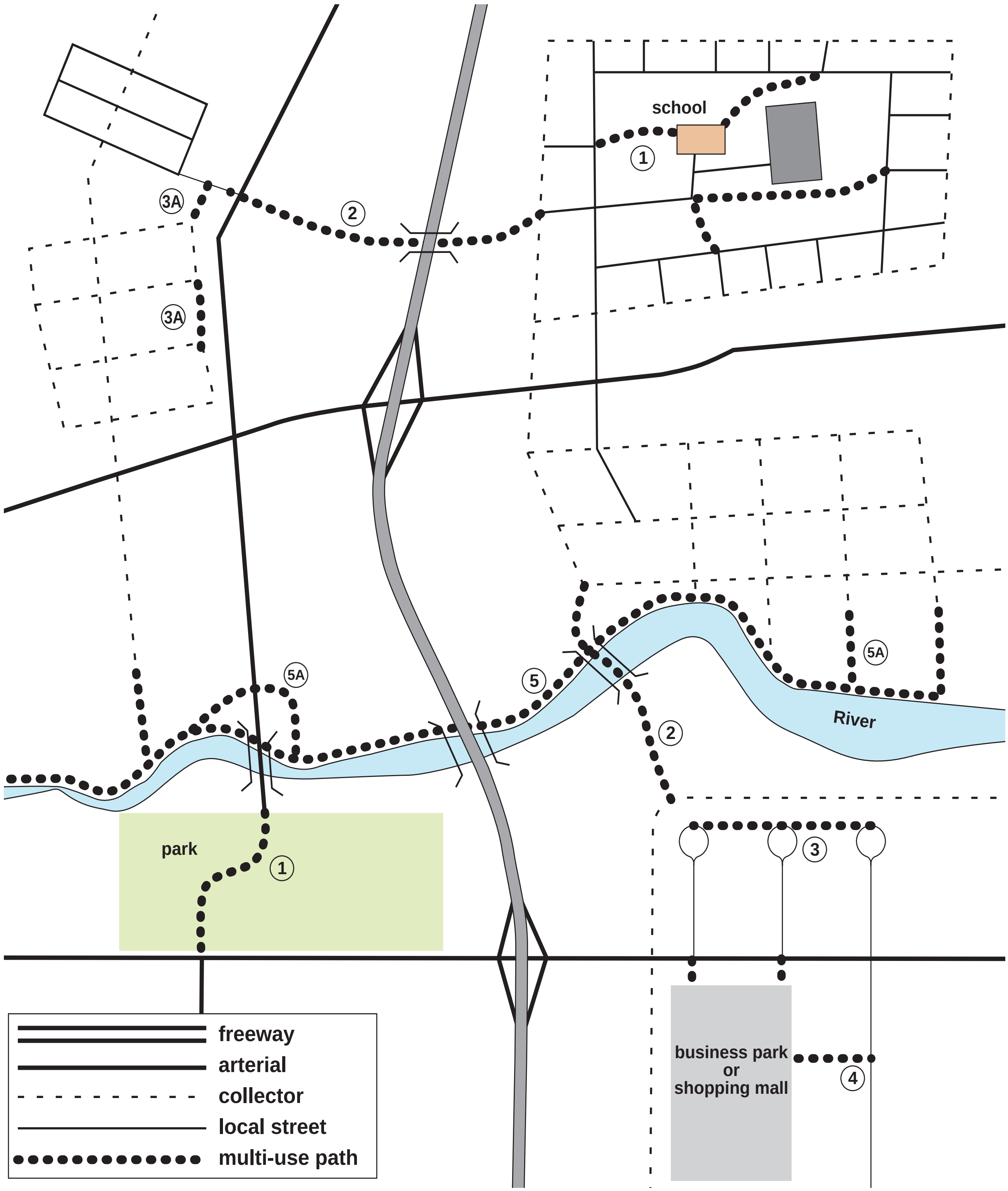



*Figure 7-1: Shared-Use path siting considerations*

crossing must be provided. Guide signs should be used to direct users to and from the path and to provide orientation and destination information on the path.

### Security

Shared-use paths in secluded areas should ensure personal security. Illumination and clear sight distances improve visibility and comfort. Location markers, mileage posts and directional signing help users know where they are. Frequent accesses improve response time by emergency providers.

### Maintenance

Shared-use paths require special trips for inspection, sweeping and repairs. They must be built to a standard high enough that allows heavy maintenance equipment to use the path without deterioration. Building to a high standard also decreases long-term maintenance needs and improves user comfort and safety.

### On-street facilities

Many experienced bicyclists prefer to ride on the road rather than a path adjacent to roadways. This can be confusing to motorists, who may expect all cyclists to use the path. The presence of a path should not be used as a reason to not provide adequate shoulders or bike lanes on roads, where appropriate, or sidewalks for pedestrians in urban areas.

### Standards

Paths should be built to a standard that accommodates all users, from commuters to recreationists, with minimal conflicts. Building a narrow path to save money can lead to problems if the path is popular. If usage is expected to be low, reconsider the need for a path. Pavement design is another important standard: even though paths do not get driven on by heavy motor vehicles, they do experience deterioration due to weather and aging. A path should last as many years as a residential street before needing maintenance or repaving.

*Path connection to local street*

## Paths Next to Roadways

### Concerns

Shared-use paths should not be placed next to roadways with many driveways and or street accesses. Half of the bicycle traffic will ride against the normal flow of motor vehicle traffic, with the following consequences for bicyclists:

- Research has shown that 95% of right turns are made without the driver ever looking right. Thus motorists crossing the path do not notice bicyclists coming from the direction opposite to prevailing traffic, especially if sight distance is poor.
- Bicyclists on the path are often required to stop or yield at cross-streets and driveways. Stopping often disrupts wheeled users' momentum; consequently, they end up not stopping, placing themselves in jeopardy when approaching a busy street crossing where yielding and/or stopping is required.
- Motor vehicles stopped on a cross-street or driveway may block the path.
- When the path ends, some bicyclists riding against traffic continue to travel on the wrong side of the street, as do bicyclists getting to a path. Wrong-way travel by bicyclists is a major cause of bicyclist-to-automobile crashes and should never be a design element, unless considerable care is taken to address the safety issues.

- Because of the proximity of motor vehicle traffic to opposing bicycle traffic, barriers may be necessary to separate the path from the roadway. Barrier design should take into consideration maintenance of the facility and use available right-of-way.

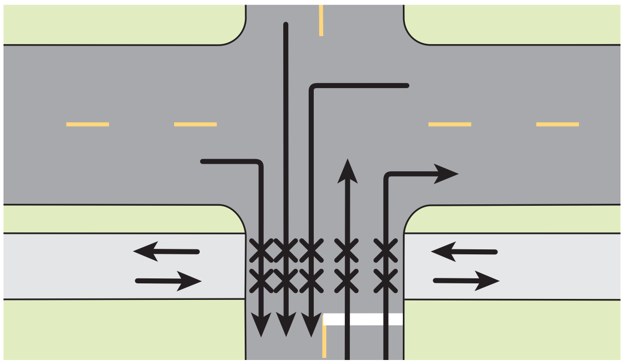


*Figure 7-2: Intersection and driveway conflicts at path*

## Design Standards

ODOT has adopted the AASHTO Guide for the Development of Bicycle Facilities for path design standards. The AASHTO guide should be consulted for geometric design standards such as sight-distance, and horizontal and vertical curves. The following section is an explanation of these standards. Though shared-use paths are intended for many users, the bicycle is the appropriate design vehicle because of its higher travel speeds.

Most of the design standards discussed here are for paths intended for both transportation and recreation. For designing recreational trails in more rural settings, refer to “Designing Sidewalks and Trails for Access,” published by FHWA: Publication No. FHWA-HEP-99-006.

Standards should be met wherever possible, but there are circumstances where economics or physical constraints make it difficult to meet standards. A reasonable approach must be taken, so extraordinary sums are not spent on a short section of path; nor should the natural landscape be excessively disturbed.

### Guidelines

**Separated paths along roadways may be considered when:**

Bicycle and pedestrian use is anticipated to be high;

The traffic conditions (high-speed, high-volumes) on the adjacent roadway are such that on-road bikeways and sidewalks may be undesirable;

The path can be kept separate from motor vehicle traffic, with few roadway or driveway crossings;

There are no reasonable alternatives for bikeways and sidewalks on nearby parallel streets;

There is a commitment to provide path continuity throughout the corridor;

The path can be terminated at each end onto streets with good bicycle and pedestrian accommodation, or onto another safe, well-designed path;

There is adequate access to local cross-streets and other facilities along the route;

Any needed grade-separation structures do not add substantial out-of-direction travel; and

The total cost of providing the path is proportionate to the need. This evaluation should consider the costs of:

Grading, paving, drainage, fences, retaining walls, sound walls, crossings, signs and other necessary design features;

Grade-separated structures needed to eliminate at-grade crossings; and

Additional maintenance, including the need for specialized maintenance equipment.

**Note:** *In many cases, the best choice is to improve the roadway system to accommodate cyclists and pedestrians, which may require connecting up local streets or improving nearby, parallel streets.*

Conversely, there are areas where high usage, or potentially high speeds dictate dimensions greater than standards for user safety and comfort.

## Width & Clearances

### Width

Ten feet is a common width for a two-way shared-use path and may be appropriate in a rural context; they should be 12 feet wide or more in areas with high mixed-use, in urban and suburban contexts. Faster-moving bicyclists require greater width than pedestrians; optimum width should be based on the relative use by these two modes. Twelve feet also allows for greater passing opportunities. High use by skaters may also require greater width.

The absolute minimum width for a two way path is 8 feet; to be used at pinch points only or where long-term usage is expected to be very low. Proper horizontal and vertical alignment is critical to ensure good sight distances.

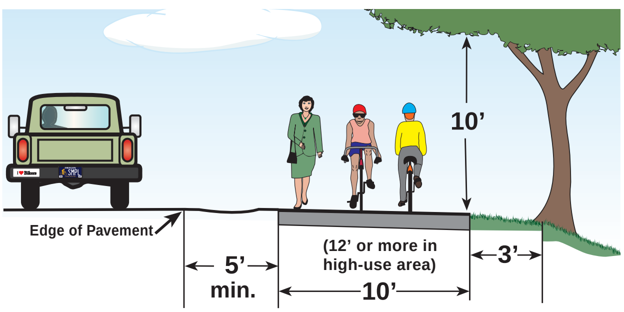



*Figure 7-3: Suggested shared use path dimensions*

Although one-way 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 6 feet wide and designed and signed to ensure one-way operation by bicyclists. One-way paths are primarily used for short connections to a roadway.

*Popular paths quickly become crowded*

## Paths with Heavy Use

A well-planned and designed path, connecting land uses conveniently, will attract many users and the path should be 12 feet or greater. A separate soft-surface jogger or equestrian path may be constructed with bark mulch adjacent to the paved path. A stable gravel shoulder is still required along the path edge to keep the surface from breaking up. Placing soft-surface jogger or equestrian path adjacent to the path also results in bark mulch encroaching onto the paved portion of the path.

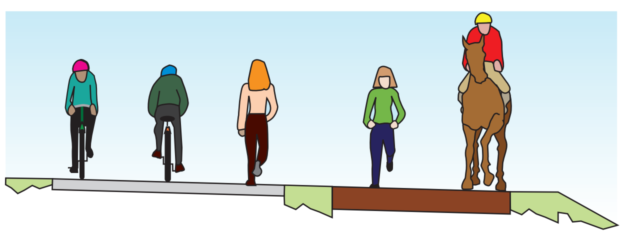


*Figure 7-4: Paved path with separate soft surface trail*

*Gravel shoulders prevent raveling of path edges*

With very high use by both pedestrians and bicyclists, the two modes can be separated with striping, to provide two one-way bike lanes next to a single walking area. For separation to work, adequate width for each mode must be provided. The minimum total width required is 16 feet: two 5-foot bike lanes and a 6-foot walking area. Eighteen or 20 feet are needed in areas of very high use or where users will want to stop to enjoy the view; the areas dedicated to walking and bicycling can vary based on their respective anticipated use. The pedestrian portion of the path should be closer to the vistas, such as next to a river, as pedestrians are more likely to linger, stop and admire views.

With exceptionally high use by both pedestrians and bicyclists, totally separate facilities should be considered: a path for cyclist and a path for pedestrians, with signing to indicate proper use.

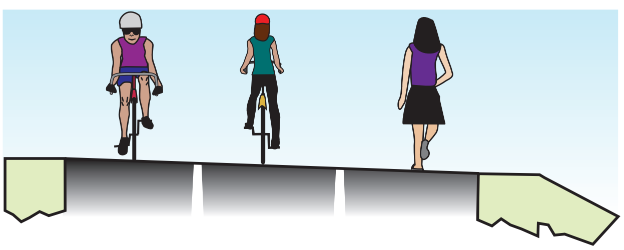


*Figure 7-5: Wide path striped to separate modes*

*Path striped to separate users*

## Lateral Clearance

A 3 foot or greater (min. 2 feet) shy distance on both sides of a shared-use path is necessary for safe operation. This 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.

## Overhead Clearance

The standard clearance to overhead obstructions is 10 feet (min. 8 feet) where fixed objects or natural terrain prohibit the full 10 feet clearance.

## Separation from roadway

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.

## Grades & Cross-Slope

AASHTO recommends a maximum grade of 5% for bicyclists, with steeper grades allowable for up to 500 feet, provided there is good horizontal alignment and sight distance; extra width is also recommended. Engineering judgment and analysis of controlling factors can help determine what distance is acceptable for steep grades.

On paths intended primarily for transportation, ADA requirements should be met: the grade of separated pathways should not exceed 5%, to accommodate wheelchair users. Based on AASHTO recommendations and ADA requirements, 5% should be considered the maximum grade allowable for shared-use paths.

For trails with primarily a recreational purpose in areas with steep terrain, these grades may be exceeded. Consult “Designing Sidewalks and Trails for Access” for guidance (Publication: FHWA-EP-01-027).

The standard cross-slope grade is 2%, to meet ADA requirements and to provide drainage. Sharp curves should be banked with the high side on the outside of the curve to help bicyclists maintain their balance.

## Typical Pavement Sections

Shared-use paths should be designed with sufficient structural depth for the subgrade soil type and to support maintenance and emergency vehicles. A good rule of thumb is to use the typical pavement section recommended for local streets in a given environment. The pavement structures in Figure 7-6 are just examples; each path must be individually designed to meet the local geological and meteorological conditions.

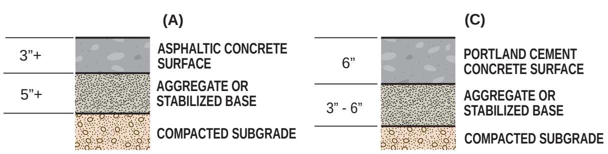



*Figure 7-6: Sample pavement designs*

The use of concrete surfacing for paths is best for long-term use. Concrete provides a smooth ride when placed with a slip-form paver. The surface must be cross-broomed. The crack-control joints should be saw-cut, not trowelled, to avoid a bumpy ride. Concrete paths cost more to build than asphalt paths, but long-term maintenance costs are lower, since concrete doesn't become brittle, cracked and rough with age, or deformed by roots and weeds, as does asphalt.

If the path is constructed over a very poor subgrade (wet and/or poor material), treatment of the subgrade with lime, cement or geotextile fabric (placed between the subgrade and the base rock) should be considered. Where paths are built in environmentally sensitive areas, the additional runoff must be accounted for. Pervious pavement materials should be considered in these circumstances, though care should be taken with pervious concrete – as many pervious concrete mix designs result in a rice crispy like surface.

## Drainage

Shared-use paths must be constructed with adequate drainage to avoid washouts and flooding, and to prevent silt from intruding onto the path due to standing water.

## Vegetation

All vegetation, including roots, must be removed in the preparation of the subgrade. New growth should be controlled with a soil sterilant or lime treatment of the subgrade. Plants that can cause other problems should be controlled; for example, plants with thorns can puncture bicycle tires.

Paths built in wooded areas present special problems. The roots of shrubs and trees can pierce through the surface and cause it to heave and break apart. Preventive methods include removal of vegetation, realignment of the path away from trees, and placement of root barriers along the edge of the path. A 12 inches deep shield creates an effective barrier; greater depth is required for some trees such as cottonwoods.

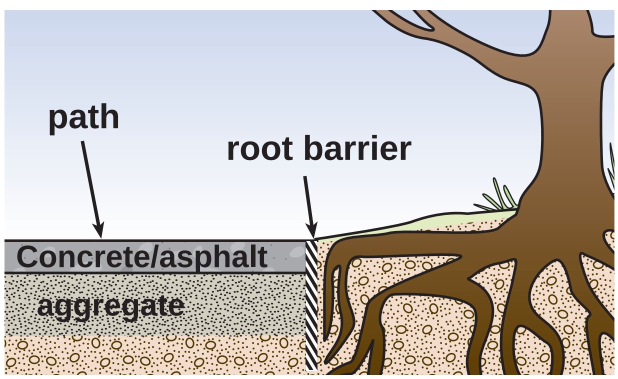



*Figure 7-7: Barrier prevents roots from upheaving path*

## Railings, Fences & Barriers

Fences or railings along paths may be needed to prevent access to high-speed roadways, or to provide protection along steep side slopes and waterways. Fences should only be used where they are needed for safety reasons. They should be placed as far away from the path as possible; minimum offset should be 2 feet. Many of these principles apply to cut-sections of paths where retaining walls are required: minimum 2 feet offset, with a rub-rail where feasible.

Forty-two inches height fence is recommended. Where concrete barriers are used, tubular railing may be added to achieve the required height. Openings in the railing must not exceed 6 inches in width. Where a cyclist's handlebar may come into contact with a fence or barrier, a smooth, 12 inches wide rub-rail should be installed at a height of 3 feet.

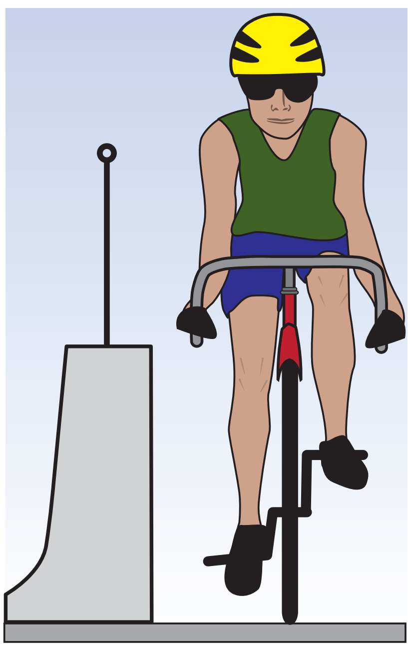


*Figure 7-8: Railing added to concrete barrier*

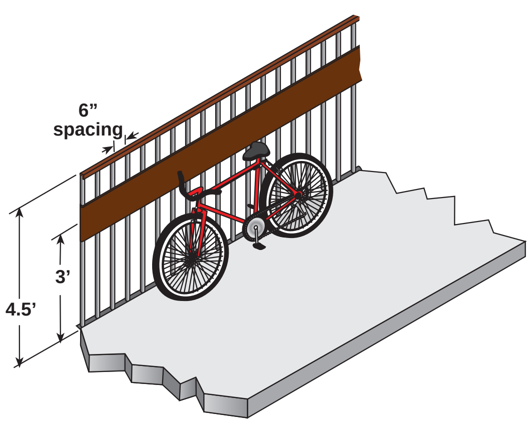
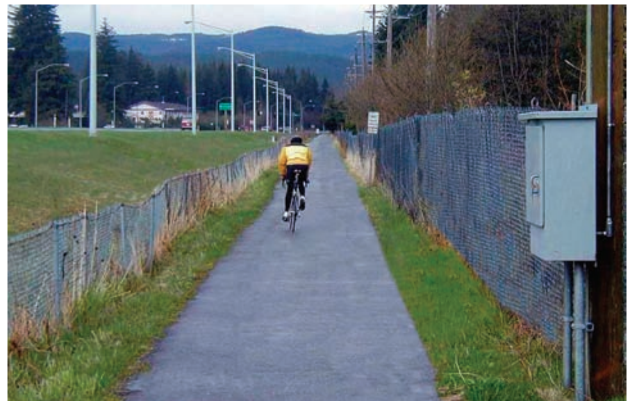



*Figure 7-9: Rub rail added to railing*

Double fencing should be avoided, (e.g. a fence at the right-of-way and a fence to keep pedestrians off freeways.) A high chain-link fence on each side of a path creates an undesirable cattle-chute effect, making users feel trapped.

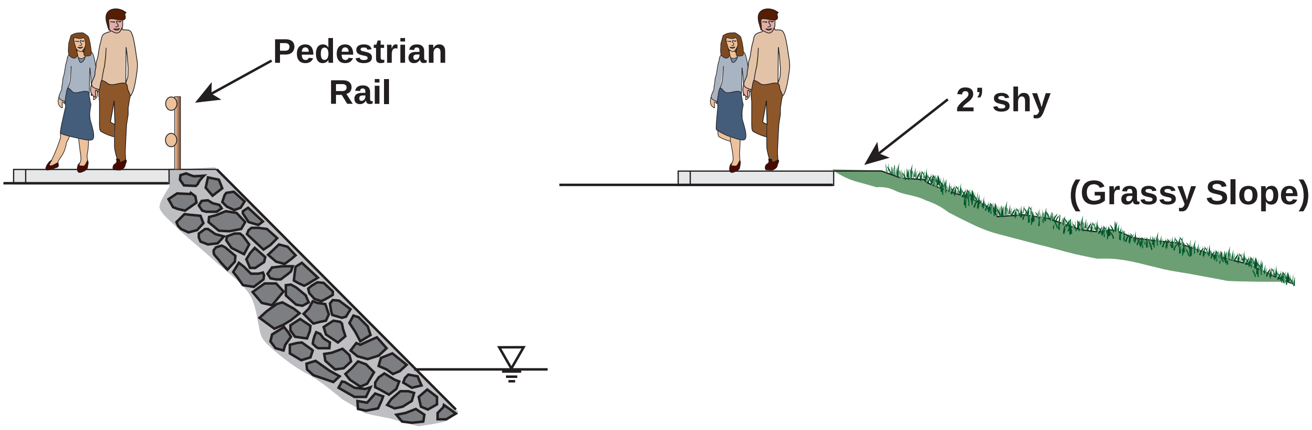


*Double fencing makes users feel trapped*

*Figure 7-10: High fencing at path edges creates cattle chute effect*

The need to include a railing next to a path is dictated by a combination of factors, few of which can be isolated or quantified. When determining the need for a rail or barrier, the designer should look at the combined effects of:

- Clear zone (also called recovery zone): A 2-foot wide (1 foot min) level area should be provided at the outer edges of the paved area so users can recover their balance if they leave the pavement. Shrubbery planted at the edge of the slope (2 feet from the path edge) can help users shy away from the edge.




*7-11: Railing needed on left, not needed on right*

- Height: The need for railing increases with the height of the path above the adjacent roadway, waterway or other hazard, unless there are other mitigating factors. For most applications a rail height of 42 inches is adequate and preserves views. In locations where bicyclists should be protected from a severe hazard, a minimum railing height of 48 inches is recommended. The maximum rail height of 54 inches should be used only where bicyclists could vault over the railing – such as on a curved section at the bottom of a steep incline.
- Cut or fill cross-slope: 2:1 or flatter is generally considered adequate, unless side-slope material is potentially harmful. Cyclists are more comfortable with 3:1 or 4:1 slope. Maintenance staff prefer a flatter slope for mowing.
- Side-slope material: while a grassy berm or soft shrubbery would not harm a person falling, prickly vegetation, rip-rap, gabion baskets or other hard or jagged objects would not adequately protect a user from injury.
- Hazard below: a freeway, deep river or torrent is a greater potential hazard than a field of hay.
- Users: small children or seniors may need greater protection than other users.

These factors should be evaluated on a case-by-case basis, and a decision made based on engineering judgment. The best decision is to flatten the slope to avoid the need for a barrier. Another option is to shift the path closer to the upslope, offering more shoulder at the down slope side.

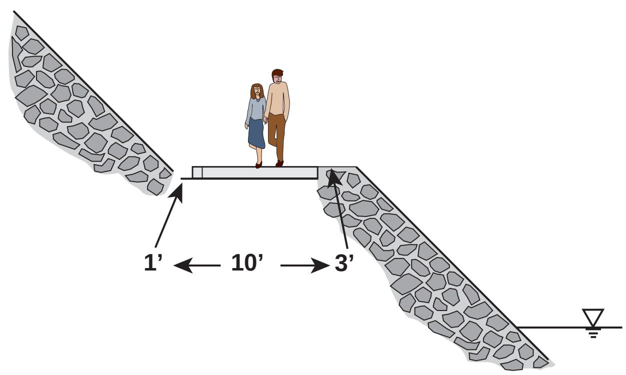



*Figure 7-12: Offsetting path reduces need for railing*

*Gentle grassy slope eliminates the need for railing*

## Illumination

The need to illuminate paths depends on many factors:

- Location: is it isolated, or adjacent to a well-lit roadway?

- Purpose: is safety or security a concern?
- Security may require continuous illumination.
- Safety may require illumination only at street crossings and access points, especially where bollards and other objects are placed to prevent motor vehicle access.
- Light pollution concerns: many jurisdictions have adopted dark sky ordinances; low-level lighting aimed down at the path surface helps reduce light pollution, and illuminate the path surface.

Engineering judgment should be used to determine the need, quantity and type of path illumination. One solution to satisfy these often competing needs is to illuminate a path only in the evening, with a sign telling users when the lighting will be turned off.

## Structures

The width of a shared-use path bridge is normally the same as the approach paved path. Where feasible, a 2-foot shy distance on both sides may be added for additional comfort. For example, a 14-foot wide structure for a 10-foot wide path.

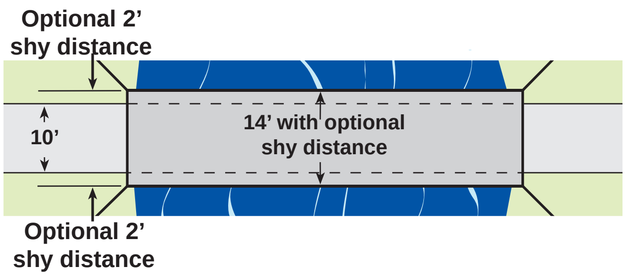



*Figure 7-13: 14 feet wide bridge serves a 10 feet wide path*

If the costs of a wider bridge are prohibitive, yet extra width is needed because it is anticipated that pedestrians will want to stop and linger to admire the view, viewpoints can be added by widening the bridge at scenic view points.

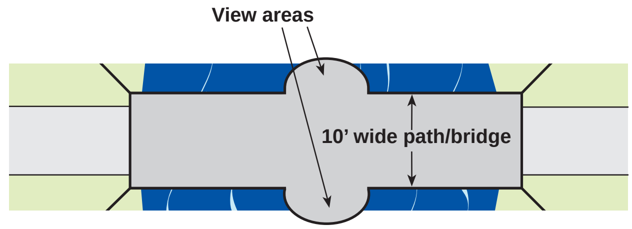



*Figure 7-14: Bridge widened at view point*

*Pedestrians stop to admire the view in widened area without impeding thru traffic*

## Street crossings

### Minor street crossings

In most cases, at-grade crossings of minor streets are acceptable. As traffic volumes on the cross-street increase, so does the need for special treatments, such as a median island or a signal.

The assignment of right of way must be consistent with accepted traffic engineering principles: if the number of anticipated path users is greater than the traffic on the cross-street, the latter should be required to yield or stop to path users. Only when the path crosses a street with higher traffic volumes should path users be required to yield to or stop for traffic on the cross-street. Path users should never be required to yield or stop to traffic at driveways.


*Path crossing a minor street should have been given priority right of way*

Requiring path users to stop or yield to traffic on minor streets and driveways creates a potential for conflicts and collisions, for the following reasons:

- Wheeled path users (cyclists, skaters etc.) who want to maintain their momentum, will quickly learn to ignore stop or yield signs at minor street or driveway intersections with little cross traffic. Then when a stop or yield sign is placed appropriately at a more important street crossing (with more traffic), cyclists, skaters, etc. often ignore it too, and proceed into traffic without stopping or yielding.
- This behavior carries over onto other streets, where cyclists have learned to ignore stop signs.
- Those who do stop at every driveway or minor street intersection cannot take advantage of the momentum naturally generated by cycling or skating.

## Major street crossings

At-grade crossings of busy roads can introduce serious conflicts, and grade separation should be sought, as most path users expect continued separation from traffic.

When grade separation structures cannot be justified, signalization or other measures should be considered to reduce conflicts. Good sight distance must be provided so vehicle drivers can see approaching path users. Most of the techniques described in Chapter 5 “Street Crossings” are applicable to path crossings (e.g. a traffic signal, a median island, advance stop lines on multi-lane roadways, etc.)

Where a path crosses a roadway at an intersection, improvements to the alignment should be made to increase the visibility of approaching path users. One method is to curve the path, so that it is not parallel to the adjacent roadway and the approach is a closer to a right angle. This improves visibility and forces cyclists to slow down.

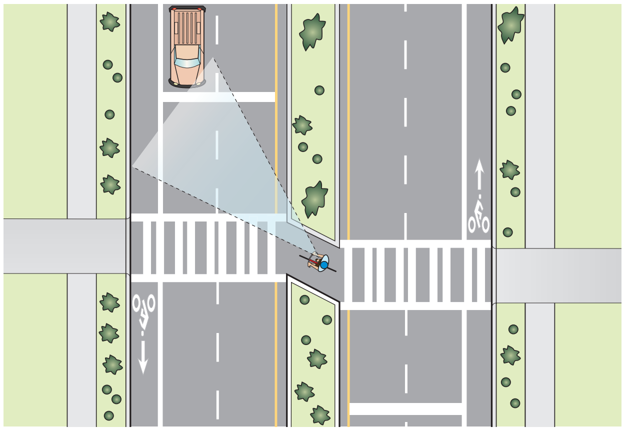


*Figure 7-15: Midblock crossing with island and advance stop bar*

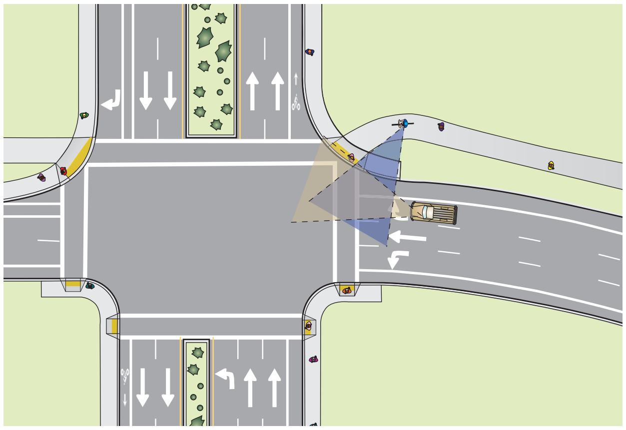


*Figure 7-16: Path is curved to align with crosswalk*

The greatest conflicts occur where paths cross freeway ramps. Motorists using these ramps are not expecting bicyclists and pedestrians at these locations.

At all path/roadway intersections, illumination should be provided so path users and vehicle drivers can see each other as they approach the conflict area. This is especially critical on paths that are otherwise unlit.

When traffic volumes are too high for path users to find acceptable gaps, even with a median island, signalization should be considered. The techniques in Chapter 5 can be used for path crossings.

## Rails-to-trails crossings

Unlike trails built on a new alignment, rails-to-trail conversions follow the alignment of the old railbed. This can result in many midblock crossings, or crossings too close to intersections. Since the alignment cannot be changed, extra care and attention must be given to ensure drivers and path users are aware of the conflicts, and to provide the best-designed crossing possible.

## Undercrossings vs. Overcrossings

When the decision has been made to separate a path from the roadway with a structure, the two choices are over and undercrossings. In some instances, natural terrain makes the choice obvious:

- If the roadway is lower than the path, an overcrossing is the obvious choice;
- If the roadway is higher than the path, the solution is an undercrossing.

When they are both at the same level, the decision is based on weighing a variety of factors. There are advantages and disadvantages to both overcrossings and undercrossings.

*Path is fully separated with an undercrossing*

## Undercrossings

Advantages: They provide an opportunity to reduce approach grades, as the required 10 feet clearance is less than the clearance required for crossing over a roadway. They are often less expensive to build. Sometimes slightly elevating the roadway (3-4 feet) is enough to make an undercrossing attractive.

Disadvantages: They present security problems, due to reduced visibility. An open, well-lighted structure can cost as much as an overcrossing. They may require drainage if the sag point is lower than the water table.

Undercrossings should be 14 feet wide or more. The standard overhead clearance of under-crossings is 10 feet; an 8-foot minimum may be allowable with good horizontal and vertical clearance, so users approaching the structure can see through to the other end. Undercrossings should be visually open for users' personal security and comfort. Illumination is needed in areas of poor visibility, when the undercrossing is long and for nighttime comfort.

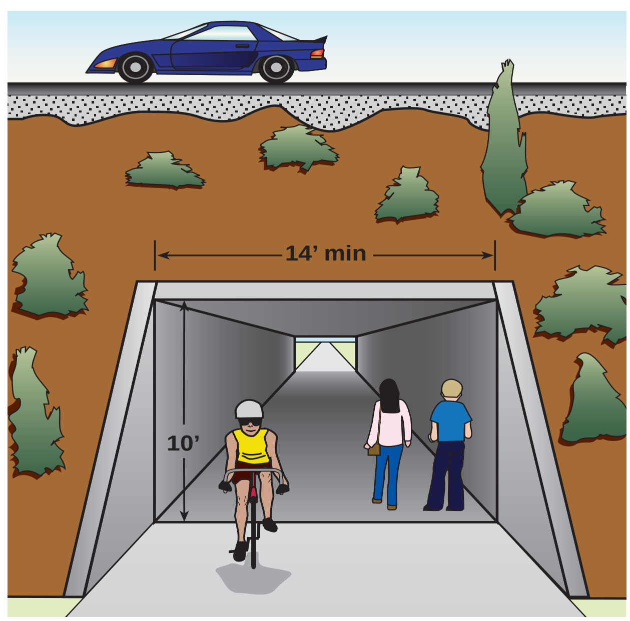



*Figure 7-17: Undercrossing*


*Undercrossing with good sight lines*

## Overcrossings

Advantages: They are more open and present fewer security problems.

Disadvantages: They require longer approaches to achieve the required clearance over roadways. The total rise can be 20 feet with an additional structural depth of 3 feet. At 5%, this requires a 400 foot approach ramp at each end, for a total of 800 feet. This can be lessened if the road is built in a cut section.

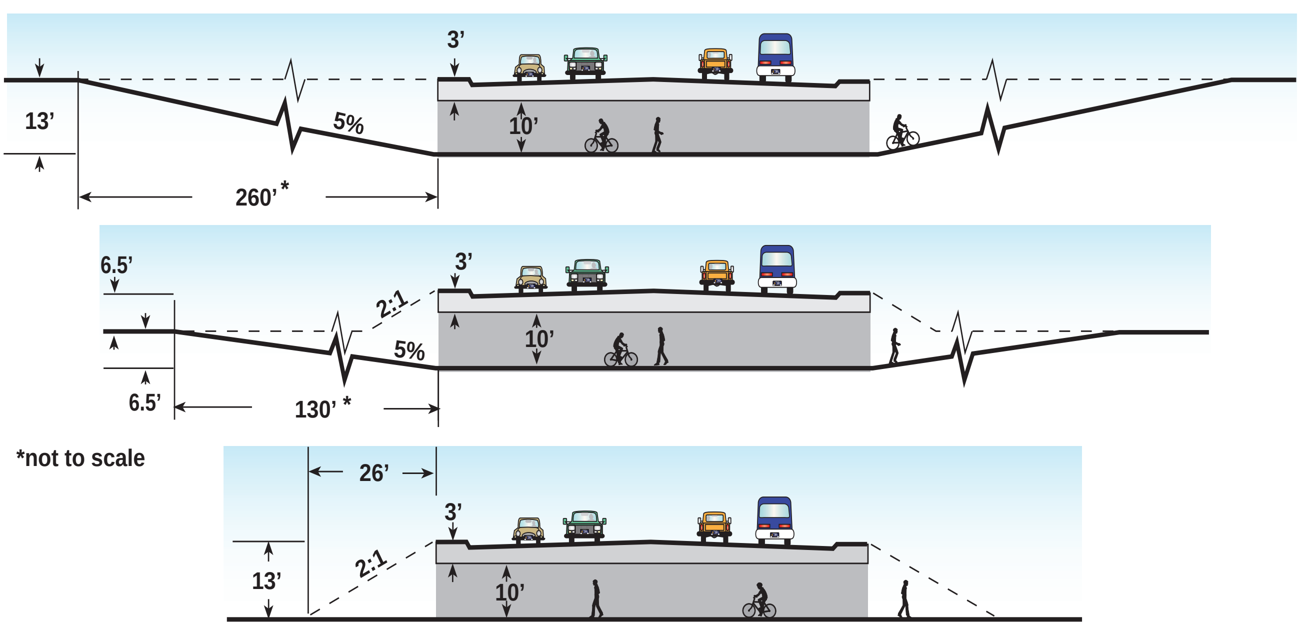



*Figure 7-18: Path undercrossings, various configurations*

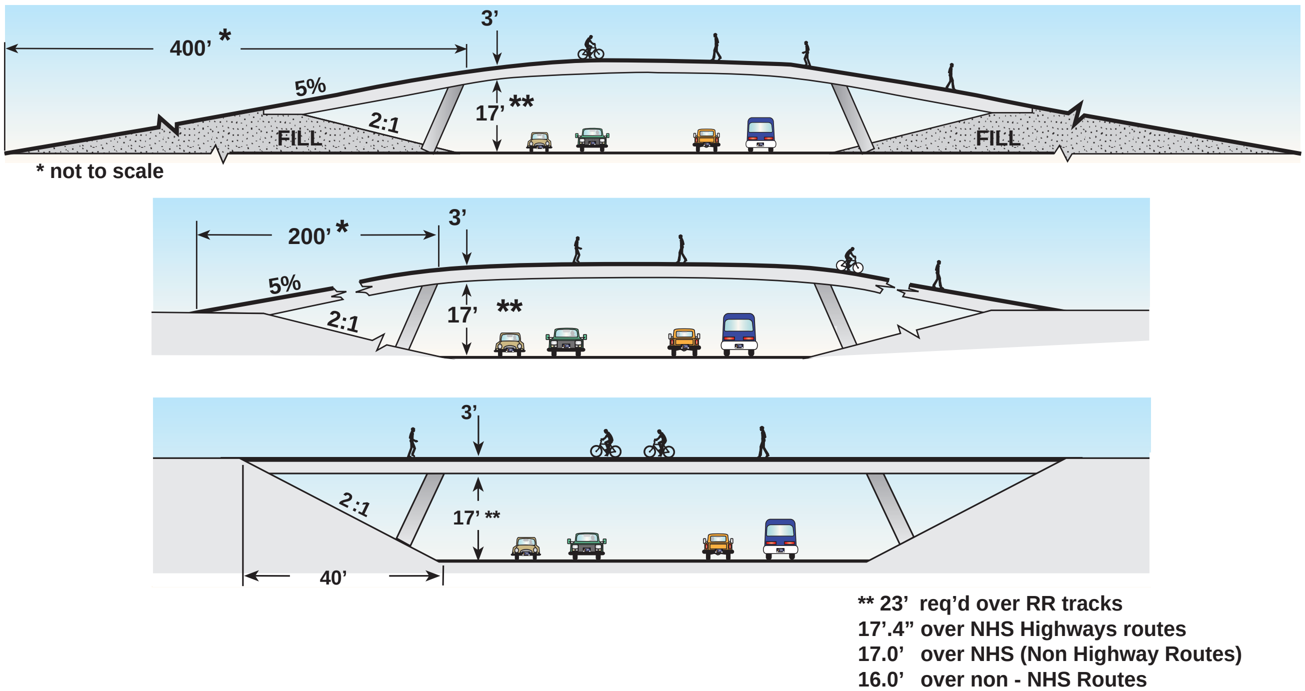



*Figure 7-19: Path overcrossings, various configurations*

## Preventing Motor-Vehicle Access

### Geometric Design

The most effective way to discourage motor vehicle access to paths is to make it physically difficult to do so. One method branches the path into two narrower one-way paths just before it reaches the roadway, making it difficult for a motor vehicle to gain access to the path.

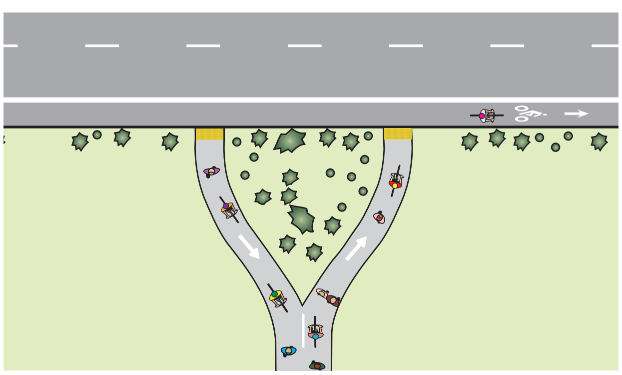


*Figure 7-20: Path splits to prevent it appearing like a driveway*

Another method is to create very tight curb returns to make it difficult for motorists to enter a path from the roadway.

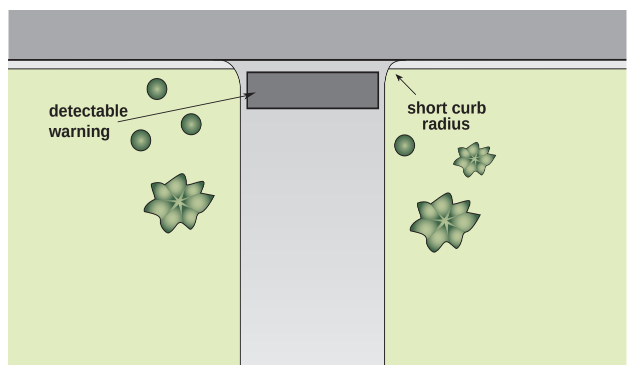



*Figure 7-21: Tight curb radii prevent motor vehicle access*

## 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, they must be spaced wide enough (min. 5 feet) 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.

*Bollards are overused and can cause injury*

*Split path entry eliminates need for bollards*

## 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 retro-reflective material and well-lit.

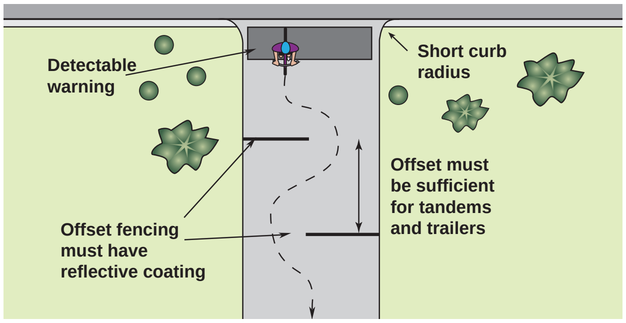


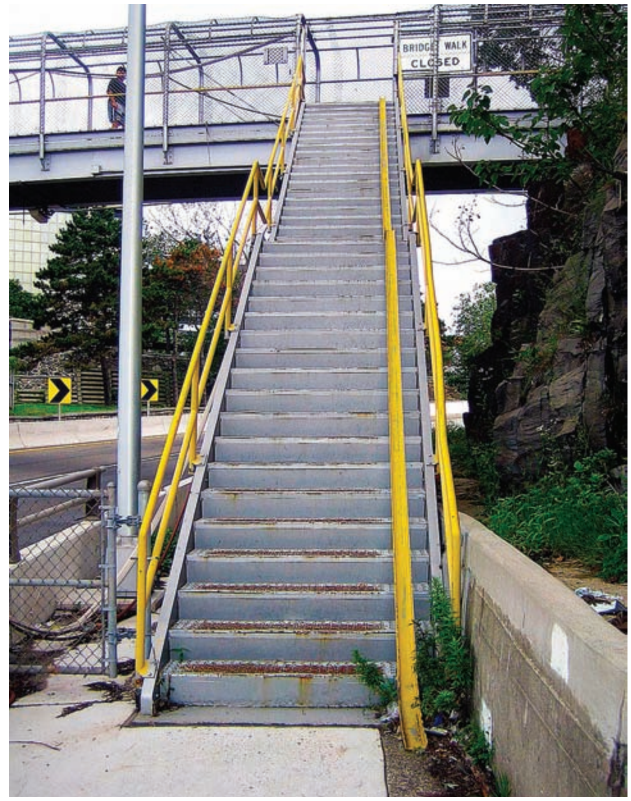

*Figure 7-22: Offset gates prevent motor vehicle access*

*Offset fencing*

## Curb Ramps

Ramps for bicycle access to shared-use paths should be built so they match the road grade without a lip. The width of the ramp is the full width of the path when the approaching path is perpendicular to the curb and a minimum of 8 feet wide when the approaching path is parallel and adjacent to the curb. Greater widths may be needed on downhill grades.

Detectable warnings are required wherever a path intersects a public street; they should not be installed at driveways, nor where an on-road bike lane merges with an off-street path.




*Metal channel (in yellow) provided for bicycle access*

## Stairways

Where a connection is needed to a destination or another path at a different elevation, a stairway can be used where the terrain is too steep for a path. A grooved trough should be provided so bicyclists can easily push their bicycles up or down.

**Note:** *Stairways are usually provided as a shortcut and do not meet all ADA requirements; destinations should also be accessible along a flatter route, even if it is longer and more circuitous. ADA should not be used as a reason to not provide stairs where beneficial and practicable.*

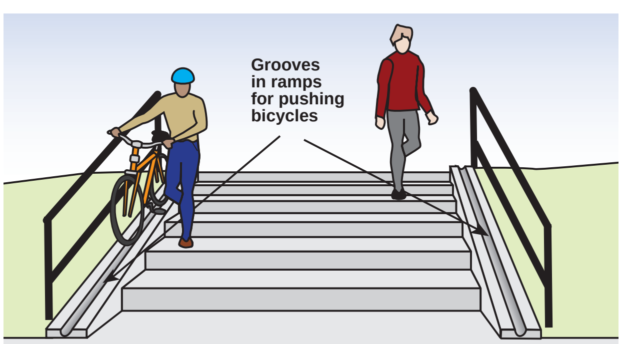



*Figure 7-23: Stairway with channel for bicycle tires*

## Signs

Paths should be signed with appropriate regulatory, warning and destination signs.

## Regulatory Signs

Regulatory signs inform users of traffic laws or regulations. They are placed at the point where the regulations apply. Common regulatory signs for bicyclists are signs R1-1 and R1-2 (Stop and Yield signs); they are reduced versions (18 inches x 18 inches) of standard motor vehicle signs, to be used where they are visible only to bicyclists (where a path crosses another path or where a path intersects a roadway at right angles).


Figure 7-24: Signs R1-1

Signs OBR1-1 and OBR1-2 should be used where the signs are visible to motor vehicle traffic (where a path is parallel and close to a roadway).

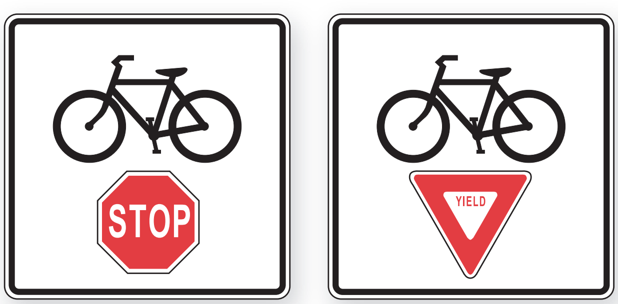



Figure 7-25: Signs OBR1-1 and OBR1-2

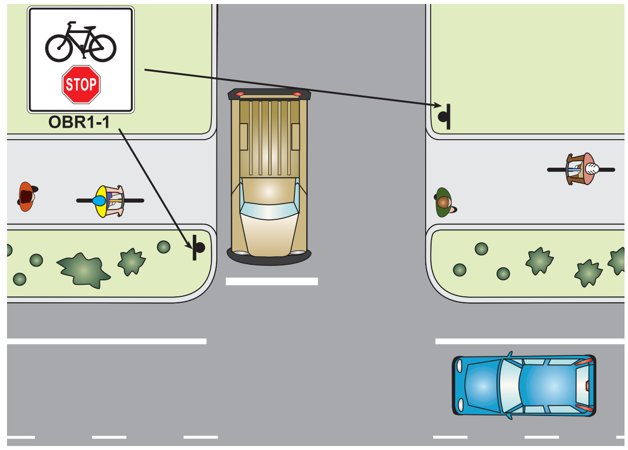



Figure 7-26: Appropriate use of sign OBR1-1 (or OBR1-2)

Sign R9-6 may be used at the beginning of shared-use paths and at important access points to warn cyclists of the presence of other users.

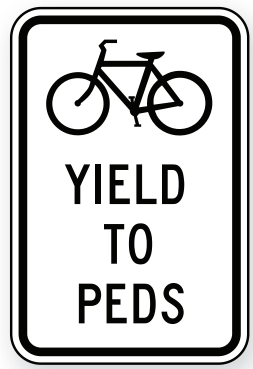



Figure 7-27: Sign R9-6

Signs R5-3 and OBR10-14 may be used at the beginning of a shared-use path if there are problems with motor vehicles using the path.


Figure 7-28: Signs R5-3 and OBR10-14

Where bicyclists using the path must cross a road at a signalized intersection (in a crosswalk) and proceed as pedestrians, sign R9-5 may be used.


*Figure 7-29: Sign R9-5*

## Warning Signs

Warning signs are used to inform path users of potentially hazardous conditions. They should be used in advance of the condition. Most are reduced versions (18 inches X 18 inches) of standard highway warning signs.

**Curves:**

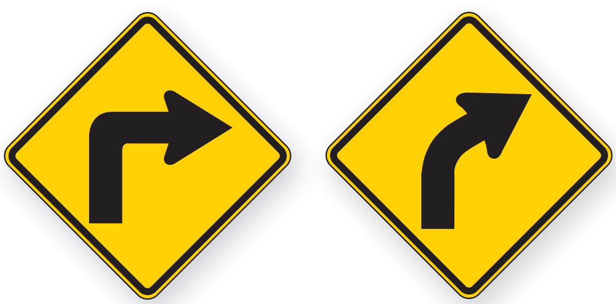


*Figure 7-30: Signs W1-1 and W1-2 (18”x18”)*

**Intersections:**

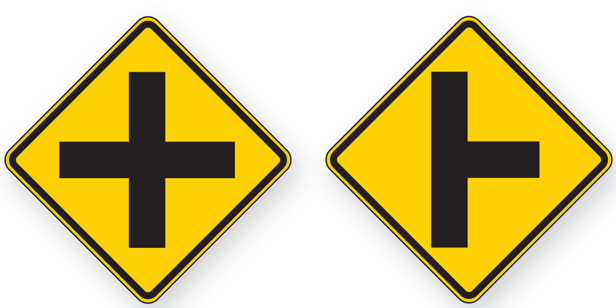


*Figure 7-31: Signs W2-1 and W2-2 (18”x18”)*

**Hill:**


*Figure 7-32: Sign W7-5*

**Height and Width Constraints:**

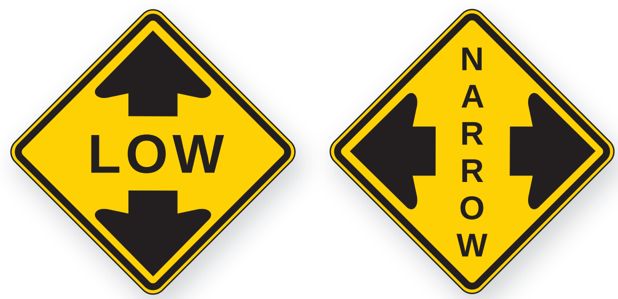



*Figure 7-33: Signs OBW12-2 and OBW12-3 (18”x18”)*

**Railroad, STOP Ahead, etc:**


*Figure 7-34: Signs W10-1 and W3-1 (18”x18”)*

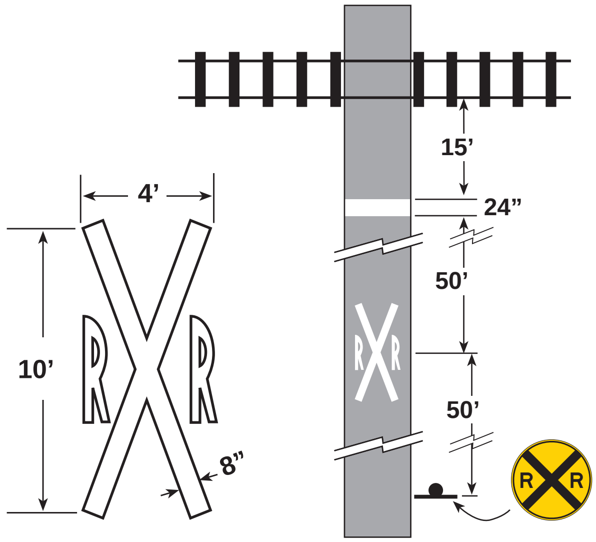



Figure 7-35: Railroad crossing ahead markings

## Path Crossing Roadway

Sign W11-15 with "XING" rider should be used only where a shared-use path crosses a roadway at an uncontrolled location. This sign is not for use where bike lanes cross streets at controlled intersections.


Figure 7-36: Sign W11-15 with rider W11-15P

## Directional, Destination & Street Signs

Where a path crosses a roadway or branches off into another path, directional and destination signs should be provided. It is also helpful to have street name signs at street crossings and access points. Signs directing users to the path are also helpful.


Figure 7-37: Directional and street signs

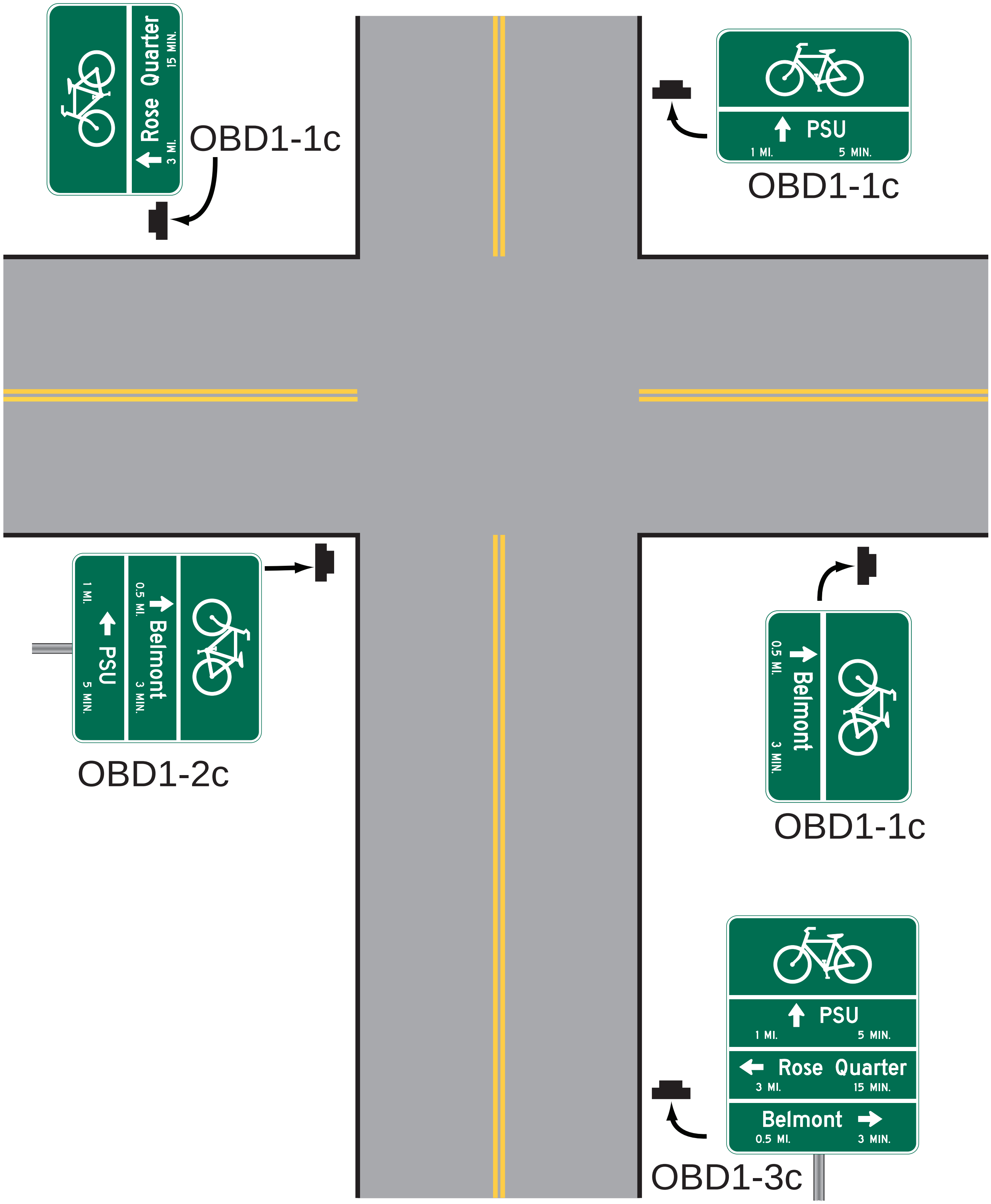



*Figure 7-38: Bicycle Route Sign Examples*

## End of Path

Where bicyclists continue riding on the roadway at the end of a path, the following sign should be used to direct cyclists to the right side of the road to minimize wrong-way riding. Guide signs should be used to direct bicyclists to their destinations.

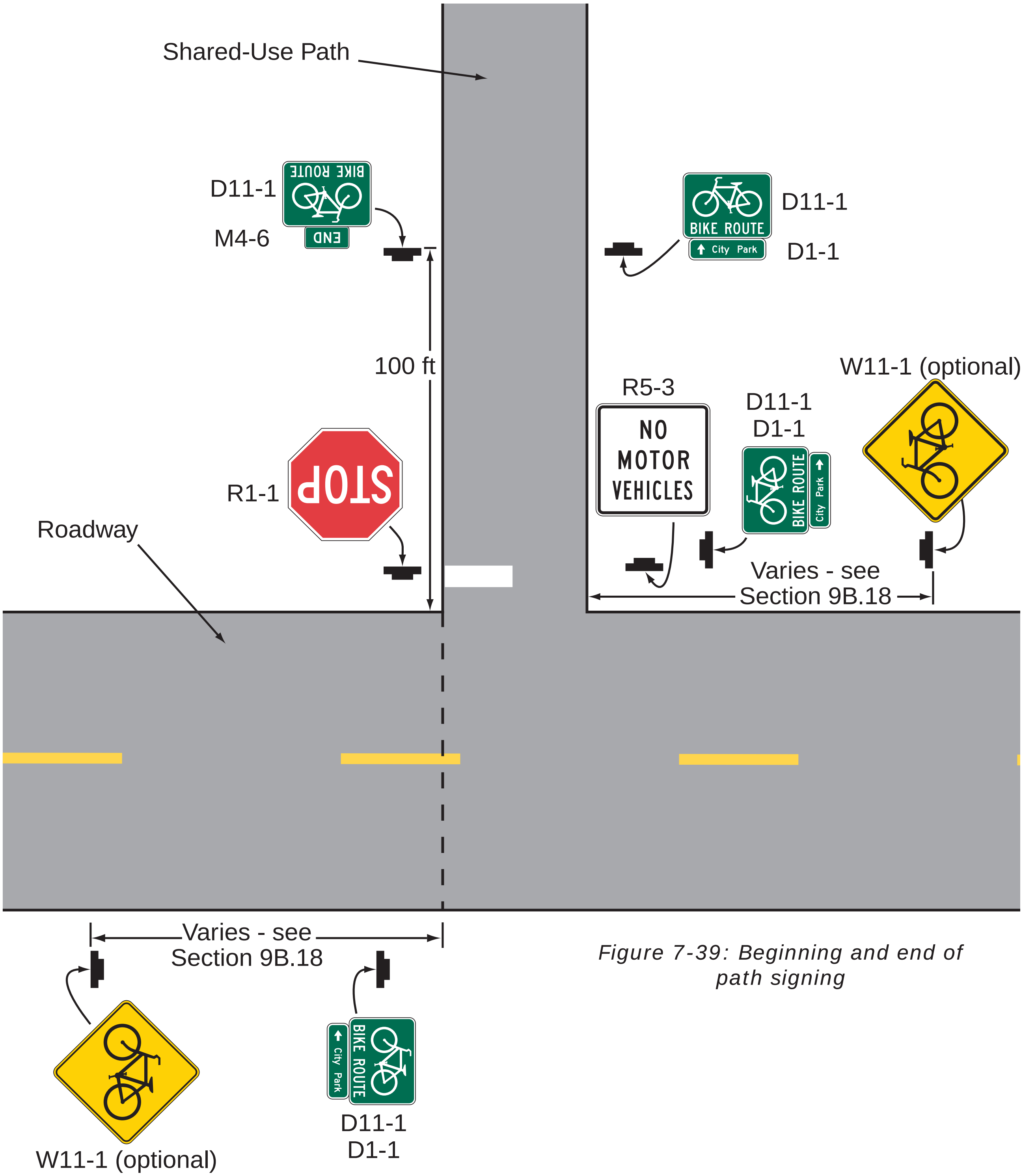



*Figure 7-39: Beginning and end of path signing*

## Placement of Signs

Signs should have 3 feet of lateral clearance from the edge of the path (min 2 feet). Because of cyclists' and pedestrians' lower line of sight, the bottom of signs should be about 5 feet above the path. If a secondary sign is mounted below another sign, it should be a minimum of 4 feet above the path. Signs placed over a path should have a minimum vertical clearance of 8 feet.

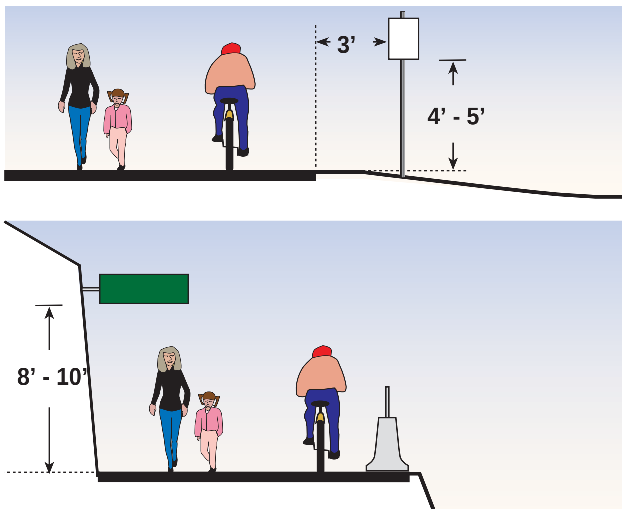



*Figure 7-40: Sign mounting clearances*

## Striping

A centerline stripe is generally not recommended for shared-use paths. Users like to walk or ride side-by-side; a centerline stripe makes them feel confined to one side only, which is rarely possible on a standard 10-foot path. A solid centerline stripe may be used through curves and areas of poor sight distance; the approach to this area may be striped with dashes.

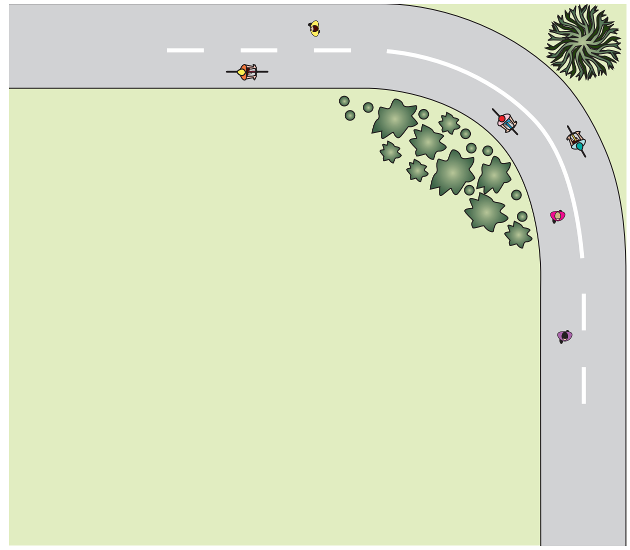


*Figure 7-41: Skip stripe followed by solid stripe in a curve*

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# 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.

Figure M-1: APPROXIMATE DURATIONS - ROADWAY DIGITAL DESIGN DELIVERY SCHEDULE (TYPICAL)

| ESTIMATED DURATION | Task |
|---|---|
| FINAL (PRE-MYLAR) PLANS DISTRIBUTION/ COMPLETION Milestone | Roadway Designer delivers Final (Pre-Mylar) plans, special provisions, and estimate for review/comment. |
| 2 Weeks | Roadway Designer prepares and submits Draft eBIDS Handoff Package* to ODOT Construction Coordinator for Review |
| 2 Weeks | Construction Coordinator Reviews Draft eBIDS Handoff package and provides comments to Roadway Designer |
| 2 Or More Months | Roadway Designer incorporates comments from Construction Coordinator into the eBIDS Handoff package |
| 1 Week | Roadway Designer provides final eBIDS Handoff package to the Project Leader no later than 1 week prior to Project Advertisement |
| PROJECT ADVERTISEMENT Milestone | Project Leader uploads eBIDS Handoff package to eBIDS |
| 6-8 Weeks | Roadway Designer coordinates with Construction Coordinator and prepares Draft Construction Survey Handoff Package*. |
| 30 days after BID OPENING Milestone | Roadway Designer delivers Draft Construction Survey Handoff Package. (30 days after Bid Opening generally coincides with Notice to Proceed) |
| 10-30 Days | Roadway Designer and Construction Coordinator work together to revise/finalize Construction Survey Handoff package to be ready for Pre-Survey Meeting. |
| PRE-SURVEY MEETING Milestone | Roadway Designer attends meeting to provide technical support to Construction Coordinator regarding the Construction Survey Handoff package. |

Minimum Duration to prepare eBIDS Handoff package starting from Final Plans Distribution Milestone to PL Delivery is 3 months

Minimum Duration to prepare Construction Survey Handoff package starting from Final Plans Distribution Milestone to Pre-Survey Meeting Milestone is 4 months

* See Highway Design Manual Appendix M for information regarding Handoff Packages

# 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:

2. 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
3. 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
4. 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.

# N1.2 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.1.3 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.1.4 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.1.4.1 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

## N.1.4.2 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

# 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 0-1. 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

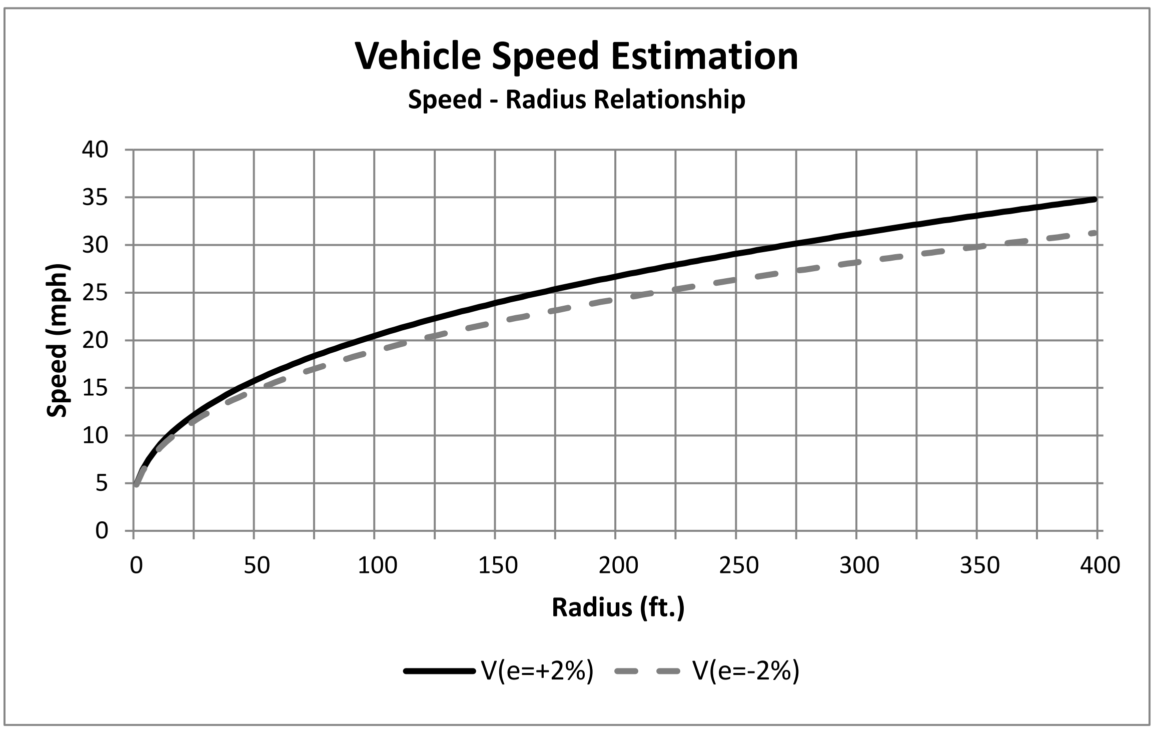



Table L–1 is a tabular form of the values in Figure 0-1 reported at 25 ft. radius intervals. In addition, NCHRP Report 672 Roundabouts: An Informational Guide, provides simplified equations to calculate speeds for given radii as well. Equation 1 is for +2% superelevation and Equation 2 is for -2% superelevation.

Table P–1: Speed, Radius Relationship

| 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:**

NCHRP Report 672

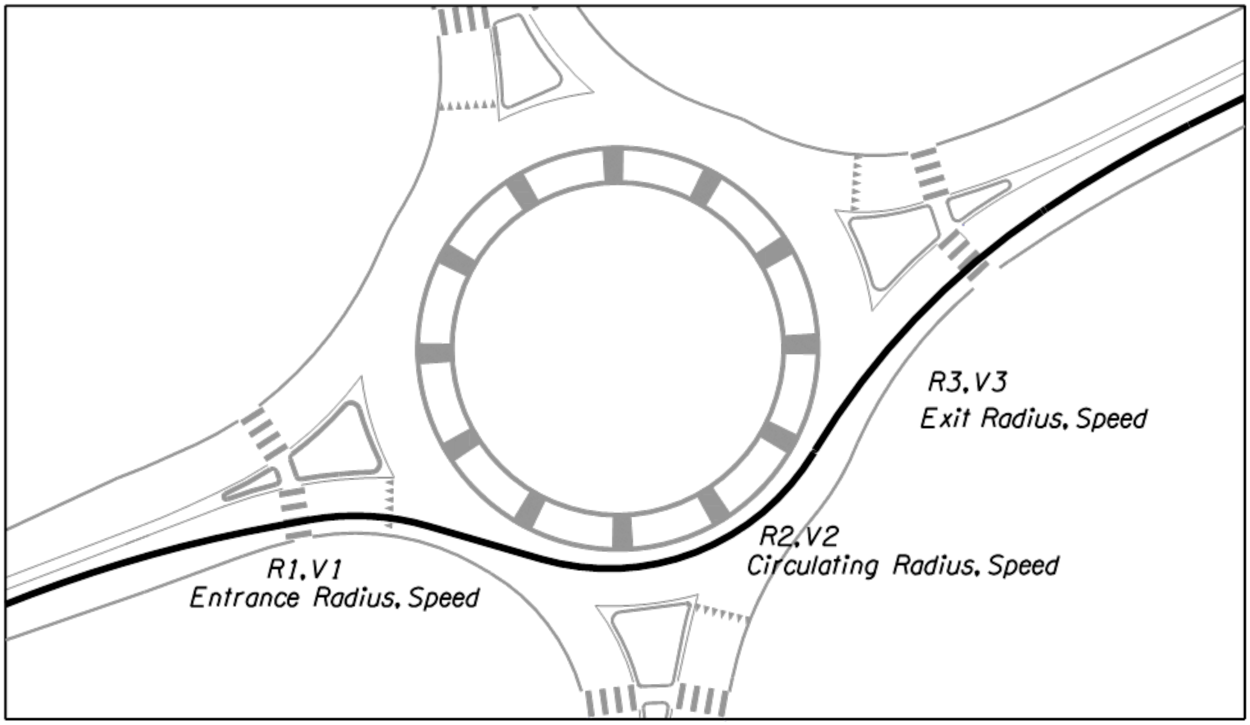
$V=3.4415R^{0.3861}$ ; e= 2%

**Equation 2:**

NCHRP Report 672

$V=3.4614R^{0.3673}$ ; e= -2%

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.

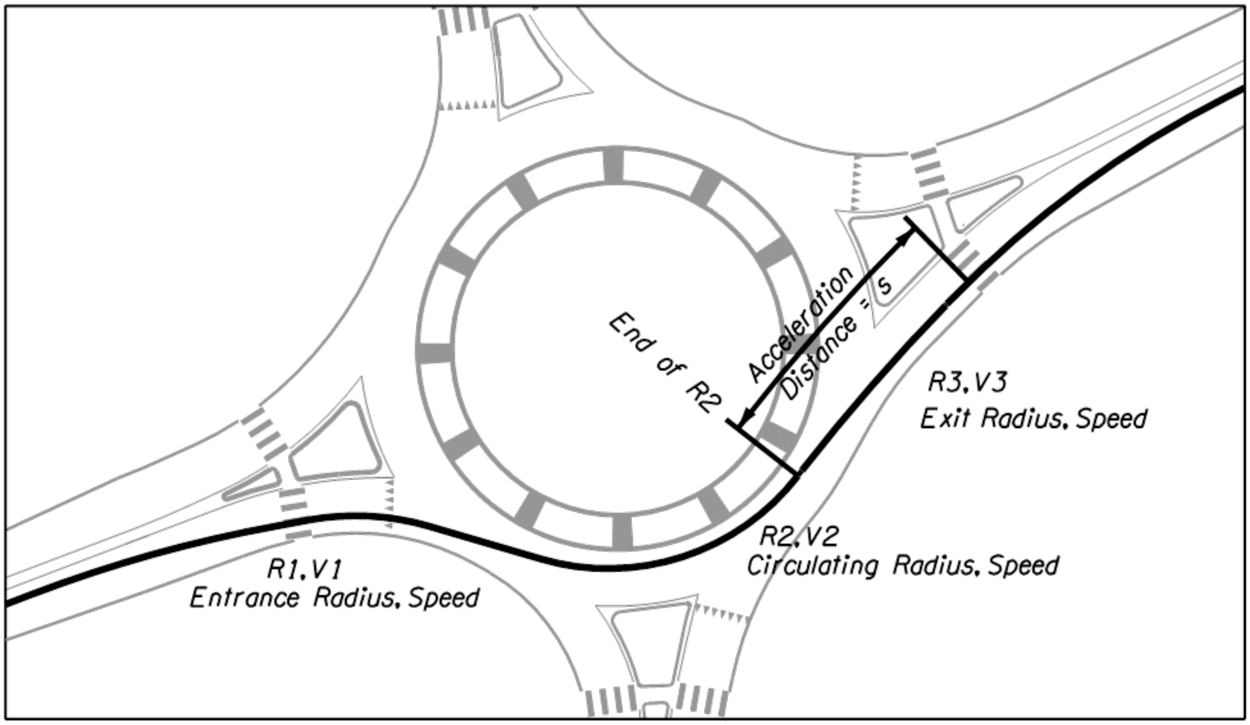
However, there is thought that exit radii designed too small to reduce predicted exit speed in an attempt to focus on pedestrian safety may unnecessarily limit overall roundabout capacity. This leads to the question, then, how to calculate appropriate exit radii to maximize capacity and still protect 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 0–2 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, $V_1$

$$\boldsymbol{V_1 = \frac{1}{1.47}\sqrt{(1.47V_2)^2 + 2a_{1,2}d_{1,2}}}$$

$V_1$ = 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/s$^2$ from observed information.

Equation 5 – Alternative Exit Speed Calculation, $V_3$

$$\boldsymbol{V_3} = \frac{\mathbf{1}}{\mathbf{1.47}}\sqrt{(\mathbf{1.47}\boldsymbol{V_2})^2 + \mathbf{2}\boldsymbol{a_{2,3}d_{2,3}}}$$

$V_3$ = 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 V3 calculation method for design as was provided for the alternate V1 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 R2,V2 and R4,V4 predicted and observed values. There may be other driver behavior factors that also affect observed R1,V1 and R3,V3 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/s2 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/s2 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 V1 values.

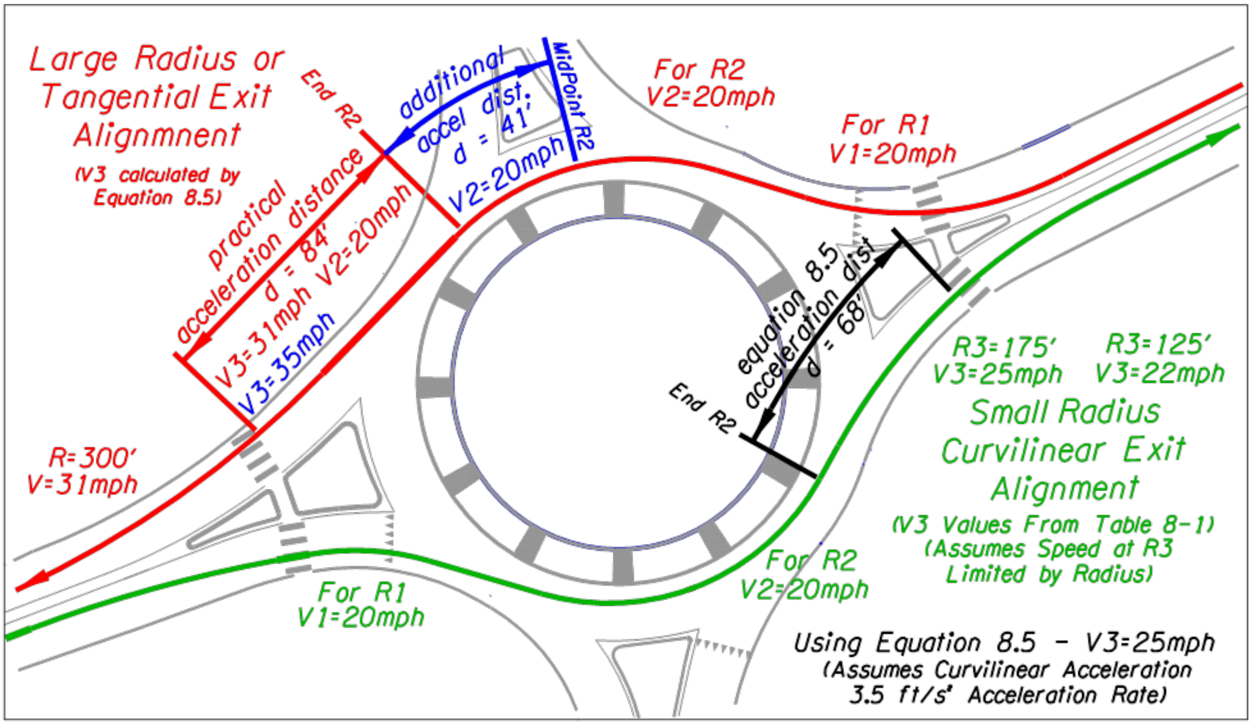
In addition to determining an acceptable acceleration rate, the other two critical variables in these equations are the V2 speed and the distance, d, over which the deceleration or acceleration can take place. Therefore, if a large radius or tangential exit is designed for a roundabout, the R2 value must provide the appropriate design V2 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 R1 and R2 that provide a 20 mph V1 and V2. The curvilinear R3 exit radius is shown as both 175 ft. and 125 ft. for illustrative purposes and correlates to a V3 speed of 25 mph and 22 mph respectively. These V3 values are based on the speed, radius equations discussed previously in this report and is shown in

Table 0–1, Figure 0-1. For comparison, the speed, acceleration equation was used to calculate a predicted V3 exit speed along the radial R3 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 V3 of 25 mph was determined. This is equal to the value predicted for V3 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 R1 and R2 that provide a 20 mph V1 and V2. However, the V3 value of 31 mph is based on the potential for vehicle acceleration from the end of R2 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 R2. 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 V2 path and a point of interest along the V3 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 R2 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 V3 speed to 35 mph. These calculated speeds are 6 mph and 10 mph faster than the predicted V3 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 0–2 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) | | | 60 mph dist (ft) | 60 mph acel (ft/sec$^2$) |
| Vehicle Data | 0-60 (sec) | 1/4 mile (sec) | | |
| 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$^2$

# Appendix Q

# MAP 21 - NHS Standards

## Roles and Responsibilities Lane Width / Truck Volume Guidance

# MAP 21 - NHS STANDARDS NHS EXPANSION WORKING GROUP

## A..2 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 | Local |
| TYPES of PROJECTS | New Construction/Reconstruction (4R), Reconstruction, Resurfacing, Restoration, Rehabilitation (3R), Development | | | |
| DESIGN EXCEPTIONS | **Approved by CA**<br>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**<br>No change from current process used by Local Agency and ODOT Region | **Approved by ODOT**<br>No change from current process used by Local Agency and ODOT Region | **Approved by Local Agency**<br>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**<br>Audit process as identified by Local Program agreements. No change in process for CA's | **Reviewed by ODOT**<br>No change from current process used by Local Agency and ODOT Region | **Reviewed by ODOT**<br>No change from current process used by Local Agency and ODOT Region | **Reviewed by Local Agency**<br>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..3 Local Agencies

## A..3.1 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..3.2 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..4 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 Engineering and Technical Services Branch 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..5 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..6 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..6.1 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..6.2 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..6.3 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?

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### W

ODOT provides a safe and reliable multimodal transportation system that connects people and helps Oregon's communities and economy thrive.

www.oregon.gov/ODOT