Designing **Livable Streets and Trails** Guide

Metro

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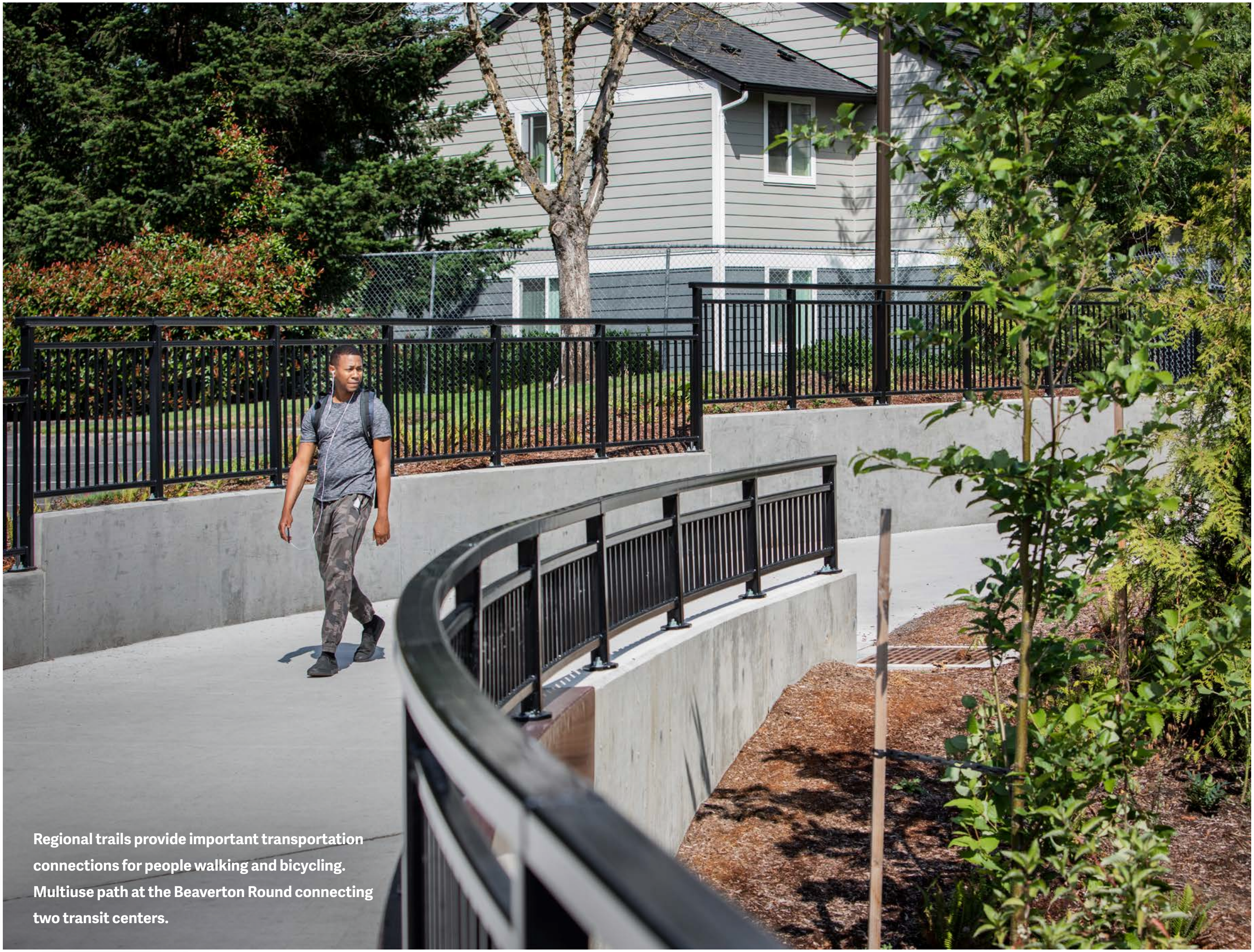

Regional trails provide important transportation connections for people walking and bicycling. Multiuse path at the Beaverton Round connecting two transit centers.

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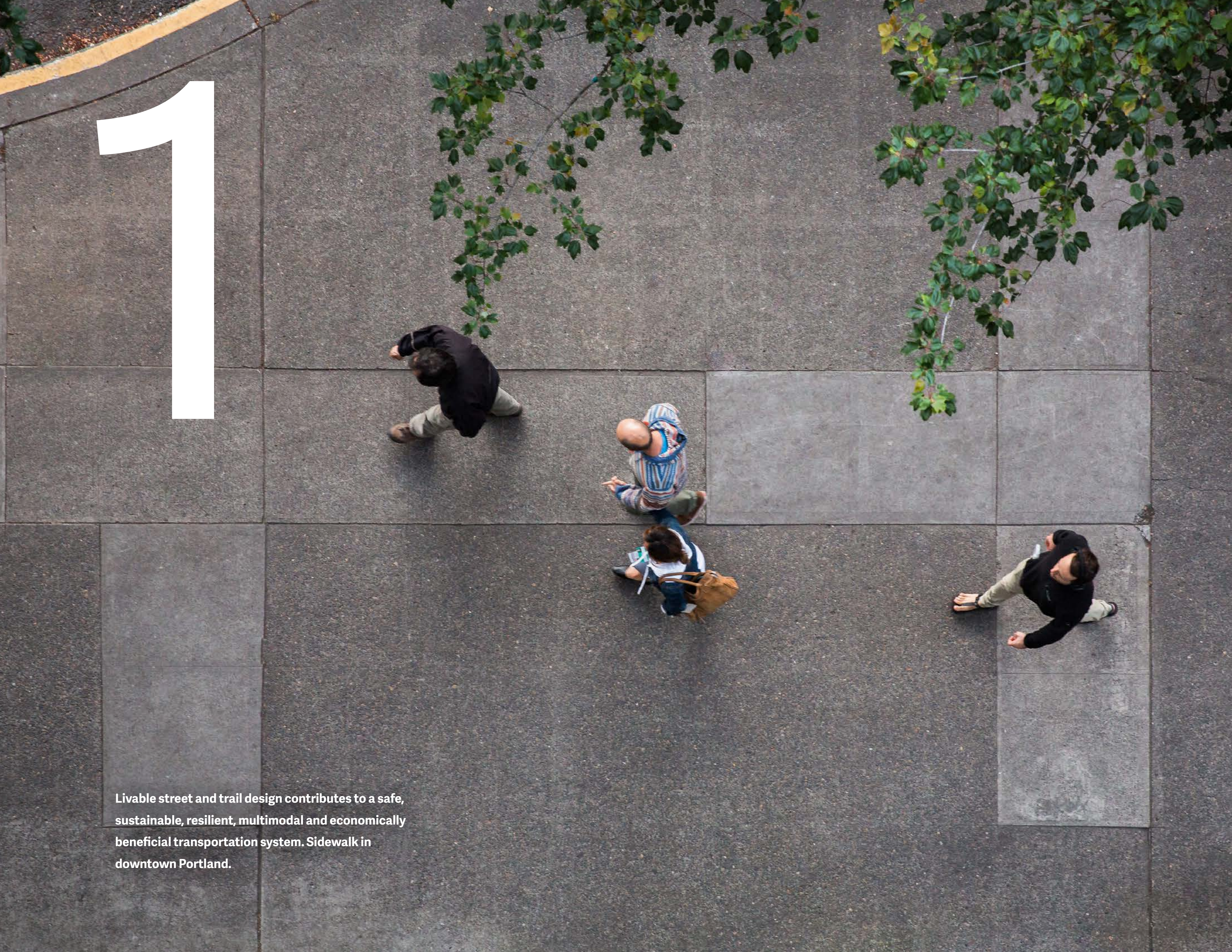

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Livable street and trail design contributes to a safe, sustainable, resilient, multimodal and economically beneficial transportation system. Sidewalk in downtown Portland.

Chapter 1

Introduction

Livable streets and trails include design elements that support safe and reliable travel while contributing to systemwide outcomes such as reduced greenhouse gas emissions and vibrant communities. SE 17th Avenue multiuse path connecting the Springwater Corridor in Portland to the Trolley Trail in Milwaukie.

Over the next several decades, the challenges faced by communities in greater Portland and the burdens placed upon the transportation network will multiply in number and complexity.

Greenhouse gas emissions from motor vehicles and serious traffic crashes are two of the most pressing transportation issues; addressing them will require a transportation system designed to serve multiple travel modes, especially walking, bicycling and public transit. Additionally, streets and trails must function not only as corridors for moving people, goods and services, but also as stormwater management facilities, community gathering spots and public spaces to enhance community livability.

1.1 Purpose of the guide

The purpose of this guide is to support implementation of the 2040 Growth Concept, which is the region's land use vision, and the *Regional Transportation Plan* (see **Chapter 2**). Along with these and other local and regional plans and policies, this guide is a resource for the agencies responsible for designing, constructing and maintaining the region's transportation system. The design guidance is intended to assist in designing new and reconstructed streets and trails, but may also be applied to maintenance projects that preserve and extend the service life of existing streets and structures when minor retrofits are needed. The guide will also be of interest to members of the public, elected officials, private developers, architects, landscape architects, planners and engineers.

This guide replaces and updates Metro's *Creating Livable Streets* and *Green Streets for Stormwater Management* guidebooks.

While the design approach included in this guide will interest communities across the country, they were identified specifically to support developing regional streets and trails consistent with the regional street design classifications adopted in the *Regional Transportation Plan* (see **Chapter 2**). Metro's other design guidebooks, *Trees for Green Streets*, *Wildlife Crossings* and *Green Trails*, provide additional resources.

Livable streets and trails...

- include safe places to travel for people of all ages and abilities
- provide orientation, safety and comfort
- encourage slower travel speeds
- are welcoming, safe spaces for people of all backgrounds and walks of life
- provide places to interact and linger
- foster a sense of community, ownership and responsibility
- protect the environment, avoiding sensitive habitat, protecting fish and wildlife, and minimizing light, noise, water and air pollution
- adapt to new mobility technologies to prioritize safety and access for everyone
- are resilient in the face of a changing climate, natural disasters and extreme weather events

What are regional streets and trails?

Streets and trails identified as "regional" in Metro's *Regional Transportation Plan* typically carry the most trips and connect to regional destinations. They are identified on regional network policy maps. Along with rail and streetcar lines, regional streets and trails serve as the backbone of greater Portland's transportation system.

Regional streets accommodate regional through trips as well as local trips. Regional streets connect centers and extend to places outside of the region. Under the traditional street functional classification system, regional streets are arterials and throughways. Serving both regional through trips and local trips distinguishes regional streets from collectors and local streets, which serve only local access trips. Regional streets are assigned a regional design classification in the *Regional Transportation Plan*. Refer to **Chapter 2** for a description of regional street design classifications.

Regional trails connect multiple destinations such as centers, parks and natural areas, transit and other regional trails. They serve as important transportation connections for people walking and bicycling, and support longer bicycle trips, often traversing more than one jurisdiction. Regional trails must be at least 75 percent off street and meet several criteria to be identified as regional.

What about emerging technologies?

Over the span of human civilization, streets have served a variety of functions. Principal among these are **mobility**, the ability to move across the land, and **access**, the ability to reach destinations. How these functions have been served has varied greatly over time. Over a century ago, walking, horseback riding, horse-drawn carriages and streetcars served most mobility needs. Hitching posts were a key element of street design and dealing with horse manure was one of the challenges. Since then, human innovation has produced bicycles, trains and automobiles, transforming street design. In the first half of the 20th century, as automobiles became a mainstay for most American households, streets were designed primarily to serve people using motor vehicles. In the past several decades, street designs have evolved to reflect the needs of people walking and bicycling as well as those traveling in motor vehicles.

This is an era of rapid innovation, evolving technologies and changing demands on the public right-of-way. Planning and design of streets and trails must encompass new mobility technologies with a people-focused approach.

For the purpose of this guide and the sake of brevity, the terms pedestrian, bicycle, transit, freight and motor vehicle encompass emerging mobility technologies for those modes.

Pedestrians refers to people walking and using wheelchairs, mobility devices or other new personal mobility technologies.
Bicycles represents bicycles, skateboards and other new micromobility technologies, like e-bicycles and e-scooters.

Transit refers to a buses or trains for mass transport, and includes all types of motive power, including internal combustion, electric and hydrogen fuel cell, and vehicle operators, including individual and computer (autonomous).
Freight refers to freight vehicles that use streets, and includes all types of motive power and vehicle operators, individual or computer (autonomous).
Motor vehicle refers to automobiles and includes all types of motive power (e.g., internal combustion, electric, hydrogen fuel cell) and vehicle operators, individual or computer (autonomous).

This guide complements existing national, state and local requirements and guidelines, and its recommendations are allowable under national guidance, including guidelines developed by the American Association of State Highway and Transportation Officials, the Federal Highway Administration and the National Association of City Transportation Officials. The *Designing Livable Streets and Trails Guide* has been developed on the basis of current design guidance, case studies, best practices for urban environments, research and evaluation of existing designs, and professional review and input. It integrates design guidance for regional streets, regional trails, stormwater management and green street treatments into one guide to encourage a holistic and comprehensive approach to designing a complete transportation system.

Metro will update this guide as needed to reflect changes in regional polices or design practices. Metro encourages users of the guide to suggest needed improvements.

Under regional policy, the design guidance and performance-based planning and design approach in this guide must be applied when transportation projects are planned, designed and/or constructed with funding allocated by the Metro Council. Some agencies may have adopted design guidelines that differ from Metro's. These agencies may require a design variance to be consistent with Metro's guidelines. Cities and counties must also allow implementation of the design guidelines, as per Section 3.08.110 of the *Regional Transportation Functional Plan*. This means that a city or county cannot prohibit any of the elements or processes included in the guide.

1.2 Structure of the guide

This guide is organized so each chapter's themes build on material introduced in previous chapters. **Design elements**, found in **Chapter 4**, are combined to support the various **functions** of streets and trails identified in **Chapter 3**. Different functions are prioritized depending on the planned land use context and other policies to achieve desired **outcomes** identified in **Chapter 2**. Renderings and cross-sections in **Chapter 5** provide examples of how design elements are applied in different contexts to support the various functions of streets and trails. Each chapter includes information that may be referenced in the step-by-step performance-based planning and design decision-making approach outlined in **Chapter 6**. Cross-references and links to relevant chapters and sections are provided throughout, allowing the reader to access the material in a non-linear fashion.

Design elements support functions to achieve outcomes.

Pedestrian realm
- Sidewalks
- Street corners

Travelway realm
- Flex zone
- Motor vehicle travel lanes
- Access management
- Medians
- Speed management treatments

Green streets and stormwater management

Bikeway design

Transit design
- Transit stops and stations
- Transit priority treatments

Intersections and crossings
- Signalized intersections
- Roundabouts and mini-roundabouts
- Unsignalized intersections
- Enhanced and midblock crossings

Regional trails
- Regional trail design principles
- Multiuse paths
- On-street trail connections

Street and trail lighting

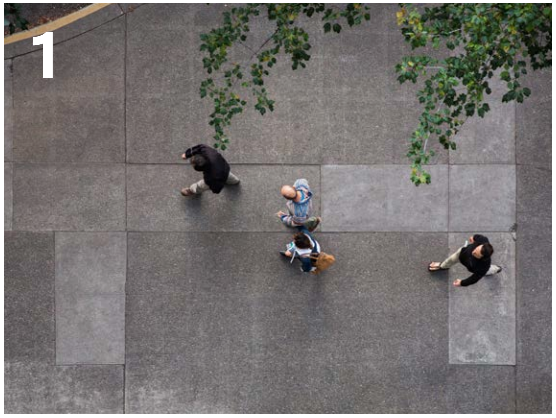
Wayfinding

Placemaking elements

Pedestrian access and mobility
Bicycle access and mobility
Transit access and mobility
Freight access and mobility
Motor vehicle access and mobility
Placemaking and public space
Green streets and stormwater management
Utility corridors
Physical activity
Emergency response

Safety
Security
Transportation choices
Efficient and reliable travel
Healthy people
Healthy environment
Reduce greenhouse gas emissions
Sustainable economic prosperity
Racial and social equity
Vibrant communities
Resiliency
Fiscal stewardship

Chapters



Chapter 1

- provides an **introduction** to the guide
- describes the **purpose** and **structure** of the guide

Chapter 2

- provides a brief history and description of the **2040 Growth Concept**, linking land use and transportation planning and design
- introduces **performance-based planning and design** for achieving desired outcomes
- describes **desired outcomes** that street and trail design should support
- outlines the key attributes of **regional street design classifications**, **regional trails** and the **parkway design overlay**
- outlines federal, state and regional **policies and requirements** that impact street and trail design

Chapter 3

- describes the various **functions** that streets and trails serve, starting with access and mobility for all travel modes
- introduces the concept of **prioritizing functions** to achieve desired outcomes

Chapter 4

- identifies **design principles** to guide decision-making throughout planning and design of streets and trails
- describes the different **realms of the street**
- describes **design elements** that serve different functions and the recommended design approach for each design element
- includes a list of **design resources** that provide additional detail

Chapter 5

- provides a series of **renderings and cross-sections** to illustrate how design elements can be combined to serve the various functions of streets and trails

Chapter 6

- outlines a series of steps in the **performance-based planning and design decision-making approach** to support development of projects that are outcome-driven
- identifies when **engaging stakeholders** and **documenting design decisions** should be considered throughout a project's lifecycle

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Many national, state, regional and local polices and requirements impact how streets and trails in greater Portland are planned, designed and constructed. Many policies support the region's land use vision and desired community and regional outcomes.

Chapter 2

Policy framework

Creating livable street and trails is critical to achieving community and regional goals and outcomes, including the 2040 Growth Concept.

This chapter describes the role of transportation design in implementing the region's land use vision. A brief description to the 2040 Growth Concept and land use design types introduces the concept of transportation design responding to land use. Regional street design classifications are defined and linked to the regional land use types. Next, performance-based planning and design are defined and describes desired outcomes identified in local and regional plans. Supporting these systemwide outcomes is at the heart of performance-based planning and design. The chapter concludes with a list of key policies and requirements that impact how streets and trails in the region are designed and should function.

The 2040 Growth Concept focuses growth in centers and along corridors. Streets and trails are designed to support the region's land use vision by supporting a variety of travel options. Gresham regional center.

2.1 The 2040 Growth Concept and transportation design

Policies supporting livable street design have been part of greater Portland's transportation and land use planning for more than 20 years. Regional street design classifications were first developed and adopted in the 1996 *Regional Transportation Plan* and Title 6 of the Urban Growth Management Functional Plan (now Title 1 of the Regional Transportation Functional Plan). These classifications were developed specifically to implement the transportation elements of the ***2040 Growth Concept***, which was adopted in 1994. At the time, the Metro Policy Advisory Committee determined that regional transportation design guidelines were needed to help achieve the 2040 Growth Concept, recognizing that a one-size-fits-all approach to designing streets would not fully support the region's land use vision.

In 1997, the *Creating Livable Streets* guidebook was published, presenting what was then a radical new approach to transportation design that crossed traditional boundaries between land use and transportation planning and linked street design to community livability. The guide was updated in 2002 and several supplemental guidebooks were also developed: *Green Streets, Trees for Green Streets, Wildlife Crossings* and *Green Trails*.

The *Designing Livable Streets and Trails Guide* carries forward the ethic of the street design guidance developed in the 1990s while updating and introducing new design elements and topics based on new policies and evolving best practices, including designs for regional trails.

The 2040 Growth Concept established a broad regional vision to guide all future comprehensive planning at the local and regional levels, including the ***Regional Transportation Plan***, the region's long-range blueprint for transportation system development. *The 2040 Growth Concept* directs most new development to mixed-use centers, corridors and main streets. Concentrating new jobs, housing and services in centers and corridors provides many benefits and has important design implications for greater Portland's transportation system. The concept relies on a balanced transportation system that adequately serves planned uses and walking, bicycling, driving, transit and freight movement.


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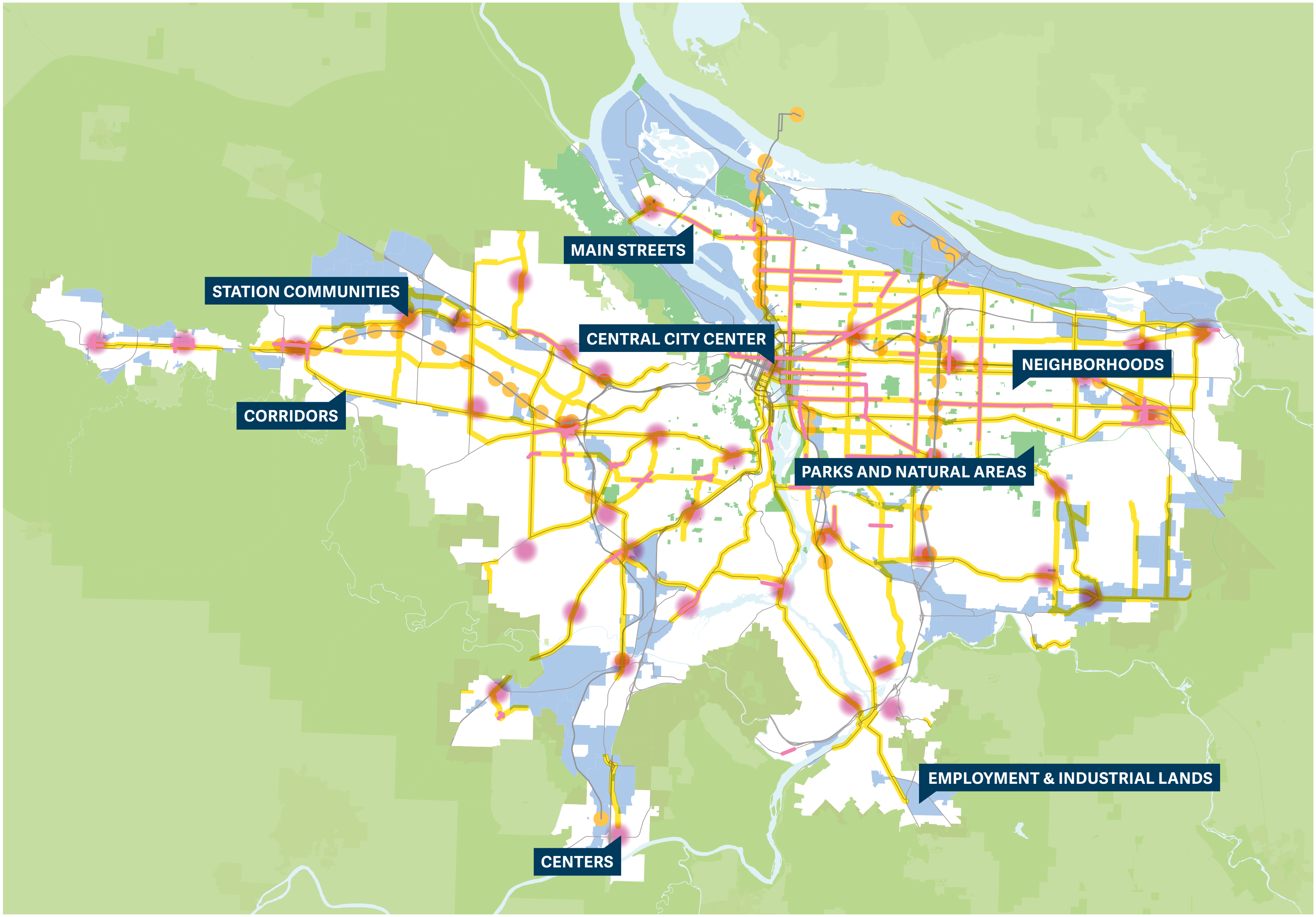


The **2040 Growth Concept** is based on a series of land use components, called 2040 land use design types, that are the building blocks for managing growth. The land use design types are identified as centers, station communities, corridors, main streets, neighborhoods, employment and industrial lands, and parks and natural areas. Regional street design classifications correspond to the different land use design types and help implement the 2040 Growth Concept.

Centers include the central city, regional centers and town centers. Centers are planned as the densest areas in greater Portland, are well served by transit and are highly accessible for people walking and bicycling. Freight truck access to centers supports businesses and residents. Centers provide housing, employment, businesses and services.

The **central city** is the hub of business and cultural activities in the region. It has the most intensive form of development for both employment and housing, with high-rise buildings common.

Regional centers provide destination retail and compact employment and housing development between two and six or more stories high. Beaverton regional center.

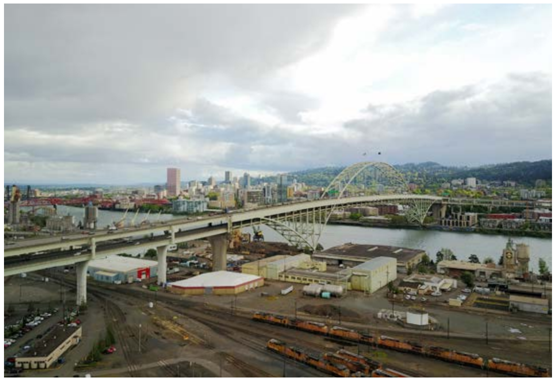
Town centers have two- to five-story (or more) mixed-use buildings containing professional services and commercial retail outlets that complement housing. Milwaukie town center.

Station communities are areas around light rail or high-capacity transit stations outside of centers. They have significant employment-related development and numerous housing types. Bicycle and vehicle parking at the stations support trips by transit into denser areas of the region. Community boundaries typically extend a few blocks around the transit station. As well as being extremely well served by transit, station communities are walkable and bikeable. Orenco Station in Hillsboro.

Corridors are multimodal streets with frequent transit service that link centers. The land use design type typically extends a block or two beyond the multimodal street. Corridors are often also regional freight routes. One- to three-story (or more) buildings line corridors, containing commercial retail, small-scale employment, or housing. NE Cornell Road in Hillsboro.

Main streets are similar to town centers in terms of land uses, but the land use design type only extends a block or two beyond the street. Main streets have neighborhood-scale commercial retail and housing in one- to three-story (or more) buildings. Main streets are multimodal and have good transit service. Main Street in downtown Tigard.

Neighborhoods comprise most of the land area of greater Portland, along with most of the streets. Neighborhoods provide single- and multi-family residences incorporating a mix of housing types including single-family dwellings, duplexes and accessory dwelling units. Neighborhoods may also have businesses and services along corridors and main streets running through the neighborhood. Newer neighborhoods are typically more compact, while some older neighborhoods have larger lots and fewer street connections. Providing paths for pedestrian and bicycle connectivity in older neighborhoods is essential. Southeast Portland neighborhood.



Employment and industrial lands offer a mix of large-scale industrial and employment uses that include office parks, manufacturing, distribution centers, marine and airport facilities and railroad switching yards. Freight access to these areas is essential, as is job access via transit. Pedestrian and bicycle travel should be well separated from heavy freight movements. Swan Island industrial area.

Image: Mike Houck

Parks and natural areas include both developed parks and undeveloped places such as natural areas, open spaces, scenic areas, rivers and streams, wetlands and floodplains. Transportation routes in these areas are designed to protect and enhance natural features. Tualatin River National Wildlife Refuge.

Mixed-use development provides housing and services in a compact, walkable area in the Hillsboro regional center.

2.2 Regional street design classifications

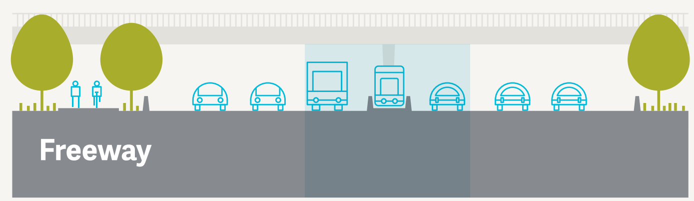
This section describes the purpose, function and land use relationships for the regional street design classifications. Metro developed regional street design classifications to support the range of transportation needs of the different land use design types in the 2040 Growth Concept. These were adopted into the *Regional Transportation Plan* in 1996 to help implement regional land use and transportation goals. The Regional Design Classifications map in the *Regional Transportation Plan* applies the classifications to the arterial and throughway network.

In addition to design classifications, the *Regional Transportation Plan* includes functional classifications for the different modal networks: pedestrian, bicycle, transit, freight and motor vehicle. All these modal networks are assigned primarily to the same regional street network, which is made up of major and minor arterials and throughways. The transit and bicycle networks include some local and collector streets, and the pedestrian and bicycle networks also include regional trails. The modal functional classifications provide policies for street design and function to serve the different modes of travel.

Regional street design classifications are based on the land use design types and informed by the modal network classifications. Regional design and functional classifications apply to local transportation system plans throughout greater Portland. Cities or counties typically adopt the classifications into their plans or provide a cross-reference if they use different terms for the classifications. Regional street design classifications are assigned to all throughways and major and minor arterials in the regional transportation system. While the design classifications only apply to arterials and throughways, this guide's design guidance can be applied to any street or trail.

Freeways and highways

Freeways and highways connect major activity centers, including the central city, regional centers, industrial and employment areas, and intermodal facilities such as the Port of Portland. Freeways and highways provide intercity, interregional and interstate connections. This design classification prioritizes long-distance and higher speed freight, motor vehicle and transit mobility. Freeways are grade separated; highways have a mix of grade-separated and at-grade intersections. Freeways and highways cross all types of land uses, and buildings are typically not oriented to these facilities.



RIGHT-OF-WAY
110'+

RIGHT-OF-WAY
100'-135'

= *Based on available width*

Regional and community boulevards

Regional and community boulevards serve the multimodal travel needs of the region's most intensely developed and developing activity centers, including the central city, regional centers, station communities, town centers and some main streets. Adjacent land uses and buildings should orient directly to the boulevard with ground-floor commercial activity, contributing to a pedestrian- and bicycle-friendly environment. Buildings typically have designs, such as a storefront or arcade, which provide transition space from the street and support pedestrian access. Boulevards are designed to prioritize pedestrian, bicycle and transit travel.

RIGHT-OF-WAY
90'-120'

RIGHT-OF-WAY
60'-80'

RIGHT-OF-WAY
70'-100'

= *Based on available width*

Regional and community streets

Regional and community streets balance the multimodal travel and access needs of corridors, neighborhoods and some main streets, along with employment and industrial areas. Regional and community streets can be located within residential neighborhoods as well as more densely developed corridors and employment centers. Development can be set back from the street. Regional and community streets can also serve as main streets with buildings oriented toward them at major intersections and transit stops.

RIGHT-OF-WAY
60'-100'

RIGHT-OF-WAY
60'-80'

RIGHT-OF-WAY
80'-120'

= *Based on available width*

Industrial streets

Industrial streets serve intermodal facilities and lower-density industrial and employment areas where buildings are seldom oriented to the street. Street designs emphasize freight mobility and access while serving multimodal travel, including transit access. Separated facilities for people walking and bicycling provide safety for all users.

RIGHT-OF-WAY
60'-90'

= *Based on available width*

Typical design components of regional street design classifications

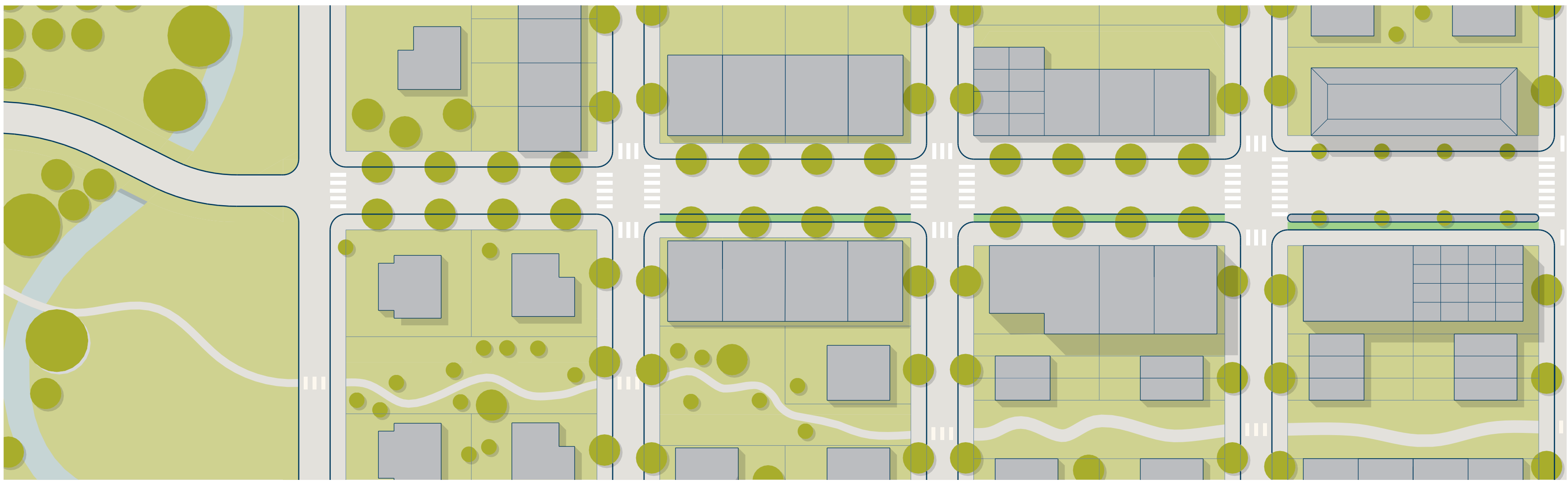
This table summarizes the general design components for each of the street design classifications. **Chapter 4** provides design guidance for the various design elements for the regional street design classifications and regional trails.

2040 Land Use Design Type	Design Classification	Street Connections	Prioritized Travel Modes	Motor vehicle Functional Classification	Target and Design Speed
Any	Freeways	Limited Grade-separated	Motor vehicle, freight, transit	Throughway	45 to 60 mph
Any	Highways	Limited Some grade-separated, signalized	Motor vehicle, freight, transit	Throughway	35 to 50 mph
Centers, station communities and some main streets	Regional and community boulevards	Many; access management emphasized	Pedestrian, transit, bicycle; access for all modes	Major arterial (regional boulevard) Minor arterial (community boulevard)	20 to 25 mph
Corridors, neighborhoods, some main streets and employment and industrial areas	Regional and community streets	Some to many; access management as possible	Balanced and modal network priorities	Major arterial (regional street) minor arterial (community street)	20 to 30 mph
Employment and industrial areas	Industrial streets	Some; access management emphasized	Freight, motor vehicle, transit	Major or minor arterial	20 to 40 mph

Number of Lanes	Medians and Turn Lanes	Flex Zone Uses	Pedestrian Design	Bikeway Design	Transit Design	Freight Design	Green Streets/ Stormwater Management
Up to six with auxiliary lanes in some places	Center barrier, no turn lanes	Shoulder for emergency use, bus on shoulder or carpool	Parallel facility; crossings on over- or underpasses; crossings every 200 to 1,200 ft.	Multiuse path; crossings on over- or underpasses	Bus on shoulder, express bus, light rail	Enhanced mobility	Vegetated landscaping and green streets treatments to manage stormwater
Up to six with auxiliary lanes in some places	Median, limited turn lanes in some locations	Shoulder for safety, emergency use, bus on shoulder or carpool	Parallel facility or buffered sidewalks; crossings on over- or underpasses; crossings every 200 to 1,200 ft.	Multiuse path or separated bikeway; crossings on over- or underpasses	Bus on shoulder, express bus, light rail	Enhanced mobility	Vegetated landscaping and green streets treatments to manage stormwater
Two to four lanes	Median desired, some turn lanes; minimize additional crossing width at intersections	None, or separated bikeway, enhanced bus, parking, green streets	Buffered sidewalks, enhanced crossings and access to transit; crossings every 200 to 530 ft. (1 to 2 blocks)	Separated bikeway; enhanced crossings	Accessible stations, priority bus treatments as appropriate	Access: loading and unloading	Vegetated landscaping and green streets treatments to manage stormwater
Two to four lanes	Median desired; some turn lanes; minimize additional crossing width at intersections	None, or separated bikeway, enhanced bus, parking, green streets	Buffered sidewalks, enhanced crossings and access to transit; crossings every 200 to 530 ft (1 to 2 blocks)	Separated bikeway; enhanced crossings	Accessible stations, priority bus treatments as appropriate	Mobility on freight corridors; access: loading and unloading	Vegetated landscaping and green streets treatments to manage stormwater
Two to four lanes	Median in some instances; some turn lanes	None, separated bikeway or multiuse path, enhanced bus, parking, green streets	Sidewalk with buffer or multiuse path; enhanced crossings and access to transit; crossings every 200 to 530 ft. (1 to 2 blocks)	Separated bikeway or multiuse path; enhanced crossings	Accessible stations, priority bus treatments as appropriate	Priority freight treatments, wider lanes and intersections	Vegetated landscaping and green streets treatments to manage stormwater

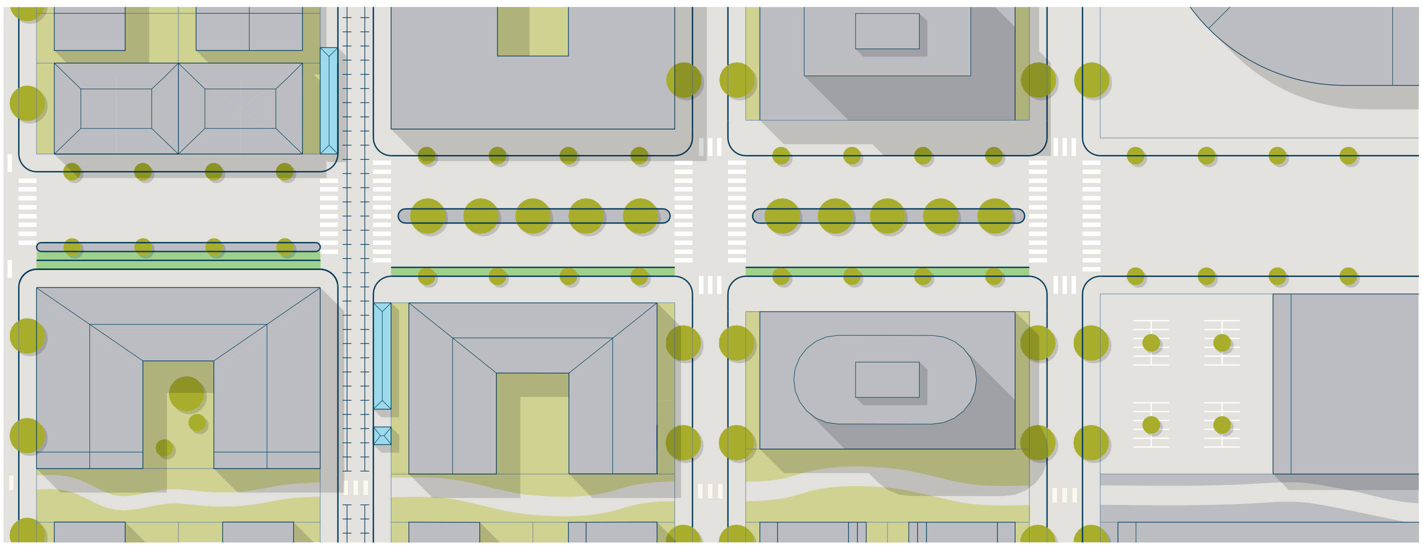
Land use and transportation transect

LESS DENSITY



	Parks and Natural Areas	Neighborhoods	Main Streets	Town Centers	Corridors
LAND USE	Developed parks and undeveloped natural areas including open spaces, scenic areas, rivers and streams, wetlands and floodplains.	Single-family and multi-family residences incorporating a mix of housing types including row houses, duplexes and accessory dwelling units. Newer neighborhoods are slightly more compact while some older neighborhoods have larger lots and fewer street connections.	Neighborhood scale commercial retail and housing in one- to three-story (or more) buildings along multimodal streets with good transit service.	Two-to five-story (or more) mixed use buildings with professional services and commercial retail outlets complimenting housing that is well served by transit.	One-to three-story (or more) buildings containing commercial retail, small scale employment or housing along major transportation routes that link centers together and are well served by transit.
TRANSPORTATION DESIGN	Transportation routes designed to protect and enhance natural features. In some cases a Parkway design overlay may be appropriate.	Regional and Community Streets	Regional and Community Boulevards	Regional and Community Boulevards	Regional and Community Streets

Station Communities	Regional Centers	Central City	Employment and Industrial Lands
Areas around light rail or high capacity transit stations outside of centers with significant employment development and numerous housing types.	Two-to six-story (or more) compact employment and housing development with destination retail served by high capacity transit.	Center of business and cultural activities for the region with intensive employment and housing in high-rises served by numerous transit options.	A mix of large scale employment and industrial uses that include office parks, manufacturing, distribution centers, marine and airport facilities and railroad switching yards.
Regional and Community Boulevards	Regional and Community Boulevards	Regional and Community Boulevards	Industrial Streets, Regional and Community Streets



Regional street design classifications support multimodal travel and the specific transportation needs of the 2040 Growth Concept land use types. Local streets serve all land use types and do not have a design classification. Freeways, highways and trails can traverse any type of land use. Roadways in parks and natural areas may have a parkway design overlay to protect and enhance natural features.

A **parkway design overlay** can be applied to streets in undeveloped areas, including parks, natural areas, open spaces and scenic areas, rivers and streams, and wetlands and floodplains. Parkways serve as linear parks and often have a parallel multiuse path. They are designed to protect, preserve and enhance the natural environment and natural features and may connect important natural features. Travel speeds are slower, no higher than 45 mph, and access is limited. They are typically not freight routes. Wide green buffers separate the roadway from buildings and development. Special design of railings, light fixtures, and wayfinding may be applied to emphasize the parkway elements.

Regional trails (also referred to as multiuse paths) are not a design classification. They are treated as a facility type. However, they are called out here because of the role they serve in the transportation system. They traverse all land use design types. Those that serve as transportation facilities for both utilitarian and recreational trips are generally near or in residential areas or mixed-use centers and provide access to daily needs.

Trails identified in the *Regional Transportation Plan* are defined as transportation facilities and are part of the regional transportation system. They are often situated in riparian corridors, rail corridors or utility corridors but are just as likely to be within the road right-of-way, as in a freeway or highway corridor. A regional trail may also transition to an on-street connection, where it may be designed as a separated bikeway and sidewalk buffered by street trees. Whatever the land use context, trails facilitate comfortable and safe pedestrian and bicycle travel.

2.3 Performance-based planning and design

As the demands on the transportation system increase, so does the need for flexibility in how roadways are designed. Performance-based planning and design can be described as an evolution away from a traditional standards-based approach to one that expands design parameters to be more flexible. The traditional approach does not allow practitioners to easily apply the wide range of available design solutions. In addition, traditional design standards typically result in streets with motor vehicle speeds that are too fast for a multimodal urban environment, and do not evaluate safety and comfort for people walking and bicycling.

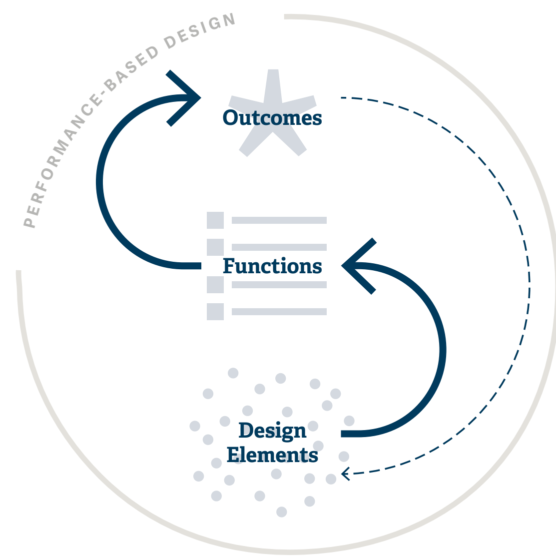
Performance-based planning and design incorporates many performance measures. These measures and related goals, such as reducing vehicle miles traveled, may be weighted to ensure that projects support priority outcomes identified in adopted plans and policies.

National design guidance, including from the American Association of State Highway and Transportation Officials, is moving toward integrating performance-based planning and design, matching appropriate design parameters with flexibility to align roadway function and user needs based on the roadway's existing and planned land use context.

The Metro Council adopted an outcomes-based planning framework in the 2010 *Regional Transportation Plan* to guide planning and decision-making, recognizing that multiple performance measures, not only level of service for motor vehicle travel, is necessary to achieve desired outcomes. The outcomes-based framework requires that the *Regional Transportation Plan* respond to the desired outcomes adopted for greater Portland, thereby allowing Metro to be a responsible steward of public investment and the social, built and natural environments that shape the region's communities.[1]

Chapter 6 provides a decision-making framework for practitioners to track decisions throughout a project cycle. This documentation process provides flexibility to choose the best design for a given context, while providing an effective way to manage risk when designing new or reconstructed roadways. The framework includes documenting the design considerations, and alternatives that were evaluated, based on clearly outlined project goals and recommendations for engaging stakeholders throughout the process.

Performance-based planning and design starts with a well-defined project need, accompanied by goals and related objectives. It then works to align design decisions with the project objectives and desired systemwide outcomes. This approach relies on developing and comparing design alternatives, using performance measures and analysis to assess progress toward achieving project objectives, and applying engineering judgment, informed by a multidisciplinary team, to reach a preferred design.



This guide uses a performance-based planning and design approach. Design elements are chosen to support the different functions the transportation system serves, such as pedestrian access, to help achieve desired outcomes, such as safety.

[1] In 2008, the Metro Council and regional partners adopted six desired outcomes to guide planning: vibrant communities, economic prosperity, safe and reliable transportation, leadership on climate change, clean air and water and equity.

2.4 Design for desired outcomes

Street and trail design directly affects greater Portland's quality of life. Under a performance-based approach, streets and trails are planned and designed to help achieve regional and community outcomes.

Safety

Streets are planned and designed so people walking, parking, shopping, bicycling, working and driving can cross paths safely. Streets are designed to slow traffic in urban areas, provide safe crossings, increase separation of travel modes and provide protection for vulnerable users to achieve Vision Zero—the elimination of deaths and life-changing injuries from traffic crashes.

Security

Streets and trails are welcoming, safe places for all people to use. Design elements such as lighting and culturally relevant public art and placemaking are used to deter crime and harassment. Activating streets and trails provides more eyes on the street and increases personal security.

Transportation Choices

Streets and trails are designed to provide a variety of transportation choices that are safe, comfortable and easily accessible. Universal design ensures that walking, bicycling, transit, rideshare services and other emerging options are equally accessible to people of all ages and abilities. The availability of a variety of transportation choices helps lower vehicle miles traveled.

Efficient and Reliable Travel

Streets and trails are well connected, planned and designed so that people can get where they need to go efficiently and reliably.

Healthy People

Opportunities for active travel and access to parks and nature are supported and increased by street and trail planning and design. Streets and trails are comfortable and safe to use for walking, running, jogging and bicycling and support human health and wellbeing. Air, noise and light pollution are reduced through design.

Healthy Environment

Streets and trails are planned and designed to increase green infrastructure and protect the natural environment by managing stormwater, reducing carbon dioxide emissions, reducing urban heat island effects, minimizing light and air pollution and protecting wildlife habitat and fish passage.

Reduce Greenhouse Gas Emissions

Street and trail plans and designs increase trips made by transit, walking and cycling, thereby reducing vehicle miles traveled and greenhouse gas emissions from motor vehicles. Street trees and other green infrastructure absorb greenhouse gas emissions and clean the air.

Sustainable Economic Prosperity

Livable streets and trails benefit businesses by creating walkable and bicycle-friendly areas and providing transportation choices for accessing jobs. Street designs support freight access to industrial areas, supporting export and import activity. Street and trail designs support tourism by creating memorable, unique places, as well as providing safe and comfortable access to destinations.

Racial and Social Equity

Streets and trails' role in increasing racial and social equity is considered in their design, creating places that are safe and welcoming to all, intuitive and easy to use regardless of race, income, age, ability, cultural background or language. Streets and trails contribute to revitalization without displacement and provide transportation options to jobs, schools, health care, food, nature, cultural resources and other places.

Vibrant Communities

A connected network of streets and trails support efficient urban form. Air, noise and light pollution are minimized. Public art, street trees and a variety of materials and surfaces create unique places that reflect a community's identity. Streets and trails are places not only for travel, but also for community gatherings, meeting places, cultural events and community identity.

Resiliency

In the face of a changing climate, natural disasters and extreme weather events, streets and trails are designed to be resilient and available as emergency response routes.

Fiscal Stewardship

Innovative and creative design approaches are used in street and trail planning and design to reduce costs and conserve resources for construction and life cycle costs, including operation, maintenance and replacement costs. External costs, such as climate change impacts, are considered in performance-based planning and design to understand the full cost specific design treatments.

2.5 Policies and requirements

This section identifies key national, state and regional policies that inform how streets and trails in greater Portland are planned, designed and function. Some policies and requirements may support design innovation or flexibility, while others may limit what can be done. At the local level, city and county governments apply land use, transportation and development codes to implement these policies on the ground.

As a federally-designated metropolitan planning organization, Metro distributes federal transportation funds to transportation agencies in the region. Consequently, Metro is required to ensure the use of these funds addresses and complies with applicable federal and state policies, regulations and laws, such as the ones listed in the following table.

National policies and requirements	Impact on design
Federal Migratory Bird Treaty Act (1918)	Projects must identify impacts to migratory birds and avoid destruction of active nests or eggs and killing of individual birds.
Fish and Wildlife Coordination Act (1934)	Requires agency consultation to identify impacts to fish and wildlife resources and recommend mitigation.
Title VI of the Civil Rights Act of 1964	Protects people from discrimination based on race, color and national origin in programs and activities receiving federal financial assistance, including transportation projects. Depends upon understanding and properly addressing the unique needs of different socioeconomic groups and involving the public for effective transportation decision-making.
Section 4(f) of the Department of Transportation Act (1966)	Applies to projects in publicly owned parks, recreational areas, wildlife and waterfowl refuges and public and private historical sites. Requires a review and documentation of a no feasible and prudent avoidance alternative and all possible planning to minimize harm.
National Historic Preservation Act (1966)	Applies to projects that could impact historical properties. Requires a review to take into account the effect a project may have on historic properties.
National Environmental Policy Act (1970), and Magnuson-Stevens Fishery Conservation Management Act, Section 7 (1976)	Any transportation project that receives federal funding is required to consider the environmental effects of the proposals and actions. NEPA requires a disclosure of impacts but does not require the decision-maker to select the environmentally preferable alternative, nor does it prohibit adverse impacts. However, best practices in environmental protection would be to avoid, or minimize or mitigate for the adverse impacts.
Clean Water Act Amendment (1972)	Addresses impacts to "waters of the U.S." Regulates point sources for water pollution, including those from roadways and motor vehicles, through the National Pollutant Discharge Elimination System. Transportation agencies are responsible for managing the stormwater runoff that discharges into the region's waters via regulated municipal separate storm sewer systems along streets, roads and highways.
Endangered Species Act (1973)	Requires that projects be designed to provide the greatest value to the greatest number of people, while avoiding or minimizing impacts to plant and animal species and their habitat, as well as the ecological processes that naturally sustain these areas. Any projects receiving federal funding must comply with the Endangered Species Act.
Clean Air Act (1990)	Mandates controls on air pollution from motor vehicles. Transportation projects and activities that limit and reduce the air pollution from motor vehicles help transportation agencies attain and remain in conformity with the Clean Air Act.

Americans with Disabilities Act (1990)	Prohibits discrimination against persons with disabilities in all areas of public life, including transportation. Requires that transportation projects be designed to be accessible to persons with disabilities.
Executive Order 12898 Environmental Justice (1994)	Requires that every federal agency identify and address the effects of all programs, policies and activities, such as transportation design, on minority populations and low-income populations. Requires involving the public in developing transportation projects that fit harmoniously within their communities.
U.S. Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations (March 11, 2010)	Supports development of fully-integrated active transportation networks. Provides several policy statements, including direction to "go beyond minimum design standards" for pedestrian and bicycle projects, and to integrate bicycle and pedestrian projects on new, rehabilitated and limited access bridges.
U.S. Department of Transportation Memorandum: Bicycle and Pedestrian Facility Design Flexibility (August 20, 2013)	Expresses the Federal Highway Administration's support for taking a flexible approach to bicycle and pedestrian facility design.
Architectural Barriers Act, accessibility guidelines for outdoor developed areas (2013)	Requires that trails developed through federally funded projects in parks and other recreational areas are readily accessible to and usable by persons with disabilities.
U.S. Department of Transportation Memorandum: Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions (May 5, 2016)	Encourages flexibility and a context-sensitive approach for projects on the National Highway System (NHS). Reduced the number of controlling criteria to 10. Of these criteria, only design loading structural capacity and design speed apply to all NHS facility types. The remaining eight criteria are applicable only to "high-speed" NHS roadways, defined as Interstate highways, other freeways, and roadways with a design speed greater than or equal to 50 mph.
State policies and requirements	**Impact on design**
"Bicycle and Pedestrian Bill" (ORS 366.514) Use of highway funds for footpaths and bicycle trails (1972)	Requires provision of bicycle and pedestrian facilities wherever a highway, road or street is being constructed, reconstructed or relocated. Serves as the state's complete streets policy.
Transportation Planning Rule (last amended 1991)	Supports the integration of land use and transportation planning. Among its many provisions, it includes requirements to reduce vehicle miles traveled. Section 8 and Section 10 are related to multimodal mixed-use areas (MMA). In areas designated as an MMA, a local jurisdiction does not need to apply local or state mobility standards when evaluating proposed plans, thus allowing more design flexibility.

Oregon Statewide Land Use Planning Goals (1974): Goal 19 Transportation; Goal 2 Land Use; Goal 5 Natural Resources, Scenic and Historic Areas, and Open Spaces; Goal 6 Air, Water and Land Resources Quality	Goal 19 requires cities, counties and the state to create multimodal transportation system plans so people are not limited in the ways they can access the jobs, goods, or services available in different parts of their community. Goal 2 requires each local government in Oregon to have a comprehensive land use plan. Transportation system plans are part of the comprehensive plan. Goal 5 covers more than a dozen resources, and local governments are asked to create inventories of these resources. These inventories identify areas that ideally should be avoided when planning and designing transportation projects. Goal 6 instructs local governments to consider the protection of air, water and land resources from pollutants, using a variety of market, zoning and management tools. The elements of Goal 6 correspond broadly to the federal Clean Air and Clean Water Acts.
Oregon Transportation Plan (last amended 2015) and associated mode and topic plans	Establishes a vision and policy foundation for a safe, multimodal transportation system. Mode and topic plans provide more specificity on how to implement the Oregon Transportation Plan, such as achieving zero deaths and serious injuries.
Oregon Highway Plan (1999)	Includes many elements that impact design, including Policy 1F, which establishes mobility targets (as defined by motor vehicle volume-to-capacity ratios). Streets are designed to meet the targets. Land Use and Transportation Policy 1B addresses the relationships between land use and transportation and identifies desired outcomes. Policy 1A describes state highway classifications, including primary functions.
Oregon Fish and Wildlife Habitat Mitigation Policy	Requires projects to evaluate the potential impact of development actions on fish and wildlife habitat and to follow guidelines to reduce, offset or avoid the impacts.
Oregon Fish Passage Law (ORS 509.580-640) (2015 edition)	Protects native migratory fish. Requires fish passage through artificial obstructions, such as roads. Agencies must consult with the Oregon Department of Fish and Wildlife to identify streams used by native migratory fish and to implement passage.
Oregon State Endangered Species Act (1987)	Requires projects to identify impacts to state-listed and candidate species not currently listed under the federal Endangered Species Act.
Section 401 Water Quality Certification of the Clean Water Act	Assesses project compliance with state water quality standards and mitigation measures. Issued in conjunction with the U.S. Army Corps of Engineers Clean Water Act Section 404 permit.
Permits and conditions for excavation or removal of archaeological or historical material	Projects are required to obtain a permit from the Oregon Parks & Recreation Department before any excavation in a known archeological site or for exploratory excavations to determine if archeological deposits are present on lands owned by state or local agencies.

Freight Reduction in Carrying Capacity Review (ORS 366.215) (2017)	Applies to a subset of state highways known as reduction review routes; prohibits designs that could limit passage of over-dimensional freight loads, unless safety or access considerations require reduction. Design exceptions to the rule must be approved by Oregon Department of Transportation. Some segments of these state facilities traverse centers and are classified as regional boulevards.
Oregon Department of Transportation Blueprint for Urban Design (2019)	Serves as interim guidance to the Highway Design Manual (2012) and other ODOT design guidance. Highlights opportunities for flexibility in the design of state owned arterials in urban areas based on land use context.
Metropolitan Greenhouse Gas Reduction Targets Rule (OAR 660-044) (last amended 2017)	Sets greenhouse gas targets adopted by the Land Conservation and Development Department for each of Oregon's metropolitan areas, including Portland. The targets are designed to help guide metropolitan areas as they implement ways to reduce greenhouse gas emissions from light vehicles, including through changes to land use and transportation plans.

Regional policies and requirements	Impact on design
Region 2040 Growth Concept (1994)	Establishes a broad regional vision to guide all future comprehensive planning at the local and regional levels, including development of the Regional Transportation Plan. Regional street design classifications were developed to implement the 2040 Growth Concept. The design classifications correspond to the different 2040 land use types, including centers, corridors, main streets, and employment and industrial areas.
Regional Framework Plan (1997)	Integrates land use, transportation and other regional planning mandates. For example, Section 1.10 addresses guiding settlement in the region in a pattern that "makes biking and walking the most convenient, safe and enjoyable transportation choices for short trips, encourages transit use and reduces auto dependence and related greenhouse gas emissions."
Urban Growth Management Functional Plan (last amended April 2018)	Title 3 Water Quality and Flood Management; Title 4 Industrial and Employment Areas; Title 6 Centers, Corridors, Station Communities and Main Streets; Title 13 Nature in Neighborhoods provide tools to implement the 2040 Growth Concept. Requires and recommends changes to city and county comprehensive plans and implementing ordinances. The following titles impact transportation design: Title 3 addresses protecting water quality, flood management and fish and wildlife conservation; Title 4 addresses protecting freight movement; Title 6 addresses developing centers and corridors, and Title 13 addresses nature in neighborhoods.
Regional Transportation Plan (2018) and associated mode and topic plans: regional freight, transit, safety and emerging technology strategies and the Climate Smart Strategy	Provide policies supporting multimodal complete street design to achieve desired outcomes and implement the 2040 Growth Concept. They include transportation targets and performance measures. Regional strategies include specific actions related to transportation design.

Regional Transportation Functional Plan (last amended 2012)	Implements the Regional Transportation Plan and the 2040 Growth Concept. Outlines the requirements for local transportation system plans. Title 1 (Transportation System Design) includes specific design requirements. States that jurisdictions must allow use of regional design guidance. Includes connectivity requirements. Requires that cities and counties consider a set of strategies to meet mobility targets, with increased motor vehicle capacity being the last option considered.
Strategic Plan to Advance Racial Equity, Diversity and Inclusion (2016)	Includes specific goals and objectives for Metro to address long-term institutional and structural changes in order to advance racial equity, diversity and inclusion, including ensuring access to safe and reliable transportation.
Green Trails (2002), Wildlife Crossings (2009), Trees for Green Streets (2002)	Provide design guidelines for developing environmentally-friendly soft-surface trails, providing safe passage for urban wildlife, and using street trees as a stormwater management tool.
Local policies and requirements	**Impact on design**
	Local policies and requirements, including transportation system plans, comprehensive plans, construction and design guidance, manuals or standards, and stormwater management requirements often have direct regulatory power and greatly impact transportation multimodal design. Local policies and requirements can vary considerably across the greater Portland area.

3

Regional trails cover a variety of functions, primarily mobility and access for people walking and bicycling. Trails can also serve as emergency response routes, enhance the natural environment and contribute to a strong sense of place. The Eastbank Esplanade, part of the Springwater Corridor, is a community gathering place, a gateway to the central city and a critical transportation connection.

Chapter 3

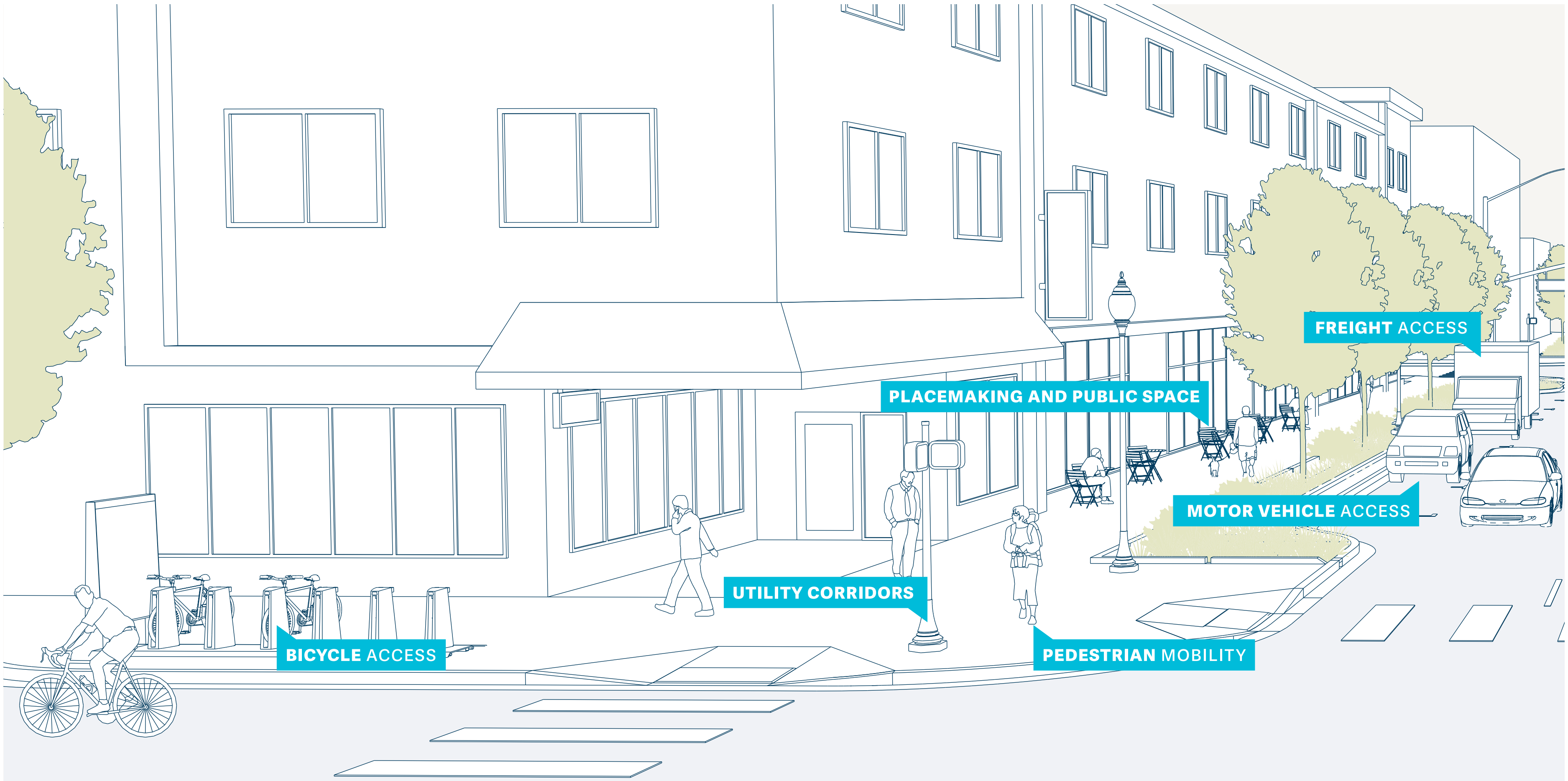
Design functions

Streets and trails serve many different functions. Various functions may be prioritized on different streets and trails, contributing to the overall performance of the transportation system. NE Cornell Road in Orenco Station.

In this guide, a design function is a use or purpose that streets and trails can serve, thereby contributing to desired systemwide outcomes described in Chapter 2.

Functions are supported through the planning and design of streets and trails. The primary functions served by a street or trail are determined by multiple factors, including supporting community and regional goals, adjacent land use, street connectivity, community needs and adopted policies.

Livable streets and trails functions



Pedestrian
ACCESS AND MOBILITY

Every street and trail has safe, comfortable space for people walking, rolling and enjoying the place they're in.

Bicycle
ACCESS AND MOBILITY

Connected bicycle networks, separated from heavy vehicle traffic, ensure that bicycling is a great way to get around communities.

Transit
ACCESS AND MOBILITY

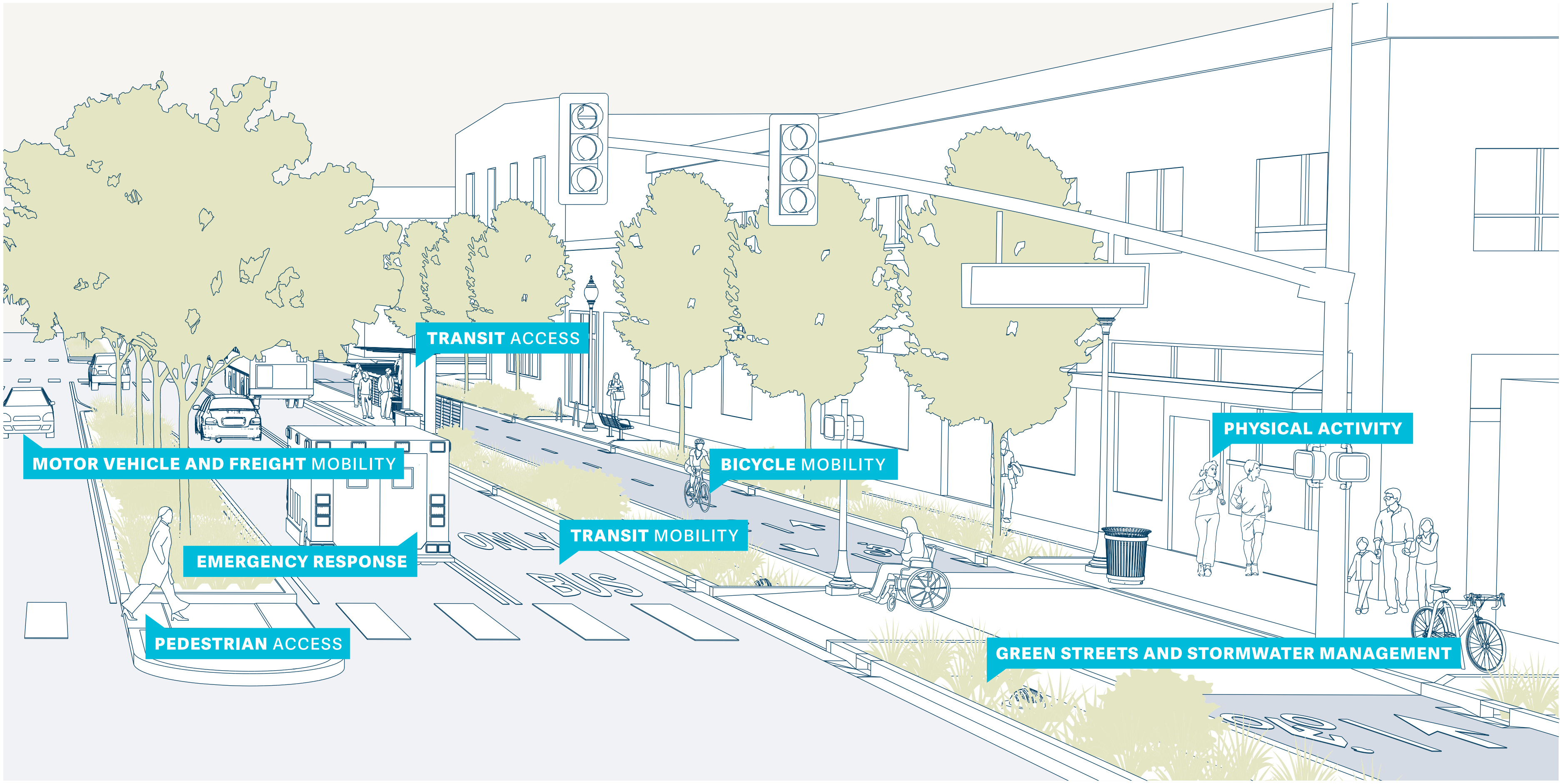
Streets enable transit to serve the region with an efficient, reliable way to travel between and within communities.

Freight
ACCESS AND MOBILITY

Key freight corridors provide reliable freight movement, and streets allow delivery access to serve both businesses and residents.

Motor Vehicle
ACCESS AND MOBILITY

Streets and throughways provide for safe, reliable travel in motor vehicles, providing space to facilitate pooled or shared trips.



Placemaking and Public Space

Streets and trails are a canvas for community life and daily commerce, helping to form regional identity.

Green Streets and Stormwater Management

Weaving nature and sustainable stormwater management into streets and trails enhances livability and protect water, air and natural assets.

Utility Corridors

Transportation corridors move more than just people and goods; they also move water, power, gas, communications and information.

Physical Activity

Streets and trails are places where people enjoy exercising and spending time outdoors whether for recreation or to get to where they need to go.

Emergency Response

In case of a local or widespread emergency, streets and throughways must provide access and evacuation routes to keep people safe.

3.1 Livable street and trails functions

Every street and trail within greater Portland serves more than one function. This section describes the typical functions streets and trails can serve.

The first group of functions, access and mobility, focus on a street or trail's ability to safely and conveniently move people and goods. These two terms are frequently used to describe transportation systems, with varying meaning. In the following descriptions:

"Access" generally refers to the function of allowing a person or good to reach an intended destination.

"Mobility" generally refers to movement and travel between two locations.

As projects are being planned and designed, various functions of streets and trails will be **prioritized**. This means they will be constructed to the highest quality standard possible through design and operations. Other functions may be **accommodated**, meaning these facilities will be built to a more basic level. Still other functions may be on a **parallel facility**. Typically, not every function can be prioritized. Different functions may be prioritized on different streets and trails, thereby contributing to the overall performance of the transportation system. **Chapter 6** provides a decision-making framework to help determine which functions should be prioritized during planning and design and to help work though design trade-offs. This framework helps create a system of streets and trails for greater Portland that serves all functions and leads to the desired systemwide outcomes.

Pedestrian access and mobility

People walking and using wheelchairs or other mobility devices
Serving pedestrians involves both mobility and access functions. For pedestrians, these functions are complementary: a street can provide a high level of pedestrian access and mobility simultaneously, and the two functions complement each other.

Safe access Walking, or using a wheelchair or other health-related personal mobility aid, is part of at least the start and end of every trip, even when most of the trip is made using another mode. Pedestrian access to places, streets and transit stops should be safe and comfortable. Americans with Disabilities Act accessibility standards must be met and universal design treatments should be used. Street crossing opportunities should be provided frequently, planned and designed for pedestrian safety and made accessible to people with varying abilities. Streets and trails should also provide people with enjoyable pedestrian access to public space and public places in all weather conditions. Building overhangs, shelters and street trees provide protection from rain, snow or extreme heat. Benches, plazas and viewing points provide spaces to pause and rest.

Safe mobility Pedestrian mobility means being able to walk or use a wheelchair or other device reasonably directly and efficiently from one place to another. Continuous sidewalks, wide enough to serve all the people using them and buffered from vehicle traffic, provide the primary infrastructure for pedestrians. Accessibility regulations must be met and universal design treatments should be used. When appropriate, trails should separate people walking and riding bicycles. Pedestrian mobility is best served by direct routes, because walking is a relatively slow means of traveling. At intersections, pedestrian crossings should be provided on all sides of the intersection, with few exceptions, to avoid undue out-of-direction travel. Signs and other wayfinding elements along streets and trails support navigation.

Bicycle access and mobility

People riding bicycles and other micromobility devices
Serving bicyclists requires both mobility and access functions, and each function should be considered distinctly. Design elements that provide bicycle access can be different from elements that facilitate bicycle movement.

Safe access People using bicycles need to be able to safely access commercial and community destinations along streets and trails. Providing access requires high-quality, comfortable bikeways and safe intersections and crossings. Convenient, secure and covered bicycle parking is also crucial for providing bicycle access. Bicycle parking should be easy to find and located close to building entrances. Bike sharing, e-scooters and other shared mobility systems can also provide convenient options. Street designs should provide adequate space within the right-of-way for parking shared bicycles and other shared systems where access is prioritized.

Safe mobility A safe, comfortable and interconnected bicycle network of streets and trails provides mobility for bicycle trips. The bicycle network should be physically separated from higher-speed and heavy motor vehicle traffic to facilitate safe and comfortable travel. Bicycle mobility is supported by direct, intuitive and connected routes. Strategies to enhance bicycle mobility, such as "green wave" signal timing (traffic signals timed for bicycle travel speeds), can further increase the attractiveness of bicycling as a travel mode. Bicycle facility designs should anticipate increased bicycle trips in the future. Designs that provide extra width now, or that allow the ability to expand in the future if needed, foster the flexibility to serve continued increases in demand for bicycling as well as other micromobility options.

Transit access and mobility

People riding public transit
Serving transit riders requires both mobility and access functions. However, there are often tradeoffs between the two functions. Closely spaced stops provide a high level of access but reduce the mobility function of the transit route by increasing travel times. Some designs can help maximize both access and mobility. A frequent, reliable and accessible transit system is one of the most effective uses of the public right-of-way, efficiently moving more people in a given amount of road space than any other mode.

Safe access Transit access means having safe and comfortable transit stops near both ends of a trip. Because most transit users walk to access transit, safe and comfortable pedestrian routes to and from stops, including safe ways to cross streets at transit stops, are essential for transit access. Streets with transit service should have comfortable, attractive and universally accessible stops connected to quality sidewalks, bikeways and safe street crossings. Transit stops with higher levels of use should provide shelter, lighting, seating, bicycle parking and potentially real-time information for travelers. At larger stations, wayfinding for pedestrians and bicyclists and bicycle storage should also be provided. Transit access can be provided with a range of transit services and modes to effectively serve the varied communities in greater Portland.

Safe mobility Transit mobility is vital for the efficient movement of people throughout the region. Exclusive transit right-of-way, priority treatments, or both can improve transit mobility and reliability when streets are congested. When transit vehicles travel in lanes shared with other vehicles, priority treatments improve mobility by addressing specific locations of recurring delay. These strategies include transit signal priority, business access and transit lanes, stops located on the far side of intersections, and queue jump lanes at intersections.

Motor vehicle access and mobility

People driving or riding in a motor vehicle
Motor vehicle travel relies on both access and mobility, but these functions are typically emphasized on different streets. Emphasizing one function necessarily means limiting the others.

Safe access Access for people traveling in motor vehicles is provided through a well-connected network of local and neighborhood streets, driveways to specific destinations, motor vehicle parking and places to drop off and pick up passengers. The access function is typically provided by curbside in centers, where destinations are clustered. On-street parking is a common form of motor vehicle access in residential areas. The curb will become an increasingly important space for motor vehicles with emerging services and technologies.

Safe mobility Motor vehicle mobility typically offers time-efficient movement throughout the region. Streets that provide maximum mobility for motor vehicles, such as freeways and highways, limit access as a means of improving safety. Other major streets need to balance motor vehicle mobility with other functions. Intersections are typically a major constraint to managing motor vehicle mobility on urban streets. Advanced signal timing strategies can help move vehicles through intersections while promoting relatively low but appropriate vehicle speeds. Roundabouts also facilitate efficient, low-speed motor vehicle movements at intersections. Managing access by limiting the number of driveways and restricting motor vehicle turning movements from side streets and driveways also promotes safe mobility.

Freight access and mobility

Moving goods and making deliveries
Freight requires both mobility and access functions, but these functions are typically emphasized on different streets and are often served by different types and sizes of freight vehicles.

Safe access For freight, access means being able to deliver goods to the intended destination. The last mile is typically the most difficult and costly segment of a freight delivery, often occurring on a street not designated as a freight route, which constrains maneuvering and loading. Delivery vehicles and workers need safe and reliable space to transfer goods to their point of final delivery without needing to worry about conflicts with other roadway users. Designated curb space for freight loading and unloading is necessary in high-traffic commercial zones; one loading zone can serve multiple businesses. Loading zones can be located on side streets or in alleys to reduce conflict with other roadway functions. Deliveries are most desirably made using smaller trucks or delivery vans that can navigate narrow streets with relatively tight corners. In locations where larger trucks make frequent deliveries, streets should be designed to accommodate them, including providing access to truck loading docks. Deliveries can also be made by bicycle, and other wheeled delivery methods, such as self-driving pods. These methods can put higher demands on sidewalks and bicycle facilities and may necessitate greater widths. Other essential elements for freight access are locations where goods are transferred between freight modes (ports, airports, and railroad facilities), and from larger vehicles to smaller vehicles for the last-mile portion of the trip. Port terminals and other intermodal facilities should be planned and designed to allow safe and efficient freight access.

Safe mobility Reliable freight movement in and through greater Portland supports Oregon's businesses and economy as well as those of the country as a whole. Agricultural products need to reach ports to be exported and sold. High-value manufactured goods often need to be shipped and delivered within a tight timeframe. And every day, goods need to be delivered to customers throughout greater Portland. The freight mobility function is primarily served on key regional freight routes and on industrial routes connecting to manufacturing, warehousing, and large commercial uses. In locations where larger trucks are frequent during daytime hours, streets should be designed to accommodate them. The cost of moving freight is minimized when the transportation network provides reliable travel times with minimal day-to-day variations.

Placemaking and public space

Neighborhoods and cities are built for people, and streets represent a large portion of the public space in a community. Streets are a canvas for community life, day-to-day social activity, public art, civic debate and joyful celebrations. Regional streets and trails help form the region's identity and contribute to the unique character of special places within greater Portland. Streets and trails should provide a place for everyone to participate in their community. This is known as placemaking. Placemaking can achieve several different goals: fostering community identity, promoting art and local artists, creating new public spaces or rebuilding a community at a human scale. From outdoor seating and unique wayfinding signage, to a redesigned park or art-filled commercial corridor, the ultimate goal is to create more livable communities and celebrate the elements that make the region a great place to live. Deliberate placemaking results in a stronger sense of place and strengthened community bonds, ultimately leading towards the regional outcomes adopted in the 2040 Growth Concept and the *Regional Transportation Plan*.

Street and trail planning and designs can support placemaking by including distinctive features such as gateway intersections, aesthetic bridge designs or public art installations highlighting the local community. Designs should also anticipate occasional street use, such as festivals, parades or farmers markets, where the street is closed to through travel. Visually interesting streets that are pedestrian-scale, with small parcels and street-fronting land uses with ground level windows, make fun, engaging places to walk and stroll.

Green streets and stormwater management

All streets and trails must manage stormwater, treating runoff to reduce pollution and infiltrate water into the ground, limiting how much stormwater and pollutants eventually make their way into vulnerable natural waterways. By incorporating green infrastructure treatments such as vegetated medians, planters, curb extensions and street trees, streets and trails can function as urban green corridors that not only manage stormwater but mitigate the harmful impacts of transportation on air, water, and wildlife habitat and connectivity. This function of streets and trails is imperative to human and environmental health.

One of the distinct advantages of having streets and trails function as green streets over "grey infrastructure" for stormwater management is their superior treatment of pollutants running off from roadways. While grey infrastructure options may have smaller footprints, they are typically more expensive to maintain and fail if not maintained. In addition, separate grey infrastructure elements are almost always needed to manage runoff quality and quantity.

Street trees and other green streets infrastructure provide a wide array of benefits in addition to stormwater management, offering wildlife habitat, improving air quality, providing shade and reducing the urban heat island affect, beautifying the surroundings, promoting human well-being and calming traffic. On streets with high levels of walking and bicycling, street trees provide buffers from traffic and air pollution. The green streets function can be further supported by using dark skies approaches to minimize the impact of street lighting on wildlife, human health and the natural environment. Designing streets and trails for stormwater management can also incorporate and enhance other functions, such as placemaking. Green street elements can be used to create a stronger sense of place and make walking and biking more enjoyable.

Utility corridors

Streets and some trails function as utility corridors. Street rights-of-way are often the places where vital utilities are located, including water and sewer pipes, power and gas lines, and communications infrastructure. Some trails are built within power line corridors. These utilities serve adjacent buildings and land uses, but also serve the streets by powering signal systems, providing street lighting, and draining water from the street surface. Different utilities have different needs: water-based utilities rely on gravity and are generally located closer to the curb or the outside travel lane, while the dry utilities, if underground, are usually located in a conduit in the right-of-way at the side of the street. Working with utility operators to locate underground pipes before an excavation project is vital to avoid line breaks and other issues and is codified into state law. Above-ground utilities are supported by poles at the side of the street. Street design must provide access to both underground and overhead utilities when repairs are needed.

As technology evolves, utility-related demands within the street right-of-way will change. Needs for information transmission and sensors will increase, and much of this equipment will be located on utility poles, on or within buildings, and within the surfaces of the streetscape. As smart sensor technology becomes increasingly prevalent, streets should be designed to allow the deployment of sensors that can communicate with a central network.

Physical activity

Transportation design contributes directly to a community's public health outcomes by supporting the function of physical activity. Safe and comfortable streets and trails give people with a place to recreate and exercise as part of their daily activities. Designs should integrate safety, shade, sun, seasons and an engaging sensory experience. Physical activity is better served by streets and trails when the negative impacts of motor vehicles are mitigated with designs that reduce noise impacts, provide buffers from vehicular traffic and minimize pollution effects. Spaces that invite people out simply for the joy of being active outdoors reap community health benefits.

Emergency response

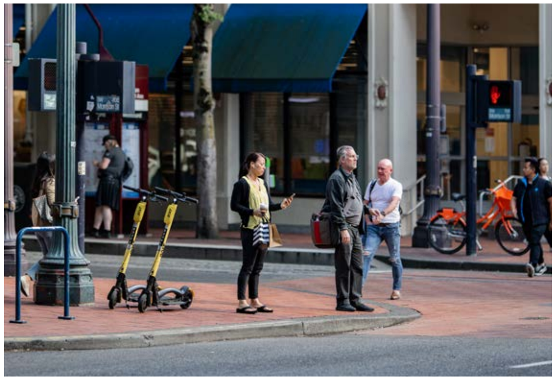
From local emergencies, such as single-alarm fires, to regional crises, such as a Cascadia subduction zone earthquake, streets are the lifeblood for any response. First responders and emergency vehicles need space to operate and deploy resources when responding to various needs during an emergency. Street designs must consider emergency vehicle access needs. Some agencies have encouraged the use of smaller vehicles to navigate through constrained urban areas. In some areas, regional trails and bicycle and pedestrian bridges can be planned and designed to serve as additional access routes for emergency vehicles (including bicycle emergency services) for big events such as an earthquake.

4

Design elements are combined to support the different functions of streets and trails. As the needs of communities evolve, so must transportation design to meet those needs. Beaverton regional center.

Chapter 4

Design principles and elements



Street and trail design elements must support multimodal travel and be flexible enough to respond to different land use contexts. SW 3rd Avenue, downtown Portland.

Chapter 4 provides planning and design guidance for regional streets and trails.

The core of this approach is to **design to serve the land use context**, as described in **Chapter 2**. This chapter provides the following information:

- **Design principles** provide an overarching approach that supports achieving systemwide outcomes. Design principles guide decision-making when designing streets and trails. In addition to the overarching design principles, principles specific to regional trails are included in the regional trails design element.

- The different **realms of the street** are described to provide a context for the design elements.

- **Design elements** provide information on planning and designing for specific functions and for the regional street design classifications, which correspond to land use.

- **Design resources** identify a variety of sources used to develop this chapter's guidance. These resources provide more detailed information on many of the topics covered by this chapter.

4.1 Design principles

This section describes key principles that should guide decision-making as streets and trails are designed.

Design with a safe systems approach

Taking a safe systems approach to roadway safety means using data-driven, strategic design to eliminate severe injury crashes. The safe systems approach takes a holistic view of the transportation system and the interactions between potentially speeding or distracted motorists and vulnerable road users. It is an inclusive approach that prioritizes safety for all transportation system users, including drivers, motorcyclists, passengers, pedestrians, bicyclists, transit riders and commercial and heavy vehicle drivers. Consistent with the adopted *Regional Transportation Safety Strategy*, which outlines a regional Vision Zero strategy, a safe systems approach recognizes that people will always make mistakes, but roadways should be designed and managed so mistakes do not result in death or serious injury.

Safe systems approach street design emphasizes managing speeds for safety, lowering speeds in areas where people are walking, bicycling and accessing transit and separating users. Separation means creating physical barriers between people moving at different speeds. As speed differentials increase, so should the level of separation. Medians, access management treatments, protected bicycle lanes and other street design elements can minimize crashes. This chapter's guidance focuses on designs that align with a safe systems approach.

Design using target speeds

Evaluating minimum sight distance, horizontal curvature, vertical curves and other design factors is based on the design speed. In the past, national guidance encouraged selecting greater dimensions that resulted in higher speeds. To achieve safe target speeds, the design speed should generally align with the target speed. Ultimately, posted speed should also align.

Achieving a target speed can be influenced by various street design elements. Wider, more open roadways encourage higher operating speeds. Conversely, a roadside with buildings, separated bikeways, parked cars and street trees can provide cues to drivers to encourage lower speeds.

Design for all users

Streets should be planned and designed for people of all ages and abilities, as well as the design vehicle for a specific facility. Before developing a design, practitioners should consider each of type of user and how they will navigate the street. Streets should be designed keeping the green transportation hierarchy in mind. The hierarchy prioritizes functions for a typical street in this order: walking, bicycling, transit, freight, carshare/taxi/commercial transport and private automobiles.

Pedestrians Street designs should prioritize mobility and access for people with a range of needs and physical abilities. The pedestrian realm and street crossings must be designed to serve people using wheelchairs and other personal mobility devices, people with vision or hearing disabilities, slower-moving people and young people.

Bicyclists People riding bicycles vary significantly in their abilities and confidence, as well as in the type of bicycle they ride. Most people do not feel comfortable mixing with motor vehicle traffic. Streets should be planned and designed to serve people of all ages and abilities. Bicycles also come in all shapes and sizes. Bicycles with trailers are often used to haul cargo or carry children, and electric bicycles can often maintain higher speeds. Moreover, new and emerging technologies are supporting development of even more options. Designers should anticipate these vehicle types using the streets.

[2] Tefft, B.C. Impact speed and a pedestrian's risk of severe injury or death. *Accident Analysis & Prevention*, Volume 50, January 2013, pp. 871–878

Transit, freight and private motor vehicles
These vehicles come in a wide variety of sizes, with varying abilities to make turns. They serve a variety of essential needs within greater Portland, including deliveries, emergency response, transit, long-haul freight and day-to-day personal mobility. The selection of a design vehicle is an essential part of developing street and intersection designs. The design vehicle is the largest vehicle that is anticipated to use the street or intersection on a regular basis. Because the selection of a design vehicle influences street dimensions such as turning radii, which in turn can impact safety and operating speeds, practitioners should choose the smallest possible design vehicle. Occasional larger vehicles can still be accommodated by encroaching on opposing lanes or using multiple point turns. Likewise, special design features such as speed cushions or truck aprons can be included to accommodate emergency vehicles and large trucks while providing speed management treatments that reduce overall traffic speeds.

Design for personal security

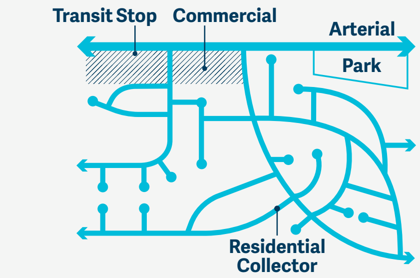
People of all races, genders, ages and abilities should feel safe from crime and harassment while using streets and trails. Unfortunately some people, especially people of color and women, can feel unsafe on some streets and trails. Street and trail designs can create welcoming spaces that help prevent crime and harassment.

Crime prevention through environmental design features such as pedestrian-scale street lighting and green street treatments, as well as more holistic approaches that include longer sightlines and minimizing pinch points, improve security. Increasing the number of people walking and riding bicycles is another strategy that increases personal security by bringing more eyes on the street.

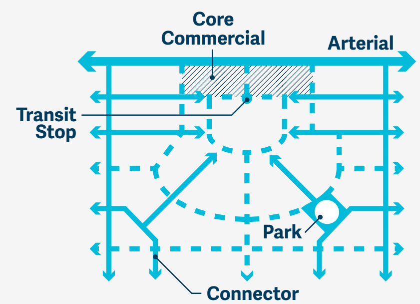
Design for connectivity

Other than throughways, streets should be well-connected to provide multiple and direct routes between destinations for people traveling in a variety of ways. This keeps local trips off the arterial network and allows better traffic circulation and increased travel reliability. Walking and biking are easier on a connected street network. Emergency response also benefits from a well-connected street system. Refer to **Chapter 2** regional street design classification for desired spacing of connecting street intersections.

Even where less-connected street networks have been established, opportunities may exist to increase connectivity for pedestrians and bicyclists by providing trails, paths, bridges and midblock street crossings.



Discouraged



Preferred

Environmental factors may impact street connectivity in some locations. Local street crossings of streams will likely be spaced at greater intervals (800 to 1,200 feet) depending on the topography along a stream. Where streets do cross streams, the crossings should be designed to mitigate impacts to stream quality. In some places, topography creates challenges to developing a street grid; for example, steep slopes tend to limit street connectivity.

Outside of centers, street networks should be designed around, rather than through, environmentally sensitive lands and should mitigate impacts when they cannot be avoided. Street networks should allow for the preservation of continuous natural areas and parks. In some places, a soft-surface footpath or paved trail may be appropriate to allow people to walk or bicycle. Metro's *Green Trails* provides more guidance for these situations.

Use a flexible approach to design

Applying flexibility to street and trail design allows practitioners to optimize a street or trail's functions while minimizing costs. In past decades, national guidelines sought to standardize roadway dimensions and designs. More recently, industry leaders have encouraged a more flexible design approach that responds to a given roadway's unique contexts, needs and constraints. Recently published resources highlight the inherent flexibility in existing design guidance. The resource section at the end of this chapter includes current publications that provide guidance on design flexibility; this guidance is continually evolving.

A flexible design approach applies professional judgment and draws on a variety of resources to develop context-sensitive designs. It requires that practitioners document the reasoning behind their design decisions to support the continued evolution of best practices and to align with tort liability practices to defend decisions and designs.

Design to protect the environment

Transportation is a major contributor to climate change and water and air pollution. Designing transportation projects to provide alternatives to driving, and to avoid, minimize or mitigate impacts on the natural environment, must be a priority.

Protecting and enhancing the natural environment creates more pleasant places for people to live, work and play, while also providing numerous health benefits. Trees provide protection from sun and rain while reducing the impacts of urban heat islands and stormwater runoff. Natural areas help reduce pollution and sequester carbon dioxide to limit climate change. Designs that reduce motor vehicle travel will also reduce light pollution from headlights and tall streetlights. Preserving habitat will limit disruptions for other species that live in the region.

Designing streets to encourage modes other than motor vehicles will help greater Portland be a national leader in addressing climate change. Building a transportation system that prioritizes walking, biking and transit use will provide opportunities to preserve and restore natural areas while reducing carbon emissions.

Design for the future

Transportation is experiencing a period of rapid technological change and innovation. Street design must consider this change as part of ensuring that design supports adopted regional systemwide outcomes. To achieve this goal, streets must be designed to create more places where people want to be. It means designing to encourage walking, bicycling, transit, other forms of shared mobility, and other emerging travel modes that align with desired systemwide outcomes. It means allocating street space to the functions that matter most, and not necessarily to the newest technology. It is impossible to predict with certainty the benefits and impacts of specific technologies; therefore, street designs should also be flexible enough to support piloting new innovations. Ultimately, streets should be designed to serve greater Portland's desired vision for the future, and not simply respond to external factors and trends.

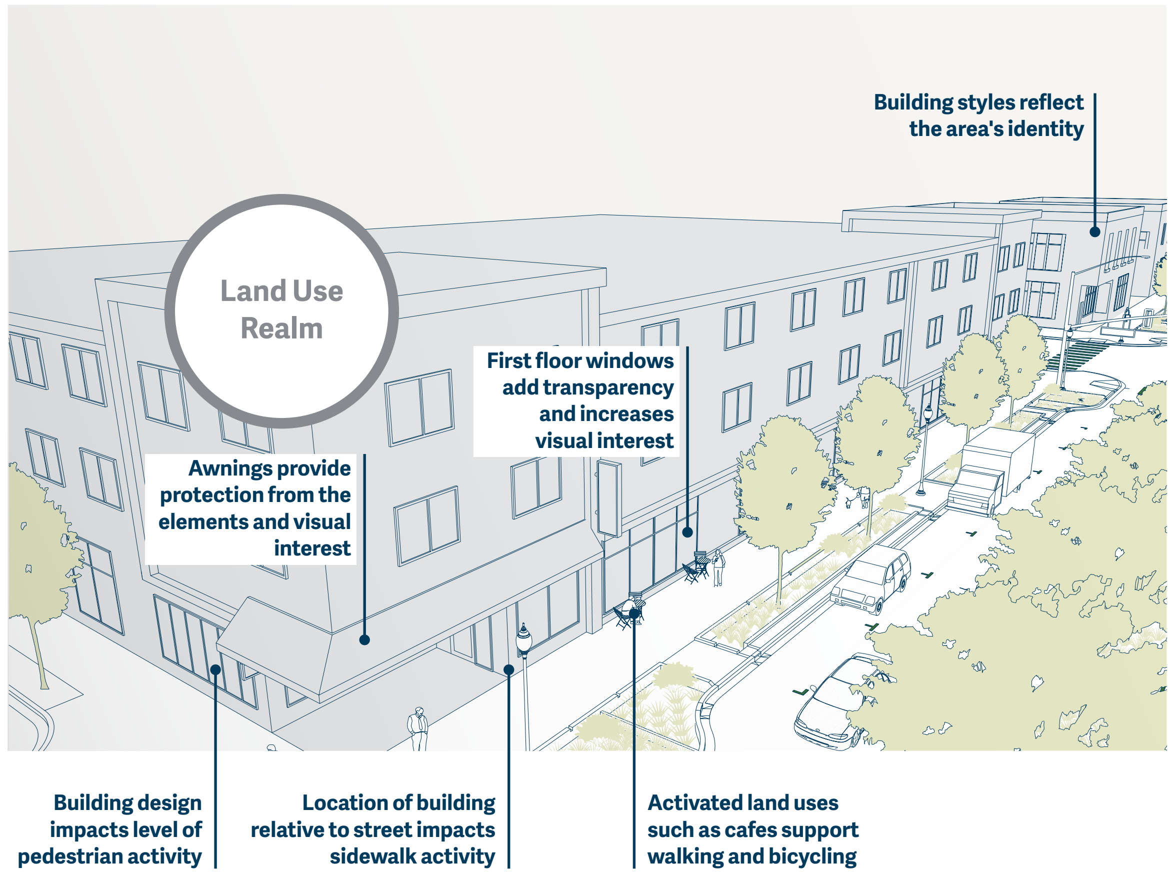
4.2 The street realm

The street realm is the overall setting in which people experience a street's character and use. It is composed of the adjacent land use, pedestrian and travelway realms. The flex zone is part of the travelway realm but can straddle the pedestrian realm as well. On-street connections for trails, as well as paths within the street right-of-way, are included in the street realm, but otherwise trails are located within their own corridor—often a stream, power line or railroad corridor. The two-way bikeway and sidewalk serve as an on-street connection for a regional trail, connecting two off-street multiuse paths.

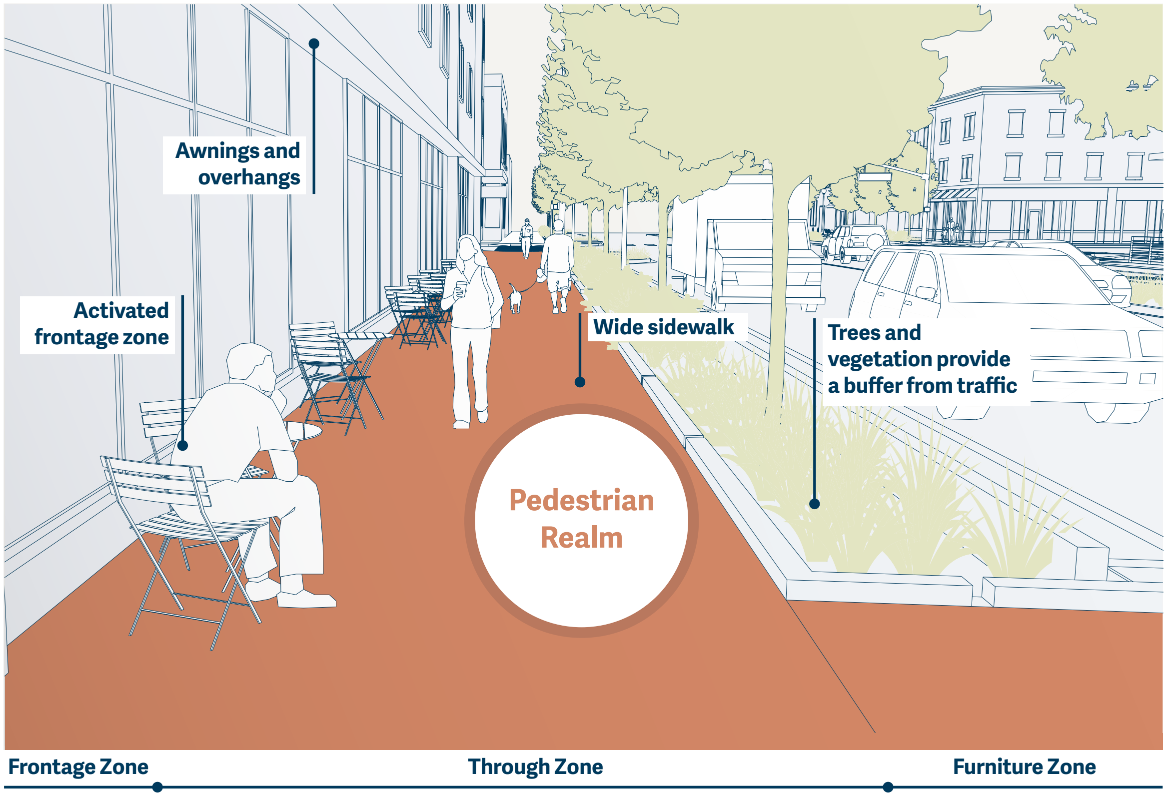
Each of the realms tends to serve different functions. However, in complex and evolving urban areas, the lines between realms are increasingly blurred. Street functions may be served in one realm on one street, and in another on a different street. This is especially true for bicycle access and mobility, transit access and mobility and green street treatments.

The adjacent **land use realm** is typically outside the public right-of-way but includes elements that directly interact with street uses and form the character of the place. Street and trail design should help achieve desired land use, while site planning and building design of adjacent land uses can help support walking, bicycling and transit.

In centers and along some corridors, the land use realm often includes buildings immediately fronting the sidewalk. It may also include plazas, parks, parking, landscaping, industrial uses or natural areas. The land use realm is closely tied to the pedestrian realm.



The **pedestrian realm** includes the area immediately adjacent to the land use realm and typically includes a sidewalk, though alternate designs may include a pedestrian facility at the same grade as other parts of the street. Sidewalks have three zones: the **frontage zone**, the **pedestrian through zone** and the **street furniture zone**. The pedestrian realm provides space for pedestrian access and mobility, while supporting other functions, often including street furniture, street trees and places for people to connect. In many urban areas, the pedestrian realm can be 20 feet or wider. Universally accessible street corners and enhanced crossings provide access to cross the street.



The **travelway realm** is the space in the middle of the street where people travel, typically by motor vehicle, transit and bicycle. The travelway is typically composed of travel lanes and bikeways and can be divided by a median, which can provide a space for street trees or green street treatments and increases safety. In general, narrower travelways (four lanes with a median or less) are best for supporting mobility functions without negatively impacting other street functions such as pedestrian access. The travelway realm includes the area known as the **flex zone**, which is the space immediately next to the sidewalk. The flex zone can serve as a transition area from the pedestrian realm to the travelway realm.

4.3 Design elements

Design elements are the building blocks that make up streets and trails. This section addresses design elements for streets first, followed by trails. Design elements that are applicable to both streets and trails, such as lighting, are addressed last. A list of additional resources for each design element is provided at the end.

Use this graphic to understand how to read and use the design elements. Each design element includes a description and a preferred design approach. Some include guidance on applying the design element to the different street design classifications. Additional design resources for each design element are provided at the end of this chapter.

Sidewalks

The pedestrian realm typically includes a sidewalk and offers space for walking, lingering and connecting to transit, other people, businesses and community spaces. Sidewalks have three zones: the frontage zone, the pedestrian through zone and the street furniture zone.

The **frontage zone** is immediately adjacent to buildings or other fronting land uses. This zone serves as a business's front door to the community, connecting to passersby through sidewalk seating or outdoor displays. Overhangs, signs, and restaurant seating are common features. It also provides the shy distance needed from buildings, walls and other structures to create a comfortable walking experience.

Young people find a welcoming space on a sidewalk in downtown Portland. Design elements such as trees, places to stop and rest, art and other visually interesting features, active land uses, buffers from traffic and access to transit help make sidewalks integral parts of the community.

The **pedestrian through zone** is a clear space for people moving along the sidewalk. It must be accessible and comfortable for all users, with sufficient space for the anticipated number of pedestrians. A wider pedestrian through zone is needed in high-traffic areas.

The **street furniture zone** is a buffer space between the pedestrian through zone and the street. It is often at the same level as the sidewalk, though sometimes uses in the flex zone, such as parking, can serve as the buffer. This space can include elements such as street trees, stormwater facilities, seating, transit stops, bike share stations, utilities and lighting. It also creates separation between users, which is important when users, such as pedestrians and motor vehicles, are traveling at different speeds (known as speed differentials).

The three zones serve unique roles and together can create an inviting pedestrian environment. The overall width and design features of each zone are determined primarily by the land use context and level of pedestrian activity.

Design approach

✔ **Wider frontage zones are typically preferred in centers and business districts.** In constrained areas, a minimum of 18-inches of shy distance is needed from walls.

✔ **Sidewalk cafes need a minimum of 2-feet of space** for a table and a chair.

✔ **Pedestrian through zone widths should allow two people walking or using a wheelchair to move side by side,** typically 6-to 9-feet of space. To meet American with Disabilities Act standards, a minimum of 5-feet wheelchair passing space at intervals of no more than 200 feet is required.

✔ **On streets with lower pedestrian volumes**, 6 feet is a typical pedestrian through zone width.

✔ **Along transit corridors**, a pedestrian through zone of at least 10 feet is desired.

✔ **At least a 5-foot buffer between the sidewalk and moving vehicles is desirable on higher speed streets.** In other areas, 4 feet is adequate. The minimum buffer width is 2 feet.

✔ **Locate street furniture to allow places for passenger pickups and drop-offs.** People generally need about 3 feet to open the car door and step out.

✔ **Incorporate vegetation and street trees in the buffer** to enhance the pedestrian realm. Street trees and landscaping need at least 4 feet of space. Refer to the **green streets design element** for further guidance.

✔ **Always include pedestrian-scale lighting along sidewalks and at street crossings.** Review the street and trail **lighting design element** for more information.

✔ **Pedestrian access to transit is a key consideration.** Refer to the **transit stop design element** for further guidance.

✔ **Safe pedestrian crossings** is a key element of pedestrian travel. Refer to the **intersections and crossings design elements** for the preferred design approach for pedestrian crossings.

Application

	Sidewalks						
	Frontage zone		Pedestrian through zone			Street furniture zone	
Design classifications	Awnings (18-inch minimum)	Sidewalk cafes (2-foot minimum)	5-to 6-feet unobstructed	6-to 8-feet unobstructed	Greater than 8-feet unobstructed	Minimal buffer (2 feet)	Typical buffer (4-to 8-feet)
Freeway	–	–	–	–	–	–	–
Highway	⊖	⊖	○	○	⊖	⊖	○
Regional boulevard	⊕	○	⊖	○	⊕	⊖	⊕
Community boulevard	⊕	⊕	⊖	○	⊕	⊖	⊕
Regional street	○	○	○	⊕	○	⊖	⊕
Community street	○	○	○	⊕	○	⊖	⊕
Industrial street	⊖	⊖	⊕	○	○	○	⊕

⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

Street corners

Every intersection in the transportation system creates street corners, the space where sidewalks come together. Pedestrians leave the sidewalk to cross the street at street corners, and vehicles, trucks and bicycles make turns around them. Transit stops are often located at or near them. Street corners, in conjunction with adjacent land uses, can also serve as places for entertainment, gathering, speaking or other activities, and provide a placemaking function.

A truck apron in the St. Johns Town Center allows a large freight truck to make a turn while slowing other turning vehicles and providing additional buffer between traffic and pedestrians waiting to cross the street.

Design approach

✔ **Corner radii should be designed to shorten pedestrian crossing width on most streets.** Minimizing corner radii (known as tight corner radii) creates compact intersections with slow turning speeds and increases safety.

✔ **In industrial areas, wider curb radii support freight movement. Truck aprons paired with bollards** can accommodate wide truck turns while slowing motor vehicles and providing an extra buffer for pedestrians.

✔ **Perpendicular curb cuts are the preferred design**, making it easier for people using personal mobility devices to cross.

✔ **Curb extensions ensure that people crossing the street are visible to people driving and should be used as appropriate.** They not only enhance safety, they support community placemaking by providing valuable space for stormwater planters, art elements, benches, street lighting, wayfinding and other placemaking elements.

✔ **Street corners must be designed in conformity with Americans with Disabilities Act requirements** to ensure people of all abilities can safely navigate crossings at intersections.

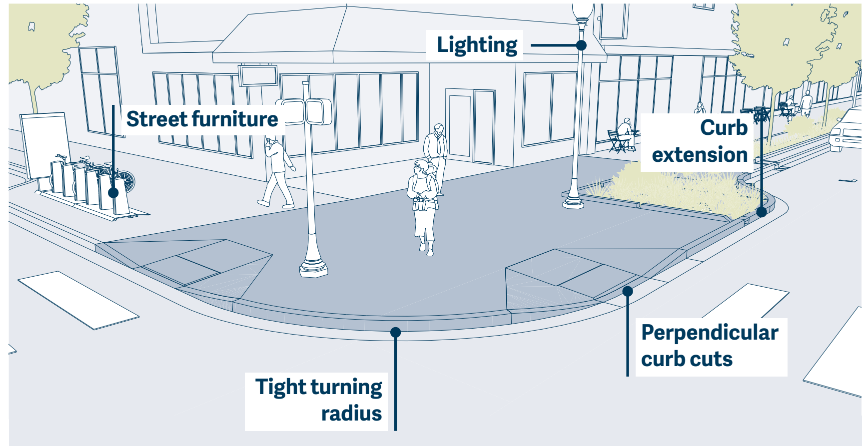
✔ **Channelized right-turn islands (pork chops) should be avoided**, especially for uncontrolled right turns, because they decrease pedestrian safety.

Application

Design classifications	Street corners: Tight corner radii (5 to 15 feet)	Wide corner radii (greater than 15 feet)	Truck apron	Perpendicular curb cuts (two)	Curb extensions
Freeway	–	–	–	–	–
Highway	Not a preferred treatment	Preferred treatment	Potential treatment	Preferred treatment	Not a preferred treatment
Regional boulevard	Preferred treatment	Not a preferred treatment	Preferred treatment	Preferred treatment	Preferred treatment
Community boulevard	Preferred treatment	Not a preferred treatment	Preferred treatment	Preferred treatment	Preferred treatment
Regional street	Potential treatment	Not a preferred treatment	Preferred treatment	Preferred treatment	Preferred treatment
Community street	Potential treatment	Not a preferred treatment	Preferred treatment	Preferred treatment	Preferred treatment
Industrial street	Not a preferred treatment	Preferred treatment	Potential treatment	Preferred treatment	Potential treatment

Preferred treatment   Potential treatment   Not a preferred treatment

Additional explanation



Specific design decisions for street corners are guided by the land use context and the functions the street serves. This figure illustrates a typical street corner. In this example, the street corner is in a town center. The street corner is designed with a tight turning radius. This provides ample space for people to wait to cross the street, for pedestrian scale lighting, a bike share station and other street furniture. The curb extensions shorten the distance for people crossing the street.

Flex zone

The flex zone is the space immediately next to the sidewalk. The flex zone can support a wide range of functions, hence the term “flex.” These include curb extensions, stormwater management features, bikeways, parking, bicycle racks, transit-only lanes, parklets and outdoor seating and pickup/drop-off areas and bike share stations.

Managing the flex zone and prioritizing uses is fundamentally about improving mobility, access and safety for all. “Paint-and-plastic” treatments can establish uses quickly and at relatively low cost, such as safer places to bicycle and more efficient routes for transit. Low-tech signage and high-tech apps are in widespread use to establish priority access by time-of-day, such as off-peak freight delivery and peak-hour transit.

The flex zone can serve a variety of functions. These functions are typically informed by the land use context and the needs of the community. Examples of flex zone uses include bikeways, parking, bus only lanes or travel lanes. Mixing flex zone uses, or providing curbside use beyond on-street parking, can further support desired outcomes.

Design approach

✔ **Flex zone uses should support the priority functions of the street**, based on the design classifications and land use context.

✔ **Use a data-driven, flexible approach to allocating space.** The Institute for Transportation Engineers provides a tool to help prioritize flex zone uses.

✔ **Flex zone uses can shift by time of day** and allow a variety of uses in high-demand areas.

✔ **Manage and price use** when the flex zone is in very high-demand locations. Motor vehicles should pay to park at the curb in these areas.

✔ **A bicycle parking corral** is a recommended use in commercial areas. A single vehicle parking spot can fit up to 12 bicycles in a bicycle corral. Parking for e-scooters, electric bicycles and bike share can also be prioritized in high-demand areas for these uses.

✔ **Loading and unloading zones** should be located to minimize distance from truck to destination.

✔ **Services such as mail delivery and garbage and recycling** require access to the curb based on services providers’ desires, and should be considered in planning.

✔ **Pickup and drop-off zones** should not impede or endanger pedestrians, bicyclists, or transit movement.

✔ **Parklets and outdoor seating** are a recommended use in centers.

✔ **Transit-only lanes or part time-transit only lanes** should be prioritized in high-frequency transit corridors or along high-frequency lines. See the **transit priority treatments design element** for more information.

✔ **Transit stops** can be located in the flex zone on floating islands or bulb-outs. These should be prioritized in high-frequency transit corridors. See the **transit stops design element** for more information on locating transit stops.

✔ **Separated bicycle facilities** should be prioritized on streets designated as a regional bikeway. See the **bikeway design element** for more information.

✔ **Green street treatments** should be prioritized wherever possible. See the **green street and stormwater management design element** for more information.

✔ **Shoulders** are appropriate along freeways and highways. On freeways and highways, shoulders can also be used as bus rapid transit lanes. Shoulders on urban streets are usually unnecessary.

Application

Design classifications	Flex zone uses: Car parking	Bicycle and other parking (scooter, motorcycle)	Loading/ unloading	Pickup/drop-off	Parklets and outdoor seating	Transit only lanes	Transit stops	Separated bicycle facilities	Green street treatments	Shoulder
Freeway	–	–	–	–	–	○	–	–	○	⊕
Highway	⊖	⊖	⊖	⊖	⊖	○	○	○	○	⊕
Regional boulevard	○	⊕	○	○	○	○	⊕	⊕	○	⊖
Community boulevard	⊕	⊕	○	○	○	○	⊕	⊕	⊕	⊖
Regional street	○	○	○	○	⊖	○	⊕	○	⊕	○
Community street	○	○	○	○	⊖	○	⊕	○	⊕	○
Industrial street	○	⊖	○	⊖	⊖	○	⊕	⊕	○	○

⊕ Preferred use ○ Potential use ⊖ Not a typical use

Motor vehicle travel lanes

Motor vehicle travel lanes serve a wide array of vehicles, from buses and trucks to automobiles and bicycles (when there is no separate bicycle facility). Because the travelway often makes up a significant portion of the overall width of the street realm, the number of lanes and their widths has a broad impact not just on people driving but on everyone in the community.

Narrower travel lanes allow for the accommodation of other uses besides motor vehicles within the right-of-way, such as bus-only lanes, separated bikeways or floating transit stops. Additionally, narrower travel lanes decrease the crossing width for people walking and bicycling. On most streets, 10-foot-wide lanes provide the same functionality for people driving as wider lanes and can improve safety for all users.

When designing lane configurations and widths, the full context of the street, its priority functions and the opportunity cost of providing additional or wider travel lanes should be considered.

From the region's busiest streets to local and collector roadways, motor vehicle travel lane design determines how everyone will use and travel along the street.
NE Hogan Drive in Gresham has four lanes with a median divider. A buffered sidewalk provides a comfortable walking experience and an alternative path for a bicyclist who does not want to use the conventional bicycle lane.

Design approach

✔ **Consider all cross-section design elements concurrently** when determining the number and width of motor vehicle travel lanes.

✔ **Default to the lower motor vehicle lane widths, typically 10 feet**, and only increase widths depending on specific needs. Elements adjacent to the travel lane can affect the appropriate lane width.

✔ On streets with **regular transit or freight traffic**, ensure a minimum of a **1-foot shy distance between the lane and vertical objects** such as parked cars, or use an 11-foot outer lane. However, 10-foot travel lanes work in constrained conditions.

✔ **Industrial streets should typically have 11-foot lanes to accommodate higher volumes larger trucks.**

✔ **Transit-only lanes should typically be 11 to 12 feet wide to facilitate transit mobility.**

Application

- ✔ Streets with target speeds of **45 mph or higher, such as freeways and highways, should have 11- or 12-foot lanes.**
- ✔ **Design elements for other modes should not be compromised or eliminated to accommodate turn lanes.**
- ✔ **On bridges, lane width and configuration should remain the same**, to continue bikeway and pedestrian facility width.
- ✔ **Road reorganizations should be considered on multi-lane roads** where safety and transit, bicycle, or pedestrian functions are high priorities.

Design classifications	Motor vehicle travel lanes: Less than 10-foot lanes	10-foot lanes	11-foot lanes	12-foot lanes	Greater than 12-foot lanes	Two-way left-turn lanes	Turn lanes
Freeway	⊖	⊖	⊖	⊕	○	—	—
Highway	⊖	⊖	○	⊕	○	○	⊕
Regional boulevard	○	⊕	○	○	⊖	○	⊖
Community boulevard	○	⊕	○	○	⊖	○	⊖
Regional street	○	⊕	⊕	○	⊖	○	○
Community street	○	⊕	⊕	○	⊖	○	○
Industrial street	⊖	⊖	⊕	⊕	○	⊕	⊕

⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

Access management

Access management refers to policies and designs that influence the location and number of motor vehicle access points (driveways and cross-streets) to adjacent land uses, along with the allowed turning movements at these locations. Access management can create a safer and more comfortable roadway environment for all users.

Chapter 3 describes access and mobility as two separate functions and these functions are fundamentally different for motor vehicles. When motor vehicle access is high, there are many access points and each land parcel may have one or more driveways where all turning movements are allowed. Motor vehicle traffic is less smooth, due to the frequent turning activity on and off the street, and streets with many access points tend to have higher crash rates. Managing the number of access points and restricting turning movements can also improve safety and operations for people walking and bicycling by reducing the number of conflict points they have with turning vehicles.

Access management seeks to enhance the safety of persons traveling by all transportation modes on a street. Limiting where driveways are located and how motorists can access them can increase safety. A driveway on W Burnside in downtown Portland increases the potential for conflict.

Access management tools range from land use code, which can require shared access between parcels, to restrictions on turning movements, to traffic signal strategies.

Access management should be developed and applied on all streets, with the specific tools selected based on the street context and priority functions.

Design approach

✔ **Limit or restrict access to properties on major streets** while providing good street connectivity to support mobility.

✔ **Raised medians manage safe access on streets with four or more through lanes** but require the provision of U-turn opportunities when turning movements into and out of driveways are restricted. See the **median design element** for more information.

✔ **Provide median islands where feasible** on streets with two-way left-turn lanes to manage access along the road.

✔ **Limit left-turning movements on multi-lane roads** to signalized intersections. Left-turning motorists will often look for oncoming motor vehicle traffic but not pedestrians or oncoming bicyclists.

✔ **Evaluate the need for right-turn lanes at driveways** and how it may impact bicycle and pedestrian movements.

✔ **Consolidate and/or reduce driveways or relocate access to side streets and frontage roads** as properties develop.

✔ **Design driveways in conjunction with access management to minimize conflicts with pedestrians and bicyclists** traveling along the street. Use the narrowest driveway width possible to serve the land use. Use apron-type driveways with continuous grade sidewalk except at high-volume driveways, where street-type intersections may be used. For wide driveways, a channelizing island can serve as a refuge for pedestrians crossing.

✔ **Where feasible, construct roundabouts to reduce conflict points and delay for all travel modes.** Roundabouts also facilitate U-turns when a raised median is used to prevent midblock left turns.

✔ Where feasible, **consider frontage roads to minimize the number access points** to serve larger developments.

Application

Design classifications	Access management							
	Medians	Two-way left-turn lanes	Left-turn lanes	Restricted left-turn movements	Right-turn lanes	Reducing access points	Frontage road	Roundabout
Freeway	⊕	⊖	⊖	⊖	⊖	⊕	⊕	⊖
Highway	⊕	○	⊕	⊕	⊕	⊕	○	⊖
Regional boulevard	⊕	○	⊖	⊕	○	⊕	⊖	○
Community boulevard	○	○	⊖	⊕	⊖	⊕	⊖	⊕
Regional street	⊕	○	○	⊕	○	⊕	⊖	○
Community street	○	○	○	⊕	⊖	⊕	⊖	⊕
Industrial street	○	⊕	⊕	⊖	○	⊖	○	○

⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

Medians

Medians serve a variety of purposes on a street and can enhance street safety and livability. They may be landscaped, raised concrete or simply painted. They can extend the length of the corridor or be provided at intersections creating refuge islands for crossing the street. Medians be designed to provide space for lighting, street trees, green streets treatments, traffic control devices, or vehicle turn lanes at intersections and driveways. They serve as pedestrian and bicycle refuge islands at intersections and midblock crossings.

Median refuge islands on E Burnside Street in Portland. In addition to creating safer streets for all users, medians also provide a more comfortable and pleasant experience.

Median design depends on the context and desired functions of a given street. Continuous two-way left-turn lanes may be used in areas with low-to-moderate vehicle speeds and frequent access points, such as residential and commercial areas. Two-way left-turn lanes remove left-turning vehicles from through travel lanes, reducing conflict and delay for the through vehicles. Raised medians restrict turning movements and reduce conflict points along commercial corridors and in centers.

Design approach

✔ **Construct median refuge islands on multi-lane roads** to reduce crossing distances for pedestrians and bicyclists. Refuge islands should be the full width of the median lane minus 0 to 1 foot for shy on each side, but at least 6-feet wide. To ensure the island is visible and sufficiently safe to use, it should extend 40 feet from the edge of crosswalk to the end of the island; at intersections, a bull-nosed design should be used. Shorter lengths may be used if site constraints make a longer island infeasible.

✔ **Emergency vehicles typically need 20-feet of clear width** to be able to deploy equipment and reach upper stories of buildings. Medians may need to be mountable to serve emergency vehicle needs.

✔ **Green street treatments should be included wherever possible within medians** and can be accommodated in a minimum width of 4 feet. Refer to the **green streets and stormwater management design element**.

Application

✔ **Consider exclusive transit space within the median** on streets with high-capacity transit service.

✔ **Use raised concrete medians** in locations where there is not enough width for a landscaped median.

✔ **Identify opportunities to install medians where there is no need for left turns.** Or pair medians at intersections with center turn lanes.

✔ **Use concrete barrier or cable barriers on higher-speed divided highways or freeways** to reduce motor vehicle crash severity.

Design classifications	Medians: Median refuge island	Landscaped median	Green streets treatments	Exclusive transit	Raised concrete median	Two-way left-turn lane	Concrete or cable barrier
Freeway	–	○	+	+	−	−	+
Highway	○	+	+	+	○	○	+
Regional boulevard	+	+	+	+	+	○	−
Community boulevard	○	○	○	○	○	○	−
Regional street	+	+	+	+	+	○	−
Community street	+	○	+	○	○	○	−
Industrial street	○	○	+	−	○	+	○

+ Preferred treatment ○ Potential treatment − Not a preferred treatment

Speed management treatments

The main objective of speed management is to slow traffic to the appropriate speed for its context and includes a variety of strategies that promote lower vehicle speeds. Achieving a relatively low motor vehicle target speed, typically between 20 and 30 mph, provides a safer environment for all travel modes. Slower speeds do not necessarily lead to congestion or significant increases in travel time. Speed management treatments can be applied to any type of street, from residential streets to arterials. The strategies appropriate for a given street will vary based on the street type and context.

Lower speeds create a better environment for walking and bicycling, NE Division Street in Portland.

Typical speed management design treatments

- ✔ **Median islands** prevent motor vehicles from making a side street through movement or left turn, reducing conflict points. Landscaped medians have a narrowing effect that encourages slower speeds.
- ✔ **Curb extensions** slow down motor vehicle traffic along a road by constraining the roadway.
- ✔ **Speed feedback signs** provide real-time feedback on vehicle speeds next to a roadway's posted speed limit, alerting motorists when they are driving too fast.
- ✔ **Narrow motor vehicle lanes** (typically 10 feet wide) create a more constrained motor vehicle space, prompting motorists to exercise caution.
- ✔ **Roundabouts** provide yield-controlled access to all vehicles approaching an intersection, which encourages vehicles to slow while passing through the intersection.
- ✔ **Road reorganizations** reallocates one or more travel lanes on a multi-lane road to transit or non-motorized travel uses, creating a more constrained motor vehicle space and reducing speeds.
- ✔ **On-street parking**, when occupied, visually narrows the travelway and effectively slows down motor vehicle traffic along a road.
- ✔ **Street trees and furniture** visually create a narrower space for motor vehicles, which helps reduce travel speeds.
- ✔ **Signal timing progressions** can be programmed for vehicle travel at any speed. Slower speed progressions encourage slower midblock travel speeds, as drivers know they will have to stop and wait at the next intersection otherwise.
- ✔ **Pavement markings and surface treatments** provide visual (and sometimes audible) cues for drivers to slow down.
- ✔ **Raised intersections** elevates the roadway grade through an intersection or midblock crosswalk, prompting drivers to slow as they navigate the intersection.
- ✔ **Traffic diverters** limit the movement of motor vehicles to a single direction, forcing drivers approaching an intersection (typically from low-volume local streets) to turn onto the cross-street where other transportation uses are prioritized. Although used primarily to manage traffic volumes, traffic diverters also calm speeds by forcing a turn and thereby eliminating a longer straightaway.

✔ **Speed humps, speed bumps, and speed cushions** are vertical traffic calming features that force motor vehicle drivers to slow down to avoid feeling an uncomfortable bump as they drive over the feature.

✔ **Neighborhood traffic circles**, typically found on low-traffic streets, reduce speeds even more.

Application

Design classifications	Median	Curb extensions	Speed feedback signs	Narrow lanes	Roundabout	Road reorganization	On-street parking	Street trees and street furniture	Signal timing progressions	Pavement markings	Raised intersection	Traffic diverter*	Traffic circle*	Speed hump or bump*
	Speed management treatments													
Freeway	⊕	–	○	–	–	–	–	–	–	–	–	–	–	–
Highway	⊕	⊖	○	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖
Regional boulevard	⊕	⊕	○	⊕	○	⊕	⊕	⊕	⊕	⊕	○	⊖	⊖	⊖
Community boulevard	○	⊕	○	⊕	⊕	○	⊕	⊕	⊕	⊕	⊕	⊖	⊖	⊖
Regional street	⊕	⊕	○	⊕	○	⊕	⊕	⊕	○	⊕	○	⊖	⊖	⊖
Community street	○	⊕	○	⊕	⊕	○	⊕	⊕	○	⊕	⊕	⊖	⊖	⊖
Industrial street	○	○	○	⊖	○	○	⊖	○	○	○	○	⊖	⊖	⊖

⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

* While these treatments are not typically appropriate on arterials and throughways, they can be very useful for traffic calming on local, residential streets.

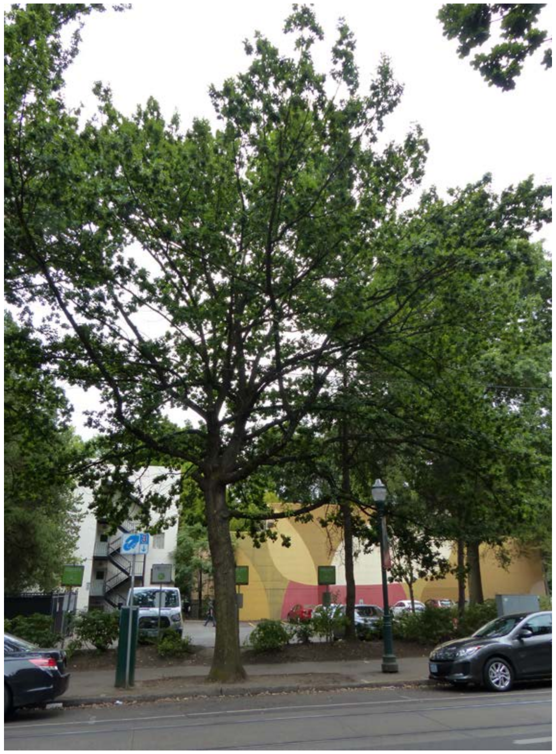
SPEED MANAGEMENT TREATMENTS

Green streets and stormwater management

A green street maximizes stormwater management on site and is designed with natural systems in mind. These treatments may contribute in fostering safe pedestrian, bicycle, transit and motor vehicle access and connectivity.

Stormwater management methods within the street right-of-way use systems of vegetation and soil to store and treat runoff, as well as reduce pollutants, enhancing watershed health.

Streets are primarily made up of impervious surfaces. As precipitation falls on these hard surfaces, it becomes stormwater runoff that needs to be directed away from the street surface. The traditional method of handling stormwater runoff has been funneling it into subsurface pipes that lead to water treatment plants or discharge directly into water bodies. This management approach requires major infrastructure costs and creates potential environmental impacts to waterways. Green streets, including street trees, can reduce these negative outcomes.



In addition to helping manage stormwater, street trees provide many benefits, giving shade in the summer, buffering pedestrians and bicyclists from traffic, serving as wildlife habitat and creating a sense of place. Street trees make a quiet, cool place to walk on a busy arterial in Portland's Lloyd District.

Green street and stormwater management design elements

Planters are structured facilities with hard walls, generally flat bottoms, soil and vegetation. They can be designed to infiltrate water into the ground or with impermeable liners where that is not feasible. Planters are often used as one of a series of facilities within a streetscape to meet stormwater requirements. A series of planters on Second Street in downtown Lake Oswego provides stormwater management within the right-of-way.

Curb extensions with landscaping are similar to planters: they have hard edges, generally flat bottoms, soil, vegetation and the option of impermeability. The defining aspect of this facility type is their placement within the flex zone realm as a landscaped curb extension adjacent to corners, at midblock locations or at pedestrian crossings. Landscape extensions can also be combined with adjacent planters within the pedestrian realm to maximize stormwater capacity. This landscape extension is on E Burnside Street in Portland.

Basins (or rain gardens) are facilities that are depressed relative to the street elevation, with bermed side slopes, flat bottoms, soil and vegetation. Basins are used where infiltration rates into the ground are acceptable. They are typically used as a single facility to handle larger volumes of water within a catchment area. This stormwater basin on Warner-Milne Road in Oregon City is set off to the side of the street, with street runoff going into inlets that drain into the basin.

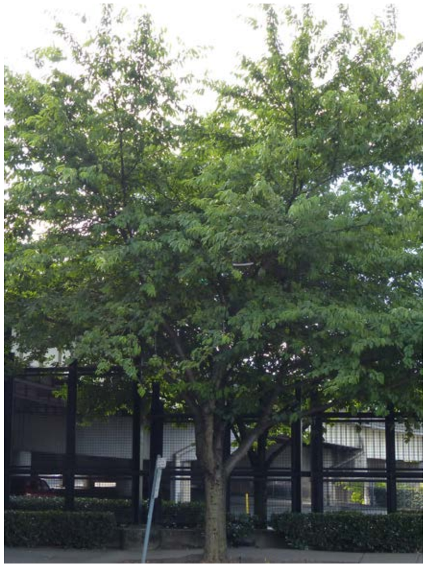
Swales are depressed landscape strips with sloped earthen sides. Swales take up more room within the right-of-way than planters because they lack a hard edge and need side slopes to match adjacent street and sidewalk grades. Swales also convey water parallel to the roadway along their sloped surfaces, which can further reduce subsurface drainage pipe needs. This streetside swale in SW Portland flows with the street slope.

Ponds and constructed wetlands are large, depressed facilities with earthen side slopes. Similar in concept to basins but larger in size, they are often used to handle large runoff volumes from an extensive catchment area. This pond is alongside Brookwood Parkway in Hillsboro. Ponds require large spaces to be installed and require maintenance roads and fencing, which should be a consideration when choosing this facility type.

Stormwater medians allow runoff to be managed in the center of the street rather than along the sides. Most streets are designed to be crowned, so water flows to the outside edges of the street. In contrast, with stormwater medians, the roadway cross-section is oriented to allow water to flow toward the center of the street. This median on SW 124th Avenue in Tualatin has a swale in the center. The roadway slopes from one side of the street to the other, and additional storm facilities were provided at the low-elevation end of the cross-slope for additional storm capacity.

Hybrid stormwater facility types can be mixed to form unique facility designs, appropriate for the street context. Hybrid facilities allow for additional flexibility in choosing designs that can best meet a street's dimensional or cost constraints.

This hybrid facility on SE Division Street in Portland includes a landscaped extension in the flex zone that extends into the furniture zone with a bermed and vegetated side slope at the sidewalk edge.



Street trees are a central element of a green street and are indispensable to a street's attractiveness and comfort. Every part of a tree helps naturally manage stormwater. Trees come in different shapes, colors, foliage types, root systems and sizes that affect how space is defined, how much shade is provided and how much rainfall will impact the urban environment. Large canopied trees typically maximize benefits. Available soil volume is the greatest constraint to growing large canopied trees. Multiple street elements, such as pavement, compacted soils and utility lines directly compete with a tree's ability to grow.

Stormwater trees are a new design technology in which stormwater management occurs within suspended pavement or structural cell systems filled with a specially designed soil mix and planted with trees. Runoff is directed into the system by diverting adjacent street inlet runoff into these systems, where it runs through the soil mix and tree roots. As the water flows through the soil, it is treated, temporarily stored and appropriately discharged away from the stormwater tree systems. This design option is one of the most compact design choices for streets with limited space.

Pervious surfaces are paving types that allow water to permeate through the surface, but which are strong enough to support pedestrians, bicycles and sometimes motor vehicles. Firm pervious pavement surfaces for streets and trails include porous asphalt, porous concrete and permeable unit pavers. Paving types include permeable pavers which allow water passage between the paver joints, and permeable asphalt and concrete. Permeable asphalt and concrete are load-bearing pavements that are similar in appearance to the pavements seen on most roadways in greater Portland. These pavement types are poured in place with fine aggregate removed from the mix, which allows water to pass through the pavement.

Design approach

Stormwater management

✔ **Refer to local stormwater facility design standards and specific performance measures for treating stormwater.** Local requirements vary, including the criteria for triggering stormwater requirements, where and how much runoff must be treated, and whether a particular type of facility is allowed.

✔ **Maximize green street and stormwater treatments to reduce stormwater pollution and manage runoff volumes.** Use vegetated facilities that infiltrate to the maximum degree possible.

✔ **Handle stormwater near the source** and integrate it into the street design.

✔ **Planters are ideal for many street types** because they provide ample stormwater storage volume in a compact space.

✔ **Curb extensions with landscaping are good on streets with on-street parking** and can also contribute to pedestrian safety and access when designed in combination with pedestrian crossings.

✔ **Basins work well in large, odd-sized right-of-way remnants** away from major pedestrian cross-traffic areas.

✔ **Swales are a good choice where space is available** and a continuous buffer from the roadway is desirable.

✔ **Ponds are a good tool to use where a large-enough space is available and ground infiltration rates are not ideal for basins.** They can store water temporarily or longer-term and are designed with a permanent wet pool that settles pollutants. Outlet control structures, designed to regulate the water leaving the site, are integral to ensuring proper operation.

✔ **Medians with swales should be carefully deployed** in areas where pedestrian crossings are anticipated; they may present challenges to people crossing the street.

✔ **Design low curbs or rails along facilities adjacent to pedestrian routes** to protect people from falling into the facilities.

Street trees

✔ **Preserve existing trees and plant new trees** with transportation projects to intercept rainfall before it hits impervious surfaces.

✔ **Consider site context and adjacent structures, street classification and available rooting space** for the tree species under consideration in new plantings. Refer to Metro's *Trees for Green Streets* guide for information on different tree species.

✔ **Plant the largest canopy tree** possible for the site context to increase stormwater and other benefits.

✔ **Transportation projects should seek to maximize the available soil volume to provide trees with the largest canopy.** Several methods are available to grow trees to maturity, including structural soils, root paths, a continuous trench, and/or suspended pavement and structural cells (refer to the glossary for definitions of these terms).

✔ **Plant trees in maximum available growing spaces**, rather than the minimum standard, wherever possible; 4-feet square is the minimum required space.

- **Trees can be planted inside or outside stormwater facilities**, but both locations require considering a number of potential conflicts such as utilities.
- **Larger tree species will need more than 1,000-cubic feet of soil to grow well** and reach mature size. Any given site may present individual challenges for a tree's successful growth.
- **Consider planting trees in the easiest-to-plant spaces first**, to maximize the ability for the trees' roots to grow.
- **Select tree species which reduce maintenance burdens** that are site-sensitive and climate-resilient.

Pervious surfaces

- **Minimize impervious paving** to limit runoff by minimizing width of roadway and using pervious paving where appropriate.
- **Minimize impermeable pavement sections within the street design**, while still fulfilling the priority functions and providing safe, accessible movement.
- **Select appropriate pavement for accessible routes.** Most permeable pavers on the market meet Americans with Disabilities Act requirements; however, their application should be evaluated carefully in areas with significant levels of pedestrian activity.
- **Pervious pavement applications are evolving and should be considered in conjunction with other stormwater treatments** and within the context of the street.
- **Pervious pavements are particularly recommended in areas that have been identified as susceptible to flooding** and in areas where space constraints prohibit street trees or other green street treatments.
- **Permeable pavers should be installed with a restraining edge**; they come in many shapes and colors.
- **Permeable pavers may need additional subsurface rock layers** for detention and/or underdrain pipes in areas with low infiltration rates.
- **Consider the maintenance needs of different pavement types** and where they are installed (street or pedestrian surface) and the capabilities of the agencies responsible for maintenance.

Bikeway design

Designing for bicyclists of all ages and abilities requires an approach that selects bicycle facilities based on surrounding land uses, bicyclist destinations, and street characteristics such as street size, traffic speeds and motor vehicle, transit and bicycle volumes.

Bikeway design treatments

Shared lanes mix bicycle and motor vehicle traffic on low-traffic streets. Pavement markings alert drivers to expect bicyclists on the street and alert bicyclists to take the lane. Bicycle boulevards are signed bicycle routes, often parallel to higher-volume streets, which employ shared lanes; these may include traffic calming treatments to manage motor vehicle speeds and volumes. This bicycle boulevard is in downtown Gresham.

Conventional bicycle lanes are typically 6 feet wide and located immediately adjacent to motor vehicle travel lanes. This type of facility is appropriate for streets with lower operating speeds. This bicycle lane is on NE Cornell Road in Hillsboro.

Buffered bicycle lanes provide a striped buffer of 2 feet or more adjacent to the bicycle lane which increases the horizontal separation between bicyclists and motor vehicles. This buffered bicycle lane is on NE Williams Avenue in Portland.

Separated bicycle lanes are located within the street right-of-way, but are physically separated from motor vehicles with a vertical element such as a curb, wands, planters or parked vehicles. The bicycle lane can also be at the same level as the sidewalk. These facilities are more comfortable for bicyclists and can attract users with a variety of skills and comfort levels. This is the preferred design for on-street trail connections. Refer to the **regional trails design elements** for information on multiuse paths and on-street trail connections. This separated bikeway is in Orenco Station in Hillsboro.

Two-way separated bicycle lanes are the same as separated bicycle lanes, but both directions of bicycle travel are located on one side of the street. The overall width needed for a two-way separated bicycle facility is less than a separated bicycle lane on both sides of the street. This two-way bikeway is on NE 21st Avenue crossing I-84 in Portland.

Image: BikePortland

Shared bus and bicycle lanes allow buses and bicycles to use the same lane on a street. In places where bus frequencies are not high, these lanes provide space for the two modes to operate at similar speeds. Buses are discouraged from passing bicyclists, and bicyclists are encouraged to pass buses only when they are stopped to load and unload passengers. SW Madison Street in Portland.

Design approach

✔ **Design the bicycle facility to serve anticipated future bicyclist volumes** and other potential users.

✔ **Low-volume, low-speed streets are suitable for shared street bicycle infrastructure.** Bicycle movement should be prioritized on these streets.

✔ **Separated bicycle lanes are the preferred treatment** on streets with higher traffic volumes and speeds.

✔ **Consider two-way separated bicycle facilities** when destinations are on one side of the street, to connect off-street trail segments, on streets with extra right-of-way, or in constrained rights-of-way.

✔ If a separated bicycle lane is not feasible in the short term, a **conventional or buffered bicycle lane and a parallel bicycle route** should be implemented. Construct parallel facilities to be comfortable for bicyclists all ages and abilities. These routes should be equally direct and provide wayfinding to destinations on the parallel street.

✔ **A 2.5-to 3-foot buffer between bicycles and parked cars** will move bicyclists out of the door zone.

✔ Review the **regional trails design element** for guidance on designing for bicycles and multiuse paths.

✔ **Consider bus/bicycle shared lanes in constrained right-of-way**, separating and prioritizing these modes of transportation over automobiles. Refer to the **transit stop design element** for guidance regarding bus stops.

Preferred bikeway design by traffic speed and volume

Motor vehicle speed	Daily motor vehicle volume	Preferred bikeway design
<20 mph	<1,500	Bicycle boulevard Shared lane markings
<25 mph	<3,000	Conventional bicycle lanes
25- 30 mph	<6,000	Buffered bicycle lanes
>30 mph	>6,000	Separated bicycle lanes Multiuse path

Preferred widths for one-way and two-way bikeways, by volume

Peak hour volume	Preferred width	Minimum width	Preferred buffer	Minimum buffer
ONE-WAY				
<150	6.5 feet	5 feet	3 feet	1 foot
150-750	8 feet	6.5 feet	3 feet	1 foot
>750	10 feet	8 feet	3 feet	1 foot
TWO-WAY				
<150	11 feet	10 feet	3 feet	1 foot
150-350	12 feet	11 feet	3 feet	1 foot
>350	16 feet	14 feet	3 feet	1 foot

Application

Design classifications	Bikeways: Shared streets*	Conventional 6-foot bicycle lane*	Buffered bicycle lane	Separated bicycle lanes (one-way)	Separated bicycle lanes (two-way)	Shared bus and bicycle lanes	Parallel facility (multiuse path or street)	Multiuse path (shared alignment)
Freeway	—	—	—	—	—	—	⊕	⊕
Highway	⊖	⊖	⊖	○	○	⊖	⊕	⊕
Regional boulevard	⊖	⊖	○	⊕	○	○	○	○
Community boulevard	○	⊖	○	⊕	○	○	○	○
Regional street	⊖	⊖	○	⊕	○	○	○	○
Community street	○	⊖	○	⊕	○	○	○	○
Industrial street	⊖	⊖	○	⊕	○	⊖	⊕	⊕

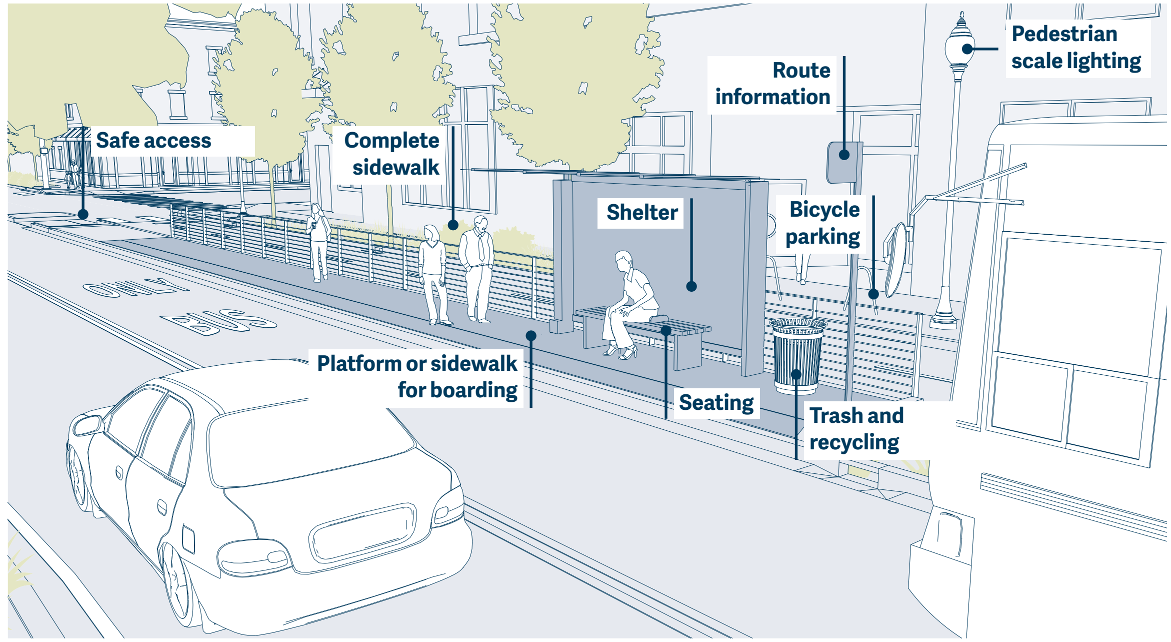
⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

* Due to motor vehicle traffic volume, these facilities do not serve most potential users on streets with regional design classifications; however, these designs may be appropriate for lower-volume, lower-speed streets.

Transit stops and stations

Transit stops and stations serve as pickup and drop-off locations for people using transit service. The quality and comfort of transit stops are highly dependent on the surrounding pedestrian environment. Every transit rider is a pedestrian at some point during their trip. Complete and connected sidewalks, safe street crossings, and buffers from traffic all contribute to the functionality and comfort of the transit stop.

Transit stop features vary widely depending on the surrounding context, from a sign with the transit line number, to shelters and benches, to a transit platform with level boarding and real-time arrival information. Other stop design considerations include stop placement along the street, boarding platforms and interactions with bicyclists.



This graphic illustrates different design elements that support safe and comfortable pedestrian access, transit mobility and bicycle mobility at transit stops and stations, such as: pedestrian scale lighting, bench, shelter, enhanced crosswalk and a bus boarding island with a bicycle bypass.

Transit stop placement

Far-side stops are located after an intersection. Far-side stops take advantage of any signal progression provided to general traffic, increase the potential benefit of transit signal priority, and reduce the potential to stop twice at the intersection (once to serve passengers and again for the traffic signal, as at a near-side stop). Far-side stops allow pedestrians to cross the street behind the transit vehicle at a marked intersection crosswalk.
E Burnside Street in Portland.

Near-side stops are located before an intersection. Near-side stops work well at stop-controlled intersections, signalized intersections where the transit vehicle would usually arrive on red, stops where transit destinations or transfer opportunities are on the near side of the intersection, and stops where the average dwell time is 75 percent or more of the traffic signal cycle length. Near-side stop placement should discourage right-turning vehicles from passing the stopped transit vehicle but should also be set back far enough to not impede visibility for (and of) crossing pedestrians. E Burnside Street in Portland.

Midblock stops are located away from intersections in the middle of a block. These stops are usually near major destinations or on streets with long blocks. There are challenges to providing safe pedestrian access to midblock transit stops. People accessing this midblock stop on outer SE Division Street, where street connections and signalized intersections are further apart, would benefit from an enhanced midblock crossing. See the **enhanced and midblock crossing design element**.

Transit stop placement

In-lane stops allow the transit vehicle to stop without leaving the through travel lane. In-lane stops are preferred because they eliminate the delay buses experience trying to re-enter the travel lane after serving a bus stop. In-lane stops may require curb extensions on streets with on-street parking. SW Hall Boulevard in Beaverton.

Pull-out transit stops require the transit vehicle to pull out of the through travel lane to serve a stop. While these stops can cause transit vehicles to be delayed re-entering traffic, they can also provide an opportunity to use a queue jump when combined with a near-side stop at a signalized intersection. NE Multnomah Street in Portland.

Transit stop and bikeway design configurations

To avoid the "leapfrogging" phenomenon where a bicycle passes a stopped bus only to be passed by the bus after it leaves the stop, best design practice takes the bicycle infrastructure out of the road and integrates it with the bus stop.

Bicycle bypasses shift a curbside bicycle lane laterally to allow it to run behind the transit stop. Most designs raise the bicycle bypass to the level of the transit stop, with a marked pedestrian crossing across the bicycle lane. A narrowed bicycle lane can be used to induce slower bicycle speeds at the stop. Yesler Way in Seattle: Photo: Roger Geller, PBOT.

Separated bicycle lanes run behind a transit stop with no lateral shift. A separated bicycle lane, if not already at curb height, should be brought up to match the level of the bus stop for pedestrian crossing ease. A narrowed bicycle lane can be used to induce slower bicycle speeds at the stop. This separated bicycle lane on NE Halsey Street in Portland is not raised up, but does provide green paint and markings for pedestrian safety.

Bicycles up and over design has no lateral shift and eliminates the island for the transit stop. Transit passengers board directly from the bicycle lane or onto a small "step out" zone. Hawthorne Bridge. Photo: Roger Geller, PBOT.

Bicycle and bus mixing zone where the bus pulls across the bicycle lane. Bicyclists either stop behind the bus and wait, or pull around the bus into the travel lane.

TRANSIT STOPS AND STATIONS

Design approach

✔ **Far-side transit stops are generally the preferred design.**

✔ **Safe, enhanced crossings with lighting should be located at or near transit stops**, generally within 100 feet of the stop.

✔ **Pedestrian-scale lighting** should be located at transit stops.

✔ **Universal design treatments, such as paved landing pads and accessible curb ramps, must be used** to ensure safe and comfortable access to and from the transit stop for people of all abilities.

✔ **Complete, accessible sidewalks and paths** connected to transit stops are critical for access.

✔ **Transit stop amenities should be included whenever possible.** Depending on passenger boarding volumes at the stop, these may include seating, shelters, real-time and posted transit information, wayfinding, bicycle parking, trash and recycling and art.

✔ **Bikeway design at stops should seek to manage conflicts** between bicyclists, transit vehicles and boarding and alighting passengers while maintaining transit and bicycle mobility.

✔ **Bicycle bypasses or separated bicycle lanes at transit stops are typically the preferred design.**

✔ **Bicycles up and over can be considered where right-of-way or budget constraints** do not allow for a full transit island or where volumes of people walking and biking are expected to be low.

Application

Design classifications	Transit stops and stations: Placement					Bikeway design			
	Far-side stop	Near-side stop	Midblock stop	In-lane stop	Pull-out stop	Bicycle bypass	Separated bicycle lanes	Bicycles up and over	Bicycle and bus mixing zone
Freeway	–	–	–	–	–	–	–	–	–
Highway	○	○	⊖	⊖	⊕	○	⊕	○	⊖
Regional boulevard	⊕	○	○	⊕	○	⊕	⊕	○	⊖
Community boulevard	⊕	○	○	⊕	○	⊕	⊕	○	○
Regional street	⊕	○	○	⊕	○	⊕	⊕	○	⊖
Community street	⊕	○	○	⊕	○	⊕	⊕	○	○
Industrial street	⊕	○	○	⊕	○	⊕	⊕	○	○

⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

Transit priority treatments

Design treatments that increase the reliability and efficiency of transit are called transit priority treatments. Priority treatments can be made systemwide, along entire corridors or at specific hotspot locations depending on need.

Transit service is provided by a wide variety of vehicle and service types and corridor designs. Commuter rail (for example, WES) typically operates on a separate right-of-way. Light rail (MAX) operates in a separate right-of-way or in an exclusive guideway within the street right-of-way, such as in the median or in an exclusive lane. Bus rapid transit, streetcar and frequent bus service have semi-exclusive transit treatments that can range from exclusive lanes and guideways to mixed-traffic operation in combination with transit preferential treatments. Other types of bus and paratransit service operate in mixed traffic. Developing street designs to support transit requires an understanding of the type of transit service that will use the street. The type of transit service will influence the design treatments.

Transit only lanes get buses, trains and streetcars out of regular traffic, prioritize transit mobility and improve reliability and travel times.

Level boarding platforms for bus, streetcar and MAX improves service for passengers and reduces loading and unloading times.

Types of transit priority treatments

Exclusive transitways provide grade-separated right-of-way for public transportation. Exclusive transitways are typically used for frequent service routes.

Transit-only lanes dedicate a portion of the street right-of-way (typically a curb lane or an area in the center of the street) to the sole use of transit vehicles.

Business access and transit (BAT) lanes are exclusive transit lanes that permit other traffic to enter to make a turn across the lane to access businesses.

Part-time transit-only lanes dedicate the flex zone for use as an exclusive transit or BAT lanes during peak periods. During other periods, the space can be used for a motor vehicle travel lane, on-street parking or other uses.

Queue jumps provide a green signal to transit vehicles at a signalized intersection ahead of other travel lanes, allowing the vehicle to continue its trip ahead of the other vehicles. Queue jumps require a transit-only lane, which can be a short, dedicated lane, or a right-turn lane that exempts transit from the turn requirement, allowing the transit vehicle to be served independently of general traffic in the same direction.

Transit signal priority adjusts traffic signal timing to reduce transit vehicle delays at signalized intersections and improve schedule reliability.

Signal progression times traffic signals so vehicles receive a series of green lights as they progress from one signal to the next. The “green wave” can be set to progress traffic at a target speed for general motor vehicle traffic or bicycle traffic, or at a speed corresponding to the average transit speed with stops.

Bus on shoulder operation allows buses to travel on the freeway or highway shoulder during congested time periods, providing a time advantage for transit over driving.

Level boarding brings the transit stop to the same height as the door to the transit vehicle, which improves service for passengers with disabilities and reduces delays related to lift deployments.

All-door boarding allows transit passengers to prepay their fare and then enter the transit vehicle using any door. This reduces dwell time at stops, compared to when all passengers enter through the front door and pay their fare on board.

Transit stop consolidation combines two or more existing stops into a single stop to reduce the number of stops that a transit vehicle needs to make along its route.

See the **transit stop design elements** for guidance on treatments at transit stops and stop placement that prioritize transit.

Design approach

✔ **All transit projects should examine possible transit priority treatments** to create faster and more reliable service.

✔ **Provide exclusive transitways or transit only lanes** whenever possible on streets with high-capacity or frequent service transit. When this is not possible, maximize transit priority through other treatments.

✔ **Removing parking and reducing adjacent lane widths can create a transit-only lane** on multi-lane streets.

✔ **Bus-on-shoulder operation is an option for highways and freeways** with wide shoulders and routinely congested conditions.

✔ **Designate exclusive space for transit vehicles at specific pinch points**, such as an approach to a bridge or major intersection.

✔ **Signing, striping, pavement coloring, and enforcement** help make motorists aware of transit lanes and can increase compliance.

✔ **Consider peak-only transit lanes on congested street segments**, where on-street parking can be prohibited during peak periods, with the space dedicated to transit operations.

✔ **Business access and transit lanes** are an option in corridors where right-turn access for general traffic is preserved, although the speed and reliability benefit for transit vehicles is not as great as with exclusive transit lanes.

✔ **Pre-signals** are an option for providing a virtual transit lane on a congested intersection approach where a transit-only lane is infeasible.

✔ **Signals can be programmed to keep transit vehicles moving**, including both passive (signal progression) and active (queue jumps, transit signal priority) treatments.

✔ **All-door boarding, level boarding, in-lane bus stops, and stop consolidation can eliminate small delays** that add up over the length of a transit line.

✔ **Where both transit lanes and separated bicycle lanes are included in a street, careful consideration of the treatment at intersections** is needed to ensure safety and travel time are improved for transit and bicyclists. See the **transit stops design element** for guidance.

Application

Design classifications	Transit priority treatments: Exclusive transitway	Transit-only lanes	Part-time transit-only lanes	Business access and transit (BAT) lanes	Queue jumps	Transit signal priority	Signal progression	Bus on shoulder	Level boarding	All-door boarding	Transit stop consolidation
Freeway	⊕	○	○	–	–	–	–	⊕	–	–	–
Highway	⊕	○	○	⊖	⊖	○	⊕	⊕	⊕	⊕	⊕
Regional boulevard	○	⊕	⊕	○	⊕	⊕	⊕	–	⊕	⊕	○
Community boulevard	○	○	⊕	○	○	⊕	○	–	⊕	⊕	○
Regional street	○	⊕	⊕	○	⊕	⊕	⊕	–	○	○	○
Community street	○	○	⊕	○	○	⊕	○	–	○	○	○
Industrial street	○	○	○	○	○	○	⊕	○	○	○	⊕

⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

Signalized intersections

Traffic signals control pedestrian, bicycle, transit, freight and motor vehicle movements at busy intersections. Pedestrian, bicycle and transit travel through intersections should be prioritized. The *Signalized Intersections* presents nine signal warrants related to motor vehicle volumes, pedestrian volumes, school crossing locations, coordinated signalization, crash history and intersections near railroad crossings to help inform whether it is appropriate to install a signal at a given intersection.

Thinking about intersections within the context of the overall street network helps clarify which locations would benefit most from a traffic signal. This process should consider how a signal would affect transit, bicycle and motor vehicle speed and flow, as well as safety for all modes. Specific travel movements or travel modes can be examined to see if they would benefit from a systemwide approach to timing signalized intersections.

Signalized intersections stop traffic moving in one direction. Short cycle lengths minimize delay for people walking and bicycling. Beaverton regional center.

Design approach

Overall intersection

✔ **Provide adequate visibility for all users** by maintaining sight triangles clear of obstructions.

✔ **Design for predictable movements** by providing consistent signal phasing, such as leading pedestrian intervals at all signals. Doing so sets consistent user expectations and leads to reduced crash rates and crash severity.

✔ **Provide protected signal phasing for pedestrians and, where feasible, bicyclists.**

✔ **Manage signals to minimize conflicts between different travel modes**, avoiding designs that create high-volume motor vehicle movements that conflict with pedestrian, bicycle or exclusive transit movements.

✔ **Build compact intersections** to reduce turning motor vehicle speeds, minimize pedestrian exposure and provide more space for sidewalks, transit and public space.

✔ **Implement short signal cycle lengths to minimize delay for people walking and biking.**

✔ **Coordinating signal timing when increasing motor vehicle capacity is a stated goal** is preferable to expanding intersections.

✔ Within urban areas, **coordinated signals can be timed to achieve slow vehicle speeds** (20 or 25 mph) or can be set to lower speeds (12 to 16 mph) to facilitate bicycle and/or transit movement.

✔ **Remove on-street parking at intersections** to improve pedestrian crossing safety. Curb extensions should be used in these instances, as well.

Crossings

Every leg of a signalized intersection should have a high-visibility marked crosswalk, accessible curb ramps and pedestrian signals with countdowns. Closing a crossing is not desirable in urban areas.

✔ **Fixed pedestrian signal timing** (pedestrian recall) that provides a pedestrian crossing phase every cycle helps maximize pedestrian mobility.

✔ **Actuated pedestrian signals** (push buttons) may be appropriate along transit corridors, at intersections with infrequent pedestrian crossings and at intersections with highly variable pedestrian and vehicle volumes.

✔ **Use audible messaging** at pedestrian crossings.

✔ **Incorporate three- to seven-second leading pedestrian intervals** at intersections with heavy volumes of conflicting turning vehicles.

✔ **Provide median refuge islands on roadways with two or more motor vehicle travel lanes.** See the **median design element** for more information.

Design approach

Intersection treatments for bicycles

Bicycle-specific intersection treatments allow bicyclists to make safe and predictable through and turning movements.

✔ **Build protected intersections** to provide greater physical separation between bicycles and motor vehicles and reduce conflict points.

✔ **Provide two-stage turn queue boxes** for left-turning bicyclists.

✔ **Use bicycle-specific infrastructure** (ranging from conventional bicycle lanes to separated bicycle lanes) for right-turning bicycle lanes. Shared-lane solutions are not preferred.

✔ **Separate through bicycle movements from right-turning motor vehicles.** Bicycle lanes between a through travel lane and a right-turn lane should prioritize bicycle movement over right-turning vehicles.

✔ **Build bicycle boxes** at the front of a motor vehicle queue to make bicyclists more visible to drivers. Bicycle boxes also offer a protected passing opportunity for faster bicyclists on narrower or heavily used bicycle facilities.

✔ **Use bicycle signals to separate bicycle movements** from conflicting motor vehicle movements where feasible.

Motor vehicle lanes: through and turn lanes

Motor vehicles are typically the highest-volume travel mode served at a signalized intersection. Designs should reduce speeds and minimize conflicts to allow safe intersection passage for all users.

✔ **Stripe narrower lane widths** to reduce speeds and make intersections more compact. Refer to the **motor vehicle travel lanes design element** for more information.

✔ **Reduce corner radii** whenever possible to shorten pedestrian crossing distances and slow down turning vehicles. Refer to the **street corners design element** for more information.

✔ **Use truck aprons for right-turn movements** to compensate for the off-tracking of frequent large vehicles, while allowing for shorter crossing distances. Refer to the **street corners design element** for more information.

✔ **Consider prohibiting right-turn-on-red movements for motor vehicles** at locations with high pedestrian and bicycle crossing volumes.

✔ **Consider removing turn lanes or prohibiting turning movements** in places where the street network provides other ways for motor vehicle drivers to navigate, while considering the potential to create unintended cut-through traffic.

✔ **Adding right-turn lanes increases intersection size and pedestrian exposure to traffic.** Analyze turning movements to determine whether a dedicated right-turn or shared turn lane would be appropriate.

Bicycle signals separate bicycle movements through the intersection, increasing safety. Rose Quarter at the Eastbank Esplanade in Portland.

Roundabouts and mini-roundabouts

Roundabouts are an alternative to signals or stop signs that can be applied to intersections in urban, suburban and rural settings.

Roundabouts feature a circulating roadway where motor vehicles yield on entry to other vehicles already in the roundabout. Pedestrian crossings are provided at intersection approaches, set back from the circulating roadway. Roundabouts are designed to slow motor vehicles to around 15 to 20 mph.

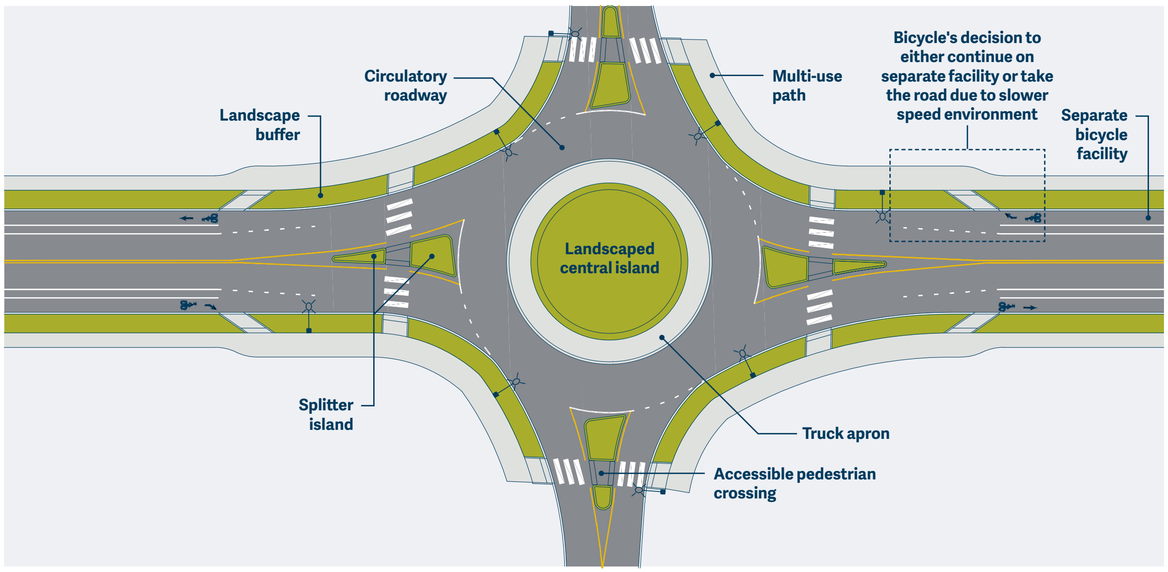
Mini-roundabouts are similar, but considerably smaller in size, with mountable central and splitter islands to accommodate occasional larger vehicles. Mini-roundabouts can be appropriate on lower-speed streets in constrained locations.

Two-way stop-controlled intersections converted to roundabouts see an 82 percent reduction in severe injury crashes, and signalized intersections converted to roundabouts experience a 78 percent reduction in severe injury crashes.[3]

Roundabouts typically require more right-of-way at the intersection than a stop-controlled or signalized intersection, but may allow for narrower cross-sections between intersections.

Roundabouts can be used on streets with one or two through lanes per direction. Single-lane roundabouts with landscaped central islands are commonly 100 to 150 feet in diameter, with additional space needed for pedestrian and possible bicycle facilities on the outside. Roundabouts can be smaller with mountable features, or may need to be larger, if designed for interstate-type tractor-trailers and oversize loads. Multi-lane roundabouts are commonly 150 to 220 feet in diameter.

A roundabout has similar motor vehicle capacity to a signalized intersection and can often reduce delay, depending on vehicle volumes. Typically, a single-lane roundabout is likely to work acceptably if the sum of entering and conflicting volumes at each entry point is less than 1,000 vehicles per hour. At higher volumes, a more detailed operational analysis is needed to determine whether a single-lane roundabout would continue to work acceptably or whether a different lane configuration may be needed.[4]



Roundabouts provide continual traffic flow through an intersection while slowing vehicle speeds, minimizing conflict points and significantly reducing crashes.

[3] Federal Highway Administration, proven safety countermeasures, FHWA-SA-17-055

[4] NCHRP Report 672, Exhibit 3-14

Design approach

Roundabouts are designed to promote slow operating speeds. Specific design features to achieve this outcome include horizontal deflection at the entries, splitter island design (to narrow the approach), central island design (to limit sightlines across the roundabout) and exit design.

Pedestrian crossings

Roundabouts enhance pedestrian safety because pedestrians cross a single direction of traffic at a time.

- ✔ **Incorporate pedestrian crossings on each roundabout leg.**
- ✔ **Use splitter islands** to create pedestrian refuges.
- ✔ **Multi-lane roundabouts may need additional pedestrian treatments** including signage and pedestrian-actuated beacons.[5]
- ✔ **Pedestrian crossings should be set back from the circulatory roadway** by approximately one motor vehicle length to focus drivers' attention on pedestrians before they enter the roundabout.

Sidewalk or path surrounding roundabout

- ✔ **A sidewalk should encircle the full roundabout** with a setback from the travel lanes.
- ✔ **Landscape buffers** discourage pedestrians from crossing to the central island.

Central island

- ✔ **Design the central island to obscure sightlines across the roundabout**, lowering vehicle entry speeds.
- ✔ **The central island should not be accessible** to anyone.
- ✔ **Construct the central island with truck mountable aprons** to accommodate larger vehicles.

Bicycle facilities

- ✔ **Construct single-lane roundabouts as shared lanes with bicycles.** Vehicles inside a roundabout are generally traveling at a similar speed to bicycles.
- ✔ **Construct separated facilities for all bicyclists to use along approaches.** The sidewalk around the roundabout should be wide enough to accommodate both pedestrians and bicyclists who do not feel comfortable sharing the circulatory roadway. See the **multiuse paths design element** for more information.
- ✔ **Do not stripe bicycle lanes** in the circulating roadway portion of the roundabout.

Motor vehicle lanes

- ✔ **Consider the anticipated motor vehicle volumes** and their turning patterns when determining the number of lanes and lane configurations needed for a roundabout.
- ✔ Multi-lane roundabouts provide **greater motor vehicle capacity.**
- ✔ Single-lane roundabouts provide **safer conditions for all users.**

[5] NCHRP Report 834: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities

Unsignalized intersections

Unsignalized intersections, where stop signs are used to control traffic, are the most common type. Two-way stop control is generally used at intersections between major and minor streets, with the minor street approaches being stop-controlled. All-way stop control is generally applied at intersections where the intersecting streets have similar traffic or user volumes, but not high enough to warrant a traffic signal. It may also be used to prioritize pedestrian crossings. Uncontrolled intersections do not have any signs and require drivers to yield to traffic approaching from the right. Uncontrolled intersections are typically used only on very low volume local streets.

Each of these intersection types is distinct and likely to be found in different settings. Roundabouts may be needed or traffic signals warranted as user volumes increase.

Stop-controlled intersections can provide safe and comfortable spaces for all users in a variety of settings. Marked crossings increase motorist awareness and pedestrian visibility. Raised crosswalk in downtown Beaverton.

Design approach

Overall intersection

- ✔ **Consider additional control treatments if any factor raises a potential issue** such as motor vehicle volumes, pedestrian volumes, bicycle routes, approach visibility and crash history before choosing stop control.
- ✔ **Maximize safety for all modes by implementing control treatments to**, manage conflicts, allow efficient multimodal operations and be accessible.

Crossings

✔ **Prioritize pedestrian visibility and protection.**

✔ **Provide marked crosswalks at intersections approaching schools, parks, senior centers** and other locations with significant pedestrian activity.

✔ **Providing stop bars in advance of a marked crosswalk** encourages drivers to stop for people crossing.

✔ **Additional design treatments** can be used to promote pedestrian safety, including curb extensions, median refuge islands, enhanced signing, rectangular rapid flashing beacons and pedestrian hybrid beacons. See the **enhanced and midblock crossings design element** for more information.

Bicycle facilities

✔ **Bicycle boulevards should allow continuous, non-stop movement** for at least half-mile intervals. Intersecting non-arterial streets should be stop-controlled. Traffic calming features can be employed to manage motor vehicle speeds and volumes.

✔ **Signage, median refuges, and actuated crossing devices** are tools for facilitating bicycle boulevard crossings of major streets.

✔ **Use median islands to get bicycles across streets with offset intersections.**

Motor vehicle lanes: through and turn lanes

✔ **Use vertical and horizontal design treatments to slow down vehicles**, especially turning vehicles. Treatments include raised crossings, curb extensions and tight corner radii.

✔ **Consider prohibiting one or more motor vehicle movements** at unsignalized intersections to prioritize other functions. See the **access management and driveways design element** for more information.

Enhanced and midblock crossings

Enhanced street crossings provide direct and safe pedestrian connections to destinations and should be spaced at intervals that support walking. Refer to **Chapter 2** and regional street design classifications for pedestrian crossing spacing guidance.

Many pedestrian destinations are oriented to the middle of a block face or are at unsignalized intersections on major streets. In places with long blocks or infrequent traffic signals, using the nearest marked or signalized crossing may result in significant out-of-direction travel for a pedestrian. In these situations, pedestrians often cross at midblock or unmarked locations, even if a safer crossing is provided down the street. Designing a midblock crossing with enhanced crossing treatments in these situations can improve pedestrian safety and connectivity. A well-designed crossing should be clear and visible to all street users and should mitigate potential adverse effects, such as rear-end vehicle crashes due to unexpected stops.

Midblock crossings, when appropriately located and designed, provide important connectivity and safety for pedestrians wanting to access community destinations and transit stops. Midblock crossing for the Rock Creek Trail in Washington County.

Enhanced and midblock crossing design treatments

Grade-separated crossings provide a bridge or tunnel across another transportation facility, such as a busy roadway or railroad tracks. Americans with Disabilities Act requirements regarding maximum grades generally require either long approaches or a switchback design that may be inconvenient for bicyclists, unless the facility being crossed is already above or below grade. Grade-separated crossings of regional streets may be appropriate in places where motor vehicle mobility is prioritized. People may avoid using grade-separated crossings if they feel unsafe using them.

Pedestrian signals are an option for providing a signalized crossing at a midblock location with high pedestrian volumes. *The Manual on Uniform Traffic Control Devices* provides warrants for pedestrian signals.

Pedestrian hybrid beacons may be used to stop traffic at a marked crossing where pedestrian volumes are not high enough to warrant a pedestrian signal. These beacons stop vehicular traffic with a solid red signal at the beginning of the pedestrian phase, while providing pedestrians with a walk indication. Toward the end of the phase, vehicles receive a flashing red indication, which allows them to proceed after stopping if there is no conflict with crossing pedestrians.

Rectangular rapid-flashing beacons are pedestrian-actuated flashing lights mounted immediately below the pedestrian crossing sign at a marked crosswalk. These beacons have shown to improve driver yielding behavior compared to signs alone, or signs with traditional flashing yellow beacons.

Median refuge islands provide pedestrians with a safe place to wait in the center of the street while crossing one direction of traffic at a time. If the median is wide enough, the pedestrian path through the refuge can be designed at an angle to orient pedestrians to face oncoming traffic.

Raised crosswalks elevate the road grade at the crosswalk, influencing motorists to slow down to avoid feeling an uncomfortable bump.

Enhanced signage includes the use of pedestrian crossing signage, which is intended to make a crossing more conspicuous to motorists.

High-visibility crosswalk markings can also make a crosswalk more conspicuous.

Curb extensions reduce crossing distance and make pedestrians waiting at the curb more visible to motorists. Refer to the **street corners design element** for more information.

Illuminating pedestrian crossings with pedestrian-scale lighting makes pedestrians using the crossings more visible to motorists after dark.

Design approach

✔ **Locate crossings to minimize delay and out of direction travel for pedestrians.** For example, a two-minute delay is roughly equal to 400 feet in out-of-direction travel.

✔ **Provide enhanced crossings in every 200 to 530 feet** where more pedestrian activity is expected.

✔ **Locate crossings considering a range of criteria**, including transit stop locations, pedestrian demand, number of lanes to cross, vehicle speeds and sight distance.

✔ **Select design treatments that maximize safety and maintain priority functions.**

✔ **Design trail crossings to incorporate multiple enhanced crossing elements.**

Application

Enhanced and Midblock Crossings

Design classifications	Grade-separated crossing	Pedestrian signal	Pedestrian hybrid beacon	Rectangular rapid flashing beacon	Median refuge island	Raised crosswalk	Enhanced signage	High-visibility crosswalk	Curb extensions	Pedestrian-scale lighting
Freeway	⊕	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	○
Highway	⊕	○	⊖	⊖	○	⊖	⊕	⊕	⊖	⊕
Regional boulevard	⊖	○	○	○	⊕	⊕	⊕	⊕	⊕	⊕
Community boulevard	⊖	○	○	○	⊕	⊕	⊕	⊕	⊕	⊕
Regional street	○	○	○	○	⊕	○	⊕	⊕	⊕	⊕
Community street	⊖	○	○	○	⊕	⊕	⊕	⊕	⊕	⊕
Industrial street	○	○	○	○	○	⊖	⊕	⊕	○	⊕
Regional trail	⊕	⊕	⊕	○	○	○	○	○	⊕	⊕

⊕ Preferred treatment ○ Potential treatment ⊖ Not a preferred treatment

Regional trails

Regional trails provide walking and bicycling connections between counties, cities and neighborhoods throughout greater Portland.

The Springwater Corridor in Gresham provides a direct connection to light rail. This section of the trail includes pedestrian-scale lighting.

The Trolley Trail in Clackamas County is designed to serve people walking and bicycling. Connections to transit and other regional trails tie it into the overall transportation system.

Regional trails are typically **multiuse paths** for non-motorized users. They must be physically separated from motor vehicle traffic for at least 75 percent of their length. They connect multiple regional destinations such as centers, parks and natural areas, transit and other regional trails. Bikeways and sidewalks on bridges are included in this definition. Some segments of regional trails may be located within a roadway right-of-way as a separated multiuse path.

On-street connections of regional trails are provided by bicycle facilities and sidewalks, including multiuse paths. On-street connections are used when there is no available alignment outside of the street right-of-way. On-street connections should provide a trail-like experience with separation from traffic.

For the purposes of this guide, the term multiuse path is used to describe a hard-surface trail outside the street right-of-way or parallel to the street or throughway, while on-street connection refers to on-street bikeways and sidewalks within the street right-of-way.

Metro's *Green Trails* guidebook focuses on developing soft-surface trails in natural areas; those types of trails are not covered within this guide.

TYPICAL USERS OF TRAILS

Pedestrians
- Walkers
- Runners
- Wheelchair users
- People with visual impairments
- Dog walkers

Bicyclists
- Electric bicycle riders
- Recumbent bicyclists
- Children
- Tandem bicyclists
- Bicyclists pulling trailers
- Pedicabs

Other potential users
- Inline skaters
- E-scooters and other electricity-powered modes
- Equestrians
- Skateboarders
- Autonomous delivery pods

Trails are not just for people walking and biking, and even those who walk and bicycle do so in a variety of ways. This table captures just some of the variety of users that enjoy regional trails.

Regional trail design principles

In addition to the street design principles included at the beginning of this chapter, regional trails should be designed in alignment with the following principles.

Serve the anticipated users Understand what types of users and how many are likely to use the trail. Different user types travel at different speeds, and trail design needs to account for potential interactions between users. People walking travel anywhere from 1 to 4 mph while moving, and may pause frequently. They may travel in wheelchairs, push strollers or have dogs on leashes. An average jogger travels about 6 mph while an average bicyclist travels at 10-12 mph, and some move more slowly. E-bicycles enable people to travel faster, 20 mph or faster. Trail design should account for all of these users and consider the potential for new user types, such as e-scooter riders. As technological developments continue to offer new travel modes, trails are likely to attract people traveling in new ways and trail use policies and designs may need to be updated.

Provide safety and security Trail design for safety and security needs to consider numerous aspects. Safety generally refers to protecting against crashes, including crashes between trail users and crashes at trail crossings of roadways. Security refers to people not feeling vulnerable to personal harm from others. Crime prevention through environmental design techniques can improve security, such as landscaping that maximizes visibility, adequate lighting, frequent access points and avoiding creating enclosed spaces.

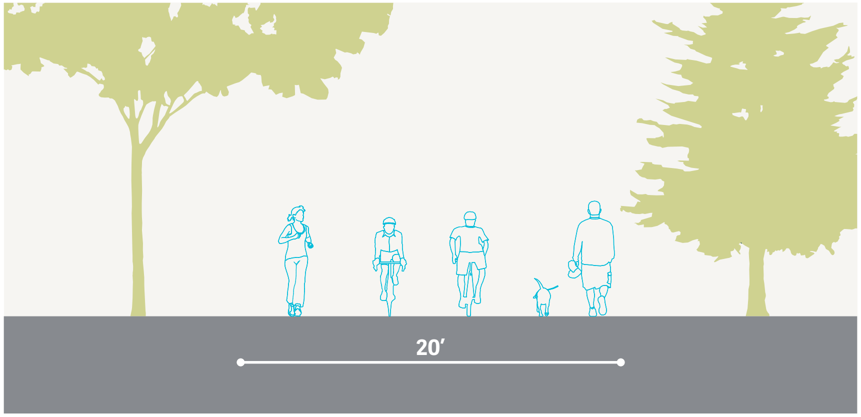
Integrate trails with the street system and neighborhoods When selecting a trail alignment, consider its context. Try to avoid locating trails in floodplains; when this is not feasible, identify an alternate route for use during high-water events. Try to select direct routes, that avoid excess out-of-direction travel. Minimize street crossings where possible, and design safe and convenient ones where they are necessary. Utility corridors, waterways and rail corridors may already have available right-of-way, which can simplify trail alignment. Neighborhood integration considers how the trail will interact with adjacent land uses and provides frequent, well-defined, visible access points to allow ready access to the trail. Creating opportunities for local involvement and investment in the trail through art, gardens, volunteering and programs can help foster community ownership and stewardship of the trail. Wayfinding elements helps trail users orient themselves and find their way to their destinations.

Fit the land use context Trails traverse various land use contexts in the region, being located in and between regional centers, as well as in natural areas. Trail design should reflect these different land use types. Trails in busy areas should encourage slower speeds, especially where users are mixed, and consider how lingering and movement will coexist. Trails in centers should make easy connections to the many destinations in these areas. Trails carrying people between destinations can focus more on efficient and direct movement; these are trails that may serve as commute routes. Trails in natural areas should be designed to avoid, minimize or mitigate ecological impacts. Consider low or no lighting and maximize setbacks from sensitive areas to avoid impacts on habitat, wildlife and water quality.

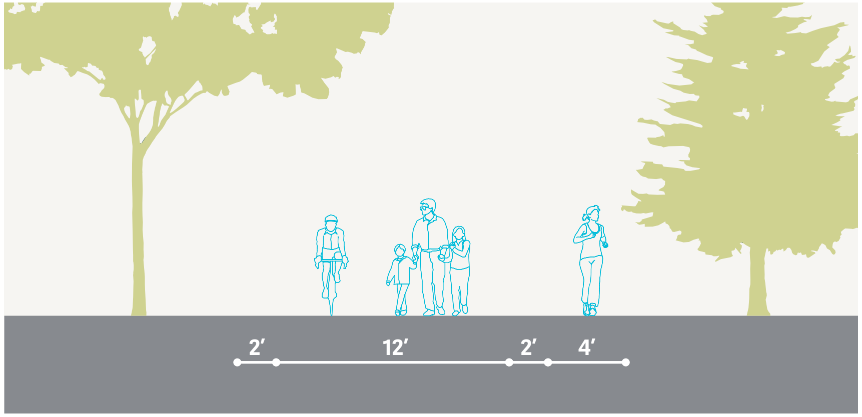
Respect the natural environment Trails can be an avenue to support and enhance the natural environment, even within an urban context. Introducing trees and natural landscaping can benefit trail users and wildlife. Designs should be harmonious with existing wildlife habitat and avoid, minimize or mitigate impacts. Incorporating nature improves local and regional air quality, reduces erosion risk and helps manage stormwater runoff.

Multiuse paths

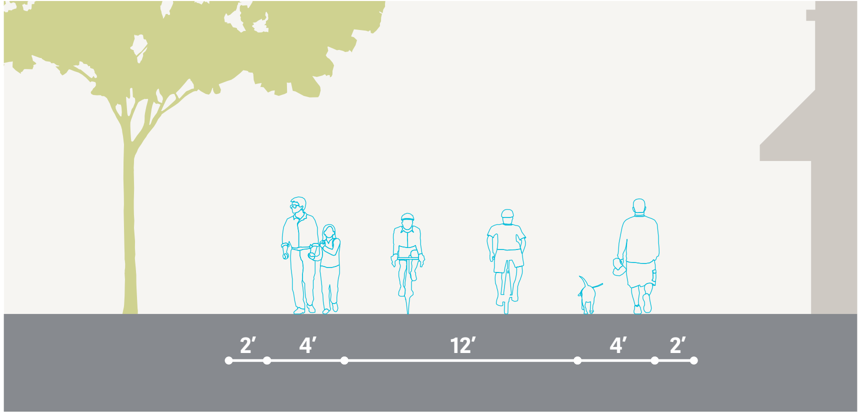
The following cross sections of multiuse paths provide examples of how regional trails might be designed in a variety of land use contexts.



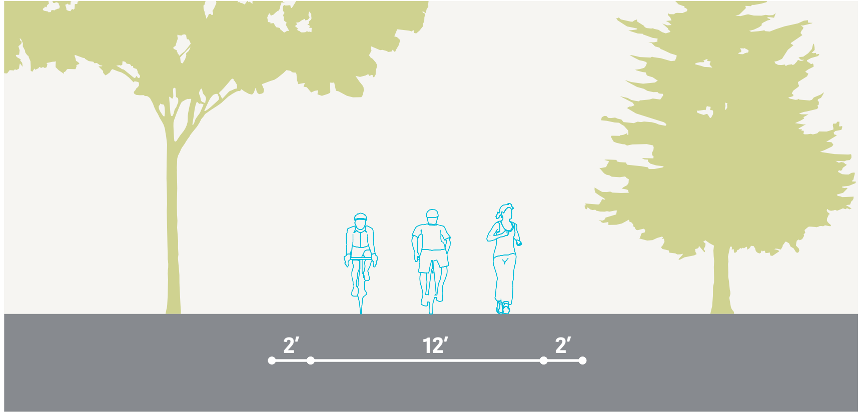
In areas with high demand and use, paths may need to be 20-feet or wider to accommodate all users.



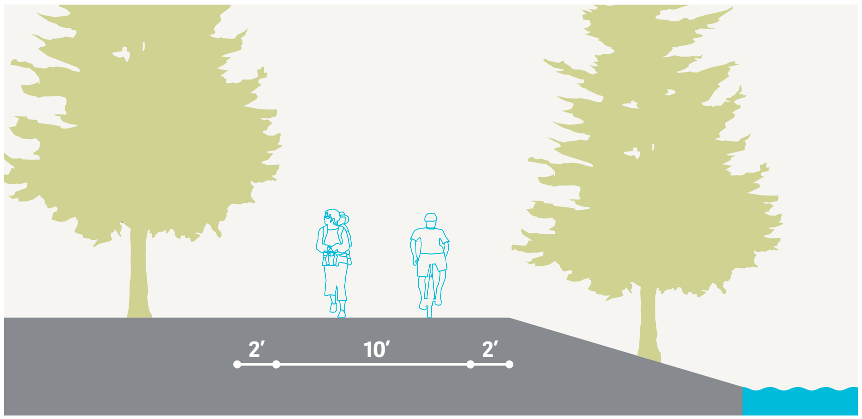
Providing a separate soft surface running path is a desirable option in some contexts.



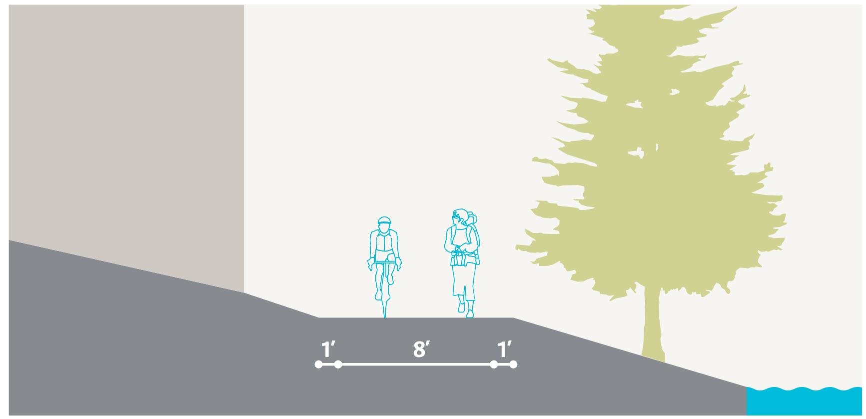
Providing separate spaces for people walking and bicycling is desirable on busy paths with high volumes of commuters.



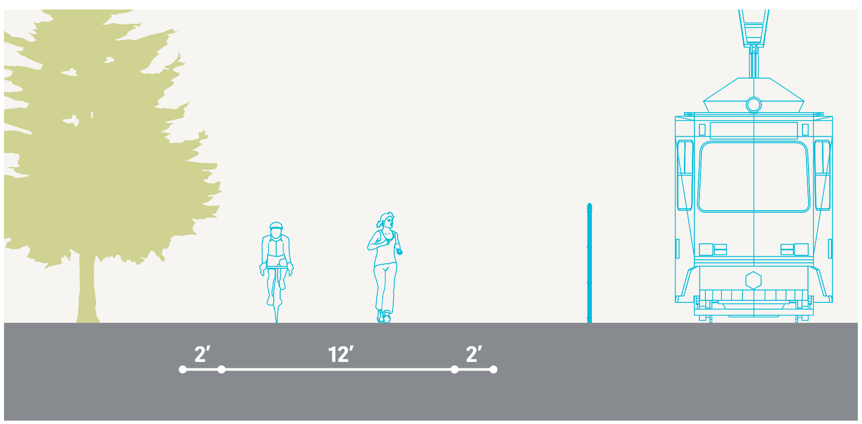
A 12-foot path with 2-foot shoulders is the typical design for a regional multiuse path.



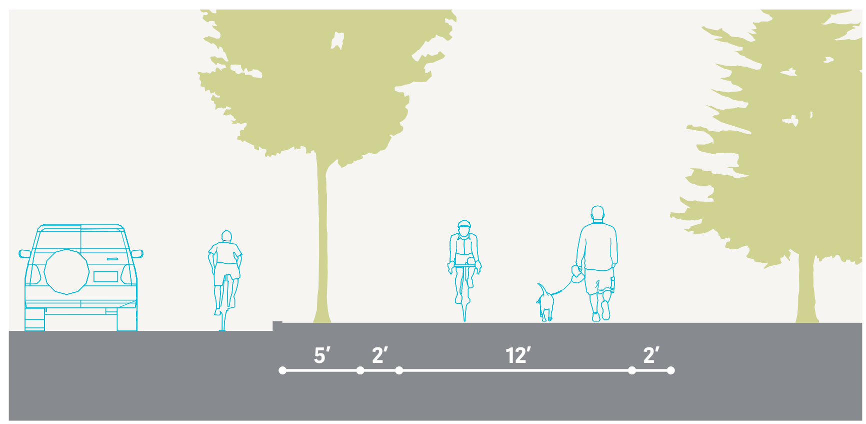
Protecting habitat may require a narrower path.



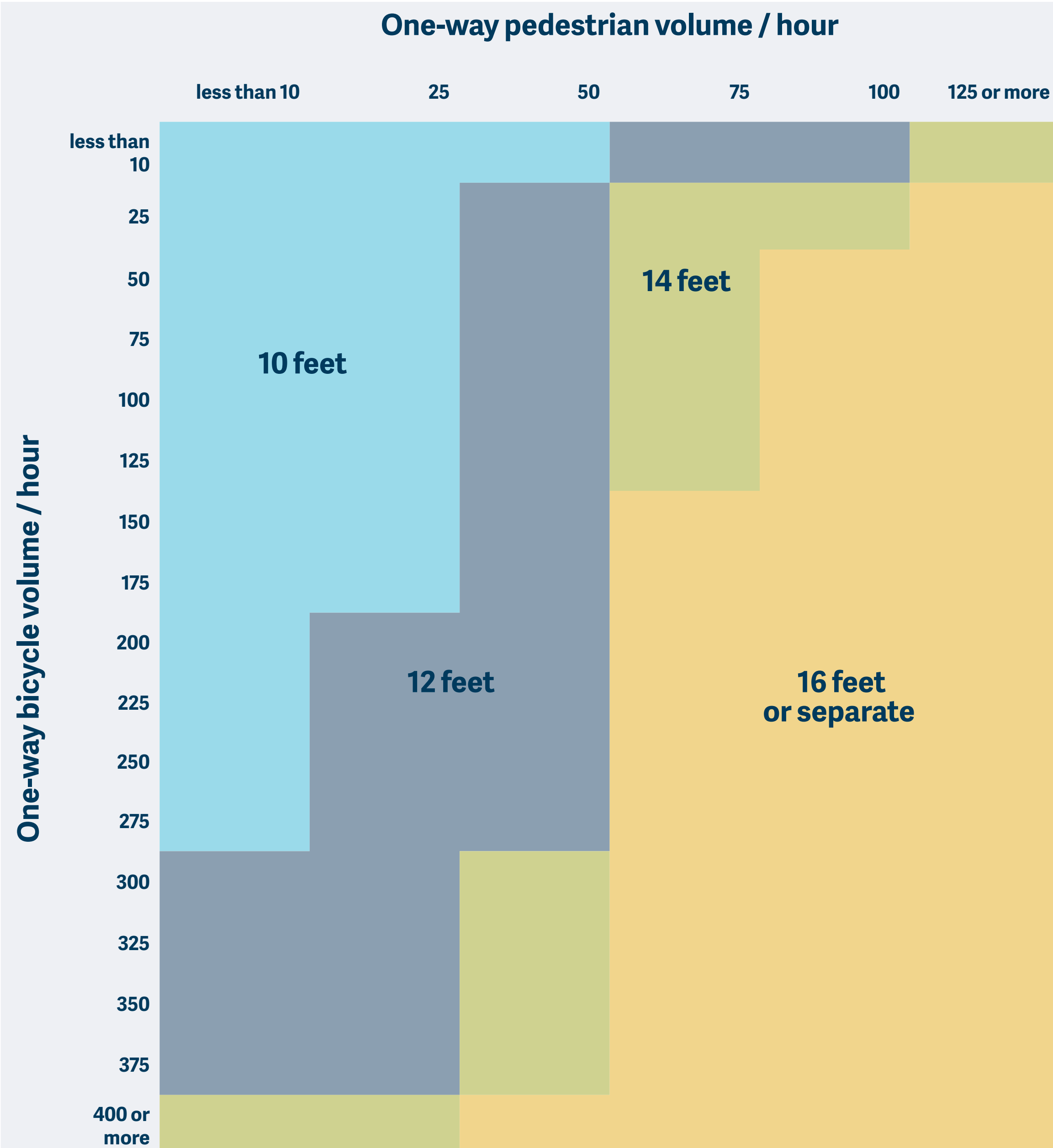
In very constrained natural environments paths can narrow to 8-feet for short segments.



A typical path width in a rail corridor.



A multiuse path can replace a sidewalk and provide a more comfortable bicycling experience within the street right-of-way.



Width and separation factors for trails

Increase width and separation	Decrease width
In centers, where lingering is expected	In environmentally sensitive environments
In places where a variety of user types are anticipated	In physically constrained settings
In places with frequent access points	To encourage slower speeds
If needed for emergency vehicle access	Where space is available (eight-foot widths to be applied for short distances only in constrained environments)

Design approach

✔ **Develop estimates of anticipated future users to help determine the width of the trail.** Consider increasing or decreasing width based on additional factors.

✔ **Evaluate options for separating pedestrians and bicyclists in busier areas.** Distinct paths or paint and surface materials can be used to separate users.

✔ **Consider location, land use context and the range of users** when designing a target speed for a trail. Not all trails should have the same speed.

✔ **Street crossings should be safe, comfortable and direct.** See the **midblock and enhanced crossing design element** for appropriate treatments.

✔ **Trail intersections should meet at 90-degree angles with adequate sight distance** and curves kept away from the intersection.

✔ At trail intersections, **the lower-volume trail should have a stop sign**.

✔ **Consider intersection treatments to manage flows at high-volume trail intersections.** Trail mini-roundabouts can reduce potential conflict points, while tightening corner radii with physical objects can slow users.

✔ **Use design treatments to slow down users** at trail intersections, street crossings, and mixing zones where other uses interact with the trail. Designs, such as pavement treatments, paint, lighting and landscaping can subtly alert all users to slow down and move intuitively through the space.

✔ **Access points should be easily visible** and provide adequate sight distance for trail users to avoid collisions.

✔ **Include wayfinding** and signage at access points.

✔ **Lighting** should be used on all trails with a transportation function.

✔ **In natural areas, lighting should be limited to essential locations**, such as street crossings, underpasses, or other conflict points.

✔ **Trails need at least 2-feet of shy distance** (more in high-traffic areas) from the edge of the paved trail to any walls, light fixtures, trees or other vertical elements.

✔ **Improve sight distance on curved trail sections** by minimizing features adjacent to the trail or by using permeable features and fencing.

✔ **Grades should not exceed five percent** and should be kept to a minimum as often as possible.

On-street trail connections

On-street connection designs cover a range of facility types, but should prioritize safety, mobility and access for trail users. Determining the specific design approach for on-street connections relies on using the design principles in the design process and seeking to provide a trail-like experience, emphasizing safety, comfort and enjoyment.

SW Moody Avenue provides a separated walking and biking connection to the Tilikum Crossing, the Springwater Corridor and the Willamette River Greenway.

Design approach

- ✔ The on-street trail connection should **serve bicyclists of all ages and abilities** and provide **comfortable and adequate space for walking.**
- ✔ **Use wayfinding to direct users to and from the on-street connection** and back to the off-street trail.
- ✔ **Provide physically separated facilities** on streets with traffic volumes greater than 1,000 vehicles per day.
- ✔ **Sidewalks and separated bicycle lanes** constitute an acceptable on-street connection on higher-traffic streets.
- ✔ **Design for transitions between a trail and bicycle lanes.** These should be examined on a case-by-case basis.
- ✔ **Two-way separated bicycle lanes are appropriate** on streets with few access points on one side of the street.
- ✔ A two-way separated bicycle lane **creates a simple transition** from a multiuse path to an on-street connection.
- ✔ **Multiuse paths on each side of the street are acceptable.** Five feet of separation from the street is desirable.
- ✔ Bicycle boulevard treatments are appropriate on **streets with traffic volumes below 1,500 vehicles per day.**
- ✔ **Trail wayfinding and shared lane markings should be used** to inform trail users that sharing the travel lane is appropriate.
- ✔ **Focus design attention at conflict points** where vehicles may conflict with trail users. Manage speed and design for visibility at these locations.
- ✔ Refer to the **bikeway design** and **pedestrian realm design elements** for additional guidance.

Street and trail lighting

Street lighting should be designed appropriately for the anticipated street users. Lighting needs for pedestrians on the sidewalks are different from those for drivers, bicyclists and other users in the travelway. In particular, pedestrians' lighting needs reflect safety concerns and reducing the fear of crime. While street lighting is appropriate and needed on most regional streets and trails, lower levels of lighting may be appropriate in other areas. In centers and at key landmarks, such as bridges, lighting can be designed creatively to contribute to the place's identity.

Pedestrian-scale lighting effectively extends business hours and creates a more pleasant street environment at night, both of which help create more livable communities across the region. Tigard town center.

Design approach

✔ **Select lighting based on the following framework to protect human and wildlife health:**

- Determine if lighting is needed for safety.
- Choose the lighting spectrum, avoiding the use of ultraviolet or blue light. Consider the impacts of the light on habitat.
- Reduce lighting intensity where possible.
- Direct light only where it is needed and shield it from locations where it is not.
- Use motion detectors and timers to limit the use of lighting only to times it is needed.

✔ **Downward-pointing fixtures** and reduced brightness can be used to minimize light pollution and environmental impacts.

✔ **Consider energy requirements**, life-cycle costs, ability to adapt to new technology, maintenance needs, replacement costs and aesthetics.

✔ **Crosswalks should be front-lit.** Lighting should not be placed directly over a crosswalk, since this does not adequately illuminate a pedestrian.

✔ **Use pedestrian-scale lighting along sidewalks and walkways**, particularly at transit stops. Pedestrian-scale lighting can increase security and create places where people feel comfortable traveling after dark.

✔ **Place light poles in the street furniture zone** and away from street trees.

✔ **Most sections of trails that function as transportation routes should be lit** while carefully considering impacts to wildlife and habitat.

Wayfinding

Wayfinding refers to **information, signs, maps** and **intuitive spatial design** that helps people move through a space by any mode of travel. Pedestrians and bicyclists may have the time to linger and consider a more detailed map of destinations and routes, particularly in centers, while people on transit or driving need street signs that are easy to read from a moving vehicle. Above all, wayfinding should be welcoming and simple to facilitate the seamless use of streets and trails by all users.

Effective wayfinding is simple to understand, regardless of how much information may be presented. Street sign in Hillsboro.

Design approach

✔ **Consider the overall transportation network** when developing wayfinding signage throughout greater Portland.

✔ **Identify the key destinations** and evaluate how people may choose to get to them.

✔ **Determine preferred routes and develop wayfinding** to inform people along these routes. For example, wayfinding may be used along a bicycle route.

✔ **Street signs within the public right-of-way must follow Manual on Uniform Traffic Control Devices** standards (Part 2 for signs in general and Part 9 for signs related to bicycles).

✔ **Street signs should not obstruct sight lines** and should be spaced appropriately so they do not block each other.

✔ **Wayfinding should be intuitive** and employ street signs as well as pavement markings and physical design features, such as gateway treatments and roadway markings.

✔ **Text sizes should be large** enough for people of all ages to see.

✔ **Sight lines** should allow people to see and recognize upcoming destinations.

✔ **Signage for transit users needs to be coordinated with the local transit agency.**

Additional information can be provided at transit stops to communicate various options for transit users.

✔ **Use pavement markings on bicycle routes** to provide continuous, intuitive, easily understandable guidance.

✔ **Include destinations and length of travel time** on bicycle route decision signage.

✔ **At intersections, provide decision signage, turn signage and confirmation signage** (confirming route) for bicyclists.

✔ **Use the Intertwine Regional Trail Sign Guidelines** on regional trails.

✔ **Wayfinding signage on poles should be legible to people in motion** and placed near eye level for pedestrians and bicyclists, but it should be placed outside the walking and bicycling path.

✔ **Minimize number of words** and use easily understandable pictures and maps on signage.

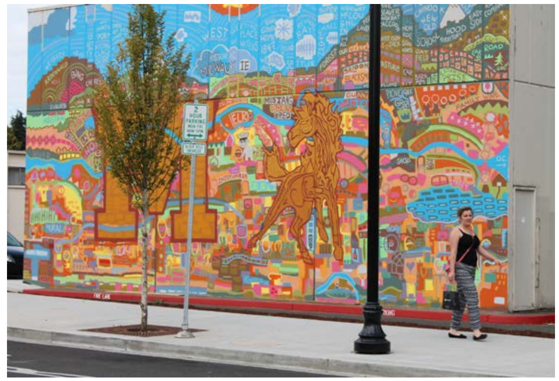
✔ **Include wayfinding in different languages** depending on community needs.

Placemaking elements

Streets and trails should include design elements that give a sense of place unique to a community's history and landscape. As part of transportation projects, placemaking elements help redefine the potential of streets and trails, potentially encouraging non-motorized transportation.

Placemaking transforms public space and cultivates a sense of ownership, belonging and safety through community engagement and physical transformation. Community-led placemaking inspires people to collectively reimagine and reinvent public spaces as the heart of every community.

Incorporating public art, trees and landscaping, and flexible public space can provide an avenue for people to build their community's identity. These are typical placemaking examples, but there is no limit to the ways a community can creatively envision placemaking elements on streets and trails.



Placemaking provides an opportunity to remake city streetscapes and trails and orient them around human experiences. Milwaukie town center.

Design approach

✔ **Partner with local artists to develop placemaking elements**, incorporate local preferences and support the local economy.

✔ **Create art and a sense of identity out of functional street and trail design elements,** such as transit stops and stations, lighting, water fountains, street trees, seating, railing, pavers and wayfinding.

✔ **Create places for people to linger** at key points along the street. Select places where people may want to linger and observe or participate in activities around them.

✔ **Provide seating**, using benches or low walls, steps or other surfaces that can serve as places to pause.

✔ **Use landscaping and trees** to create a sense of place and provide spaces along streets and trails to relax.

✔ **Create flexible public space** that can evolve or be programmed for different uses, depending on the time of year and community desires.

✔ **Consider ongoing costs and maintenance** when developing public spaces and amenities.

4.4 Design resources

This section includes resources related to the design elements included in section 4.3. The resources are organized by design element and include links for online readers. Design guidance sources include the Federal Highway Administration (FHWA), the National Association of City Transportation Officials (NACTO), the Institute of Transportation Engineers (ITE), the American Association of State Highway Transportation Officials (AASHTO), the Transportation Research Board (TRB) and the National Cooperative Highway Research Program (NCHRP).

Sidewalks

NACTO, "Urban Street Design Guide," ***Sidewalks***

NACTO, "Transit Street Design Guide," ***Accessible Paths & Slopes***

SFBetterStreets, Design Guidelines, ***Sidewalk Zones***

Street corners

NACTO, "Urban Street Design Guide," ***Intersection Design Elements: Corner Radii***

NACTO, "Urban Street Stormwater Guide," ***Stormwater Elements: Stormwater Curb Extension***

FHWA, "Signalized Intersections: An Informational Guide," ***Chapter 4: Geometric Design***

FHWA, PEDSAFE Pedestrian Safety Guide and Countermeasure Selection System, ***Curb Radius Reduction***

FHWA, BIKESAFE Bicycle Safety Guide and Countermeasure Selection System, ***Curb Radius Reduction***

U.S. Access Board, ***"Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way"***

Flex zone

NACTO, "Blueprint for Autonomous Urbanism," ***Curbside Management***

NACTO, ***"Curb Appeal: Curbside Management Strategies for Improving Transit Reliability"***

Seattle Department of Transportation, ***Flex Zone/Curb Use Priorities in Seattle***

SF Park, ***"Putting Theory Into Practice"***

District Department of Transportation, "ParkDC," ***Innovative Curbside Management***

International Transport Forum, ***"The Shared-Use City: Managing the Curb"***

ITE, Curbside Management Resources, ***"Curbside Management Practitioners Guide"***

Motor vehicle travel lanes

NACTO, "Urban Street Design Guide," ***Streets, Street Design Elements***

TRB, "Highway Capacity Manual," ***Sixth Edition Highway Capacity Manual: A Guide for Multimodal Mobility Analysis*** (must be purchased)

TRB, NCHRP Research Report 855, ***"An Expanded Functional Classification System for Highways and Streets"***

TRB, NCHRP Research Report 880, ***"Design Guide for Low-Speed Multimodal Roadways"***

TRB, ***"Relationship of Lane Width to Safety for Urban and Suburban Arterials"***

FHWA, ***"Achieving Multimodal Networks: Applying Design Flexibility & Reducing Conflicts"***

ITE, ***"Designing Walkable Urban Thoroughfares: A Context Sensitive Approach"***

ITE Journal, September 2018, ***"Optimizing Lane Widths: A Data Driven and Performance-Based Approach"***

Canadian Institute of Transportation Engineers, ***"Narrower Lanes, Safer Streets"***

AASHTO, ***"A Policy on Geometric Design of Highways and Streets" (The Green Book), Seventh Edition*** (must be purchased)

Access management and driveways

TRB, NCHRP Research Report 900, ***"Guide for the Analysis of Multimodal Corridor Access Management"***

TRB, ***"Access Management Manual," Second Edition, and "Access Management Application Guidelines"***

FHWA, Access Management, ***Access Management Program Plan***

Oregon Department of Transportation, ***"Analysis Procedures Manual," Version 2***

Medians

NACTO, "Urban Street Design Guide," ***Pedestrian Safety Islands***

NACTO, "Urban Bikeway Design Guide," ***Median Refuge Island***

NACTO, "Transit Street Design Guide," ***Downtown Median Transit Street, Median Rapid Transit Corridor***

FHWA, "Traffic Calming ePrimer," ***Median Island***

FHWA, Office of Operations, ***Benefits of Access Management Brochure***

Speed management treatments

NACTO, "Urban Street Design Guide," ***Street Design Principles, Speed Reduction Mechanisms***

NACTO, "Urban Bikeway Design Guide," ***Speed Management***

FHWA, "Traffic Calming ePrimer," ***Module 3: Toolbox of Individual Traffic Calming Measures***

FHWA, Techbrief, ***"Traffic Calming on Main Roads Through Rural Communities"***

FHWA, Safety Program, ***Speed Management Toolkit***

FHWA, "Course on Bicycle and Pedestrian Transportation," ***Traffic Calming***

National Collaborating Centre for Healthy Public Policy, "Traffic-calming Measures," ***Glossary***

Green streets and stormwater management

NACTO, "Urban Street Stormwater Guide," ***Stormwater Elements: Stormwater Curb Extension***

City of Portland, ***2016 Stormwater Management Manual***

City of Gresham, Environmental Services, ***Stormwater Management Manual***

City of Oregon City, Public Works, ***Stormwater and Grading Design Standards***

City of Wilsonville, ***2015 Public Works Standards***

Clean Water Services, ***LIDA Handbook***

Clean Water Services, ***Design and Construction Standards***

Sustainable Sites Initiative, ***SITES Reference Guide, Version 2*** (must be purchased)

Portland Parks and Recreation, ***Portland Planting Standards***

James Urban, FASLA, ***"Up by Roots Health: Healthy Soils and Trees in the Built Environment"*** (must be purchased)

Metro, ***"Trees for Green Streets"***

Interlocking Concrete Pavement Institute

Bikeway design

NACTO, "Urban Bikeway Design Guide," ***Bike Lanes***, ***Cycle Tracks***, ***Bikeway Signing & Marking***, ***Bicycle Boulevards***

NACTO, "Urban Street Design Guide," ***Streets***, ***Street Design Elements***

NACTO, ***"Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities"***

FHWA, ***"Separated Bike Lane Planning and Design Guide"***

FHWA, ***"Achieving Multimodal Networks: Applying Design Flexibility & Reducing Conflicts"***

Massachusetts Department of Transportation, ***"Separated Bike Lane Planning & Design Guide"***

TRB, NCHRP Research Report 880, ***"Design Guide for Low-Speed Multimodal Roadways"***

AASHTO, "Guide for the Development of Bicycle Facilities" (forthcoming)

Portland Bureau of Transportation, ***"Portland Protected Bicycle Lane Planning and Design Guide"***

Transit stops and stations

TRB, TCRP Report 183, ***"A Guidebook on Transit-Supportive Roadway Strategies"***

NACTO, "Transit Street Design Guide," ***Stations & Stops***, ***Station & Stop Elements***, ***Transit Streets***, ***Transit System Strategies***

NACTO, "Urban Street Design Guide," ***Street Design Elements***

FHWA, ***"Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts"***

FHWA, ***"Separated Bike Lane Planning and Design Guide"***

Seattle Department of Transportation, ***"Bike Lanes and Transit Service"***

Seattle Department of Transportation, ***"Expanding Networks to Seattle's Job Centers"***

Massachusetts Department of Transportation, ***"Separated Bike Lane Planning & Design Guide"***

Transit priority treatments

TRB, TCRP Report 183, ***"A Guidebook on Transit-Supportive Roadway Strategies"***

NACTO, "Transit Street Design Guide," ***Transit Lanes & Travelways***, ***Active Transit Signal Priority***, ***Transit Approach Lane/Short Transit Lane***

Portland Bureau of Transportation, "Enhanced Transit Corridors Plan," ***Executive Summary*** and ***Plan***

Signalized intersections

TRB, NCHRP Research Report 812, ***"Signal Timing Manual," Second Edition***

NACTO, "Urban Street Design Guide," ***Intersections***, ***Traffic Signals***

NACTO, "Urban Bikeway Design Guide," ***Intersection Treatments***

NACTO, "Transit Street Design Guide," ***Intersections***

FHWA, "Manual on Uniform Traffic Control Devices," ***Pedestrian Control Features***, ***Highway Traffic Signals***

Massachusetts Department of Transportation, "Separated Bike Lane Planning & Design Guide," ***Chapter 4: Intersection Design***

Roundabouts and mini-roundabouts

TRB, NCHRP Report 672, ***"Roundabouts: An Informational Guide"***

TRB, NCHRP Report 825, ***"Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual"***

TRB, NCHRP Research Report 834, ***"Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities: A Guidebook"***

FHWA, ***Mini-Roundabouts: Technical Summary***

FHWA, ***Proven Safety Countermeasures***

Unsignalized intersections

NACTO, "Urban Street Design Guide," ***Intersections***, ***Crosswalks and Crossings***

NACTO, "Urban Bikeway Design Guide," ***Intersection Treatments***, ***Bicycle Boulevards***

ITE, ***"Unsignalized Intersection Improvement Guide"***

FHWA, Issue Briefs, ***"STOP Signs"***

Federal Transit Administration, ***"Manual on Pedestrian and Bicycle Connections to Transit"***

Enhanced and midblock crosswalks

NACTO, "Urban Street Design Guide," ***Midblock Crosswalks***

TRB, NCHRP Report 562, ***"Improving Pedestrian Safety at Unsignalized Crossings"***

ITE, ***"Designing Walkable Urban Thoroughfares: A Context Sensitive Approach"***

Multiuse paths

Metro, ***Intertwine trail counts and survey data***

Metro, ***"Lighting Regional Trails: Best practices and recommendations"***

Metro, ***"Best practices: busy shared-use paths"***

FHWA, ***"Small Town and Rural Multimodal Networks"***

AASHTO, ***"Guide for the Development of Bicycle Facilities," Fourth Edition*** (available for purchase)

AASHTO, "Guide for the Development of Bicycle Facilities" (forthcoming)

TRB, NCHRP Report 562, ***"Improving Pedestrian Safety at Unsignalized Crossings"***

U.S. Access Board, ***ADA Standards for Transportation Facilities***

U.S. Access Board, Supplemental Notice of Proposed Rulemaking, ***Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; Shared Use Paths***

Washington State Department of Transportation, Design Manual, ***Chapter 1515 Shared-Use Paths***

Colorado Department of Transportation, Roadway Design Guide, ***Bicycles and Pedestrian Facilities***

Massachusetts Department of Transportation, Shared Use Path Design Guide (forthcoming)

City of Toronto, ***"Toronto Multi-Use Trail Design Guidelines"***

CROW, the Netherlands, ***"Design Manual for Bicycle Traffic, "The CROW Manual"***

On-street trail connections

NACTO, "Urban Bikeway Design Guide," ***Bicycle Boulevards***

AASHTO, "Guide for the Development of Bicycle Facilities" (forthcoming)

U.S. Access Board, ***ADA Standards for Transportation Facilities***

Washington State Department of Transportation, Design Manual, ***Chapter 1515 Shared-Use Paths***

Colorado Department of Transportation, Roadway Design Guide, Chapter 14: ***Bicycles and Pedestrian Facilities***

Street and trail lighting

NACTO, "Urban Street Design Guide," ***Sidewalks***, ***Commercial Shared Street***, ***Visibility/Sight Distance***

FHWA, ***"Informational Report on Lighting Design for Midblock Crosswalks"***

FHWA, ***"PEDSAFE: Lighting and Illumination"***

U.S. Department of Energy, Solid-State Lighting Program, ***"Pedestrian-Friendly Outdoor Lighting"***

U.S. Department of the Interior, ***"Artificial Night Lighting and Protected Lands"***

Metro, ***"Lighting Regional Trails: Best practices and recommendations"***

Seattle Department of Transportation, ***Pedestrian Lighting Citywide Plan***

International Dark-Sky Association, ***Fixture Seal of Approval***

Wayfinding

Metro, ***The Intertwine Regional Trails Signage Guidelines***

NACTO, "Urban Bikeway Design Guide," ***Bike Route Wayfinding Signage and Markings System***

NACTO, "Transit Street Design Guide," ***Passenger Information & Wayfinding***, ***System Wayfinding and Brand***

FHWA, "Manual on Uniform Traffic Control Devices," ***2D. Guide Signs – Conventional Roads***

Massachusetts Institute of Technology, "Designing Navigable Information Spaces," ***Design Principles for Wayfinding***

Placemaking elements

Project for Public Spaces Public Space Resources, ***"What is Placemaking?"***

Project for Public Spaces, Placemaking, ***"What if We Built Our Cities Around Places?"***

National Endowment for the Arts, The Mayor's Institute on City Design, ***"Creative Placemaking"***

Urban Land Institute, UrbanLand, ***"10 Best Practices for Creative Placemaking"***

NACTO, Designing Cities, ***"Chicago's Placemaking Programs"***

5

Regional trail. This rendering illustrates a 12-foot-wide trail with a 2-foot buffer on each side in a natural open space. The trail crosses a stream, using best practices in natural resource protection. The trail connects to a bikeway and features an enhanced midblock crossing of a regional street.

Chapter 5

Visualizing livable streets and trails

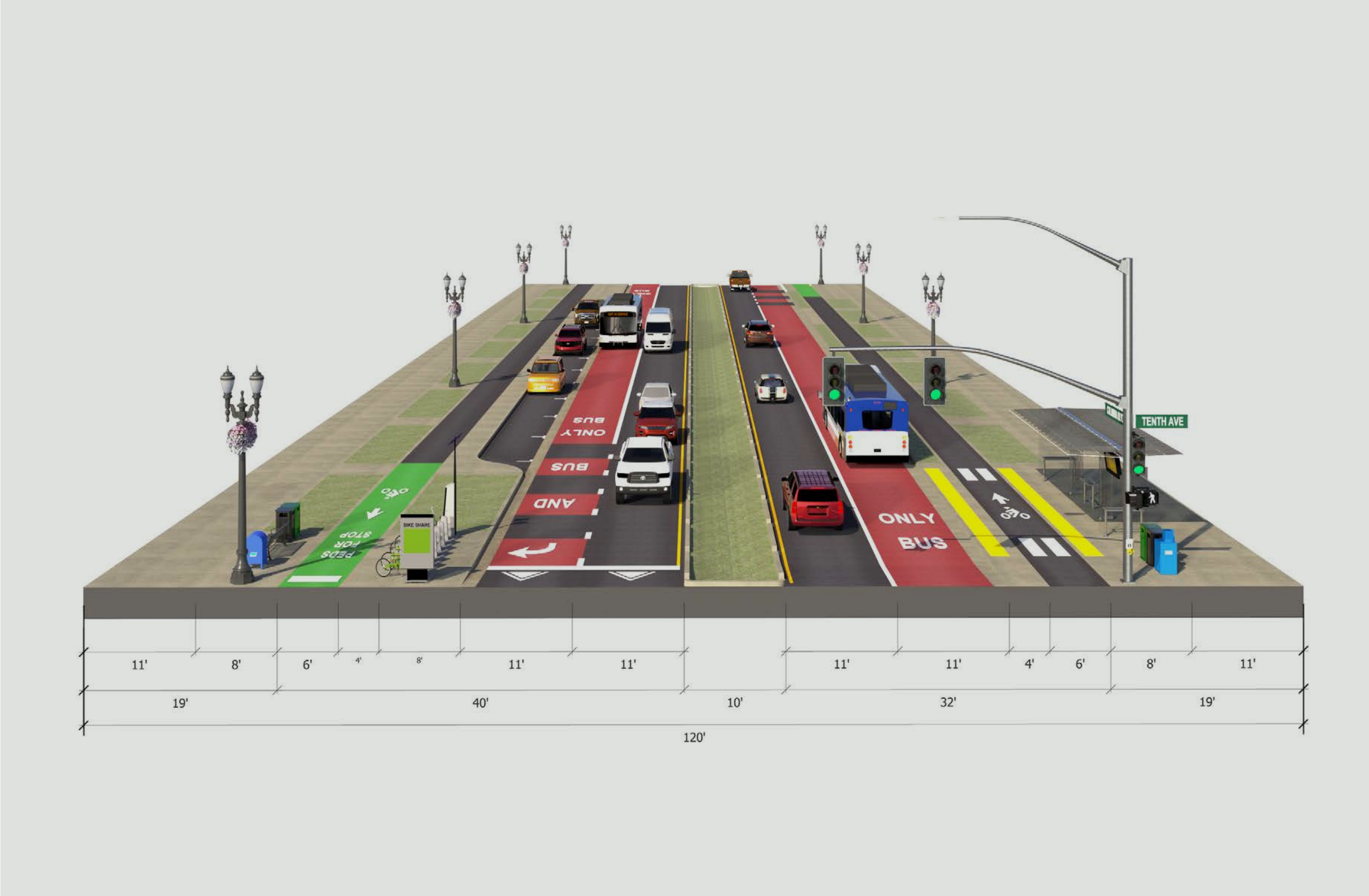
Cross-sections and renderings help stakeholders understand how different design elements will look and function once constructed. Springwater Corridor at Main City Park in Gresham.

No two streets or trails will be designed exactly the same. Street and trail design, whether it occurs in one major project or over time through phasing and incremental changes, depends on many different factors, from the surrounding and planned land uses to the various functions the street or trail needs to serve.

This chapter provides illustrative examples of streets and trails in a variety of contexts. Context—the surrounding and planned land use where the street or trail is located—influences how the street or trail should be designed, function and feel. Depending on the land use context, there may be more or less right-of-way available. This too will influence the design elements that can be used to support the various functions the street or trail serves. Design elements can be combined in endless variations to serve the unique needs of different communities.

The following streetscape renderings illustrate potential design treatments of the street design classifications described in **Chapter 2**. A cross-section of each of the renderings provides dimensions. Regional trails are included as part of the streetscape in several of the renderings, either as parallel multiuse paths or on-street connections, as described in the **regional trails design element** in **Chapter 4**.

Regional boulevard



Regional boulevard cross-section

Regional boulevard. This rendering illustrates a four-lane arterial in a town center. Buildings are between one and three stories high. An ample frontage zone in front of some buildings provides space for outdoor seating. Sidewalks are buffered from the separated bikeway and traffic. Street trees provide shade, reduce noise and help manage stormwater. A central median manages stormwater with a bioswale. One of the travel lanes has been converted to a transit-only lane. Due to space constraints, transit riders cross the bikeway to board the bus.

Regional boulevard

Regional boulevard cross-section

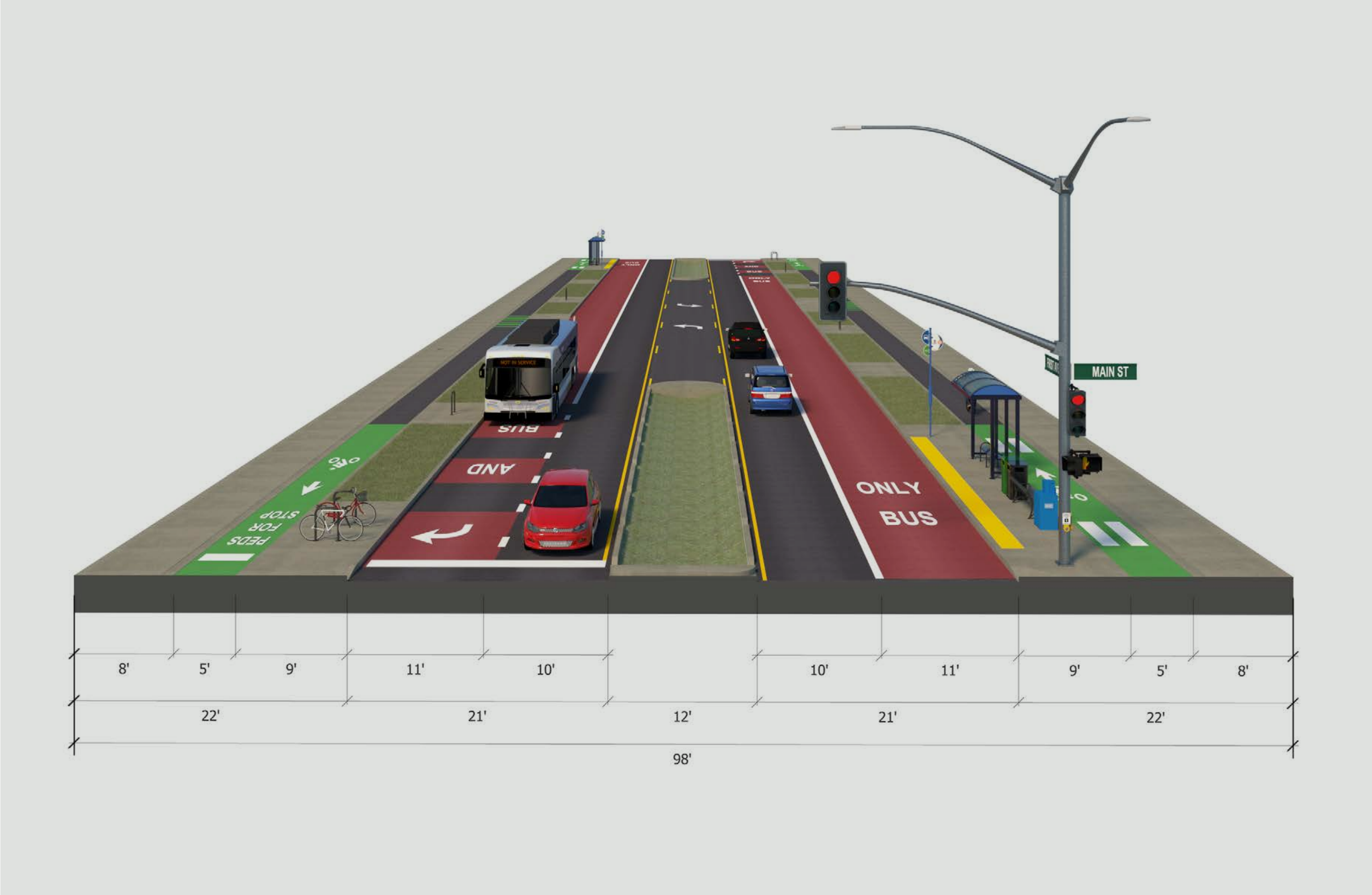
Regional boulevard. This rendering illustrates a four-lane arterial in a regional center. Buildings are between two and six stories high. Parking has been removed from the flex zone to provide a separated bikeway. One of the travel lanes is a transit-only lane. Due to space constraints, transit riders cross the bikeway to board the bus. Bulb outs and a median increase safety.

Community boulevard

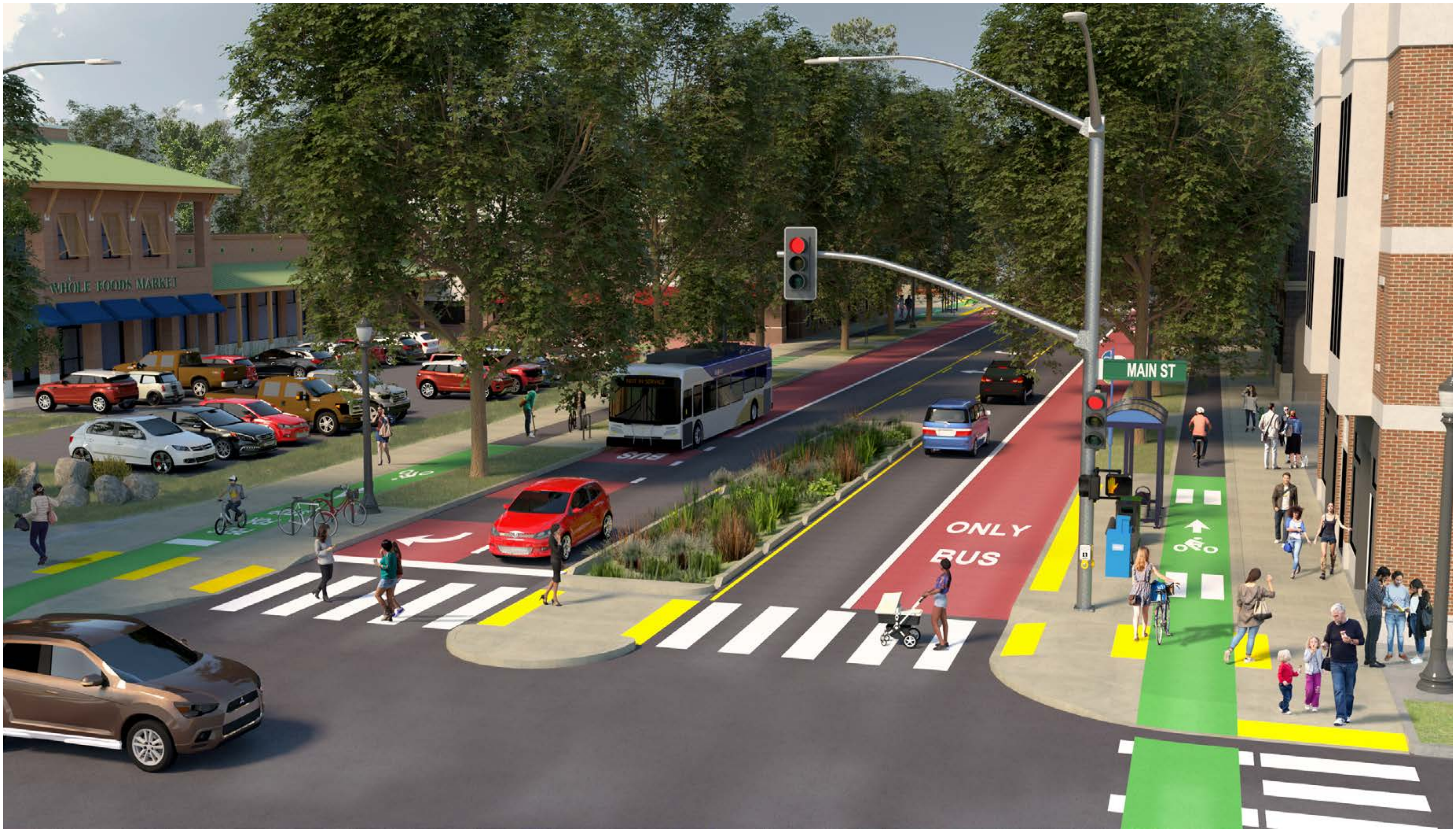
Community boulevard cross-section

Community boulevard. This rendering illustrates a four-lane arterial in a regional center. Buildings are between two and six stories high. Due to space constraints, a parallel bicycle boulevard provides an alternative route to shared bus-bicycle lanes. Bicycle parking along the street and wayfinding provide access to the street for bicyclists. Due to space constraints, transit riders cross the bikeway to board the bus. A median increases safety.

Regional street



Regional street cross-section



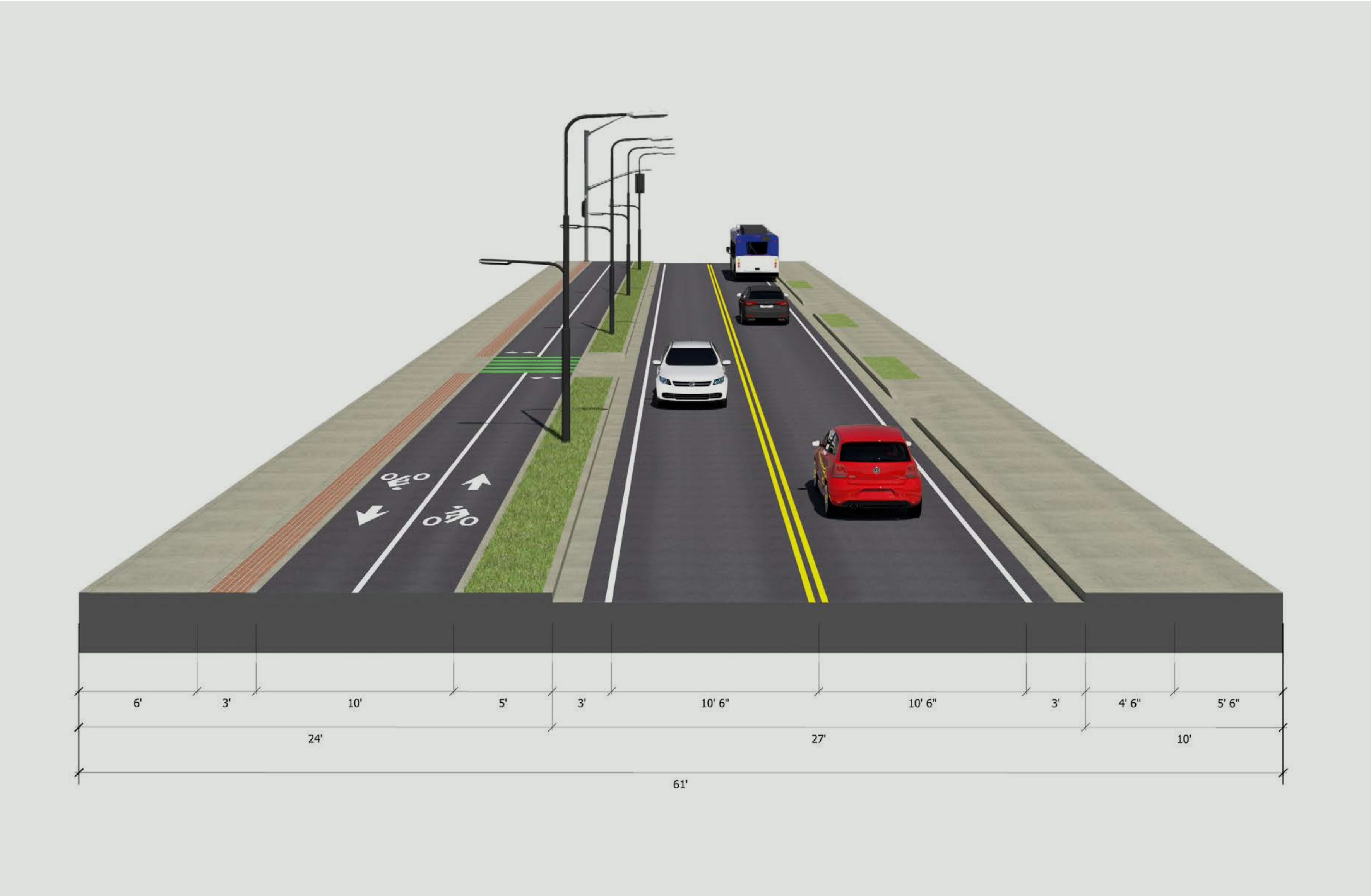
Regional street. This rendering illustrates a four-lane arterial in a regional corridor. Buildings are between one and four stories and some have a deeper set back. A median at the intersection increases safety, while center turn lanes provide access to businesses. Bus-only lanes improve transit travel times and reliability and were added by removing parking and narrowing the adjacent travel lane. Separated bikeways continue behind the bus stop.

Community street

Community street cross-section

Community street. This rendering illustrates a two-lane minor arterial. The surrounding land use is a neighborhood and this segment of the street functions as a main street. The flex zone includes on-street parking and planted bulb outs.

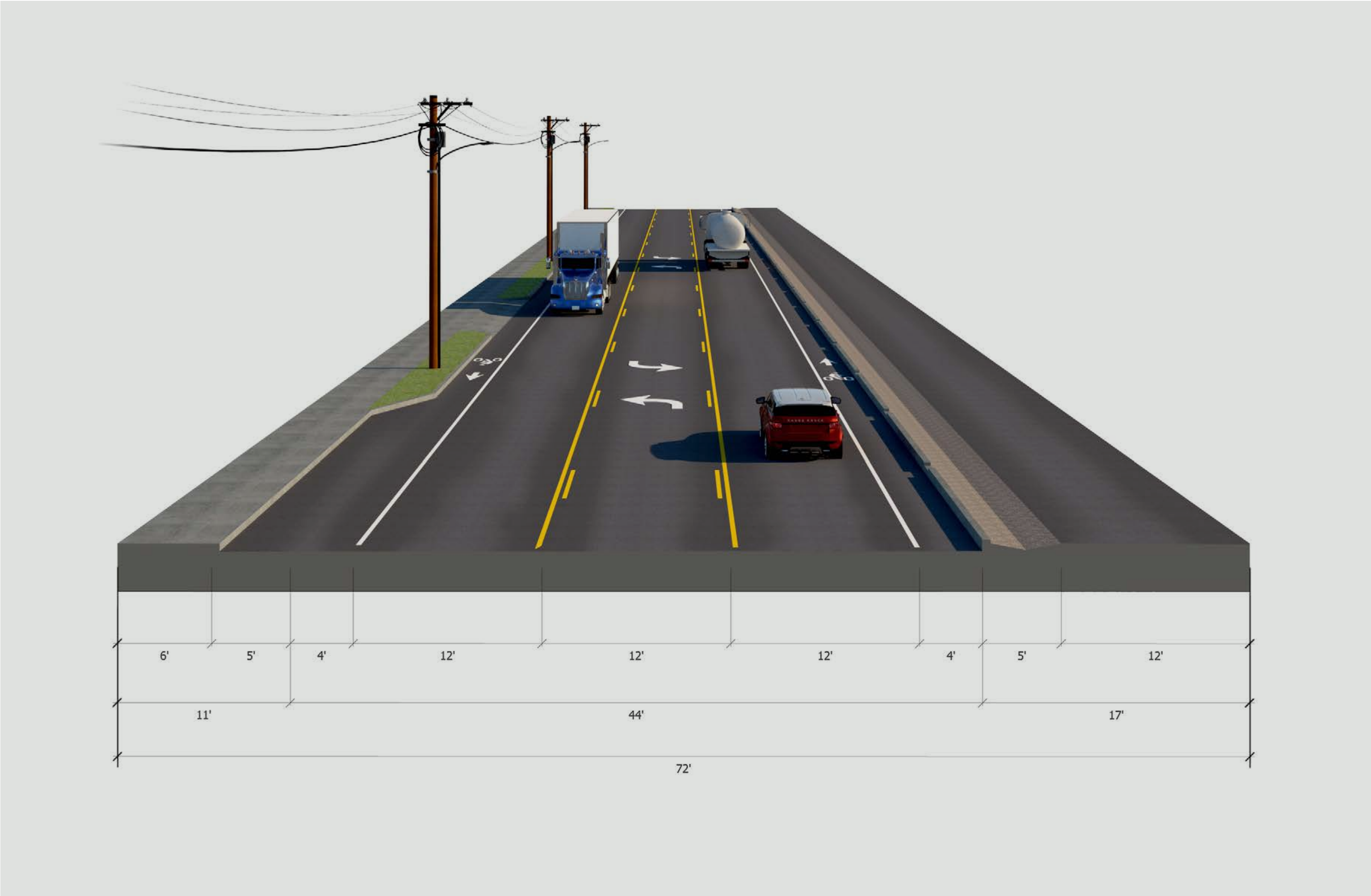
Community street



Community street cross-section

Community street. This rendering illustrates a two-lane minor arterial. The surrounding land use is primarily neighborhood with some small businesses. Buildings are between one and four stories. The separated bikeway provides additional buffer between people on the sidewalk and traffic.

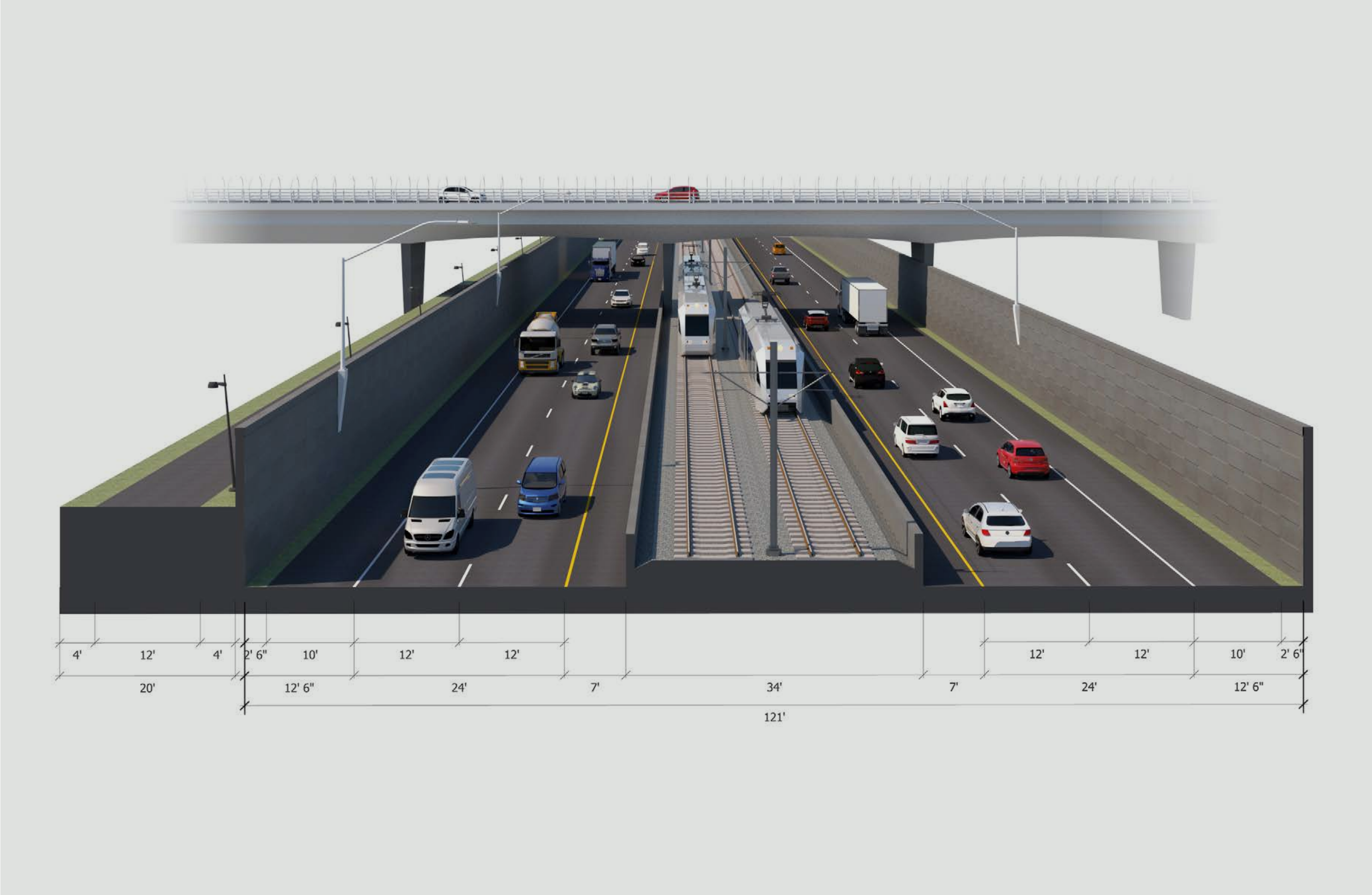
Industrial street



Industrial street cross-section

Industrial street. This rendering illustrates a two-lane arterial in an industrial area. Buildings are between one and two stories with large setbacks. A center turn lane and wide driveways accommodate the turning movements of large trucks. A parallel multiuse path increases safety for all users.

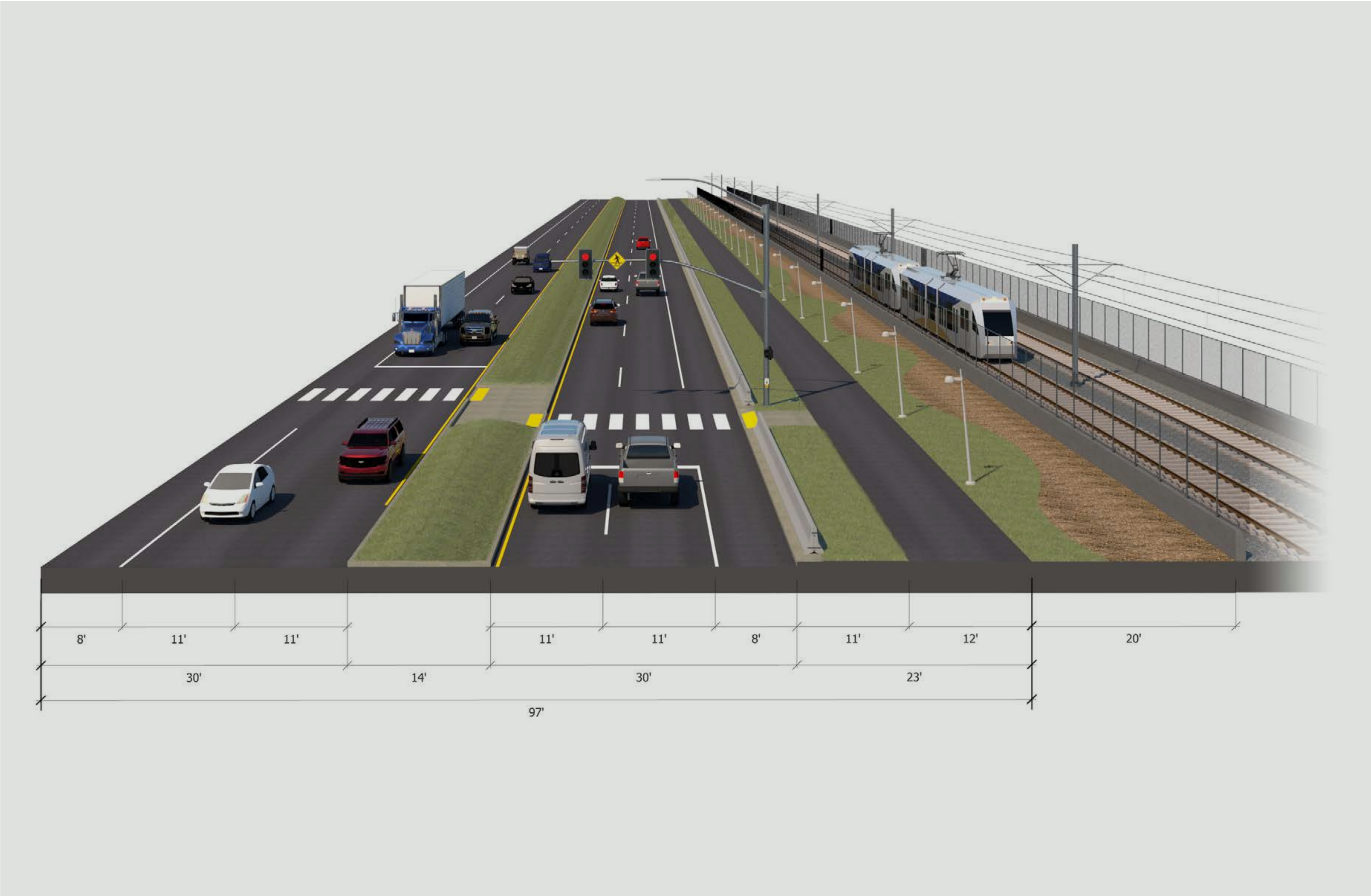
Freeway



Freeway cross-section

Freeway. This rendering illustrates a four-lane throughway in a regional center. The center median is dedicated to light rail and a wide shoulder allows for the possibility of bus on shoulder. Freight and motor vehicle mobility are prioritized. Vegetation along the corridor manages stormwater runoff and reduces noise and air pollution. A multiuse path in the right-of-way is separated by a sound wall and vegetation. Frequent access points to the path increase use and security.

Highway

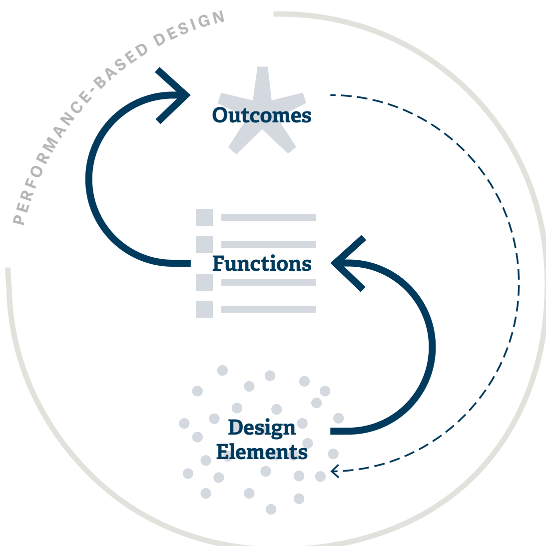


Highway cross-section

Highway. This rendering illustrates a four-lane throughway that is not grade separated and has some street connections. Land uses are set far back from the highway. The center median increases safety and supports motor vehicle mobility. Parallel light rail and a multiuse path provide transportation options within the corridor. Signalized intersections provide access to the path and light rail stations.

6

A performance-based design approach continuously focuses on systemwide outcomes and ensures that the final design stays true to transportation and land use system plans, adopted policies, stakeholder engagement and decisions made during the funding process. Highway 26 facing the West Hills.



Chapter 6

Performance-based design decision-making framework

This chapter describes a planning and design approach that gives practitioners the flexibility to develop solutions to serve prioritized functions and promote desired systemwide outcomes while balancing project costs and other constraints.

Tying together the guidance from prior chapters, this chapter provides step-by-step instructions to apply a performance-based framework as streets and trails are planned and designed. It adheres to an overarching approach where design elements support prioritized functions to achieve desired outcomes.

6.1 Policy guides decision-making

Performance-based planning and design helps ensure transportation projects are achieving desired project objectives and systemwide outcomes while balancing project costs and other constraints.

This approach relies on developing and comparing design alternatives, employing a range of performance measures and analyses to assess progress towards objectives, and using engineering judgment, informed by a multidisciplinary team, to reach a preferred design.

Throughout the design process, design alternatives are assessed to determine if they are adhering to adopted policies and goals, ensuring that adopted policies and goals are guiding decision-making and informing trade-offs.

The design process is typically initiated after a project has been identified as a priority in a transportation system plan based on policies as discussed in **Chapter 2**, and when resources are identified to move the project forward into concept planning and design. Projects are included in transportation system plans because they contribute to the overall functioning of the transportation system and help achieve adopted policies and goals.

More detail on applying performance-based design can be found in *NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets*

Performance-based planning and design is an evolution away from the traditional standards-based design approach to an approach that expands design parameters to be more flexible and context-sensitive.

Key features and benefits of a performance-based planning and design decision-making approach include:

- Promoting responsible use of public resources to get to the outcomes that are most important and avoid the unnecessary expense of a one-size-fits-all approach.
- Meaningfully engaging communities in project decision-making.
- Providing transparency in decisions through data-driven performance measurement and documenting community needs and design decisions, especially as trade-offs are considered.
- Holistically considering implications for systemwide outcomes to work towards the lowest-cost action that will adequately address the project needs.
- Acknowledging and considering that the majority of transportation projects occur within the existing system, one in which there are a variety of real constraints, including funding, competing objectives, existing infrastructure, physical constraints and traditional design standards.
- Supporting the development of a connected network of streets and trails that serve all travel modes and support other community functions.

6.2 Applicable project types

The performance-based planning and design process can be applied to reconstruction, modernization and new construction projects. It can also be applied to preservation or pavement maintenance projects.

Preservation projects typically focus on the pavement surface between curbs. Even within this more limited scope, however, there can be opportunities to reexamine the street design. Practitioners can use an abbreviated version of the decision-making framework to review the street's existing functions and determine whether a different allocation of the street surface would better support the desired functions and outcomes. Repaving projects can be used to add bikeways, buffers, transit treatments and enhanced street crossings.

While the details included in this chapter primarily address streets, trails and intersections, the process should also be applied to new roadway alignments, interchanges, bridges or other transportation projects.

A multidisciplinary project team improves decision-making to develop design-based solutions

Agencies should strive to create multidisciplinary project teams that collaborate throughout the planning and design process. Including multidisciplinary technical staff and teams helps ensure the needs of the community are addressed, that projects are feasible and that desired outcomes are met.

Involving people with relevant technical skills early in the project in areas such as civil engineering, landscape architecture, natural resource preservation, cultural resources and geotechnical engineering, particularly in developing and evaluating alternatives, allow teams to identify and address feasibility or implementation challenges early on.

Involving people with policy and community engagement skills throughout the development of the final design can help ensure that later design decisions continue to align with policy goals and community needs and priorities.

6.3 How to use this chapter

This chapter is laid out in a series of eight steps that work to align design decisions with project objectives and desired systemwide outcomes.

The chapter is written for the **practitioners** that will be leading the design process, with the understanding that many **stakeholders** will participate at different stages or throughout the entire process. A performance-based planning and design approach works best with a **multidisciplinary project team**, which improves decision-making to develop design-based solutions.

The process typically starts with a project that has been identified and vetted through a public planning process, where a well-defined project need, goals and related objectives have been determined.

Each of the eight steps includes **checklists** and a **series of questions** for the practitioner to consider. The answers to these questions should be documented throughout the process. Look for the **document box** in each step for guidance on the type of information that should be documented.

Each step also includes best practices for stakeholder engagement opportunities. Look for the **engaging stakeholders box** for guidance on engagement strategies that increase awareness, understanding and transparency during the design process. These best practices are intended to align with and support, but not replace, local processes already in place.

Engage stakeholders

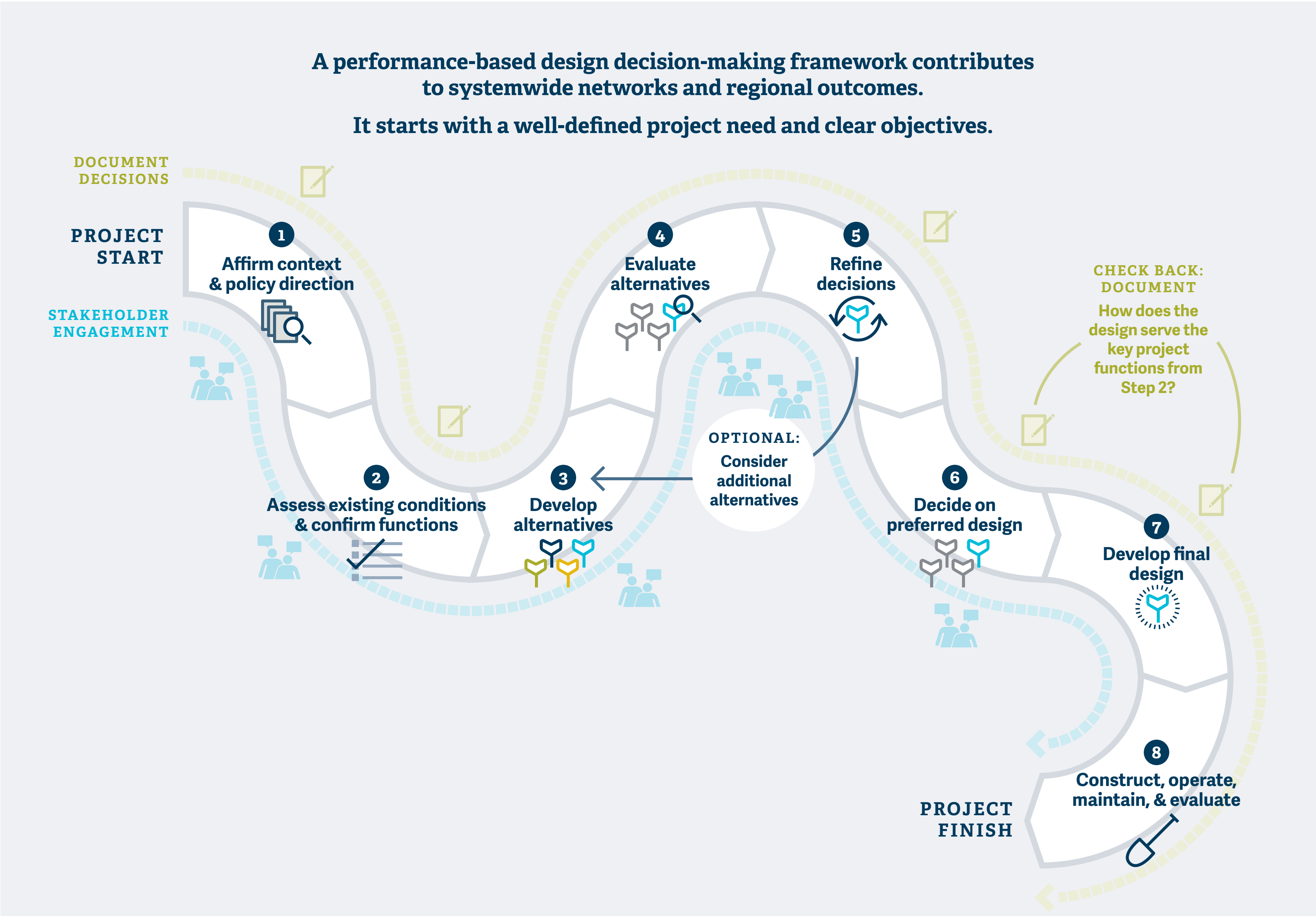
Key to transparent performance-based decision-making is engaging diverse, multidisciplinary viewpoints and impacted communities to make sure the design represents community goals.

The design process should clearly articulate and document who the project will serve and who will be impacted by the project.

Document

Documenting planning and design decisions along with the reasoning behind them tells the story to stakeholders and reduces legal risk for the implementing agency.

6.4 Decision-making framework



Step 1: Affirm context and policy direction

Step 1 begins when a project from a transportation system plan is chosen to move towards construction. In some cases, funding for final design and construction is secured prior to initiating the design process, meaning that some design decisions will be made prior to the design stage. In other cases, funding is secured incrementally through competitive funding sources as the design progresses.

Typically, the project has been identified and prioritized in local and regional transportation system plans through robust stakeholder engagement. Ideally, the project has been selected to move forward because of its potential to contribute to systemwide outcomes.

Following recognition of the need for the project, the performance-based design approach is initiated by affirming the project context and the applicable policy direction.

Step 1 lays the framework to ensure the ultimate design stays true to transportation and land use system plans, adopted policies, stakeholder engagement and decisions made during the funding process. Practitioners should refer to **Chapter 2** to be familiar with current policies and requirements.

Engage stakeholders

Develop a plan for engaging stakeholders during this step. For each stakeholder group, determine whether their final approval is required to move the design forward; typically elected bodies and government agencies. Impacted communities should be involved throughout the decision-making process. Typical stakeholder groups include:

- the public
- elected officials and agency staff
- community representatives, especially from historically marginalized communities
- businesses from the project area
- managing agency of the right-of-way
- owners of adjacent properties
- neighborhood associations
- operators that use the right-of-way, such as transit, mobility services, emergency services, utility services and freight carriers
- others as needed to meet project needs.

In step 1, practitioners review and affirm adopted policies by answering the following questions:

- [ ] What are the project needs and objectives?
- [ ] How will the project contribute to systemwide outcomes?
- [ ] What is the planned land use vision within the project area? Review 2040 Growth Concept land use types as well as any additional guidance from the jurisdiction's codes or plans that are likely to shape future land use.
- [ ] What are the regional and local design classifications of streets within the project area?
- [ ] What are the local and regional modal policies for pedestrians, bicycles, transit, freight and motor vehicles on streets and trails in the project area? Review modal policy maps in the *Regional Transportation Plan*, local transportation system plans or area plans to determine the planned mobility role of the streets or trails within each modal network.

- [ ] What are the relevant local, regional and state policies and requirements related to the project area?

- [ ] What potential environmental resources and benefits, including wildlife corridors, wetlands and other sensitive habitats have been identified in the *Regional Transportation Plan* and other plans? Depending on the project and the surrounding environment, determine what type, if any, of National Environmental Policy Act documentation is needed for the project.

- [ ] What are the current applicable stormwater regulations and standards for the project area?

- [ ] Who does the project serve and who might be impacted by it?

- [ ] Has there been past stakeholder engagement for the project?

- [ ] Who are the key stakeholder groups?

Document

Prepare documentation that affirms the context and policy direction. Documentation at this step is often in the form of an intergovernmental agreement, a project agreement or charter, or a project scope. Having project decision-makers sign onto these documents can increase accountability and commitment to project outcomes.

Step 2: Assess existing conditions and confirm functions

Step 2 prepares the information needed to develop and evaluate the project alternatives in steps 3 and 4. Practitioners should refer to **Chapter 3** to be familiar with Metro's design functions and classifications, as well as **Chapter 4**, which defines the street realms.

Step 2 focuses on:

- Collecting information related to existing conditions and constraints
- Assessing and confirming which functions are currently served and determining which functions should be prioritized
- Selecting performance measures to evaluate the project alternatives

Assess existing conditions and constraints

Collecting data about existing conditions and constraints is critical to developing appropriate design solutions. These data also supply an important benchmark. After a project is completed, additional data are collected to provide a before-and-after study, which contributes to industry knowledge and best practices.

Existing conditions and constraints data are also often used in evaluating the design alternatives. The level of data collection and documentation will vary depending on the scale and complexity of the project and its specific needs.

Engage stakeholders

In this step, the project team seeks input on stakeholder priorities to influence the prioritization of street functions and the performance measures used to evaluate the project alternatives in step 4. Stakeholder knowledge can also inform the existing conditions assessment. It may be helpful to weight the input of some stakeholders, especially those directly impacted by projects, or groups that have not historically been represented in decision-making.

The following questions should be considered when **documenting existing conditions**:

General

- ☐ What are the socioeconomic demographics, land-use patterns, historical and cultural context of the project area?
- ☐ How many people are living and working in the project area now and planned for in the future?
- ☐ Has the surrounding community been disproportionately impacted in the past?
- ☐ What are the ownership patterns of nearby properties, including rental and home ownership for displacement analysis?
- ☐ Are there traffic safety issues in the project area?
- ☐ How willing are sellers if right-of-way is needed?
- ☐ Are there historic and cultural resources in the project area?
- ☐ Are there environmental resources, including sensitive habitat, in the project area, which should be avoided and protected?
- ☐ What wildlife uses this area and what impacts might occur?

STEP 2

- ☐ Is there a need for wildlife crossings?
- ☐ Are there physical constraints, such as bridges, over- or underpasses, railroads or major utilities?
- ☐ Are there air quality concerns in the study area?
- ☐ What is the baseline air quality in the project area?
- ☐ What types of land uses and destinations are served by the project?

Pedestrian

- ☐ Are there sidewalks or paths?
- ☐ If yes, what is their width and condition?
- ☐ Is there access for people with disabilities along the sidewalk and paths and at crossings?
- ☐ What level of pedestrian activity is occurring today?
- ☐ Is there potential for greater pedestrian activity?
- ☐ What is the location, spacing and design of pedestrian crossings? Do they serve desired crossing locations?

Bicycle

- ☐ Are there any existing bicycle facilities?
- ☐ If yes, what is their width and condition?
- ☐ What are current and forecast bicycle volumes?
- ☐ Is there a potential for greater bicycle activity?
- ☐ Are new mobility technologies, such as e-scooters or electric bicycles, being used in the project area?
- ☐ If not, is there the potential for them to be used here?
- ☐ What is the location, spacing and design of bicycle crossings? Do they serve desired crossing locations?

Transit

- ☐ What type and frequency of transit is available?
- ☐ What types of transit facilities exist on the street, such as stops, lanes, or other priority treatments?
- ☐ Are transit vehicles currently experiencing high levels of delay during peak hours?
- ☐ Does transit service experience low levels of reliability (poor on-time performance)?
- ☐ How many riders are transit services carrying?

Stormwater and green streets

- ☐ What are the key physical characteristics of the project area, such as slopes, soil infiltration rates or existing waterways? In some cases, a topographic survey may be needed to adequately identify conditions.
- ☐ What is the adjacent natural drainage system?
- ☐ What type of stormwater system, if any, exists in this location?
- ☐ What is the size of the catchment area?
- ☐ Is there a flex zone wide enough to accommodate curb extensions?
- ☐ Is the street or trail identified in a stormwater management plan?
- ☐ What right-of-way constraints exist in this location that could influence green street infrastructure? Consider overall width, presence of driveways, and overhead or underground utilities.

☐ Are there regulations or requirements specific to the watershed/sewershed, such as water quality or species of concern?

☐ Is the project area included in an urban forestry plan?

☐ What are the types, ages, size and health of existing trees in the project area?

Flex zone

☐ What types of flex zone uses are occurring now?

- Car, bicycle, and other parking, such as bike share or e-scooter
- Loading and unloading, including mail, garbage and recycling
- Passenger pickup and drop-off
- Parklets or sidewalk cafes
- Transit lanes and stops
- Bicycle facilities
- Green street treatments
- Shoulder

☐ To what extent are these uses occurring? For example, what is the parking utilization? How often is the loading zone in use?

☐ What is the availability of off-street parking in the vicinity? What is the parking availability on side streets?

Travelway

☐ What is the existing lane configuration and lane width?

☐ What are the volumes of motor vehicles, transit, pedestrians, bicyclists and freight vehicles using the street?

☐ What portion of existing vehicular capacity is used during the peak hour or study period?

☐ If applicable, how many hours of the day experience near, at, or over-capacity vehicle demand?

☐ What are the crash patterns on this street in terms of severity, cause, modes involved, location and other factors?

Intersections

☐ What is the existing intersection configuration?

☐ What are the volumes of people traversing the intersection by each of the various modes?

☐ What are the crash patterns at the intersection and what movements are they associated with?

☐ In developing future volumes, travel demand model forecast volumes should be considered only the starting point, because travel patterns are likely to be impacted by factors not fully accounted for within travel demand models. How well is the intersection serving current and forecast users, considering all modes?

☐ What vehicle turning movements are accommodated or allowed at each intersection?

☐ How many crossings are marked? In Oregon, if it is not marked otherwise, every intersection is a legal pedestrian crossing. Are any crossings closed?

☐ Does the intersection already have any specific treatments designed to better serve bicyclists, pedestrians, transit or freight?

Trails

☐ If there is an existing trail, what is the width, striping and surface type?

☐ How many streets does the trail need to cross?

☐ What is the lane configuration, width and travel speed of those crossing streets?

☐ Are there environmental resources or physical constraints?

☐ What are current and/or forecast trail user volumes?

Assess and confirm functions

Existing conditions information is used to assess which functions are being served by the facility, if an existing street or trail, and whether those functions are prioritized, accommodated or not served on the existing facility. Refer to **Chapter 3** for a description of functions.

Next, practitioners work with stakeholders to confirm which functions should be served on the reconstructed or new street or trail, referring back to the policy context in step 1 and the existing conditions data.

For each function, determine whether it should be prioritized, accommodated or served on a parallel facility:

Prioritized. The function is typically prioritized in the design classification and should be served to the highest level of quality possible through design and operations.

Accommodated. The function is typically accommodated in the design classification at a basic level. Accommodated functions are typically prioritized at a higher level on a parallel facility or elsewhere on the network.

Served on a parallel facility. The function is typically is served on a parallel facility or elsewhere on the network in adherence with regional and local modal plans and polices.

Select performance measures

In conjunction with assessing the current functions, practitioners work with stakeholders to select performance measures to evaluate project alternatives in step 4. When selecting performance measures, consider:

- Measures that evaluate how well a project supports systemwide outcomes including safety, access, mobility, reliability, efficiency, affordability, equity, and environmental and public health.
- Measures that evaluate whether, and to what extent, prioritized and accommodated functions are served.
- Measures that align with any additional project objectives. For example, if a project has an objective to minimize impacts on local properties, a measure could be "right-of-way acquisition required."
- Measures specifically related to intersections, if applicable (further described in step 4).

The set of performance measures should:

- Reflect the project needs and objectives, systemwide outcomes and desired functions.
- Be understandable and easy to communicate.
- Be consistently, objectively measurable.
- Help differentiate between alternatives.
- Be specific to the study area in question.
- Be at a level of detail proportionate to the project size.

Also consider whether to weight particular performance measures more heavily than others within the evaluation. Weighting can be adjusted based on public input and should also take into account whether there is more than one measure capturing the same benefit of a design.

Document

- ☐ Document previous or current engagement that helped shape the prioritization of functions and performance measures.
- ☐ Document existing conditions, existing functions and desired functions.
- ☐ Document the reasons for the desired functions where they differ from existing functions.
- ☐ Document the performance measures that will be used to evaluate project alternatives.

Prioritizing functions by regional design classification

Design classifications	Pedestrian access	Pedestrian mobility	Bicycle access	Bicycle mobility	Transit access	Transit mobility	Freight access	Freight mobility	Auto access	Auto mobility	Placemaking, public space	Street trees, vegetation	Stormwater management	Utility corridors	Physical activity	Emergency response
Freeway	−	−	−	−	−	+ (shaded)	−	+ (shaded)	−	+	−	○	○	+	−	+
Highway	○	○	○	○	−	+ (shaded)	−	+ (shaded)	−	+	−	○	○	+	−	+
Regional boulevard	+ (shaded)	+ (shaded)	+ (shaded)	+	+ (shaded)	+	○	○	+	○	+	+	+	○	○	○
Community boulevard	+ (shaded)	+ (shaded)	+ (shaded)	+	+ (shaded)	+	○	○	+	○	+	+	+	○	○	○
Regional street	+ (shaded)	+	+	+ (shaded)	+	+ (shaded)	+	○	+	○	○	+	+	○	○	○
Community street	+ (shaded)	+	+	+ (shaded)	+	+ (shaded)	+	○	+	○	○	+	+	○	○	○
Industrial street	○	○	○	○	○	○	+ (shaded)	+	+	+	○	○	○	+	−	+
Regional trail	+	+	+	+	−	−	−	−	−	−	+	+	○	○	+	○

\+ Typically prioritized ○ Typically accommodated − Typically served on parallel facility

(shaded) Prioritize in trade-offs in constrained spaces

This table provides guidance on the functions that are typically prioritized for each street design classification. Regional trails are also included to provide guidance on the functions that these facilities provide and that should be prioritized. This guidance is general. Each project will be informed by unique context that will inform the prioritization of functions.

STEP 2

Prioritizing functions by regional design classification

	Existing			Desired		
Street functions	Priority	Accommodated	Not served	Priority	Accommodated	Not served or served on a parallel facility
Pedestrian access	☐	☐	☐	☐	☐	☐
Pedestrian mobility	☐	☐	☐	☐	☐	☐
Bicycle access	☐	☐	☐	☐	☐	☐
Bicycle mobility	☐	☐	☐	☐	☐	☐
Transit access	☐	☐	☐	☐	☐	☐
Transit mobility	☐	☐	☐	☐	☐	☐
Freight access	☐	☐	☐	☐	☐	☐
Freight mobility	☐	☐	☐	☐	☐	☐
Auto access	☐	☐	☐	☐	☐	☐
Auto mobility	☐	☐	☐	☐	☐	☐
Placemaking and public space	☐	☐	☐	☐	☐	☐
Green streets	☐	☐	☐	☐	☐	☐
Stormwater management	☐	☐	☐	☐	☐	☐
Utility corridors	☐	☐	☐	☐	☐	☐
Physical activity	☐	☐	☐	☐	☐	☐
Emergency response	☐	☐	☐	☐	☐	☐
Other ________________	☐	☐	☐	☐	☐	☐

This table shows one way to document how various functions are currently served on an existing facility and how the project might change the way functions are prioritized and served.

Step 3: Develop alternatives

In step 3, practitioners develop two or more design alternatives that address the project need, contribute to systemwide outcomes and serve the desired prioritized functions in different ways. Design alternatives are potential project designs, described at a high level, which can be compared and evaluated.

Alternatives development should be guided by the design principles described in **Chapter 4**. Alternatives may range significantly in the level of investment required and may include low-cost, interim solutions and programmatic elements.

Engage stakeholders

In this step the project team seeks input from stakeholders on the development of alternatives, providing opportunities that allow stakeholders to generate cross-sections, design ideas and identify priorities. Engagement opportunities should help stakeholders understand the challenges, opportunities and trade-offs of the project alternatives.

Develop alternatives for street segments, corridors and trails

To develop design alternatives, practitioners start by selecting design elements to serve the prioritized and accommodated functions.

The initial development of alternatives does not need to include specific design details, such as signal pole location or pavement slope, but should consider the cross-sectional elements to be included, and their widths. Elements serving priority functions should be prioritized over elements serving accommodated functions.

Some alternatives are likely to exceed the available right-of-way. Depending on the likelihood and impacts of right-of-way expansion, practitioners may determine that one or more alternatives should be developed to stay within the existing right-of-way or curb location.

For streets, each alternative should define the following, consistent with the design classification and functions:

- ☐ Number and width of motor vehicle travel lanes
- ☐ Presence and width of exclusive transit right-of-way, if applicable
- ☐ Stormwater management approach
- ☐ Width/use of flex zone, if applicable
- ☐ Width/type of median
- ☐ Width/type of bicycle facility
- ☐ Width of sidewalk/pedestrian realm
- ☐ Width of any other cross-sectional elements, if applicable
- ☐ Street trees
- ☐ Intersection control type (see next section)

For trails, each alternative should define the following:

- ☐ Width of trail and buffers, if applicable
- ☐ Method to separate users, if applicable
- ☐ Access points, if applicable
- ☐ Stormwater management approach
- ☐ Width of any other cross-sectional elements, if applicable
- ☐ Type of street crossings, including whether they are overcrossings, at grade or undercrossings

- [ ] For at-grade crossings, general anticipated treatment type (for example, at an existing intersection, new signal or beacon, passive crossing treatments)

In some cases, it is helpful to include an alternative that is not fully aligned with the prioritized functions, particularly if a stakeholder group advocates for it. In this case, include the alternative alongside others and carry it forward to the evaluation in step 4. This can contribute to learning and understanding among members of the project team and other stakeholders. It may lead to a more refined articulation of priorities.

Develop alternatives for intersections

The development of intersection alternatives should consider all potential intersection control types and designs, including:

- [ ] Two-way stop control
- [ ] All-way stop control
- [ ] Roundabout (mini, single-lane, and multi-lane)
- [ ] Signalized intersection
- [ ] Midblock crossing

Practitioners may also consider more than one intersection design alternative using the same control type, if applicable. In step 5, intersection design will be refined further to include elements that serve specific needs of pedestrians, bicyclists and freight.

What about right-of-way?
Most of the roadway corridors and some of the trail corridors within greater Portland have established rights-of-way and, in many cases, are surrounded by developed land uses. Whether or not to consider alternatives beyond the existing right-of-way is a project-specific decision. In determining whether to think beyond the existing right-of-way, consider:

- What are the existing building footprints and setbacks along the corridor?
- How would existing land uses be impacted?
- How many property owners would be impacted if right-of-way is acquired?
- Are property owners willing sellers?
- Is the corridor likely to undergo significant redevelopment?
- What is the anticipated funding source for this project?

Even if right-of-way acquisition is deemed to be infeasible, it may be helpful to include an alternative that requires it, for purposes of comparison.

Other project types
Projects, such as bridges or interchanges should generally follow a similar approach to alternatives development: consider Federal, state, regional and local policy guidance, consider functions to be served, and develop alternatives in alignment with documented best practices. Resources listed at the end of **Chapter 4** can be used to supplement the information provided within this guide.

Questions and considerations for developing alternatives in step 3

This section details specific considerations for the various travel modes and street and trail functions to help inform alternatives development.

Pedestrian

- ☐ If the street is part of the regional pedestrian network and pedestrian access or mobility is a priority function in the design classification, include alternatives that prioritize pedestrian functions.
- ☐ Include enhanced crossing treatments as appropriate to serve pedestrian access needs across the street.
- ☐ Determine what sidewalk widths could serve anticipated activity, including pedestrian movement, places to linger (for example, resting, waiting for transit, sidewalk cafes), and other functions served in this realm (for example, bicycle parking, utilities, street trees).
- ☐ People walking need to be buffered from motor vehicle movement, and sometimes from bicycles depending on how bikeways are being designed. Determine what options can be considered for a buffer within the pedestrian realm or flex zone, such as street trees, landscaping or on-street parking.

Bicycle

- ☐ If the street is part of the regional bicycle network and bicycle access or mobility is a priority function in the design classification, include alternatives that prioritize serving bicycle functions.
- ☐ Identify facility types and widths that could serve anticipated volumes of bicyclists and riders of all ages and abilities (given existing conditions and other components of each alternative).
- ☐ Determine whether buffer widths can be minimized by providing greater physical protection in one or more alternative.
- ☐ Determine whether anticipated volumes of bicyclists and pedestrians can be served with a multiuse path on one or both sides of the street, particularly if space is constrained.

Transit

- ☐ If the street is part of the regional transit network and transit access or mobility is a priority function in the design classification, include alternatives that prioritize serving transit functions.
- ☐ Determine which treatments would provide the highest levels of operational benefits for transit, given the existing conditions.
- ☐ Determine whether the street or trail provides access to transit and include alternatives that show enhanced access.

Stormwater and green streets

- ☐ Identify the type of green street treatments and placement options for them within the right-of-way.
- ☐ If possible, identify right-of-way remnants (small, publicly owned parcels adjacent to the street, but not part of the street) or other locations adjacent to existing right-of-way that could be used to develop green street treatments, such as rain gardens.
- ☐ Look for opportunities to reduce impermeable surface and runoff volumes. Use vegetated green street treatments as buffers where possible.
- ☐ Identify locations to include street trees to augment tree canopy, whether in the median, flex zone, sidewalk furniture zone, or adjacent to the right-of-way.

Flex zone

- ☐ Determine which types of uses in the flex zone best serve the priority functions for this street based on guidance from **Chapter 4**.
- ☐ Consider alternatives where flex zone uses are served on adjacent streets.

- [ ] Consider alternatives that allocate the flex zone in different ways. Space for bicycle parking, green street treatments, or other flex zone uses may occur within the street furniture zone of the sidewalk, on curb extensions, or even within the adjacent properties. Adjacent properties often can accommodate bicycle parking, green street treatments, or sidewalk cafes.

- [ ] Select flex zone designs that would mitigate the predominant crash types identified in the existing conditions assessment, if applicable.

Travelway

- [ ] If the street is part of the regional freight network and freight access or mobility is a priority function in the design classification, include alternatives that preserve freight functions.

- [ ] If the street has two through lanes per direction and fewer than 25,000 vehicles per day, include an alternative that reallocates travel lane space to other functions.

- [ ] If lanes are wider than 10 feet, consider opportunities to reallocate space by narrowing lanes.

- [ ] Include an alternative with design elements that decrease operating speeds, which may reduce the widths needed for buffers or shy distance.

- [ ] If the street is located within a relatively connected street grid, consider whether turning movement restrictions are feasible to minimize the need for left-turn lanes.

- [ ] If wildlife crossings are anticipated, include designs to accommodate them.

Intersections

- [ ] If there are existing buildings close to the street corners, include alternative(s) that preserve them. For other alternatives, evaluate the value (monetary, cultural and historical) of the structures in determining whether they could be redeveloped.

- [ ] If there are existing trees in the vicinity of the intersection, include alternative(s) that preserve them. For alternatives that do not, identify ways to mitigate the loss of tree canopy.

- [ ] Include an alternative with intersection designs that would mitigate predominant crash types identified in the existing conditions assessment.

- [ ] Ensure that alternatives provide opportunities for daylighting the intersection, a practice that removes visual barriers (such as parked cars) between pedestrian crossings and oncoming vehicles.

- [ ] If the study area is on a freight route or has heavy volumes of traffic, include an alternative with design elements that enhance safety by separating trucks and other vehicles from pedestrians and bicyclists crossing the intersection.

Document

Prepare documentation of the alternatives developed as part of step 3. Ultimately, this documentation can be combined with documentation from steps 4, 5 and 6 to describe the flow of the alternatives evaluation. Documenting alternatives visually can be helpful in communications with stakeholders.

Step 4: Evaluate alternatives

In step 4, practitioners use a performance-based analysis to evaluate the alternatives developed in step 3 using the performance measures selected in step 2.

Engage stakeholders

In this step, seek input from stakeholders on which alternative(s) best meet their needs. The alternatives evaluation may result in differing opinions. In some instances, it may be appropriate to increase the weight of input of different stakeholder groups, such as historically underrepresented communities. Stakeholders should gain a common understanding of the project and design decisions, even if they do not agree with each decision. Achieving this goal may require special efforts to reach stakeholders who have been excluded in the past.

Stakeholder engagement methods that offer various levels of depth and detail on the analysis allow stakeholders to engage according to their level of interest and investment in the results.

Using easily-understandable measures and summarizing the evaluation in a table or matrix can improve understanding for stakeholders with varying degrees of technical experience.

Evaluating street segment, corridor or trail alternatives

At the outset, confirm that there are sufficient data and information to evaluate each of the alternatives for the systemwide outcomes, project objectives and functions, and then determine whether other measures needed.

At a minimum, the evaluation (based on the performance measures) should answer:

- ☐ How well does this project contribute to desired systemwide outcomes? For example, the evaluation could use predicted safety performance to measure the anticipated crash reductions resulting from cross-sectional or intersection design elements.

- ☐ What impacts does this project have on desired systemwide outcomes? For example, the evaluation could use “area of sensitive habitat impacted” as a measure of the impact to the environment.

- ☐ How well are the prioritized and accommodated functions served by each alternative? For example, the evaluation could use sidewalk width to measure pedestrian access and mobility or level of traffic stress to measure bicycle access and mobility.

- ☐ What functions are served elsewhere?

Weighting and trade-offs

In some cases, the alternatives evaluation in step 4 may not immediately lead to a clear answer, but will instead reveal a number of shortcomings for specific functions or outcomes. These are potential trade-offs associated with each alternative. It can be helpful, as noted in step 2, to consider weighting some measures more heavily than others. For example, if a project is being designed on a high-crash corridor with funding specifically allocated to improve safety, the evaluation should consider weighting safety-related measures above other measures.

Weighting the various functions relative to each other depends in part on the design classifications. The performance of prioritized functions should be weighted higher than accommodated functions for the design classification.

Sometimes, the evaluation will lead to a new alternative being developed. In that case, practitioners should develop and evaluate this alternative in alignment with steps 3 and 4.

Cost is another metric often considered when evaluating alternatives. All else being equal, a lower-cost alternative is a better use of public funds. At this stage of the process, alternatives may not have the level of detail required to develop a cost estimate. However, the identification of an order-of-magnitude cost can help inform a cost comparison of alternatives relative to each other. Operations and maintenance requirements can also be considered in the evaluation, particularly when more than one agency will be involved. If different intersection control types and configurations are considered distinctly from segment alternatives, they should also be evaluated.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires agencies to consider a project's significant environmental impacts and inform the public of the impacts and potential alternatives. NEPA documentation, in the form of an environmental assessment or an environmental impact statement, is required for projects receiving federal funding that do not fall under the categorical exclusion. By the time step 4 is reached, practitioners should have determined whether NEPA documentation will be needed for the proposed alternatives and if so, what type. If NEPA documentation is needed, the evaluation must include an assessment of a variety of environmental impacts, including aspects such as air quality, wildlife, habitat, climate and noise. The Environmental Protection Agency and other federal transportation agencies offer more information related to NEPA.

Evaluating intersection alternatives

An intersection control evaluation may require more in-depth technical evaluation than cross-sectional alternatives to determine how well functions are being served. The intersection control evaluation should use performance measures to assess the following:

- ☐ Alignment with the prioritized and accommodated functions

- ☐ Predicted safety performance
  - Consider using safety performance functions from the *Highway Safety Manual* to estimate anticipated crash reductions.
  - To evaluate design aspects not covered by safety performance functions, consider an assessment of potential conflict points between various users presented by each design alternative.

- ☐ Multimodal operations
  - At present, there is no single metric available for assessing operations across all modes. Practitioners may need to select a set of measures to evaluate operations.
  - Consider operations based on existing volumes of users, as well as anticipated future volumes. In developing future volumes, travel demand model forecast volumes should be considered only the starting point, because travel patterns are likely to be impacted by factors not accounted for within travel demand models.

- ☐ Consider available right-of-way, adjacent properties, existing placement of accesses, slopes, natural resources, roadway alignments, and other factors that impact design feasibility.

- ☐ Life cycle costs, considering capital, maintenance, operations, user (for example, delay, crashes or fuel use) and other anticipated costs.

The evaluation should lead to the selection of a preferred intersection control type. Further design details are then considered within step 5.

Document

Develop documentation of the alternatives evaluation, including an explanation of how performance measures were evaluated. This ensures the evaluation can be verified and repeated if new alternatives are introduced.

Step 5: Refine design decisions

Step 5 provides guidance on how to refine design decisions for one or more alternatives prior to selecting and developing a preferred design concept in step 6. In step 5, practitioners draw on the results of the alternatives evaluation to work through trade-offs and further refine the design of one or more alternatives. In a highly complex project, or if several alternatives are still under consideration, step 5 may include additional analysis and/or stakeholder outreach to inform refinements that improve the performance of a given alternative. In other cases, step 5 effort may be minimal.

Engaging stakeholders

All stakeholders, including staff representing agencies involved in decision-making, are involved in choosing between the alternatives and refining design decisions. Opportunities to provide input during this step are essential for transparency. Additional stakeholders identified during the alternatives evaluation should be consulted.

Street segment, corridor or trail design decisions

Refinements to the design alternative(s) should consider the following:

- ☐ Sensitivity testing for increased volumes of users in the future (how long will this design serve the community in a changing future?).
- ☐ Which design elements, if any, should (or could) be designed for relatively easy change or redesign in the future in response to changing demand, use patterns or emerging technologies.
- ☐ Consider how each street user will transition from the project area to the existing infrastructure on each side, and design for an intuitive transition.
- ☐ Considering constructability of alternatives may influence the final configuration of each alternative. It is sometimes necessary to change the location of intersections and/or alignment of roads to maintain access during construction.
- ☐ Opportunities for low-cost, interim improvements that only partially meet the project need, objectives, and functions, as long as they do not preclude future investments to fully serve the needs.
- ☐ Implementation strategies, including opportunities for phasing.

Sometimes, the process of refining design alternatives will lead to consideration of a new alternative. In that case, practitioners should develop and evaluate the alternative in alignment with steps 3 and 4.

STEP 5

Intersection design decisions

In addition to the considerations listed for street segments, corridors or trails, refinements to intersection design alternative(s) may include the following approaches:

☐ If not done as part of step 4, develop lane configurations, including turn lane presence, considering the trade-offs inherent in this decision (as discussed in the intersections section of **Chapter 4**)

☐ Consider the physical dimensions of the anticipated users to inform the development of the intersection geometry, including pedestrians, bicyclists, and various vehicle types, as discussed in the design principles in **Chapter 4**.

- Two wheelchair users side-by-side at all locations.
- Cargo bicycle or bicycle with trailer (about 9 feet) for turning movements and at queuing locations
- Standard bus where bus turning movements will be made
- Select design vehicle (for motor vehicles) depending on anticipated normal daily turning movements (not the largest vehicle)
- Select a larger control vehicle if applicable, and accommodate occasional turning movements by using opposing lanes if needed.

Trade-offs

In conjunction with developing refinements to the design, practitioners are likely to face trade-offs when refining the design decisions, such as when the ideal treatments to serve priority functions simply cannot be achieved given the project's constraints. Follow these steps when considering these trade-offs:

☐ Review policy requirements, guidance and direction to ensure that any trade-offs made are consistent with adopted regional policies.

☐ Consider which of the prioritized functions will most contribute to the desired systemwide outcomes. Refer to the **prioritizing functions by regional design classification table** for guidance on which functions to prioritize.

☐ Determine whether any functions can be well served on a parallel route that can be completed as part of the project. In determining whether to serve bicycling on a parallel route, consider level of stress of the parallel route, number and type of destinations on each route, amount of out-of-direction travel, total distance and current use patterns. If selected, the parallel route should be completed as part of the project.

☐ Use narrower widths for some or all design elements within the street, keeping in mind the green transportation hierarchy. Confirm that motor vehicle lane widths are the narrowest possible appropriate for the anticipated users and street design.

☐ Consider designs to slow traffic speeds, allowing for narrower buffers and the potential to mix some travel modes, for example through paved multiuse paths to serve pedestrians and bicyclists or through low-speed shared bus-and-bicycle lanes.

Document

Develop documentation of the alternatives considered (including additional alternatives introduced during or after the evaluation), a summary of the evaluation and any additional analysis supporting the refinement of design decisions. This documentation can be summarized and combined with the preferred design concept developed in step 6.

Step 6: Decide on a preferred design concept

Following the additional refinement in step 5, practitioners and stakeholders should have adequate information to decide which design concept to move forward. If more than one alternative was carried through step 5, the evaluation can be updated to fully reflect these refinements.

Ultimately, the preferred design concept selected in step 6 should reflect a performance-based approach to serving the prioritized functions and contributing to desired systemwide outcomes. Clear agreement on this design concept is critical before moving to step 7.

Involving practitioners with multidisciplinary technical knowledge through steps 3, 4, 5 and 6 is helpful to develop feasible alternatives and ensure that technical issues needing to be addressed are identified as alternatives are being refined.

Engage stakeholders

In this step, the project team shares the preferred design with stakeholders, along with a clear evaluation of how the design aligns with the prioritized functions and delivers on the envisioned outcomes.

Engagement with agency stakeholders is needed to gain concurrence with the design concept.

Whenever possible, ensure that individual agency representatives remain the same through the process to build understanding and agreement leading to the design concept.

Engage a variety of disciplines within the lead agency to further understand design implications and confirm design decisions. Include professionals involved in construction, signal operation (if applicable) and maintenance.

In this step, practitioners develop a design concept (which may be referred to as a 5-percent or 15-percent design) that can communicate the following information:

- Overall footprint of the proposed design
- Configuration and width of proposed design elements within the design
- Areas of potential right-of-way impact
- Approach to stormwater management, including type of facilities and general locations
- How prioritized functions are supported
- How desired systemwide outcomes are supported

Vetting the preferred design concept

☐ Conduct additional technical evaluation and develop additional design details related to:

- Horizontal and vertical alignment design
- Grading
- Environmental impacts
- Signing and striping
- Illumination needs and impacts
- Stormwater management needs
- Impacts to existing trees
- Utilities

☐ Refine the preferred design with regard to how the various travel modes will be accommodated during construction

☐ Identify key design details yet to be resolved and assess potential risk associated with the outstanding items. For example, there may still be significant unknowns (for example, whether utilities will need to be relocated) that can affect the project cost and timeline.

☐ Confirm operational and maintenance needs and responsibilities. In many cases, regionally classified streets are ones that affect and involve more than one entity for operation and maintenance. Understanding these responsibilities allows those organizations to weigh in as the design concept is developed to ensure they are able to operate and maintain the facilities as intended. For example, some separated bicycle facility designs cannot be swept with a standard street sweeper due to their narrower width. In these cases, agencies need to consider other maintenance solutions, such as purchasing a specialized narrow sweeper, partnering with an agency that already owns one or considering a different maintenance method.

☐ Prepare (or refine) a cost estimate for the preferred design.

- Confirm/identify funding sources.
- What can be designed and constructed within the available funding sources?
- Are there other funding sources that may contribute to specific aspects of the project?

Document

In documenting the preferred design and preparing to move into final design, address each of the following:

☐ Develop a design concept drawing to clearly communicate the concept to stakeholders and the final design project team.

☐ Review and verify that the preferred design concept serves the project functions identified in step 2. If it does not, return to step 3 of the process. If, during the development of the design concept drawing, there are any refinements that result in changes to functions served or to anticipated performance of the street, this should be clearly documented with reasons justifying the change.

☐ Document agency concurrence on the preferred design concept, both from the lead agency and from other involved agencies. Document any design agreements with partner agencies, such as design exceptions or concurrence when applicable, and/or identify the need for future design justification documentation.

Step 7: Finalize design

The final design is developed based on the preferred design concept and provides the detailed engineering specifications needed to initiate construction. The final design and its implementation should serve the identified functions, contribute to systemwide networks and further the desired outcomes.

Often, the personnel on a project team may change between the development of the preferred design and the final design. This occurs naturally because different areas of expertise are required at each stage of the project delivery process.

However, it is critical to maintain some continuity to ensure that the project ultimately delivers what was intended at the outset. Clear and ongoing documentation, along with frequent check-backs to earlier stages of the project can ensure this continuity.

Engage stakeholders

If faced with design challenges during the final design stage, project teams should involve stakeholders from earlier project stages to further understand key priorities and preferred design decisions. Agencies that will be involved with future maintenance or operation should also have opportunities to provide input on final design decisions.

Prior to embarking on final design, the project team should:

- ☐ Verify project context and need, objectives, functions, and performance measures used to arrive at the preferred design (steps 1 and 2), especially if the preferred design was developed more than three years prior. If any of these have changed, revisit the alternatives developed and determine whether it is necessary to develop and evaluating additional or new alternatives.
- ☐ Review and understand the overarching project purpose and any other documented goals.
- ☐ Review and understand key project outcomes and functions identified in steps 1 and 2.
- ☐ Review design decision documentation from steps 3, 4, 5 and 6 that led to the selection and development of the preferred design.

STEP 7

Develop the final design

Development of the final design and construction bid documents typically occurs in several stages. These may vary by agency and project, but often follow a process of developing 30-percent, 60-percent, and 90-percent designs, and a 100 percent final design. At the conclusion of this step, the project team will release plans, specifications, and estimates, which are the basis for collecting bids from contractors for construction.

As the final design progresses, the project team will need to:

☐ Seek permits from various agencies, as required.

☐ Acquire right-of-way, if needed.

☐ Continue to confirm and evaluate funding sources and opportunities.

☐ Outline future operations and maintenance activities and costs.

☐ Document whether the final design contributes to desired outcomes, serves identified functions and aligns with the preferred design. If not, determine whether the final design is a low-cost incremental improvement that does not preclude serving those functions in the future.

☐ Collect before data as a basis for project evaluation.

☐ Develop a process for monitoring the project after construction and measuring how well it is serving the priority functions.

Document

Any deviations from the preferred design concepts should be documented and justified.

- Review and verify that the design, with deviations, will still serve the key project functions identified in step 2.
- If not, consult stakeholders and community members to determine next steps.
- Achieve agreement (documented) on deviations to move the project forward.
- If consensus cannot be reached, it may be necessary, and ultimately less costly, to stop development of the final design and return to step 2 or 3 of the process.

Step 8: Construct, operate, maintain and evaluate

In step 8, the project is constructed and becomes part of the transportation system. Operations and maintenance are key aspects of ensuring that the street serves its intended functions. A performance evaluation and ongoing monitoring following construction can help contribute to best practices for future projects.

Engage stakeholders

At this step, discuss construction sequencing with stakeholders. Stakeholders sometimes prefer a major impact within a short period rather than smaller impacts over an extended construction period. Notify adjacent property owners of the construction schedule and any anticipated impacts during the construction period. Construction and completion of the project is also a time to celebrate with stakeholders and the community. Ribbon-cuttings or public events are an opportunity to share the story of the project and its anticipated contributions.

Engage stakeholders in reviewing the evaluation results.

Construction

Construction of the final design should maintain alignment with the intended systemwide outcomes and priority functions. Prior to construction, especially if there has been a significant time between final design and construction, the project team should:

- Review and understand the desired systemwide outcomes and priority project functions documented in steps 1 and 2.
- Review design decision documentation that led to the development of the final design.

During construction, the project team should ensure:

- Clear, safe and accessible routes for all travel modes are provided, including detours if necessary. When designing detours, limit out-of-direction travel as much as possible for pedestrians and bicyclists. Engage daily users of the project area in developing detour routes.
- Natural resources in the project area are protected throughout the construction phase.
- Ongoing communication occurs with the surrounding community about construction process and timeline.
- Coordination occurs with other construction activities in the vicinity, including considering other projects that would impact alternative routes that travelers are likely to use.

Document

Document any minor design adjustments made during construction.

STEP 8

Operations and maintenance

As an agency operates and maintains the roadway or trail, it may find other opportunities for smaller changes or investments that could further enhance the project's alignment with the key priority functions and overall outcomes.

As maintenance occurs and as repaving projects are performed on a roadway, the project team should review any previously documented key priority functions before making alterations to the streetscape.

Identify the need for specialized equipment or personnel training due to complex designs or specific design features. For example, busy urban roadways are often more difficult to maintain and operate than rural highways. Urban roadway design features are more likely to include such elements as street trees, vegetated stormwater management solutions, separated bicycle facilities, complex multimodal signal operations, busy transit stops, and pedestrian crossing treatments. Agencies need to equip responsible maintenance staff with the resources (training and ongoing funding) to properly maintain the roadway investments.

Evaluation

After a project is constructed, agencies can use project performance measures (or variations of them) to evaluate outcomes and inform design details of specific elements to better serve key functions in future designs.

For example, if travel time reliability for any mode was used as a performance metric, travel times should be monitored and compared to the goal. This monitoring can help the agency evaluate whether, or to what extent, selected designs are helping fulfill the project intent.

Projects that include new practices or design exceptions should be reviewed and evaluated approximately three to five years after construction to document performance impacts, contributing to the refinement of industry best practices.

Before-and-after evaluations can provide quantitative data agencies can use for future justification of design decisions and project alternative evaluations. Collect data before you implement a new design and afterwards, then compare.

Document

Three to five years after construction, conduct a thorough evaluation and report how well the project is performing, in alignment with the original project objectives and priority functions.

Glossary

Access management Enables access to land uses while maintaining roadway safety and mobility through controlling access location, design, spacing and operation.

Access The ability to reach desired goods, services, activities and destinations. Locations that can be accessed by many people using a variety of modes of transportation generally have a high degree of access.

Arterial street A class of street. Arterials are intended to provide general mobility for travel within the region. Arterial streets link major commercial, residential, industrial and institutional areas. Major arterial streets are usually spaced about one mile apart. Minor arterials are spaced half a mile apart. Arterials are designed to accommodate bicycle, pedestrian, truck and transit travel.

Automated vehicle (AV) Also known as a driverless car, self-driving car or robotic car, AVs use sensors and advanced control systems to operate independently of any input from a human driver. Automated vehicles can include delivery pods.

Auxiliary lane Provides a direct connection from one interchange ramp to the next. The lane separates slower traffic movements from the mainline, and can smooth the flow of traffic and reduce the potential for crashes.

Avoid, minimize or mitigate approach A hierarchical approach to protecting the environment known as sequencing that involves understanding the affected environment and addressing effects throughout project development.

Best practices For purposes of this document, a general term of preferred practices accepted and supported by experience of the applicable professional discipline. It is not prescriptive to a particular set of standards or a particular discipline.

Bicycles In this guide, refers to bicycles, skateboards and other new micromobility technologies, like e-bicycles and e-scooters.

Bikeway A general term denoting improvements and provisions made to accommodate or encourage bicycling, including all types of bicycle facilities and shared roadways.

Bike share Fleets of bicycles available for short-term rental within a defined service area. Some bike share systems now offer electric bikes.

Biofiltration The use of vegetation such as grasses and wetland plants to filter and treat stormwater runoff as it is conveyed through an open channel or swale, or collects in an infiltration basin.

Capacity Any transportation facility's ability to accommodate a moving stream of people or vehicles in a given place during a given time period. Increased capacity can come from building more streets or throughways, adding more transit service, timing traffic signals, adding turn lanes at intersections or many other sources.

Climate change Any significant change in the measures of climate lasting for an extended period of time. Climate change includes major variations in temperature, precipitation or wind patterns, among other environmental conditions, that occur over several decades or longer. Changes in climate may manifest as a rise in sea level, as well as increase the frequency and magnitude of extreme weather events now and in the future.

Complete streets A transportation policy and design approach where streets are designed, operated and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities, regardless of mode of transportation.

Congestion A condition characterized by unstable traffic flows that prevents movement on a transportation facility at optimal legal speeds.

Connectivity The degree to which streets connect to one another and the density of intersections (more intersections reflect a greater degree of connectivity).

Context-sensitive design A model for transportation project development that requires a proposed project be planned not only for its physical aspects as a facility serving specific transportation objectives, but also for its effects on the aesthetic, social, economic and environmental values, needs, constraints and opportunities in a larger community setting.

Continuous trench An installation method where a contiguous volume of soil is provided, often between rows or groups of trees, to maximize air and water exchange for tree roots. These systems are constructed in the street furniture zone because the compaction requirements are less stringent than under the sidewalk.

Crime prevention through environmental design (CPTED) A multidisciplinary approach for reducing crime and the fear of crime through urban and environmental design and the management and use of built environments.

Design speed A design control often used in roadway design guidance to determine minimum sight distance, curvature and other elements, such as deceleration. In the past, guidance has encouraged selection of as high a design speed as practical. However, with an emphasis on achieving lower speeds on urban streets, the design speed should generally align with the desired target speed. Ultimately, posted speed should also align.

Emerging technologies In this document, this term refers to new developments in transportation technology like automated vehicles or smartphones, and services that operate using these technologies, like car and bike share.

Equity See racial equity and social equity.

Facility A fixed physical asset (structure) enabling a transportation mode to operate (including travel, as well as the loading and unloading of passengers). Facility types include streets, throughways, bridges, sidewalks, bikeways, transit stations, bus stops, ports, air and marine terminals and rail lines.

Flex zone The space immediately next to the sidewalk that may consist of a variety of different elements.

Frontage zone The area immediately adjacent to buildings or other fronting land uses.

Freight In this guide, refers to trucks, and includes all types of motive power (e.g., internal combustion, electric, hydrogen fuel cell) and vehicle operators, individual or computer (autonomous).

Functional classification The class or group of roads to which a road belongs, typically arterial, collector, and local. Throughways fall under "arterial" in the federal highway classification system.

Green infrastructure Is a term that can encompass a wide array of specific practices that protect the natural environment, including an approach to water management that protects, restores, or mimics the natural water cycle.

Green street Street designed with an innovative stormwater management approach that captures rain where it falls by using vegetation, soil and engineered systems to slow, filter and clean stormwater runoff from impervious surfaces.

Green transportation hierarchy A concept applied when street space is constrained, or competing functional classification designations create conflict, investment and design treatments are prioritized according to the hierarchy in this order: walking, bicycling, transit, freight, carshare/taxi/commercial transport and private automobiles.

Impervious surface A surface that cannot be penetrated by water, preventing infiltration and generating runoff. Examples include pavement, rock and rooftops.

Intermodal facilities Examples include major rail yards, marine terminals and airports.

Last mile (for freight) The movement of goods from a transportation hub, such as a warehouse, to the final delivery destination, such as a grocery store.

Livability In this document, livable streets and trails are facilities designed to support independence and access to a variety of travel options; provide orientation, safety and comfort; support social and racial equity and welcoming, safe spaces; encourage a sense of community yet provide sufficient privacy; foster a sense of neighborly ownership and responsibility; avoid and mitigate for light, noise, water and air pollution; and support regional and community outcomes.

Micromobility Is a new concept that is developing around new forms of transportation such as e-bikes, e-scooters, and bicycle sharing systems.

Mixing zones These are areas where trails and other uses intersect. Examples include trails that go through parks, riverfront areas, plazas or in front of buildings. In these situations people may be crossing the trail at various points and in random ways.

Mobility The ability to move people and goods to destinations efficiently and reliably.

Mobility targets Historically, volume-to-capacity ratios for motor vehicles for different roadway classifications.

Mode A type of transportation distinguished by means used (e.g., walking, bicycle, bus, single– or high–occupancy vehicle, train, truck, air, marine).

Mode choice The ability to choose one or more modes of transportation.

Motor vehicle In this guide, refers to a personal motor vehicle that is not public transit, and includes all types of motive power (e.g., internal combustion, electric, hydrogen fuel cell) and vehicle operators, individual, hired driver or computer (autonomous vehicles).

Multimodal The movement of people or goods by more than one mode.

National Pollutant Discharge Elimination System (NPDES) A provision of the Clean Water Act that prohibits pollutant discharge into waters of the United States unless a special permit is issued by the Environmental Protection Agency, a state or (where delegated) a tribal government or Indian reservation.

Natural buffer A variable-width area maintained with natural vegetation between a pollutant source and a water body that provides natural filtration and other forms of protection.

Network A cohesive system of connected routes.

New mobility services Transportation services like ride hailing and car and bike share, which operate using smartphones and other emerging technologies.

Pedestrian In this guide, refers to a person walking, using a wheelchair, mobility device or other new personal mobility technologies.

Pedestrian facility A facility provided for the benefit of pedestrian travel, including walkways, protected street crossings, crosswalks, plazas, signs, signals, pedestrian scale street lighting and benches.

Pedestrian through zone A clear space for people moving along the sidewalk.

Performance measure A measure of how well something performs relative to desired outcomes. Used to support decision-making.

Polluted runoff Rainwater or snowmelt that picks up pollutants and sediments as it runs off roads, highways, parking lots, and other land-use activities that can generate pollutants.

Porous pavement and pavers Alternatives to conventional asphalt that use a variety of porous media, often supported by a structural matrix, concrete grid or modular pavement, which allow water to percolate though to a sub-base for gradual infiltration.

Project development A phase in the transportation planning process during which a proposed project undergoes a more detailed analysis of its social, economic and environmental impacts and various project alternatives. After a project has successfully passed through this phase, it may move forward to right-of-way acquisition and construction phases. Project development activities include: environmental assessment/ environmental impact statement work, design options analysis, management plans, and transit alternatives analysis.

Protected intersection (bicycle) Provide greater physical separation between bicycles and motor vehicles and reduce conflict points, with design treatments such as bicycle boxes, marked intersection crossings, two-stage turn queue boxes, separated lanes and median refuge islands.

Racial equity When race can no longer be used to predict life outcomes and outcomes for all groups are improved. The removal of barriers with a specific focus on eliminating disparities faced by and improving equitable outcomes for communities of color with the intent of also effectively identifying solutions and removing barriers for other disadvantaged groups..

Regional streets Regional streets accommodate both regional through trips and local trips. Regional streets connect centers and connect to places outside of the region. Providing for both regional through trips and local trips distinguishes regional streets from collectors or local residential streets which serve local access trips.

Regional Transportation Plan A long-range transportation plan that is developed and adopted for the greater Portland metropolitan planning area covering a planning horizon of at least 20 years.

Right-of-way Land that is publicly-owned, or in which the public has a legal interest, usually in a strip, within which the entire road facility (including travel lanes, medians, sidewalks, shoulders, planting areas, bikeways and utility easements) resides. The right-of-way is usually acquired for or devoted to multi-modal transportation purposes including bicycle, pedestrian, public transportation and vehicular travel.

Root paths Narrow trenches extending radially from a tree pit about 4-inches wide and 12-inches deep, inserted below new pavement. Root paths allow roots to grow and extend below the pavement with fewer restrictions from compaction.

Runoff Water from rainfall, snowmelt or otherwise discharged that flows across the ground surface instead of infiltrating the ground.

Safe system approach to speed setting In this approach, speed limits are set according to likely crash types, resulting impact forces, and the human body's ability to withstand these forces. It allows for human errors (that is, accepting humans will make mistakes) and acknowledges that humans are physically vulnerable (that is, physical tolerance to impact is limited). Therefore, in this approach, speed limits are set to minimize death and severe injury as a consequence of a crash.

Safety Protection from death or bodily injury from a motor vehicle crash through design, regulation, management, technology and operation of the transportation system.

Security (public and personal) Protection from intentional criminal or antisocial acts while engaged in trip making through design, regulation, management, technology and operation of the transportation system.

Shy distance Is the space left between vehicles, bicycles or pedestrians as they pass each other or a fixed object such as a curb or building. The amount of shy distance required for safety tends to increase with speed.

Social equity The idea that all members of a community should have access to the benefits associated with civil society. The pursuit of an equitable society requires recognition that some members of a society have more or less privilege and that in order to provide equitable situations, the impacts of these privileges (or lack thereof) must be addressed.

Stakeholders Individuals and organizations with an interest in or who are affected by the transportation planning process, including federal, state, regional and local officials and jurisdictions, institutions, community groups, transit operators, freight companies, shippers, non-governmental organizations, advocacy groups, the general public, and people who have traditionally been underrepresented.

Stormwater Water produced by a storm event or conveyed through a storm sewer system or ditches.

Stormwater management The effort to provide treatment for and reduce volumes runoff of rainwater or melted snow into streets or other sites to reduce pollution of waterways.

Street This term collectively refers to arterial, collector and local streets.

Street furniture zone The buffer space between the pedestrian through zone and the street. This space can include elements such as street trees, stormwater facilities, seating, transit stops, bike share stations, utilities and lighting.

Structural soils A growing medium consisting of specially-graded angular rock or sand mixed with soil that, when blended and compacted, provides air and water pockets that allow for root growth.

Suspended pavement and structural cells Manufactured boxes, cells or vaults that suspend pavement over the soil volume below. The pavement is installed on top of the structured system, while inside the void is a large volume of soil specifically designed and compacted to allow for optimal root expansion. These systems have a high upfront cost, but reduce the need to fix broken pavement sections caused by root upheaval. They also result in reduced tree mortality and subsequent tree replacement costs.

Swale A natural or human-made open depression or wide, shallow ditch that intermittently contains or conveys runoff.

Target speed The desired speed at which vehicles should operate on a roadway or trail. Design elements are used to design the street or trail to achieve the desired target speed. Wider, more open roadways promote higher operating speeds. Conversely, a roadside with buildings, parked cars and street trees can provide cues to drivers to reduce speeds.

Traffic Movement of motorized and non-motorized vehicles and pedestrians on transportation facilities. Often, traffic levels are expressed as the number of units moving over or through a particular location during a specific time period.

Transit In this guide, refers to a bus or train, and includes all types of motive power, including internal combustion, electric and hydrogen fuel cell, and vehicle operators, including individual and computer (autonomous).

Transportation system Various transportation modes or facilities (aviation, bicycle and pedestrian, throughway, street, pipeline, transit, rail, water transport) serving as a single unit or system.

Travelway Is the space in the middle of the street where people travel, typically by motor vehicle, transit and bicycle.

Trip A one–way movement of a person or vehicle between two points.

Truck apron A raised, mountable curb found at roundabouts and right-turn lanes. Allows large trucks and buses to navigate turns without striking fixed objects or other road users while slowing speeds of smaller vehicles.

Two-stage turn queue box Provides a safe way make left turns at multi-lane signalized intersections from a right-side bikeway, or right turns from a left-side bikeway. May also be used at unsignalized intersections to simplify turns from a bikeway. At midblock crossing locations, a two-stage turn queue box may be used to orient bicyclists properly for safe crossings. Multiple positions are available for queuing boxes, depending on intersection configuration.

Urban heat island effect This condition is caused by the prevalence of heat-storing materials such as concrete and asphalt, and anthropogenic heat sources such as automobiles in urban areas. It is estimated that temperatures in cities are approximately seven to nine degrees higher than in surrounding rural areas. Street trees in urban areas can greatly reduce this effect.

Vision Zero A system and approach to public policy developed by the Swedish government which stresses safe interaction between road, vehicle and users. Highlighted elements include a moral imperative to preserve life, and understanding that system conditions and vehicles must be adapted to match the capabilities of the people that use them. Vision Zero employs the Safe System approach.

Volume-to-capacity ratio A traditional measure of congestion, calculated by dividing the number of motor vehicles passing through a section of roadway during a specific increment of time by the motor vehicle capacity of the section. For example, a V/C ratio of 1.00 indicates the roadway facility is operating at its capacity. Also referred to as level-of-service, this ratio has been used in transportation system planning, project development and design as well as in operational analyses and traffic analysis conducted during the development review process.

Vulnerable users In this document, this term refers to groups of people that are more vulnerable to being killed or severely injured in traffic crashes. Vulnerable users are pedestrians, bicyclists, motorcycle operators, children, older adults, roadway construction workers, people with disabilities, people of color and people with low incomes.

Watershed The land area, or catchment, that contributes water to a specific water body. All the rain or snow that falls within this area flows to the water bodies as surface runoff, in tributary streams, or as groundwater.

ABOUT THIS GUIDE

This guide is the third edition of the *Creating Livable Streets* handbook and the second edition of the *Green Streets: Innovative Solutions for Stormwater and Stream Crossings* handbook. Metro's other design guidebooks, *Trees for Green Streets*, *Wildlife Crossings* and *Green Trails*, provide additional resources. This edition was developed through a collaborative effort from a multi-jurisdictional technical work group and consulting team with a wide array of professional expertise.

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Separated two-way bikeway on NE 21st Avenue bridge, Portland.

If you picnic at Blue Lake or take your kids to the Oregon Zoo, enjoy symphonies at the Schnitz or auto shows at the convention center, put out your trash or drive your car – we've already crossed paths.

So, hello. We're Metro – nice to meet you.

In a metropolitan area as big as Portland, we can do a lot of things better together. Join us to help the region prepare for a happy, healthy future.

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