KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING
610 SW Alder Street, Suite 700, Portland, OR 97205 P 503.228.5230 F 503.273.8169

TECHNICAL MEMORANDUM

Pendleton TSP Pedestrian, Bicycle & Transit Update

Active Transportation and Transit Toolbox

Date:	October 7, 2015	Project #:18685
To:	Advisory Committee (AC)	
From:	Matt Hughart (KAI), Sara Muse (KAI), Mathew Berkow (N\N), Stephanie Wright (N\N)	
cc:	Project Management Team (PMT)	

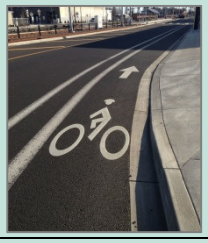
This memorandum provides a toolbox of active transportation and transit treatments that could potentially be investigated for implementation in the City of Pendleton.

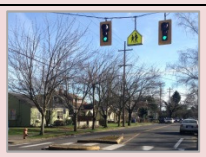
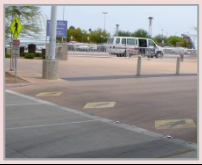
TOOL BOX

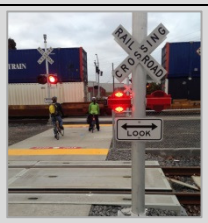
The treatments are organized into the categories listed above, with headers and footers indicating the categories. Where applicable, the treatments are organized from highest level of protection to lowest level of protection. Typically, the treatments that provide the most protection will have the highest appeal to a wide variety of users. For example, bicycle treatments are commonly categorized by the level of separation they provide bicyclists from motor vehicles. Separated facilities have been found to attract more bicyclists of a variety of ages and abilities and are generally considered “lower stress” facilities. However, separated facilities must be carefully designed to allow for safe crossings and turning movements for both motor vehicles and bicyclists at intersections. As another example, treatments for pedestrian mid-block crossings range from a high-level of protection with a pedestrian signal to a lower level of protection with a high-visibility crosswalk. Intermediary levels of protection can be provided with a pedestrian hybrid beacon or rectangular rapid flashing beacon.

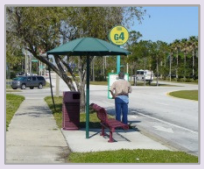
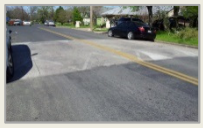
Table 1 summarizes the treatments provided in the toolbox by category. The toolbox that follows provides more detail on each facility type, benefits, other considerations, and common applications.

Table 1. Toolbox Contents

	Page #	Treatment	Image	Level of Separation / Protection
Bicycle Facilities	BF-1	Multi-Use Path		High Level of Separation/Protection
	BF-2	One-Way Separated Bike Lane (Cycle Track)		
	BF-3	Two-Way Separated Bike Lane (Cycle Track)		
	BF-4	Buffered Bike Lane		
	BF-5	Standard Bike Lane		
	BF-6	Advisory Bike Lane		
	BF-7	Paved Shoulder		
	BF-8	Bicycle Boulevard		
	BF-9	Shared Lane Roadways		Low Level of Separation/Protection

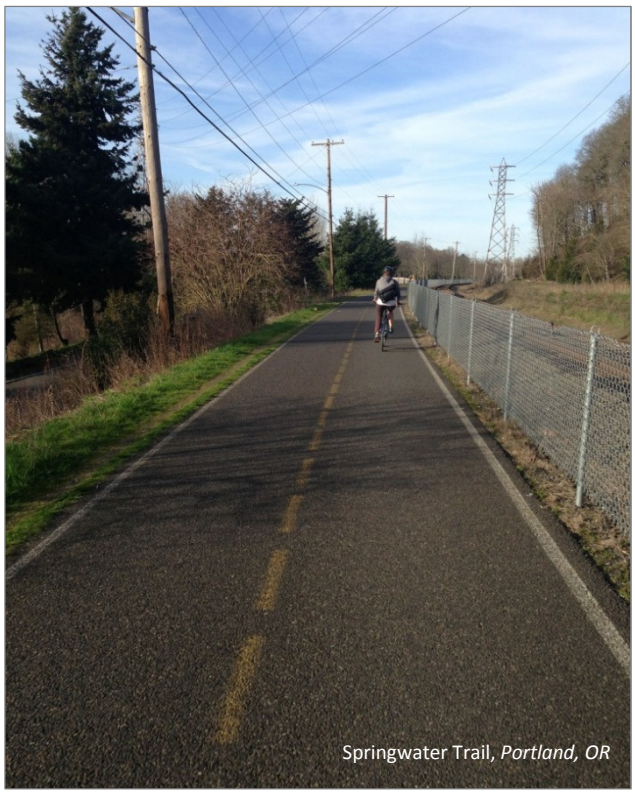
Pedestrian Facilities	PF-1	Multi-Use Path		High Level of Separation/Protection
	PF-3	Sidewalk		
	PF-2	Pedestrian Path (Sidepath)		
	PF-4	Shoulder Pedestrian Facility		Low Level of Separation/Protection
General Crossing Treatments	CT-1	Grade Separated Crossing		High Level of Separation/Protection
	CT-2	Pedestrian Signal		
	CT-3	Pedestrian Hybrid Beacon		
	CT-4	Rectangular rapid Flashing Beacon		
	CT-5	Crossing Island (Pedestrian Refuge)		
	CT-6	Bulb-Out/Curb Extension		
	CT-7	Raised Pedestrian Crossing		
	CT-8	High Visibility Crosswalk		Low Level of Separation/Protection

	CT-9	Leading Pedestrian Interval (LPI)		Not Applicable
Railroad Crossing Treatments	RR-1	Automatic Pedestrian Gate		**High Level of Separation/Protection**
	RR-2	"Active" Treatments		
	RR-3	Basic "Passive" Treatments		
	RR-4	Other "Passive" Treatments		**Low Level of Separation/Protection**
Bicycle Intersection Treatments	BI-1	Bike Signal		**High Level of Separation/Protection**
	BI-2	Bike Boxes		
	BI-3	Two-Stage Left Turn Boxes		
	BI-4	Pavement Markings Through Intersections		**Low Level of Separation/Protection**

Pedestrian/Bicycle Amenities	A-1	Bicycle Parking		Not Applicable
	A-2	Street Furniture and Lighting		Not Applicable
	A-3	Transit Stop Shelters		Not Applicable
Traffic Calming Treatments	TC-1	Rumble Strips		Not Applicable
	TC-2	Speed Bumps, Speed Humps, Speed Tables		Not Applicable
	TC-3	Reduced Curb Radii		Not Applicable

MULTI-USE PATH

Cost: $$$



Springwater Trail, *Portland, OR*

OC&E Trail, *Klamath Falls, OR*

Multi-use paths are paved, bi-directional, trails away from roadways that can serve both pedestrians and bicyclists. Multi-use paths can be used to create longer-distance links within and between communities and provide regional connections. They play an integral role in recreation, commuting, and accessibility due to their appeal to users of all ages and skill levels.

Benefits

- Provides facility for both pedestrians and bicyclists in less space than separate facilities.
- Separation from motor vehicles can attract users of all levels.

Constraints

- May be unsafe in areas with frequent crossings or driveways.
- When parallel to roadways, requires substantial space for buffer.
- Potential for conflicts between bicyclists and pedestrians due to shared facility.
- Isolated paths may introduce personal security concerns.

Typical Applications

- Medium- to long-distance links within and between communities that also serve as recreational facilities.
- Parallel to roads in rural areas where sidewalks and on-street facilities are not present.

Design Considerations

- Best suited in areas where roadway crossings can be minimized (such as parallel to travel barriers such as highways, railroad tracks, rivers, shorelines, natural areas, etc.).
- Necessitate high-visibility treatments for crossings.
- A minimum width of 10 feet is recommended for low-pedestrian/bicycle-traffic contexts; 12 to 20 feet should be considered in areas with moderate to high levels of bicycle and pedestrian traffic.
- Pavement markings can be used to indicate distinct space for pedestrian and bicycle travel.

Additional Guidance

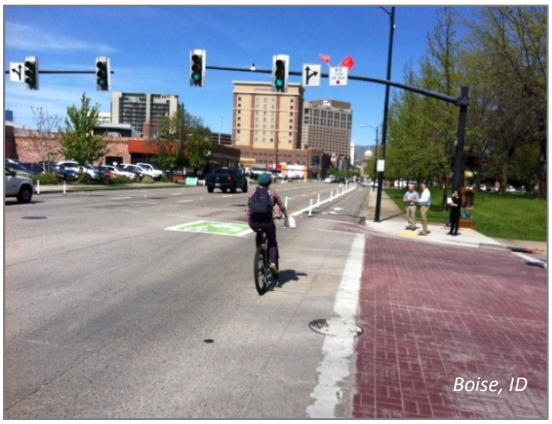
- AASHTO Guide for the Development of Bicycle Facilities
- ODOT Highway Design Manual

ONE-WAY SEPARATED BIKE LANE (CYCLE TRACK)

Cost: $-$$$


NE Cully Boulevard
Portland, OR


NE Multnomah Street
Portland, OR


Boise, ID

A one-way separated bike lane (SBL), also known as a cycle track or protected bike lane, is a bicycle facility within the street right-of-way separated from motor vehicle traffic by a buffer and a physical barrier, such as planters, flexible posts, parked cars, or a mountable curb. On two-way streets, a one-way SBL would be found on each side of the street, like a standard bike lane.

Benefits

- Provides physical separation from motor vehicle traffic, which can attract users of all levels.
- Buffer can provide opportunities for landscaping.
- Reduced risk of "dooring" when parked cars are present.

Constraints

- Requires additional right-of-way over standard bike lane.
- Construction may be more expensive than standard bike lane.
- May introduce street maintenance considerations, depending on buffer type.

Typical Applications

- Roadway segments with sufficient right-of-way or where a "road diet" (vehicle lane reduction) can be implemented.
- Key segments of the bicycle network where more protection is desirable, such as areas with higher traffic volumes or speeds, or routes to common destinations, like schools.
- Roadways with infrequent driveways and side street accesses.

Design Considerations

- Intersections must be designed to ensure visibility of bicyclists using the facility. Treatments include separate signal phases for bicyclists and high visibility pavement markings.
- Buffer type can vary depending on context, presence of parking, and available right-of-way.
- Green pavement markings or striping can add visibility and awareness in "conflict areas" or intersections where bicycle and vehicle travel paths cross.

Additional Guidance

- NACTO Urban Bikeway Design Guide
- CROW Design Manual for Bicycle Traffic
- ODOT Highway Design Manual
- ODOT Bicycle and Pedestrian Design Guide
- FHWA Separated Bike Lane Planning and Design Guide

TWO-WAY SEPARATED BIKE LANE (CYCLE TRACK)

Cost: $-$$$

Davis, CA

Broadway
Seattle, WA

A two-way separated bike lane (SBL), also known as a two-way cycle track or protected bike lane, is a facility within the street right-of-way separated from motor vehicle traffic by a buffer and a physical barrier, such as planters, flexible posts, parked cars, or a mountable curb. Two-way SBLs serve bi-directional bicycle travel within the facility on one side of the street.

Benefits

- Requires less right-of-way than a one-way SBL, due to the need for only one buffer.
- Provides physical separation from motor vehicle traffic, which can attract users of all levels.
- Reduced risk of "dooring" when parked cars are present.

Constraints

- May be less intuitive due to apparent "wrong-way" travel on one side of street.
- Concern about crashes in areas with frequent crossings or driveways.
- Construction may be more expensive than standard bike lane.
- May introduce street maintenance considerations, depending on buffer type.

Typical Applications

- On-street connections between off-street multi-use paths.
- Roadways with infrequent driveways and side street accesses.
- Key segments of the bicycle network where more protection is desirable, such as areas with higher traffic volumes or speeds or routes to common destinations, like schools.
- On one-way streets where two-way bicycle travel is desirable.

Design Considerations

- Intersections must be designed to ensure visibility of bicyclists using the facility. Treatments include separate signal phases for bicyclists and high visibility pavement markings.
- Buffer type can vary depending on context, presence of parking, and available right-of-way.
- Green pavement markings or striping can add visibility and awareness in "conflict areas" or intersections where bicycle and vehicle travel paths cross.

Additional Guidance

- NACTO Urban Bikeway Design Guide
- CROW Design Manual for Bicycle Traffic
- FHWA Separated Bike Lane Planning and Design Guide

BUFFERED BIKE LANE

Cost: $-$$$

Capitol Boulevard
Boise, ID

Buffered bicycle lanes are on-street lanes that include an additional striped buffer of typically 2-3 feet between the bicycle lane and the vehicle travel lane and/or between the bicycle lane and the vehicle parking lane.

Benefits

- A parking-edge buffer on streets with on-street parking can reduce the likelihood of "dooring."
- Increased separation from motor vehicles (over standard bicycle lanes) can increase bicyclist comfort.

Constraints

- Does not provide physical protection and therefore may not attract bicyclists of all levels.
- The additional width provided by the buffer may invite motorists to illegally park in the lane if not adequately signed and enforced.

Typical Applications

- Long-distance links within and between communities.
- Streets with sufficient pavement width to provide a buffer.
- Widely applicable in both urban and rural settings.
- Segments of the bicycle network with moderate vehicle speeds or volumes.

Design Considerations

- Typical buffer width is 2-3 feet, in addition to standard bicycle lane width of 5-6 feet, but a combined width of 6 feet is acceptable.
- Green pavement markings or striping can add visibility and awareness in "conflict areas" or intersections where bicycle and vehicle travel paths cross.
- Buffer space can have markings or rumble strips to deter vehicles from traveling or parking in the space.

Additional Guidance

- AASHTO Guide for the Development of Bicycle Facilities
- NACTO Urban Bikeway Design Guide
- ODOT Highway Design Manual
- ODOT Bicycle and Pedestrian Design Guide

STANDARD BIKE LANE

Cost: $-$$$

A standard bike lane is an on-street facility that provides space designated for bicyclists, separated from vehicles by pavement markings.

Benefits

- Provides a designated facility for bicyclists using the minimum pavement width.
- Provides increased visibility for bicyclists.
- Relatively inexpensive treatment when pavement width is available.

Constraints

- Can position bicyclists in the "door zone" if located adjacent to parked vehicles without a buffer.
- Motorists may illegally park in the lane if not adequately signed and enforced.
- Does not provide physical protection or horizontal buffer from vehicles and therefore does not attract bicyclists of all levels.

Typical Applications

- Arterials, collectors, and other non-local streets with speeds higher than 25 mph or over 3,000 average daily motorized traffic volumes.
- Streets without sufficient right-of-way or pavement width for buffered bike lanes or separated bike lanes (SBLs).

Design Considerations

- Typical bike lane width is 6 feet, with 5 feet in constrained locations. A minimum 4-foot width can be used on constrained segments where on-street parking is not present.
- Green pavement markings or striping can add visibility and awareness in "conflict areas" or intersections where bicycle and vehicle travel paths cross.

Additional Guidance

- AASHTO Guide for the Development of Bicycle Facilities
- NACTO Urban Bikeway Design Guide
- ODOT Highway Design Manual
- ODOT Bicycle and Pedestrian Design Guide

ADVISORY BIKE LANE

Cost: $

Hanover, NH
Photo: Danny Kim, *The Dartmouth*

Hanover, NH
Photo: Danny Kim, *The Dartmouth*

Advisory bike lanes, also known as "suggestion lanes," are bicycle lanes that motor vehicles can use to pass oncoming motor vehicles after yielding to bicyclists. Advisory bicycle lanes are used in combination with a single center lane (without a centerline) for bi-directional motor vehicle travel on relatively low-volume streets.

Benefits

- Provides striped bicycle facility on roadways with very limited right-of-way or pavement width.
- Encourages slower motor vehicle speeds and yielding to bicyclists.
- Very inexpensive treatment consisting of only signing and striping.

Constraints

- Motorists may not initially understand advisory lanes due to limited applications in the US to date.
- Does not provide physical protection from vehicles and may not attract bicyclists of all levels.

Typical Applications

- Streets with less than 6,000 average daily motorized traffic that do not have sufficient width for exclusive bicycle facilities.
- Can be applied in urban or rural contexts.

Design Considerations

- Advisory bike lanes can be striped as 5-7 foot lanes with a single center motorized vehicle lane of 10 to 18 feet.
- Explanatory signage may be helpful in US contexts to communicate to motorists that they must yield to bicyclists before passing oncoming vehicles.

Additional Guidance

- CROW Design Manual for Bicycle Traffic (Netherlands Design Guide)

PAVED SHOULDER

Cost: $-$$

Tucson, AZ


Hawaii

A paved road shoulder can serve as a bicycle facility that provides space separated from motor vehicle traffic in rural areas.

Benefits

- Provides a space separated from motorists.
- Requires less right-of-way than a separated multi-use path.

Constraints

- Does not provide physical protection from vehicles and may not attract bicyclists of all levels.
- Shoulders serving other uses, such as broken-down vehicles, may force bicyclists into travel lanes.

Typical Applications

- Typically applied on rural roadways.
- Also used as an interim treatment in urbanizing areas.

Design Considerations

- A 6-foot width is preferred to accommodate bicycle travel, with a 4-foot minimum in constrained areas. Greater widths can be used in higher-speed locations.
- Rumble strips or profiled striping can be used to enhance safety and minimize motorists encroaching on the shoulder.

Additional Guidance

- AASHTO Guide for the Development of Bicycle Facilities
- ODOT Highway Design Manual
- ODOT Bicycle and Pedestrian Design Guide

BICYCLE BOULEVARD

Cost: $

Portland, OR


SE Spokane Street
Portland, OR

Bicycle boulevards are low-volume, low-speed streets where bicycles and motorized vehicles share road space, but where bicycle movements are prioritized and optimized through use of motorized vehicle restrictions, traffic calming elements, and intersection crossing treatments.

Benefits

- Typically does not require additional right-of-way.
- Can create a comfortable space for bicyclists of all levels.
- Enhances connectivity of the network for bicyclists.

Constraints

- Bicycle boulevards may reduce through routes for motorized vehicles
- Some treatments, such as traffic circles or chicanes, may be expensive.

Typical Applications

- Local routes parallel to larger, higher-traffic roadways, such as arterials or collectors.
- Low-traffic neighborhood routes that can enhance the bicycle network connectivity.

Design Considerations

- A variety of traffic calming elements can be employed, including speed humps, traffic circles, chicanes, median barriers, and traffic diverters in order to keep traffic volumes low and minimize through-traffic.
- Consider providing “bicycle-only” through movements at intersections, where motorists are required to turn off the bicycle boulevard.
- Include shared lane markings and wayfinding signage for bicyclists.
- Recommended for streets with posted speeds of 25 mph or lower and volumes less than 3,000 average daily motorized traffic.

Additional Guidance

- NACTO Urban Bikeway Design Guide
- Manual on Uniform Traffic Control Devices (MUTCD)

SHARED LANE ROADWAYS

Cost: <$

Prince George's County, MD

Cornell Road,
Portland, OR


Pennsylvania

Shared lane roadways include roadways without separate bicycle facilities on which bicycle travel is not prohibited. Most roadways, with the exception of some limited access freeways, are "shared lane roadways" if they do not have a different type of bicycle facility. Shared lane roadways that are part of a designated bicycle network may include shared lane markings ("sharrows") or signage to indicate the legal presence of bicyclists in the travel lane.

Benefits

- Allows for bicycle travel when other treatments are not feasible.
- Low- to no-cost.

Constraints

- Does not provide any separation from vehicles.
- Without additional traffic-calming treatments, it is likely to attract only strong and fearless bicyclists.

Typical Applications

- Rural roadways without shoulders often use "share the road" signage to indicate to road users that bicyclists may be present.
- Sharrows are typically used in urban or suburban locations on bicycle network links where other facilities are not present.

Design Considerations

- Sharrows should be placed at least 4 feet from the edge of the curb or on-street parking.

Additional Guidance

- ODOT Bicycle and Pedestrian Design Guide
- ODOT Highway Design Manual
- Manual on Uniform Traffic Control Devices (MUTCD)

Pedestrian Facilities

MULTI-USE PATH

Cost: $$$

Springwater Trail
Portland, OR

Hawthorne Bridge
Portland, OR

Orlando, FL

Multi-use paths are paved, bi-directional, trails away from roadways that can serve both pedestrians and bicyclists. Multi-use paths can be used to create longer-distance links within and between communities, provide regional connections and play an integral role in recreation, commuting, and accessibility due to their appeal to users of all ages and skill levels.

Benefits

- Provides opportunity for a scenic recreational pedestrian facility.
- Hard surface allows for universal accessibility.

Constraints

- Pedestrian and bicycle conflicts may occur in shared space.
- When parallel to roadways, require substantial space for buffer.
- Isolated paths may introduce personal security concerns.

Typical Applications

- Medium- to long-distance links within and between communities that also serve as recreational facilities.
- Rural areas where sidewalks and on-street facilities are not present.

Design Considerations

- Best suited in areas where roadway crossings can be minimized (such as parallel to travel barriers such as highways, railroad tracks, natural areas, rivers, shorelines, etc.).
- Necessitate high-visibility treatments for crossings.
- A minimum width of 10 feet is recommended for low-pedestrian/bicycle-traffic contexts; 12 to 20 feet should be considered in areas with moderate to high levels of bicycle and pedestrian traffic.
- Pavement markings can be used to indicate distinct space for pedestrian and bicycle travel

Additional Guidance

- ODOT Bicycle and Pedestrian Design Guide
- AASHTO Guide for the Development of Bicycle Facilities

SIDEWALK

Cost: $$$


Portland, OR


SE 17th Avenue
Portland, OR

Milwaukee Ave
Portland, OR

A sidewalk is a dedicated pedestrian facility adjacent to the roadway and separated from traffic by a curb.

Benefits

- Provides pedestrians with a dedicated physically-separated space.
- Provides means of mobility for people using wheelchairs, people with strollers, or others who may not be able to travel on an unpaved surface.

Constraints

- Adding a concrete curb and sidewalk to streets adds a substantial expense to the overall construction cost.
- Stormwater drainage needs to be considered when retrofitting existing streets.

Typical Applications

- Typically provided on urban (non-rural) and residential streets, with the exception of limited access freeways.
- Typically added to streets in urbanizing areas as development occurs.

Design Considerations

- Typically 6 to 8 feet wide. Sidewalks should be constructed at least 5 feet wide, with a minimum of 4 feet of clear width, excluding a shy distance of 1.5 feet from the curb and any adjacent obstructions.
- A landscaped buffer is preferable in residential areas and in locations with higher traffic speeds and volumes.
- Wider sidewalks of 12 to 20 feet can be beneficial in commercial or "town center" areas in order to accommodate higher pedestrian volumes, street furniture, pedestrian scale lighting, business signage, bike parking, transit stops, and other amenities.

Additional Guidance

- ODOT Highway Design Manual.
- ODOT Bicycle and Pedestrian Design Guide
- AASHTO Green Book
- NACTO Urban Streets Design Guide

PEDESTRIAN PATH (SIDEPATH)

Cost: $$

Thielson St
Echo, OR

Skyline Boulevard
Portland, OR

A pedestrian path is a hard-surface path adjacent to the roadway in lieu of a sidewalk in areas where other bicycle facilities exist. Similar to a multi-use path, pedestrian paths are narrower in width and generally do not invite bicycle travel.

Benefits

- Provides a hard surface for pedestrians buffered from the roadway.
- Requires less right-of-way than a multi-use path.
- Lower cost than construction of a full sidewalk with curb and gutter.

Constraints

- May also attract bicyclists, creating the potential for conflicts between pedestrians and bicyclists.

Typical Applications

- In constrained rural areas where sidewalks are not present and multi-use paths cannot be accommodated.
- As an interim treatment in urbanizing areas to make connections between sidewalk facilities.

Design Considerations

- Typically 5- to 8-foot wide asphalt surface.
- Pedestrian paths are typically separated from the roadway by a gravel or vegetated buffer instead of a curb and gutter.
- Should follow ADA standards to allow for universal access.
- Though not intended for bicyclists, pedestrian paths may attract bicyclists if a separate bicycle facility is not provided.

Additional Guidance

- FHWA Designing Sidewalks and Trails for Access
- ODOT Highway Design Manual

SHOULDER PEDESTRIAN FACILITY

Cost: $-$$

SE Powell Blvd
Portland, OR

Boise, ID

A paved shoulder facility provides access for pedestrians on a hard surface in rural areas where sidewalks are not present.

Benefits

- Provides a hard surface space separated from motorists.
- Requires less right-of-way than a separated multi-use path.
- More cost-effective than installing sidewalks.

Constraints

- Does not provide physical protection of a curb and may not be comfortable for all users.
- Shoulders serving other uses, such as broken-down vehicles, may force pedestrians into travel lanes.

Typical Applications

- Typically applied on rural roadways.
- Also used as an interim treatment in urbanizing areas.

Design Considerations

- A 6-foot width is preferred to accommodate pedestrian travel, with a 4-foot minimum of paved surface in constrained areas. Greater widths can be used in higher-speed locations.
- Rumble strips or profiled striping can be used to enhance safety and minimize motorists encroaching on the shoulder.

Additional Guidance

- ODOT Highway Design Manual
- AASHTO Green Book

General Crossing Treatments

GRADE SEPARATED CROSSING

Cost: $$$$$


Scottsdale, AZ


Portland, OR


Portland, OR

A grade-separated crossing is a bridge (overcrossing) or a tunnel (undercrossing) that carries non-motorized traffic over or under a motorized corridor or other barrier to travel.

Benefits

- Provides physical separation from motor vehicle traffic, attracting users of all levels.
- Minimizes crash risk and can provide a safe crossing of any type of facility, including railroads and limited access highways.

Constraints

- Grade-separated crossings can be very expensive.
- Depending on topography, may require significant additional space to make grade changes.
- Long under-crossings have the potential to present safety and security issues.

Typical Applications

- Crossings of limited access highways, multi-lane roadways, or railroads.
- Multi-use path crossings often have grade separated crossings in order to provide comfortable and safe crossings for users of all levels.

Design Considerations

- If a substantial slope or out-of-direction travel is required, some bicyclists or pedestrians may avoid using the crossing, so minimize slope and out-of-direction travel if possible.
- In selecting a grade separated crossing, consider the surrounding topography, natural features, and floodplain.
- Consider whether the crossing needs to accommodate equestrians.
- Ensure adequate sight distance for bicyclists entering the facility to see oncoming bicyclists or pedestrians. If not possible, consider requiring bicyclists to dismount.

Additional Guidance

- NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings

General Crossing Treatments

PEDESTRIAN SIGNAL

Cost: $$$$

This crossing type can provide pedestrians with a signal-controlled crossing at a mid-block location or at a previously stop-controlled intersection where pedestrian volumes warrant full signalization. The signal remains green for the mainline traffic movement until actuated by a push button to call a red signal for traffic.

Benefits

- Has nearly 100 percent rate of motorist yielding behavior at crossing locations.
- Same appearance as standard traffic signal, so motorist understanding is high.

Constraints

- Must be activated by pedestrians.
- More costly than other crossing treatments.

Typical Applications

- Midblock crossings with high pedestrian or bicycle demand and/or high traffic volumes.
- At locations where multi-use paths intersect with roadways.
- At previously stop-controlled intersections where pedestrian volumes warrant a signal.

Design Considerations

- The push button to activate the pedestrian signal should be easily accessible by pedestrians, wheelchair users, and bicyclists (if applicable).

Additional Guidance

- Manual on Uniform Traffic Control Devices (MUTCD)
- NACTO Urban Street Design Guide
- NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings

General Crossing Treatments

PEDESTRIAN HYBRID BEACON

Cost: $$$-$$$$

Juneau, AK

Boise, ID

A pedestrian hybrid beacon (sometimes called a HAWK signal) is a pedestrian activated signal that is unlit when not in use. It begins with a yellow light alerting drivers to slow, and then displays a solid red light requiring drivers to remain stopped while pedestrians cross the street. Finally, the beacon shifts to flashing red lights to signal that motorists may proceed after pedestrians have completed their crossing.

Benefits

- Has nearly 100 percent rate of motorist yielding behavior at crossing locations.
- Improves pedestrian safety and reduces pedestrian-involved crashes.
- Less delay to motor vehicle drivers than a signal.

Constraints

- Must be activated by pedestrians.
- More costly than other crossing treatments.

Typical Applications

- Midblock crossings with high pedestrian or bicycle demand and/or high traffic volumes.
- At locations where multi-use paths intersect with roadways.

Design Considerations

- The push button to activate the pedestrian hybrid beacon should be easily accessible by pedestrians, wheelchair users, and bicyclists (if applicable).

Additional Guidance

- Manual on Uniform Traffic Control Devices (MUTCD)
- NACTO Urban Street Design Guide
- NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings

General Crossing Treatments

RECTANGULAR RAPID FLASHING BEACON (RRFB)

Cost: $$-$$$


Portland, OR


Pendleton, OR

These crossing treatments include signs that have a pedestrian-activated "strobe-light" flashing pattern to attract motorists' attention and provide awareness of pedestrians and/or bicyclists that are intending to cross the roadway.

Benefits

- Provides a visible warning to motorists at eye level.
- Increases motorists yielding behavior at crossing locations over round yellow flashing beacons (80 to 100 percent compliance).
- Allows motorists to proceed after yielding to pedestrians and bicyclists.

Constraints

- Flashing beacons must be activated by pedestrians.
- Motorists may not understand the flashing lights of the RRFB, so compliance may be lower than with a traffic signal.

Typical Applications

- Midblock crossings with medium to high pedestrian or bicycle demand and/or medium to high traffic volumes.
- Locations where multi-use paths intersect with roadways.

Design Considerations

- The push button to activate the RRFB should be easily accessible by pedestrians, wheelchair users, and bicyclists (if applicable).
- Consider adding a push button in the median island for crossings of multi-lane facilities.

Additional Guidance

- Manual on Uniform Traffic Control Devices (MUTCD)
- NACTO Urban Street Design Guide
- NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings
- ODOT Bicycle and Pedestrian Design Guide

General Crossing Treatments

CROSSING ISLAND (PEDESTRIAN REFUGE)

Cost: $-$$


Portland, OR


Portland, OR

A crossing island in the median provides a protected area in the middle of a crosswalk for pedestrians to stop while crossing the street. Also called pedestrian refuge islands or median refuges, they can be used at intersections or mid-block crossings.

Benefits

- Reduces pedestrian exposure at marked and unmarked crosswalks.
- Requires shorter gaps in traffic to cross the street.
- Allows pedestrians to cross in two phases.

Constraints

- Streets with constrained right-of-way may not have sufficient width to allow for a crossing island.

Typical Applications

- Preferred treatment for crossings of multi-lane streets.
- Often used in areas with high levels of vulnerable pedestrian users, such as near schools or senior centers/housing.
- Often applied in areas with high traffic volumes or with a pedestrian crash history.

Design Considerations

- Must have at least 6 feet of clear width to accommodate people using wheelchairs.
- At crossing locations where bicyclists are anticipated, a width of 10 feet or greater is desirable to accommodate bicycles with trailers or groups of bicyclists.
- Can be applied in conjunction with other traffic control treatments.

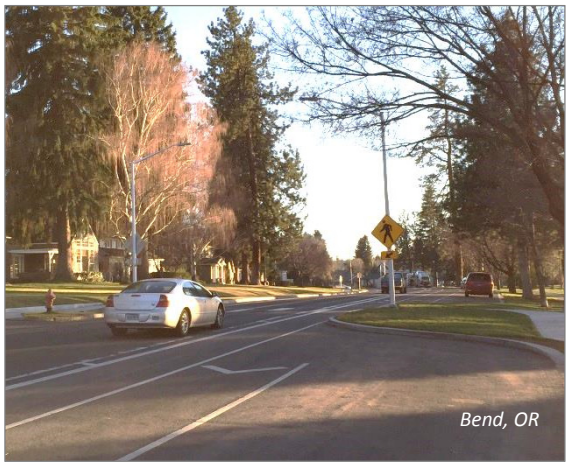
Additional Guidance

- ODOT Bicycle and Pedestrian Design Guide
- NACTO Urban Streets Design Guide
- NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings

General Crossing Treatments

BULB-OUT/CURB EXTENSIONS

Cost: $$



An extension of the curb or the sidewalk into the street (in the form of a bulb), usually at an intersection, that narrows the vehicle path, inhibits fast turns, and shortens the crossing distance for pedestrians.

Benefits

- Shortens crossing distances for pedestrians.
- Reduces motorist turning speeds.
- Increases visibility between motorists and pedestrians.
- Enables permanent parking
- Enables tree and landscape planting and water runoff treatment.

Constraints

- Can only be used on streets with unrestricted on-street parking.
- Physical barrier can be exposed to traffic.
- Greater cost and time to install than standard crosswalks.
- Can present turning radius problems to large vehicles.

Typical Applications

- Mid-block or intersection pedestrian crossings on streets with unrestricted on-street parking.
- Streets with on-street parking where pedestrian volumes ≥ 20 pedestrians per hour, ADT ≥ 1,500 vehicles per day, and average right-turn speeds ≥ 15 mph.

Design Considerations

- Include a narrow passage for bicyclists to prevent conflict with vehicles.
- Provide accessible curb ramps and detectible warnings.
- Include landscaping on the curb extension to differentiate path for pedestrian travel, especially for pedestrians with vision impairments.

Additional Guidance

- ITE/FHWA Report Traffic Calming: State of the Practice
- FHWA Designing Sidewalks and Trails for Access *Part II of II: Best Practices Design Guide*

General Crossing Treatments

RAISED PEDESTRIAN CROSSING

Cost: $$


Orlando, FL


Pendleton, OR


Sanford, FL

Raised pedestrian crossings bring the level of the roadway even with the sidewalk, providing a level pedestrian path and requiring vehicles to slow. Raised crossings can be used at midblock crosswalks or intersections.

Benefits

- Provides a better view for pedestrians and motorists
- Slows down motorists.

Constraints

- Can be difficult to navigate for large trucks, snow plows, and low ground clearance vehicles.
- Relatively expensive.

Typical Applications

- Raised crosswalks are typically provided at midblock crossings on two-lane roads where pedestrian volumes ≥ 50 pedestrians per hour and speed control is needed.
- Raised crosswalks may be provided at intersections where low-volume streets intersect with high-volume streets or where a roadway changes character (such as from commercial to residential).
- Raised crosswalks should not be used on transit routes or where there are steep grades or curves.

Design Considerations

- Raised crosswalks should be even with the sidewalk in height and at least as wide as the crossing or intersection.
- Provide detectable warnings for pedestrians where they cross from the sidewalk in to the crossing area.
- Consider drainage needs and provide appropriate treatments.
- Use colored asphalt as opposed to brick or decorative surface materials to make the crossing smoother for those with mobility impairments.

Additional Guidance

- ITE/FHWA Report Traffic Calming: State of the Practice
- FHWA Designing Sidewalks and Trails for Access *Part II of II: Best Practices Design Guide*

General Crossing Treatments

HIGH VISIBILITY CROSSWALK

Cost: $

Portland, OR

Mount Rainier, MD

Boise, ID

High visibility crosswalks consist of reflective roadway markings and accompanying signage at intersections and priority pedestrian crossing locations.

Benefits

- Communicates potential for pedestrian crossings to motorists.
- Designates a preferred crossing location for pedestrians.
- Motorists are required to stop for pedestrians entering crosswalks.
- Low cost.

Constraints

- Can be more effective with other types of traffic control (signals, stop signs).
- At uncontrolled locations (midblock), motorist compliance is not as high as with other treatments.

Typical Applications

- High visibility crosswalks are typically applied at intersections of arterials, collectors, and/or other facilities with moderate to high vehicle volumes and speeds.
- Can be applied at mid-block locations, especially in conjunction with other treatments.

Design Considerations

- Crosswalk striping can vary, and may include continental striping (top photo), ladder striping, zebra striping (middle photo), etc.
- Can be constructed with paint or thermoplastic material.
- Minimum width is 6 feet, but wider crossings are preferred in areas with high number of pedestrians.

Additional Guidance

- NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings
- ODOT Bicycle and Pedestrian Design Guide

General Crossing Treatments

LEADING PEDESTRIAN INTERVAL (LPI)

Cost: $


Orlando, FL


Sacramento, CA

A leading pedestrian interval gives pedestrians a 2-5 second head start before the concurrent vehicle phase turns green to allow pedestrians to enter and occupy the crosswalk before turning vehicles get there.

Benefits

- Pedestrians are more visible in the crosswalk before vehicles start moving.
- Helps reduce conflicts with pedestrians and turning vehicles.

Constraints

- Reduces green time for vehicle movements.
- May add to delays at intersections operating near capacity.

Typical Applications

- Used in areas where right-turning vehicle movements often interfere with pedestrian crossing movements.

Design Considerations

- Only possible when pedestrian signal faces are present.

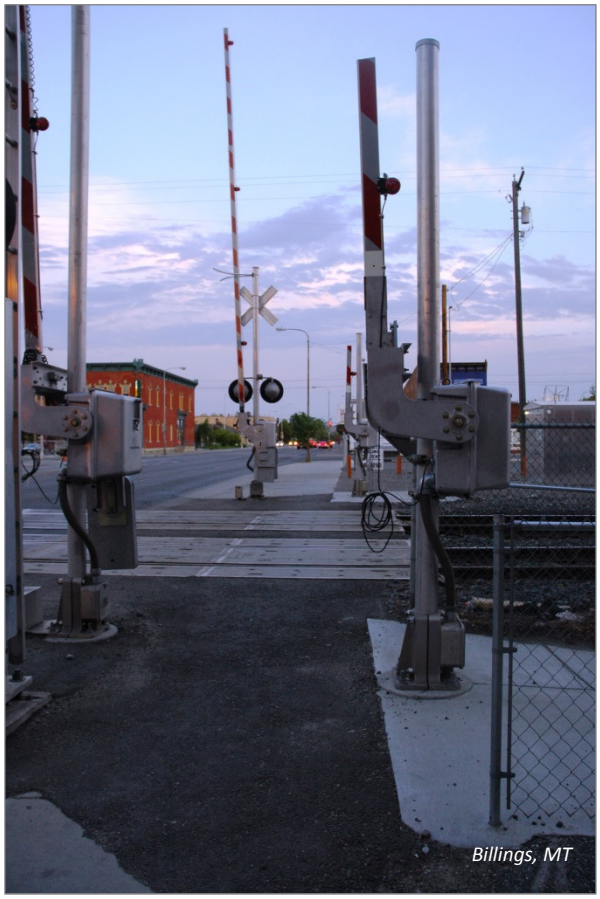
Additional Guidance

- ODOT Signal Design Manual
- ODOT Bicycle and Pedestrian Design Guide

Railroad Crossing Treatments

AUTOMATIC PEDESTRIAN GATE

Cost: $$$$$



This "active" treatment is a gate connected to and activated by the train signal system, and lowers in tandem with the motor vehicle gate. It is designed to prevent pedestrians and bicyclists from crossing when a train is approaching.

Benefits

- Provide positive control and effectively communicates to pedestrians and bicyclists the need to stop at the railroad crossing.

Constraints

- More costly than other crossing treatments.
- Without channelization, pedestrians may walk around the gate.

Typical Applications

- Locations with limited sight distance at the pedestrian crossing.
- Locations with high-speed train operation.

Design Considerations

- Must provide sufficient clear space between gate and railroad crossing, so that pedestrians or bicyclists do not get trapped if the gates descend while they are crossing.

Additional Guidance

- FHWA Railroad Highway Grade Crossing Handbook
- Manual on Uniform Traffic Control Devices (MUTCD)
- TCRP Report 69 Light Rail Service: Pedestrian and Vehicular Safety

Railroad Crossing Treatments

"ACTIVE" TREATMENTS: FLASHING LIGHT SIGNALS AND AUDIBLE WARNINGS

Cost: $$$

Portland, OR

Lehi, UT

Flashing light signals consist of two light units that flash alternately at a rate of 45 to 65 times per minute and are typically applied at motorized vehicle crossings. Smaller variations of flashing light signals, located at eye level, can be used at pedestrian and bicycle crossing locations. Audible warning bells can accompany the flashing lights. These treatments are "active" in that they only operate when a train is approaching.

Benefits

- Actively communicate the approach of a train to pedestrians and bicyclists.
- Allows pedestrians to rely on active warning instead of needing to make a crossing judgment.

Constraints

- More costly than passive crossing treatments.
- Audible warnings may have impact on surrounding community.

Typical Applications

- At roadway intersections, active treatments are often used to control motorized vehicles and can also apply to adjacent pedestrian and bicycle facilities.
- At exclusive pedestrian or bicycle crossings, active treatments are used in locations where trains are traveling at moderate speeds, where pedestrian and bicycle volumes are moderate to high, or in cases with limited sight distance.

Design Considerations

- Eye-level variations of typical flashing light signals can be used for exclusive pedestrian and bicycle crossings.
- Audible warning devices are generally installed in conjunction with flashing light signals.

Additional Guidance

- FHWA Railroad Highway Grade Crossing Handbook
- Manual on Uniform Traffic Control Devices (MUTCD)
- TCRP Report 69 Light Rail Service: Pedestrian and Vehicular Safety

Railroad Crossing Treatments

BASIC "PASSIVE" TREATMENTS

Cost: $

Portland, OR


Portland, OR

Basic treatments that can be used at rail crossings include "Stop Here" pavement markings, tactile warnings, and "look both ways" signage. These passive treatments are used to signal to pedestrians and bicyclists the correct location to stop when a train is approaching at a crossing and reminds them to look both ways before proceeding. "Passive" treatments are always present, as opposed to "active" treatments, which are operational only when a train is approaching.

Benefits

- Clearly indicates the safe stopping location to pedestrians and bicyclists in locations where it may be unclear.

Constraints

- Used alone, does not provide an active warning to pedestrians of an approaching rail vehicle, so pedestrians must make a judgment on when they can cross safely.

Typical Applications

- Used in crossing locations where the safe stopping location may not be clear.
- Generally used at signalized or unsignalized crossings where trains are moving at lower speeds.
- Can be used in conjunction with other crossing treatments. At intersections, pedestrian and bicyclists may also be alerted by audible and flashing light signals that warn motorists of approaching trains and may be controlled by pedestrian or bicycle signal heads.

Design Considerations

- Signs generally located on the right-hand side of the crossing, but should be located to optimize visibility.
- "Stop Here" and tactile warnings should be located in an area that provides safe queuing space for bicycles and pedestrians.

Additional Guidance

- FHWA Railroad Highway Grade Crossing Handbook
- Manual on Uniform Traffic Control Devices (MUTCD)
- ODOT Bicycle and Pedestrian Design Guide
- TCRP Report 69 Light Rail Service: Pedestrian and Vehicular Safety

Railroad Crossing Treatments

OTHER "PASSIVE" TREATMENTS

Cost: $-$$

Beaverton, OR

Lehi, UT

Other "passive" treatments include channeling (railing, fencing, or landscaping treatments) of pedestrian and bicycle movements to a specific location and swing gates that require a positive action by users, who must pull them open in order to cross the tracks.

Benefits

- Channelization can slow pedestrians and bicyclists and position them to look both ways prior to crossing railroad tracks.
- Swing gates prevent pedestrians and bicyclists from crossing without stopping, increasing the likelihood that they will look both ways for trains.

Constraints

- Channelization and swing gates must be carefully designed to ensure they are ADA accessible.
- Pedestrians must make judgment about when it is safe to cross.

Typical Applications

- Used in crossing locations where pedestrians or bicyclists may cross tracks without looking or may fail to look both ways before crossing.

Design Considerations

- Ensure that channel and swing gate dimensions allow for ADA access.
- Can be paired with "active" warning devices such as flashing light signals and audible warnings to further enhance effectiveness.

Additional Guidance

- FHWA Railroad Highway Grade Crossing Handbook
- Manual on Uniform Traffic Control Devices (MUTCD)
- TCRP Report 69 Light Rail Service: Pedestrian and Vehicular Safety

Bicycle Intersection Treatments

BIKE SIGNAL

Cost: $$$$


Portland, OR

Portland, OR

Bicycle-only signals can be used at intersections to provide a separate signal phase that is dedicated to bicyclists.

Benefits

- Provides bicycles with a dedicated signal phase without potential motor vehicle conflicts.
- Provides increased protection for bicyclists.

Constraints

- May increase intersection delay for motorists and bicyclists with the addition of a signal phase.

Typical Applications

- Roadway intersections with multi-use trails.
- At intersections with separated bike lanes on the roadways, or at transitions to and from two-way separated bike lanes.
- At intersections where large numbers of turning vehicles have the potential to conflict with through bicycle movements.

Design Considerations

- Ensure that signal heads are clearly visible to cyclists.
- Install painted indicators on bicycle detectors to show bicyclists where to wait.
- Consider prohibiting right-turn-on-red for motorists if right turns conflict with bicycle movements.

Additional Guidance

- NACTO Urban Bikeway Design Guide
- FHWA Separated Bike Lane Planning and Design Guide

Bicycle Intersection Treatments

BIKE BOXES

Cost: $

Portland, OR

Portland, OR

Bicycle boxes are designated spaces at signalized intersections, placed between a set-back stop bar and the pedestrian crosswalk, that allow bicyclists to queue in front of motor vehicles at red lights.

Benefits

- Increases the visibility of queued bicyclists.
- Allows bicyclists to start up and enter the intersection in front of motor vehicles when the signal turns green and/or position for a left-turn.
- Provides queuing capacity for bicycles at signals beyond a typical bike lane.

Constraints

- Driver compliance rates vary.
- Bike boxes may prevent drivers from making right-turn-on-red movements.

Typical Applications

- Signalized intersections, particularly those with high bicycle volumes.
- Signalized intersections where a designated bicycle route turns left.

Design Considerations

- Minimum depth of the bike box should be 10 feet, and it should extend across the bike lane, any buffer space, and at least one adjacent vehicle travel lane.
- Can be extended across multiple vehicle lanes on multilane streets to allow bicyclists to position for left turns.

Additional Guidance

- Manual on Uniform Traffic Control Devices (experimental status)
- FHWA Separated Bike Lane Planning and Design Guide

Bicycle Intersection Treatments

TWO-STAGE LEFT TURN BOXES

Cost: $


Portland, OR


Seattle, WA

Two-stage left-turn boxes allow bicyclists to safely and comfortably make left-turns at multilane intersections from a right-side bicycle lane or cycle track. Bicyclists arriving on a green light travel into the intersection and pull out into the two-stage turn queue box away from through-moving bicycles and in front of cross street traffic, where they can wait to proceed through on the next green signal.

Benefits

- Provides a low-stress option for left turns, so that bicyclists do not need to merge into traffic.
- Provides a clear and visible location for queuing bicyclists waiting to cross.

Constraints

- May be difficult to accommodate within a constrained intersection geometry.

Typical Applications

- At signalized intersections with multi-lane roadways.
- At locations where a low-stress left turn movement for bicyclists is desirable.

Design Considerations

- Should be located out of the way of through bicyclists, usually between the bike lane and the crosswalk. If there is on-street parking, space may be available between the bike lane and vehicle travel lane.
- Consider using passive bicycle detection in the two-stage left turn box to call the green signal phase for bicyclists.

Additional Guidance

- Manual on Uniform Traffic Control Devices (experimental status)
- FHWA Separated Bike Lane Planning and Design Guide

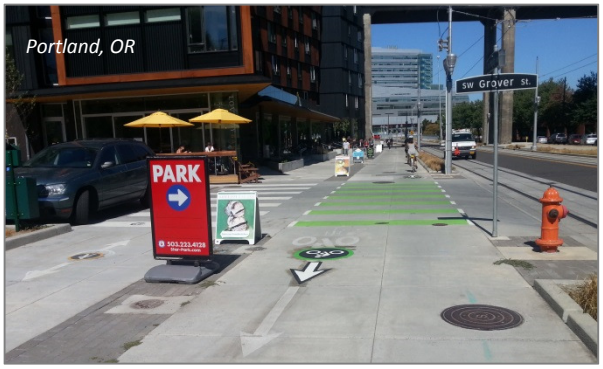
Bicycle Intersection Treatments

PAVEMENT MARKINGS THROUGH INTERSECTIONS

Cost: $


Portland, OR


Portland, OR



Portland, OR

Pavement markings can be extended through the intersection for both cycle tracks and bicycle lanes. Green paint can be used in "conflict zones" where vehicles and bicycles may cross paths in intersections, at driveways, or at right turn pockets.

Benefits

- Green paint can alert drives of a conflict zone.
- Paint through an intersection can help bicyclists know where to cross and alert drivers to look for bicyclists.

Constraints

- Paint may wear more quickly in intersections and require additional maintenance due to vehicles crossing it more frequently.

Typical Applications

- Intersections and conflict zones, especially in high-traffic or high-speed areas.

Design Considerations

- Use white dashed lines at a minimum to extend a treatment through an intersection or across a conflict zone. Dashed green pavement can enhance awareness and visibility.
- Other non-standard treatments, such as solid green paint or bicycle "chevron" markings have been used in locations throughout the US.

Additional Guidance

- Manual on Uniform Traffic Control Devices (experimental status)
- FHWA Separated Bike Lane Planning and Design Guide
- NACTO Urban Bikeway Design Guide

Bicycle/Pedestrian Amenities

BICYCLE PARKING

Cost: $


Corvallis, OR


Banks, OR


Portland, OR

Devices and/or areas that allow secure bicycle parking, often located at areas of high bicycle and pedestrian traffic such as bus stations, shopping centers, schools, and multi-use trails.

Benefits

- Provides a secure location to store and lock bicycles.
- Relatively inexpensive and easy installation.
- Encourages community bicycle use and makes local attractions/businesses more accessible to bicyclists.

Constraints

- Requires space in potentially busy areas, such as sidewalks.
- May remove on-street parking space if located on the roadway.

Typical Applications

- Typically provided at areas of high bicycle and pedestrian traffic such as bus stations, shopping centers, schools, and multi-use trails.

Design Considerations

- The size and design of the bicycle rack can vary based on the estimated number of users and available space.
- Covered bicycle parking can provide protection from the weather for parked bicycles and people as they lock and unlock bikes. Bike lockers can provide additional security.
- If possible, bicycle racks should be placed immediately adjacent to the entrance/location they serve.
- Rack should not be placed to block the entrance of a building or inhibit pedestrian flow.
- Racks should be easy to find, convenient, and secure.

Additional Guidance

- APBP Bicycle Parking Guidelines

Bicycle/Pedestrian Amenities

STREET FURNITURE AND LIGHTING

Cost: $$-$$$


Austin, TX


Ft Lauderdale, FL

Street furniture includes pedestrian seating, information/ wayfinding structures, and trash cans. Street furniture and lighting can be used to enhance the pedestrian experience and encourage pedestrian activity on a street.

Benefits

- Encourages walking and sense of comfort and security for pedestrians.
- Relatively inexpensive and easy installation.
- Encourages foot traffic and can make local attractions/ businesses inviting.

Constraints

- Requires space in potentially busy areas, such as sidewalks.
-

Typical Applications

- Typically provided at areas of high bicycle and pedestrian traffic such as bus stations, shopping centers, schools, and multi-use trails.
- Street furniture and pedestrian-scale lighting is usually provided on corridors with commercial activity and anticipated high-pedestrian use.

Design Considerations

- Street furniture should not be placed to block the entrance of a building or inhibit pedestrian flow.
- The type and size of street furniture should be based on the available space and anticipated demand.
- Street furniture should be accessible to all users.

Additional Guidance

- AASHTO Roadway Lighting Design Guide

Bicycle/Pedestrian Amenities

TRANSIT STOP SHELTERS

Cost: $$$

Portland, OR

Orlando, FL

Transit stop shelters help protect passengers waiting to load the bus from the elements and provides a great level of comfort. They also increase the visibility of transit stops and attractiveness for riders.

Benefits

- Provides protection from the elements and a place to sit for people waiting for transit.
- Provides a prominent visual cue about where the transit stop is located.

Constraints

- Costs more than a simple signed bus stop.
- Require additional sidewalk width beyond a standard 6-foot width.

Typical Applications

- Typically provided at bus stops with higher levels of activity or those that serve major transfer points, senior communities, schools, or major trip generators.
- May be paired with other bus stop amenities, like benches and bicycle parking.
- Shelters can be fully enclosed or just an overhead canopy, although semi-enclosed shelters are most common.

Design Considerations

- The style of the transit stop shelter can depend on the preferences of the local jurisdiction.
- At stops with a high number of daily boardings (i.e. over 100), a larger shelter or multiple shelters should be considered.
- Shelters should be cleaned and maintained regularly.
- Shelters should have transparent sides for greater visibility and panels should be resistant to fading or clouding.

Additional Guidance

- TCRP Report 19: Guidelines for the Location and Design of Bus Stops

Traffic Calming Measures

RUMBLE STRIPS

Cost: <$

Pavement surface treatments intended to cause drivers to experience vehicular vibrations signaling them to slow down. Rumble strips can be raised pavement markers across the roadway or grooves along the shoulder or centerline. Rumble strips are best used in conjunction with other traffic calming treatments.

Benefits

- Low cost.
- Speed reduction and increase in driver awareness.

Constraints

- Vibration noise created may be inappropriate in residential areas.
- Perceived more as a warning to slow down, than a physical measure that forces slower speeds.
- Impact the comfort and control of bicyclists.
- Potential impacts on pavement deterioration based on pavement quality and placement.

Typical Applications

- Roadways with high speeds or where driver inattention is an issue.
- Rumble strips can be used on shoulders to alert drivers they are entering a part of the roadway not intended for use.
- Roadway rumble strips placed across the roadway are used to alert drivers of a changing roadway condition or the need for speed reduction.

Design Considerations

- All road users need to be considered and accommodated. Bicycles need particular attention, especially if they are expected to use the roadway or shoulders.
- There are a variety of types of rumble strips, so the site application should be considered to determine the most appropriate design.

Additional Guidance

- FHWA Technical Advisory: Shoulder and Edge Line Rumble Strips

Traffic Calming Measures

SPEED BUMPS, SPEED HUMPS, SPEED TABLES

Cost: $$


Howard County, MD


Austin, TX

There are a number of raised treatments that can be used in the roadway to slow vehicular traffic, including speed bumps, humps and tables.

Speed humps utilize a larger vertical radius than speed bumps that results in wider widths and a gentler crossing by vehicles.

Speed tables are wide mountable obstructions installed on the pavement surface across travel lanes, and intended to cause vehicles to slow. Speed tables are wider flat-top speed humps, and are gentler on vehicles. They can be used on higher order roads than bumps or humps, because they allow a smoother ride and higher speeds.

Benefits

- Relatively inexpensive.
- Effectively slows vehicle speeds, with speed bumps and humps reducing speeds more than speed tables.
- Easily navigated by bicyclists.

Constraints

- May be considered noisy by nearby residents.
- Forces emergency vehicles to slow down.
- Inappropriate on streets with bus traffic due to rider comfort and reduced travel speeds.

Typical Applications

- Speed bumps or humps can be used on lower order roadways, whiles speed tables are appropriate on higher order roadways.
- Roadways where a reduction in speeds and traffic calming is desired.
- Speed bumps, humps, or tables work well with curb extensions.

Design Considerations

- Drainage needs should be considered and accommodated.
- Treatments should be used midblock, not at intersections.
- Treatments are not appropriate on roadways with grades over 8%.
- Advance signing and pavement markings on the treatment can be provided.
- Typically preferred for treatment not to cover a bike lane.

Additional Guidance

- ITE Traffic Calming Measures

Traffic Calming Measures

REDUCED CURB RADII

Cost: $$


Lake Oswego, OR


Lake Oswego, OR

Orlando, FL

Street corner is reconstructed with a smaller radius to reduce vehicle turning speeds.

Benefits

- Forces sharper turn by right-turning motorists and thus slower speeds.
- Improves safety of pedestrians by reducing crossing width and slowing motorists.

Constraints

- Requires additional space that may not be available.
- Makes turning movements more challenging for large vehicles and may not accommodate all trucks.

Typical Applications

- Typically used at intersections with high vehicle speeds and high pedestrian volumes where space is available.

Design Considerations

- The street type, angle of intersection, land uses, etc. should be considered when designing the curbs.
- Maintenance vehicles, emergency vehicles, school buses, and other anticipated large vehicles should be provided for in the design.
- The effective turning radius (considering presence of parking, bike lanes, medians, etc.) should be used to evaluate the ability of vehicles to make a turn, not the curb return radius.
- In locations where reducing the curb radius is challenging based on design vehicles, consider using a compound radius, at-grade paving treatments, or advance stop lines.

Additional Guidance

- FHWA Signalized Intersections: An Informational Guide
- FHWA Pedestrian Safety Guide for Transit Agencies
- NACTO Best Practices for Pedestrian Master Planning and Design

ELEMENTS OF A BUS STOP

A bus stop provides a place for transit passengers to wait. Provide shelters at high-ridership bus stops, which afford cover from the rain and wind and indicates where to catch the bus. Create a maintenance plan to ensure that bus stops are cleaned regularly. Bus stops can also serve as a placemaking opportunity for the surrounding area. Consider forming partnerships with communities, businesses, or organizations who want bus stops or shelters as a way to generate funding or to ensure maintenance.

Figure 1 A bus stop with shelter

Provide bus shelters at stops with boardings above a certain threshold, depending on land-use context:

- Rural Locations: 10 boardings per day
- Suburban Locations: 25 boardings per day
- Urban Locations: 50 boardings per day

Design Considerations

General guidelines for making bus stops safe, secure, and pleasant for passengers are shown below.

Figure 2 – Elements of a bus stop

(A) Simple but effective shelter provides protection from elements and visually marks the station while being cost-effective.

(B) Artistic or community derived shelter design or art elements create identity for the city and bus system.

(C) Signage provides information on routes, schedules and general transit information.

(D) Landscaping can create shade and a buffer from the street without impeding circulation, sight lines, and/or safety.

(E) Access to bus stop is connected to the sidewalk.

(F) Bicycle racks expand multimodal transportation options. They can also be an opportunity for community art and expression.

(G) Amenities such as garbage and recycling containers maintain a cleaner site.

(H) Benches offer riders respite while waiting.

Source: "Transit in Small Cities: A primer for Planning, Siting, and Designing Transit Facilities in Oregon." 2013.

- Keep shelter walls clear for visibility and security.
- Size bus shelters to fit several passengers comfortably without obstructing the sidewalk or substantially blocking nearby buildings or storefronts.
- A bench provides convenience for waiting transit customers. Benches can be installed without shelters. Maintain a clear space behind the bench for sidewalk users.
- Install lighting at the pedestrian level. Pedestrian-scale lighting stands 9-12 feet above the sidewalk. Use LED or halogen lighting if possible as it casts off a warmer light. Lighting fosters security and safety.
- Place wayfinding at stops such as a system map, a downtown pedestrian map with nearby landmarks, route schedules, and connections to other transit services.
- Secure bike parking protected from the elements allows bus passengers to bike to the station, extending the reach of transit.
- Other amenities can include a trash can, pay phone, etc.

Figure 3 – Service information as part of downtown circulator

Figure 4 – Bus stop incorporating historic district design

Source: Nelson\Nygaard

Additional Guidance

- Transit Cooperative Research Program Report 19: Guidelines for the Location and Design of Bus Stops. Transportation Research Board, 1996.
- "Transit In Small Cities: A Primer for Planning, Siting, and Designing Transit Facilities in Oregon." March 2013. p. 41-54. Oregon Transportation and Growth Program.

BUS STOP PLACEMENT

Base the location of a bus stop on proximity to activity centers and destinations; make it easy to access by foot, bike, or car, and create a streetscape element that contributes to a safe, attractive public realm. Factors to consider include:

- *How many potential bus passengers are located near the stop?*
- *Where are trip generators located? (Schools, parks, malls, etc.)*
- *Where is the nearest adjacent bus stop?*

Once the need for a stop is identified, the actual placement of the stop at an intersection or midblock produces operational tradeoffs as discussed below. Factors include:

- *How many routes serve this stop, and is there a potential for transfers?*
- *Are there clear sightlines approaching the bus stop?*
- *Is the intersection stop or signal-controlled? If midblock, does a safe place to cross the street exist?*

Location

Bus stop spacing depends on land use. In dense areas, more frequent stops are needed, typically every 500 and 1200 feet. In suburban and rural areas, place stops every ¼-mile on average; however, acceptable ranges span from 600 to 2,640 feet. Possible bus stop locations include the near side of an intersection, the far side of an intersection, or midblock. Each configuration has advantages and disadvantages as summarized below.

	Advantages	Disadvantages
Far-side stop	• Reduces conflicts between right-turning vehicles and buses • Minimizes sight distance problems approaching intersection • Encourages pedestrians to cross behind the bus	• Buses may block the intersection during rush hour • May obscure sight lines for crossing vehicles and pedestrians • Traffic waiting behind the bus may back up into the intersection
Near-side stop	• Allows passengers to reach the bus closest to the crosswalk • Buses are already stopped at red lights or stop signs • Allows passengers to get on or off while the bus is stopped at a light • Allows drivers to see oncoming traffic	• Increases conflicts with right-turning vehicles • Stopped buses may obscure sightlines for pedestrians and vehicles turning right • Buses may block the through lane during rush hour
Mid-block stop	• Preserves sight lines for drivers and pedestrians • May give passengers more room to wait	• Requires more distance for no-parking restrictions • Encourages passengers to cross mid-block even if there isn't a crosswalk • Increases walking distance from the intersection to the stop

Buses can serve stops by stopping in the travel lane, in the parking lane, in the shoulder, or in a bus bay, as summarized in Figure 5. Bus bulbs (or curb extension) allow the bus to pick up and drop off passengers without leaving the travel lane, reducing delays from pulling back into traffic and providing extra sidewalk space for passengers. On arterial roads with high speeds, bus bays allow the bus to leave traffic. If a street contains on-street parking, signs or bulb-outs restricting parking near the bus stop allows the bus access to the curb.

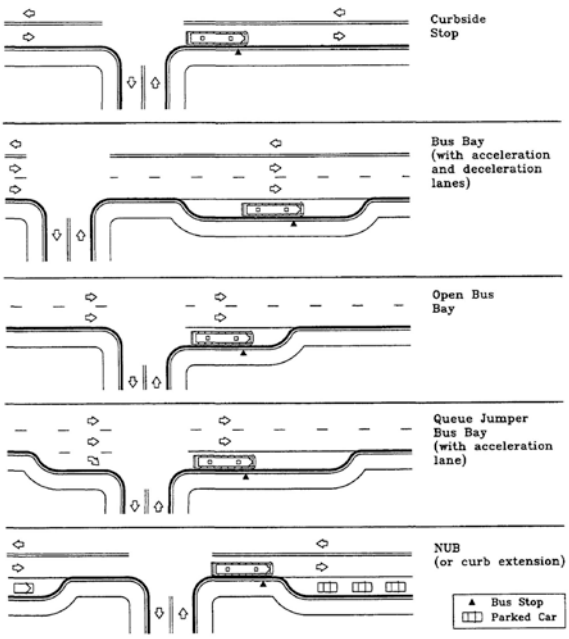


Figure 5 Bus stop locations (Source: TCRP Report 19)

Location

- Locate bus stops at least 50 feet from a crosswalk whenever possible to reduce conflicts with people crossing the street on foot.
- Bus stops should not be placed immediately before a crosswalk, as the bus can prevent pedestrians and traffic from seeing each other.
- Space bus stops at least 100 feet from alleys or frequently-used curb cuts to reduce conflicts with vehicles entering and exiting. Close driveways to close to bus stops.
- Bus stops may either be placed within the public right-of-way or, when space is not available, on adjacent private property. This requires cooperation with property owners for maintaining and ensuring access to the stop.

Stop Length

- Bus requires at least 60 feet along the curb to pull into the stop and decelerate, stop, and accelerate back into traffic. Bus bulbs allow buses to slow and take off in the travel lane, thus bus bulbs can be 40 feet or the length of the vehicle.

Signage

- Demarcate bus stops with a flag sign on a post embedded in the sidewalk at least 2 feet from the curb edge. Signs should be 25 to 35 feet from the front edge of the bus zone to give the bus room to pull out from the stop.
- Include basic information on signs, such as service operator, routes serving that stop, schedule information, and major stops on the route.

Landing Zone

- Provide a landing zone at each bus door measuring at least 5 feet wide parallel to the curb and 8 feet deep. This allows enough room for the bus to extend its ramp for riders with mobility impairments.
- Keep landing zones clear of any curbside obstacles, such as street trees, planters, planting beds, light poles, or sign posts.
- Maintain a clear sidewalk through space adjacent to the bus stop at least 10 feet wide, which provides adequate space for passengers to wait while allowing people to walk around the bus stop.

Additional Guidance

- Transit Cooperative Research Program Report 19: Guidelines for the Location and Design of Bus Stops. Transportation Research Board, 1996.
- "Transit In Small Cities: A Primer for Planning, Siting, and Designing Transit Facilities in Oregon." March 2013. p. 41-54. Oregon Transportation and Growth Program.
- Highway Design Manual, Oregon Department of Transportation, 2012.

Figure 6 Bus pulls into transit center

TRANSIT CENTERS

A transit center serves as the hub of the transit network – the place where multiple routes converge and where passengers transfer between routes or get to their final destination. The best-used transit centers are also located at activity hubs – in downtown or at regional shopping location. Transit centers can range from a sheltered transfer area to more substantial facilities that include places to buy tickets, offices and break rooms for staff, restrooms for both staff and customers, and even ancillary features such as a community meeting room. Transit centers are often located at the end of a transit route or near a significant destination, and can also be co-located with park-and-ride facilities or carpool lots. Transit centers present an opportunity for placemaking and public space creation.

Recommended Elements

- Covered waiting area with seating, whether provided as an open-air shelter or within an enclosed lobby.
- Information on transit service, such as route maps, timetables, and real-time arrival and departure information.
- Facilities for ticket vending, such as automated ticket vending machines or a retail counter with staff.
- Clear and lighted signage, which makes the facility legible for riders.
- All transit loading areas should include a landing zone for passengers getting on or off the bus. If there are multiple stops within the facility, each stop should have a landing zone.
- Staging area for buses to park before picking up customers. This can be the same as the bus loading area if there is signage to let riders know when the bus will depart.
- Safe, secure, and highly visible bicycle parking near the waiting area. Bicycle parking can consist of racks and/or lockers. Covered parking protects bicycles from the elements.
- Both pedestrian walkways and bicycle parking should have paths separate from other modes to reduce conflicts with transit vehicles.
- ADA accessible parking closest to the bus boarding area.

Optional Elements

- Consider including space for regional bus service, such as Greyhound or airport shuttles.

- Consider co-locating the transit center with a park-and-ride facility.
- Include a passenger drop-off area near the waiting area where drivers can wait while picking up passengers. Spaces should have 15-minute time limits to discourage long-term parking. The drop-off area should be located to avoid conflicts with parked vehicles or buses.
- Consider incorporating ancillary uses, such as retail space, a community meeting room, or a police substation that can support other community development goals, provide revenue opportunities for the transit provider (in the case of retail), and provide "eyes on the street" to reduce crime. Locate park-and-ride and drop-off area opposite the building from the transit loading area, allowing riders to move through the facility to increase foot traffic for retail.
- Transit centers are logical places for drivers to begin or end their shifts or switch drivers. Provide a staff break room or restrooms for transit drivers taking their breaks. Likewise, consider including office space for transit agency staff within the transit center.

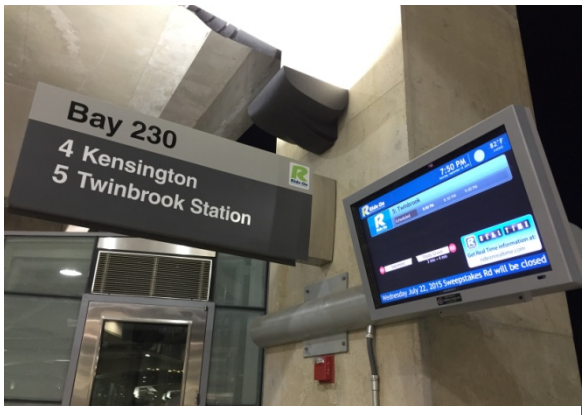


Figure 7 Real-time transit information displays

Figure 8 Keizer Transit Center (Keizer, OR)

Urban Design and Siting Considerations

- Locate the transit center at the end of a transit route or near a significant destination, such as a downtown or major shopping area.
- Design the transit center so transit vehicles can easily circulate to and through the facility.
- Use pavement treatments, crosswalks, ADA ramps, and lighting to create a distinctive and easy-to-understand pedestrian environment.
- Provide clear sight lines and open design to increase safety and provide "eyes on the street" and crime prevention through environmental design (CPTED).

Additional Guidance

- Transit Cooperative Research Program Report 19: Guidelines for the Location and Design of Bus Stops. Transportation Research Board, 1996.
- "Transit In Small Cities: A Primer for Planning, Siting, and Designing Transit Facilities in Oregon." Oregon Transportation and Growth Program, March 2013. p. 41-54.
- "Public Transit in Smaller Cities: Meeting Facility Design Needs." Oregon Transportation and Growth Program, June 2011. p. 137-149.
  Highway Design Manual, Oregon Department of Transportation, 2012.

Figure 9 A park-and-ride lot

PARK & RIDE / PARK & POOL

Park-and-ride and park-and-pool facilities allow commuters and other travelers to drive to a parking facility and use transit or carpool to their eventual destination. This can reduce traffic congestion, relieve the need for parking in downtown areas and activity centers, and save costs for commuters. Park-and-ride lots can also be an opportunity for land banking for future development. These programs work well in rural or suburban areas where fixed-route transit is limited, and in communities with long commutes.

Park-and-ride or park-and-pool lots may be owned by a city, transit agency, or by a business that has excess parking during typical work hours.

General Design Considerations for both Park-and-Ride and Park-and-Pool

- Integrate Park-and-ride/pool lots into existing downtowns with landscaping or buildings as a buffer to the street to create an active, attractive street wall. Provide wayfinding information pointing users to downtown destinations if the site is currently disconnected.
- Landscaping can provide aesthetic enhancement, provide shade or a wind break, direct pedestrian and vehicle movement, and absorb stormwater to reduce runoff. Landscaping can include trees, bushes, plants, and grass.
- Provide adequate signage visible from the street indicating that parking is available, at what times, and at what (if any) cost. Ensure signage clearly states that park-and-ride/pool users are allowed to park.
- Install pedestrian-scale lighting for safety and security or users throughout the lot.
- Size park-and-ride facilities based on the need and available space. In general, 90 to 100 parking spaces fit on one acre of land.

Additional Design Considerations for Park-and-Ride

- Include a bus loading area for passengers to get on and off the bus, as well as a bus staging area for buses to park before picking up passengers.
- Ensure clear and safe movement for motor vehicles that is connected to the bus loading area, but separate from areas where buses travel.
- For exclusive park-and-ride lots, provide a passenger drop-off area near the waiting zone where drivers dropping passengers off can enter and exit. This area should include short-term parking spaces.
- Locate bicycle parking near the waiting area, in a location that reduces conflicts with pedestrians and transit vehicles, but remains visible and provides protection from the elements.
- Provide ADA accessible parking closest to the bus boarding area.

Additional Guidance

- "Transit In Small Cities: A Primer for Planning, Siting, and Designing Transit Facilities in Oregon." Oregon Transportation and Growth Program, March 2013. p. 52-58.

Figure 10 Sign at a shared parking lot

SHARED PARKING

Shared parking provides an opportunity to maximize usage of existing parking resources without the expense of building and maintaining an exclusive parking lot. It maximizes the available supply of parking by allowing multiple uses with different peak times to share facilities. Shared parking may be enabled to allow park-and-ride or park-and-pool locations on existing parking lots through adopted ordinances. Transit agencies can collaborate with many different kinds or organizations to manage shared parking, including municipal or state governments, public organizations, or private businesses. Different operating models include:

- Transit agency pays a private property owner for the ability to use its parking lot as a park-and-ride.
- A municipal government may require new developments to set aside parking for a park-and-ride.
- The lot may be primarily used as a park-and-ride, but other parking uses are allowed during off-peak hours. In this arrangement, the transit agency may lease parking to public agencies or local businesses or residents.

The two types of shared parking lots are described below. In either situation, multiple users or property owners may pool land or parking to create the shared lot.

Informal park-and-ride lots are not specifically designated for transit riders, but are located near a transit stop and allow drivers to park for long periods of time.

Joint use lots are shared between uses via an agreement between the lot owner (public or private) and transit agency. This practice makes use of existing parking lots underused during peak transit times. This includes parking lots for houses of worship, movie theatres, shopping centers, parks, and other uses that are busy on weekends and evenings but are closed or less active during the day.

Pros and Cons of Shared Parking

Pros	Cons
• Shared parking lots can encourage pedestrian activity in shopping districts by allowing park-and-ride users to visit local businesses before or after their transit trip. • Promotes transit use. • Uses land more efficiently, creating more space for development or other uses. • Can reduce the costs of building or maintaining parking for transit agencies, local governments, or private organizations. • Can spark collaboration and commitment among various business = more sense of community. • Shared parking is flexible and can adapt to parking behavioral changes. • Shared parking facilities can reserve land for future transit-oriented development.	• Shared parking agreements are required between the parking lot owner and the various parking lot users. • The user sharing the lot remains at the disposal of the lot owner, who could choose to terminate the agreement. • Overlap between when different users are active may result in more demand for parking than is available.

Design Considerations

- Like park-and-ride lots, locate shared parking facilities in visible, easy-to-access locations near transit stations.
- Have a clear, direct, well-lit path between the shared parking facility and the transit stop.
- Ensure shared parking facilities are large enough to meet demand during peak transit times. This may be accomplished by setting aside a portion of spaces for transit users, or making the entire lot available to transit users at times when the other uses in the lot are not active.
- Outside of peak transit times, a shared parking facility may be used for special events, such as farmers markets, food truck events, or community festivals.

Additional Guidance

- "Transit In Small Cities: A Primer for Planning, Siting, and Designing Transit Facilities in Oregon." Oregon Transportation and Growth Program, March 2013. p. 52-58.
- "Transit Supportive Parking Policies." TCRP Synthesis J-07, Topic SH-15. Transportation Research Board, 2015.
- "Sustainability and Parking." East-West Gateway Council of Governments, St. Louis, Missouri. http://www.ewgateway.org/nb/Sustainability_Parking.pdf
- Willson, Richard. "Parking Policy for Transit-Oriented Development: Lessons for Cities, Transit Agencies, and Developers." Journal of Public Transportation, Vol. 8, No. 5. 2005.