# Mobility Master Plan Bicycle and Pedestrian Design Guidelines

The City of Tacoma has been working to implement on-street projects to encourage walking and cycling, improve safety, and enhance the quality of the walkway and bikeway networks so that these activities become integral parts of daily life. While Tacoma is growing it has predominantly a built urban environment, so many future projects will involve retrofitting existing streets and intersections. The city has significant changes in topography, a high demand for on-street parking, a roadway system heavily reliant on high-capacity arterials, and many other complex situations. When looking to implement sidewalks and bike lanes or other improvements on City of Tacoma streets, most standard design manuals offer limited solutions.

The Tacoma Mobility Master Plan Design Guidelines are a compliment to the Tacoma Mobility Master Plan and are a chapter of the 2009 Complete Street Residential and Mixed Use Guidelines. They are designed to provide greater detail and a more exhaustive range of design options for pedestrian and bicycle treatments. These design concepts are based on current walkway and bikeway design guidelines for typical situations provided in City of Tacoma Design documents, including:

- Downtown Plan
- Complete Streets Design Guidelines
- City of Tacoma Comprehensive Plan
- Tacoma Dome Trails Linkages Study
- ADA Transition Guidelines
- Open Space Element
- Six-Year Street Programs Plan

In addition, Association of State Highway and Transportation Officials (AASHTO) G*uide for the Development of Bicycle Facilities*, and the *Manual of Uniform Traffic Control Devices* (MUTCD) 2003, Part 9 Traffic Controls for Bicycle Facilities and 2009 update were also used. The Tacoma Mobility Master Plan guidelines use these documents as a baseline for minimum conditions, and are intended to find creative solutions to a wide range of pedestrian and bicycle facility types. These treatments draw upon creative solutions in use in other states as well as European cities. These designs are conceptual at this stage, and should undergo additional engineering review before being applied in Tacoma. Strong design guidelines will allow the City of Tacoma to improve the quality of the walkway and bicycle network by applying the highest standard of pedestrian and bicycle safety, comfort, and convenience.

The following are key principles for these pedestrian and bicycle guidelines:

- **The walking and bicycling environments should be safe.** Sidewalks, pathways, crossings, and bicycle routes should be designed and built to be free of hazards and to minimize conflicts with external factors such as noise, vehicular traffic and protruding architectural elements.
- **The pedestrian and bicycle network should be accessible.** Sidewalks, pathways and crosswalks should ensure the mobility of all users by accommodating the needs of people regardless of age or ability. Bicyclists have a range of skill levels and facilities should be designed for the use of experienced cyclists at a minimum, with a goal of providing for inexperienced / recreational bicyclists (especially children and seniors) to the greatest extent

possible. In areas where specific needs have been identified (for example, near schools) the needs of appropriate types of bicyclists should be accommodated.

- **The pedestrian and bicycle network should connect to places people want to go.** The pedestrian and bicycle network should provide a continuous direct routes and convenient connections between destinations, including homes, schools, shopping areas, public services, recreational opportunities and transit.
- **The walking and bicycling environment should be clear and easy to use.** Sidewalks, pathways and crossings should be designed so people can easily find a direct route to a destination and delays are minimized. All roads in the City of Tacoma are legal for the use of bicyclists (except those roads designated as limited access facilities which prohibit bicyclists). This means that most streets are bicycle facilities, and should be designed, marked and maintained accordingly.
- **The walking and bicycling environment should provide good places.** Good design should integrate with, and support the development of, complementary uses, and should encourage preservation and construction of art, landscaping and other items which add value to public ways. These components might include open spaces such as plazas, courtyards, and squares and amenities including street furniture, banners, art, plantings and special paving, which, along with historical elements and cultural references, should promote a sense of place. Public activities should be encouraged and commercial activities such as dining, vending and advertising may be permitted when they do not interfere with safety and accessibility. A complete network of on-street bicycling facilities should connect seamlessly to the existing and proposed off-street pathways to complete recreational and commuting routes around the City.
- improvements should be designed to achieve the maximum benefit for their cost, including initial cost and maintenance cost as well as reduced reliance on more expensive modes of transportation. Where possible, improvements in the right-of-way should stimulate, reinforce and connect with adjacent private improvements.
- **Design guidelines are intended to be flexible and can be applied with professional judgment by designers.** Specific national and state guidelines are identified in this document, as well as design treatments that may exceed these guidelines. It is recognized that statutory and regulatory guidance may change. For this reason, among others, it is noted that the guidance and recommendations in this document are meant to complement the other resources considered during the design process.

## National and State Guidelines / Best Practices

The following is a list of references and sources utilized to develop design guidelines for the Tacoma Mobility Master Plan Design Guidelines. Many of these documents are available online and are a wealth of information and resources available to the public.

### Federal Guidelines

- AASHTO Guide for the Development of Bicycle Facilities, 1999. American Association of State Highway and Transportation Officials, Washington, DC. www.transportation.org
- AASHTO Policy on Geometric Design of Streets and Highways, 2001. American Association of State Highway and Transportation Officials, Washington, DC. www.transportation.org
- Manual on Uniform Traffic Control Devices (MUTCD), 2003. Federal Highway Administration, Washington, DC. http://mutcd.fhwa.dot.gov

### *State and Local Guidelines*

- Washington State Design Manual, Division 15 – Pedestrian and Bicycle Facilities. http://www.wsdot.wa.gov/Publications/Manuals/M22-01.htm
- Tacoma Public Works Design Manual http://wspwit01.ci.tacoma.wa.us/download/PDF/Code/2004DesignManual1.pdf

### *Best Practices Documents*

- FHWA Report HRT-04-100, *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations.* http://www.tfhrc.gov/safety/pubs/04100/
- Road Diet Handbook: Setting Trends for Livable Streets. 2006. Jennifer Rosales.
- Bicycle Facility Selection: A Comparison of Approaches. Michael King, for the Pedestrian and Bicycle Information Center. Highway Safety Research Center, University of North Carolina – Chapel Hill, August 2002 http://www.bicyclinginfo.org/pdf/bikeguide.pdf
- Bicycle Parking Design Guidelines. http://www.bicyclinginfo.org/pdf/bikepark.pdf
- City of Chicago Bike Lane Design Guide. http://www.bicyclinginfo.org/pdf/bike_lane.pdf
- The North Carolina Bicycle Facilities Planning and Design Guidelines, 1994. NCDOT Division of Bicycle and Pedestrian Transportation. http://www.ncdot.org/transit/bicycle/projects/resources/projects_facilitydesign.html
- Wisconsin Bicycle Facility Design Handbook. 2004. Wisconsin Department of Transportation. http://www.dot.wisconsin.gov/projects/bike.htm
- Florida Bicycle Facilities Planning and Design Handbook. 1999. Florida Department of Transportation. http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.htm#Florida%20Bike%20Handbook
- Oregon Bicycle and Pedestrian Plan. 1995 Oregon Department of Transportation. http://www.oregon.gov/ODOT/HWY/BIKEPED/planproc.shtml
- City of Portland (OR) Bicycle Master Plan. 1998. City of Portland (OR) Office of Transportation. http://www.portlandonline.com/shared/cfm/image.cfm?id=40414

## *Document Organization*

This document provides a toolbox of design treatments for bicycles and pedestrians. The first section, *Application of Design Principles*, is a summary of the information that outlines which treatments are appropriate for use on different street types. The design toolkit following provides guidelines for implementation of bicycle and pedestrian treatments.

# Application of Design Principles

This section provides a synthesis of the design principles presented in following sections. It specifically considers bicycle and pedestrian treatments that are appropriate to residential and commercial streets, the Downtown area and streets near schools. This section is designed to comply with other City of Tacoma design documents and notes where recommendations differ from those accepted by the reviewed City documents.

## Residential Streets

Streets with low traffic volumes and speeds, residential streets in Tacoma generally have good walking and bicycling environments. The *Residential Streets Complete Streets Design Guidelines* (RSCSDG) states that, "Complete Streets for residential streets are envisioned to enhance neighborhood livability and aesthetics while safely and comfortably accommodating walking, bicycling, automobiles, service vehicles, and in some cases, transit."

This document also states that residential streets are usually comfortable for bicycles. Residential streets that are designated as bicycle routes or bike boulevards will receive special design treatments to raise awareness of the presence of bicycles and address other safety concerns, particularly at intersections. Many of these treatments are discussed under Section 2.2.3 of the *Mixed-use Center Complete Streets Design Guidelines*. In addition, the Tacoma Mobility Master Plan will provide further guidance and strategies for accommodating bicycles on all streets within the City.

## Pedestrian Treatments on Residential Streets

The RSCSDG recommends five-foot wide sidewalks on both sides of a street to accommodate wheelchairs or two pedestrians walking side by side. Five feet is the preferred width; however, four-foot sidewalks can be acceptable in constrained areas with low pedestrian use. In addition to sidewalks of adequate width, crosswalks, intersection treatments and pedestrian amenities are appropriate along residential streets.

## Bicycle Treatments on Residential Streets

Most residential streets safely accommodate bicycle travel without additional design features. Bicyclists can safely travel in the lane with automobiles due to tow speeds and volumes. However, many local streets are not conducive to traveling longer distances, either because of a lack of street continuity or crossings of larger streets. The RSCSDG notes these issues, as well as concerns about "cars pulling in and out of driveways and on-street parking spaces, opening doors of parked cars, uncontrolled intersections, and intersections with arterials streets." The document recommends Bicycle Boulevard treatments, and directs readers to the *Mixed-use Center Complete Streets Design Guidelines*.

Traffic calming and other treatments along the corridor reduce vehicle speeds on a Bicycle Boulevard so that motorists and bicyclists generally travel at the same speed, creating a safer and more-comfortable environment for all users. Bicycle Boulevards also incorporate treatments to facilitate safe and convenient crossings where bicyclists must traverse major streets. Bicycle Boulevards work best in well-connected street grids where riders can follow reasonably direct and logical routes with few twists and turns.

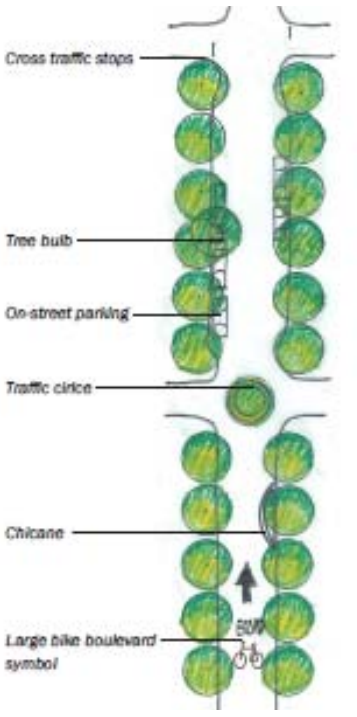



**Figure 1. Bicycle Boulevard Design,** *RSCSDG*

# Mixed-Use Streets

The *Mixed-use Center Complete Streets Design Guidelines* (MCCSDG) provides guidance for adopting Complete Streets policies and practices for Mixed-use Centers. The MCCSDG defines a Complete Street as "a street that safely and comfortably accommodates all users and travel modes, fosters livability, neighborhood identity and character and incorporates features that reduce environmental impacts." Mixed-use Centers are considered 'urban villages' that are "distinctive, attractive, and rich in amenities and that provide more convenience and choice for residents and employees."

## *Pedestrian Treatments on Mixed-Use Streets*

According to MCCSDC, the sidewalk and amenity zones should:

- Provide an unobstructed, continuous and safe circulation system that serves the same destinations as are served by the road system
- Provide convenient access to local land uses and transit
- Provide a buffer for pedestrians and adjacent properties from the traffic and noise from the street
- Provide visual interest and support community interaction through open space and other public activity space
- Safely accommodate people of all ages and abilities
- Support environmental goals through the integration of green infrastructure.

The document specifies a minimum sidewalk width of 10-12 feet (inclusive of the frontage zone), with seven feet acceptable in constrained areas.

In addition, pedestrian and driver sight distances should be maintained near driveways, and curb cuts should be minimized in areas with pedestrian traffic. Intersections are particularly important along mixed-use streets, as higher traffic levels and pedestrian volumes increase the potential for conflicts between road users. Landscape buffers and/or low walls should separate sidewalks from parking and off-street passenger loading areas. Scored or textured concrete should be used where appropriate to alert sight-impaired people of the sidewalk edge. Additional pedestrian treatments for mixed-use streets are shown in Table 42.

**Table 1. Pedestrian Treatments for Mixed-Use Streets**

| Element | Usage | Treatment | Page |
|---|---|---|---|
| **Intersection Treatments** | | | |
| **Marked crosswalks** | Standard treatment at intersections in Mixed-Use areas. | 2.1 | 20 |
| **Raised crosswalk or intersection** | At high pedestrian traffic and low vehicle traffic intersections. | 2.1.1 | 21 |
| **Flashing warning signs** | At high pedestrian traffic and low vehicle traffic intersections. | 2.1.2 | 21 |
| **In-street 'yield to pedestrians signs'** | At high-traffic intersections (ped/automobile). | 2.1.3 | 21 |
| **Curb extensions** | To be considered with wider roadways or higher traffic volumes | 2.2.1 | 22 |
| **Median refuge island** | To be considered with wider roadways or higher traffic volumes | 2.2.2 | 22 |
| **Minimizing curb radius** | Where streets currently provide high-speed wide right-turns | 2.2.3 | 23 |
| **Parking control** | Where on-street parking blocks visibility for pedestrian crossings | 2.3.1 | 24 |
| **Advance stop bars** | Prior to a marked crosswalk on streets with at least two travel lanes in each direction | 2.3.2 | 24 |
| **Curb ramps** | Standard; ADA-compliant with tactile markings | 2.4 | 25 |
| **Half-Signalized crossings** | At pedestrian/bicycle-only crossings or crossings of a high-volume street from a quieter street | 2.5 | 27 |
| **Pedestrian push button/ signal indication** | Standard at signalized intersections | 2.6 | 28 |
| **Traffic calming** | | | |
| **Street Trees** | Standard | 2.8.1 | 31 |
| **Raised crosswalks** | At high pedestrian traffic/low vehicle traffic intersections | 2.8.2 | 31 |
| **Street closures/diverters** | To minimize turning conflicts onto commercial streets | 2.8.7 | 32 |
| **Pedestrian amenities** | | | |
| **Pedestrian scale lighting** | Standard | 5.1.1 | 35 |
| **Street trees** | Standard | 5.1.2 | 35 |

## *Bicycle Treatments on Mixed-Use Streets*

Due to significantly constrained roadway space in mixed-use centers in Tacoma, the MCCSDC recommends shared lanes markings where vehicle speeds and volumes are low. In most cases, bike lanes are preferable where possible.

The appropriate bicycle facility for any particular roadway whether new or existing should be primarily dictated by vehicle volume and speed of the roadway. Figure 2 shows the results of a study that combined bikeway dimension standards for ten different communities in North America. The goal of the study was to survey the varying requirements available and provide a best practices approach for providing bicycle facilities. The study included comparison with European standards providing context for the North American standards for the inclusion of bicycle facilities into roadways.

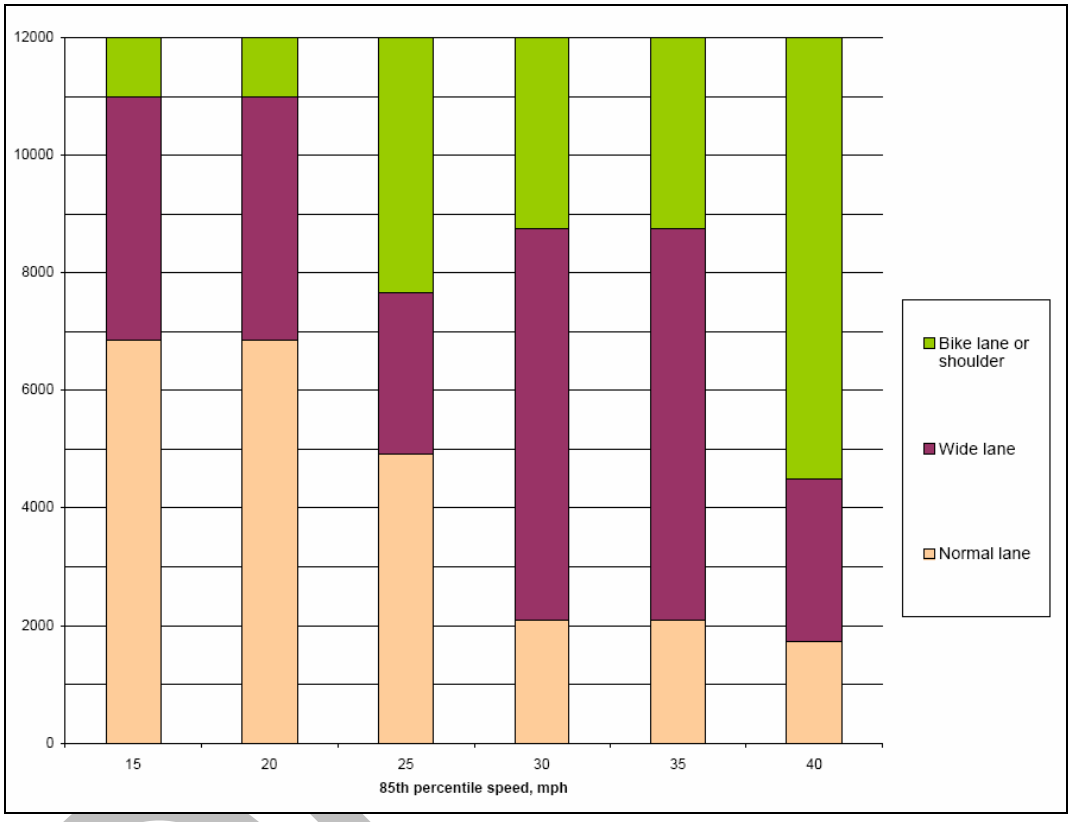



**Figure 2. Bicycle Facility Selection Chart[1]**

Bicycle treatments include the following facility types:

- **Shoulder Bikeways:** Typically found in areas with less vehicular traffic, shoulder bikeways are paved roadways with striped shoulders (4'+) wide enough for bicycle travel. Shoulder bikeways often, but not always, include signage alerting motorists to expect bicycle travel along the roadway. See Treatment 7, page 52 for additional guidance.
- **Bike Lanes:** Designated exclusively for bicycle travel, bike lanes are separated from vehicle travel lanes with striping and also include pavement stencils. Bike lanes are most appropriate on streets where higher traffic volumes and speeds indicate a need for greater separation. See Treatment 8, page 53 for additional guidance.
- **Shared Lane Markings:** Shared lane markings (also known as "sharrows") are high-visibility pavement markings that help position bicyclists within a shared vehicle/bicycle travel lane. These markings are typically used on streets where dedicated bike lanes are desirable but are

[1] King,. Michael. (2002). Bi*cycle Facility Selection: A Comparison of Approaches.* Pedestrian and Bicycle Information Center and Highway Safety Research Center, University of North Carolina – Chapel Hill.

not possible due to physical or other constraints. See Treatment 9, page 74 for additional guidance.

- **Bicycle Boulevards:** Bicycle Boulevards are developed through a combination of traffic calming measures and other streetscape treatments, and are intended to slow vehicle traffic while facilitating safe and convenient bicycle travel. Appropriate treatments depend on several factors including traffic volumes, vehicle and bicycle circulation patterns, street connectivity, street width, physical constraints, and other parameters. See Treatment 10, page 75 for additional guidance.
- **Cycle Tracks:** A cycle track is a hybrid type bicycle facility combining the experience of a separated path with the on-street infrastructure of a conventional bike lane. See Treatment 11, page 87 for additional guidance.

It is important to note that bicycles are permitted on all roads in the state of Washington, with the exception of some limited access highways. As such, Tacoma's entire street network is effectively the community's bicycle network, regardless of whether or not a bikeway stripe, stencil, or sign is present on a given street.

## School Routes

Along school routes, increasing the visibility of pedestrians is crucial to safety for students. In addition, younger students may run into traffic or otherwise disobey traffic guides where they are not clear. Treatments specific to school routes should have high visibility-crosswalks with pedestrian push buttons at signals. These can include in-pavement flashers, signage, warning beacons, and other treatments. Street corners should have ADA-accessible curb ramps.

Youths under age 16 may be unfamiliar with operating any type of vehicle on a road and may be nervous about riding in a street with cars. Many younger children (ages seven to 11) use sidewalks for riding to schools or parks, which is acceptable in areas where pedestrian volumes are low and driveway visibility is high. Where on-street parking and/or landscaping obscures visibility, sidewalk riders may be exposed to a higher incidence of accidents. Sidewalk riding also increases conflicts with pedestrians. Older children (12 years or older) who consistently ride at speeds over ten miles per hour (mph) should be directed to riding on-street wherever possible. Children riding the wrong-way on-street are common, pointing to the need for safety education.

The student bicyclist will benefit from route markers, bike paths, bike lanes on low-speed streets, neighborhood routes, traffic calming, wider curb lanes, and educational programs. Casual bicyclists will also benefit from marked routes that lead to parks, schools, shopping areas, and other destinations. To encourage youth to ride, routes must not have substantial traffic volumes or speeds, and otherwise be safe enough for parents to allow youth to ride. Bicycle Boulevards are appropriate treatments at these locations.

# Design Toolbox

# 1. Sidewalks

## Design Summary

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel that is separated from vehicle traffic. Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped planting strip area. Sidewalks are a common application in urban and suburban environments. The Complete Streets Design Guidelines provide guidance for appropriate sidewalk treatments for specific areas.

## Discussion

Installing new sidewalks can be costly, particularly if drainage improvements such as undergrounding of roadside culverts and installation of curb/gutter are part of the design. However, fixing short gaps in an existing sidewalk network is important to maximize system continuity, and can be a relatively low-cost fix. The figures to the right show examples of poorly-designed and well-designed sidewalks, respectively. This section addresses design considerations contributing to a good pedestrian environment both along sidewalks and at intersections.

*Narrow sidewalks can often be blocked by utilities*

*A well-designed sidewalk provides plenty of pedestrian space*

## Additional Guidance

The sidewalk corridor is the portion of the pedestrian realm between the roadway edge and right-of-way boundary, generally along the sides of streets. A variety of considerations are important in sidewalk design. Providing adequate and accessible facilities should lead to increased numbers of people walking, improved safety, and the creation of social space. Attributes of well-designed sidewalks include the following:

- **Accessibility**: A network of sidewalks should be accessible to all users and meet ADA requirements.
- **Adequate width:** Two people should be able to walk side-by-side and pass a third person comfortably, and different walking speeds should be possible. In areas of intense pedestrian use, sidewalks should be wider to accommodate the higher volume of walkers.
- **Safety:** Design features of the sidewalk should allow pedestrians to have a sense of security and predictability. Sidewalk users should not feel they are at risk due to the presence of adjacent traffic.
- **Continuity:** Walking routes should be obvious and should not require pedestrians to travel out of their way unnecessarily.
- **Landscaping:** Plantings and street trees within the roadside area should contribute to the overall psychological and visual comfort of sidewalk users, without providing hiding places for attackers.
- **Social space:** Sidewalks should be more than areas to travel; they should provide places for people to interact. There should be places for standing, visiting, and sitting. The sidewalk area should be a place where adults and children can safely participate in public life.
- **Quality of place:** Sidewalks should contribute to the character of neighborhoods and business districts and strengthen their identity.

# 1.1. Zones in the Sidewalk Corridor

## Design Summary

The Sidewalk Corridor is typically located within the public right-of-way between the curb or roadway edge and the property line. The Sidewalk Corridor contains four distinct zones: the Curb Zone, the Furnishings Zone, the Through Pedestrian Zone, and the Frontage Zone, shown right.

## Discussion

The Curb Zone

Curbs prevent water in the street gutters from entering the pedestrian space, discourage vehicles from driving over the pedestrian area, and make it easy to sweep the streets. In addition, the curb helps to define the pedestrian environment within the streetscape, although other designs can be effective for this purpose. At the corner, the curb is an important tactile element for pedestrians who are finding their way with the use of a cane

The Furnishings/Planting Zone

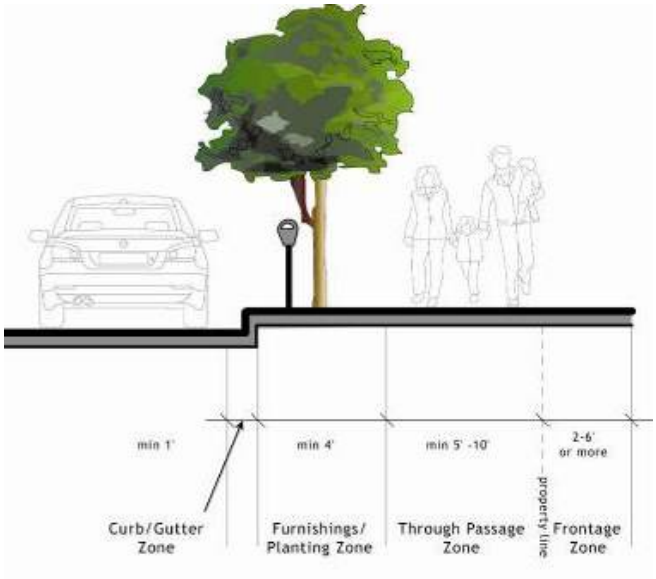
The Furnishings Zone buffers pedestrians from the adjacent roadway, and is also the area where elements such as street trees, signal poles, utility poles, street lights, controller boxes, hydrants, signs, parking meters, driveway aprons, grates, hatch covers, and street furniture are properly located. This is the area where people alight from parked cars.

The Through Pedestrian Zone

The Through Pedestrian Zone is the area intended for pedestrian travel. This zone should be entirely free of permanent and temporary objects.

The Frontage Zone

The Frontage Zone is the area between the Through Pedestrian Zone and the property line. This zone allows pedestrians a comfortable "shy" distance from the building fronts, in areas where buildings are at the lot line, or from elements such as fences and hedges on private property.




*Sidewalk Zones*

*This sidewalk has plantings in the furnishing zone and in the frontage zone, and also provides sufficient through passage zone width*

## 1.2. Sidewalk Widths

### Design Summary

Sidewalks should be at least five feet wide in residential areas, six otherwise, exclusive of the curb and other obstructions. This width:

- Enables two pedestrians (including wheelchair users) to walk side-by-side, or to pass each other comfortably
- Allows two pedestrians to pass a third pedestrian without leaving the sidewalk

### Discussion

Proposed sidewalk guidelines apply to new development and depend on available street width, motor vehicle volumes, surrounding land uses, and pedestrian activity levels. Standardizing sidewalk guidelines for different areas of the City, dependent on the above listed factors, ensure a minimum level of quality for all sidewalks. The table to the right provides guidance for minimum sidewalk widths by street type.

In some cases, it is possible to increase the dimensions of the sidewalk corridor, either through acquisition of right-of-way or public walkway easements, or by re-allocation of the overall right-of-way (such as by narrowing roadway travel lanes or reducing the number of lanes).

As part of a roadway reconstruction project on a street with a narrow sidewalk corridor, project planners should first analyze the impact of reclaiming a portion of the existing right-of-way. If this proves impractical, the feasibility of acquiring additional right-of-way should be examined. Acquisition should be considered where its cost is reasonable in proportion to the overall project cost.

In the case of infill development, the dedication of public right-of-way or the granting of a public walkway easement to widen the sidewalk corridor may be included as a requirement for obtaining a building permit or land use approval.

**Recommended Minimum Sidewalk Widths by Street Type:**

| | Curb | Planting Strip (Buffer) | Sidewalk Width |
|---|---|---|---|
| Arterial and Collector Streets | 1 ft. | 6-8 ft. | 8 ft.* |
| Local Neighborhood Residential Streets | 0-1 ft. | 6-8 ft. | 5 ft.* |
| Commercial Walkways | 1 ft. | 6-8 ft. | 6-10 ft. |
| Mixed Use Center Streets | 1 ft. | 6-8 ft. | 10-12 ft. |

*Note: short sidewalk segments can have narrower widths in physically-constrained areas.


*Example of a sidewalk with trees and sufficient space for pedestrians to walk together*

## 1.3. Sidewalk Surfaces

### Design Summary

- Sidewalks should be surfaced in concrete or asphalt.
- Sidewalk surfaces should be smooth and continuous.

### Discussion

MUCCSDG states that, "the selection of sidewalk surface treatments should take into consideration that some patterns and joints may cause vibrations that are uncomfortable for wheelchair users."

It is also desirable that the sidewalk surface be stable, firm and slip resistant. Preferred materials include Portland Cement Concrete (PCC) and Asphalt Concrete (AC). PCC provides a smooth, long-lasting and durable finish that is easy to grade and repair. AC has a shorter life expectancy but may be more appropriate in less urbanized areas and in park settings. Crushed aggregate may also be used as an all-weather walkway surface in park areas, but this material generally requires a higher level of maintenance to maintain accessibility.

The *Americans with Disabilities Act* allows a maximum two percent cross-slope on sidewalks and other walkways. Where sidewalks meet driveways, curb cuts or intersections, a three-foot wide area should be maintained with a two percent cross-slope.

Additional sidewalk treatment options can be attractive and increase visibility of pedestrians. Brick is often used in downtown areas that have high pedestrian use, while pervious pavement can be used to minimize environmental and drainage impact.

*Concrete is often used as a shared-use path material, and also can be used for sidewalks*


*Asphalt is a common sidewalk surfacing material*

*Brick can be an attractive and high-visibility surfacing*

*Permeable pavement can be used where drainage is an issue*

## 1.4. Addressing Sidewalk Obstructions

### Design Summary

Obstructions to pedestrian travel in the sidewalk corridor typically include sign posts, utility and signal poles, mailboxes, fire hydrants and street furniture.

The RSCSDG requires that sidewalks in Mixed-Use Centers provide five feet clear of obstructions.

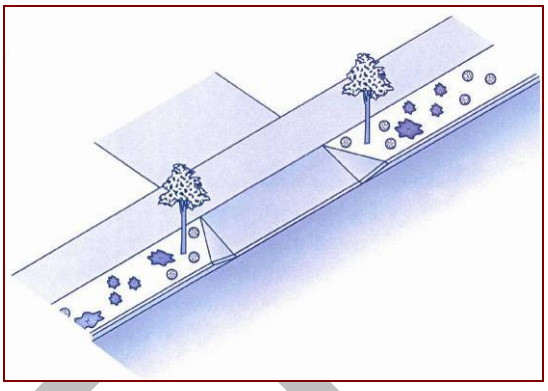
### Discussion

Obstructions should be placed between the sidewalk and the roadway to create a buffer for increased pedestrian comfort. When sidewalks abut perpendicular or angle on-street parking, wheelstops should be placed in the parking area to prevent parked vehicles from overhanging in the sidewalk. When sidewalks abut hedges, fences, or buildings, an additional two feet of lateral clearance should be added to provide appropriate shy distance.

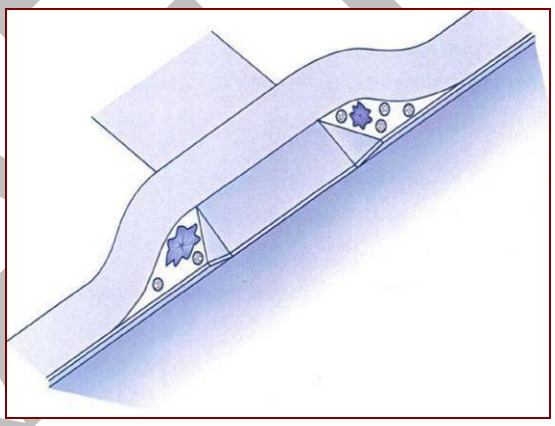
Driveways represent another sidewalk obstruction, especially for wheelchair users. The following techniques can be used to accommodate wheelchair users at driveway crossings:

- Reducing the number of accesses reduces the need for special provisions. This strategy should be pursued first.
- Constructing wide sidewalks avoids excessively steep driveway slopes. The overall width must be sufficient to avoid an abrupt driveway slope.
- Planter strips allow sidewalks to remain level, with the driveway grade change occurring within the planter strip (top graphic at right).
- Where constraints preclude a planter strip, wrapping the sidewalk around the driveway has a similar effect (middle graphic at right). However, this method may have disadvantages for visually-impaired pedestrians who follow the curb line for guidance.

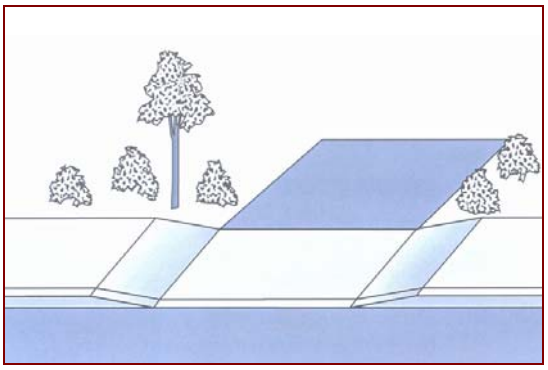
When constraints only allow curb-tight sidewalks, dipping the entire sidewalk at the driveway approaches keeps the cross-slope at a constant grade (bottom graphic at right). However, this may be uncomfortable for pedestrians and could create drainage problems behind the sidewalk.



*Driveway apron utilizing the planting strip*



*Sidewalk wrapped around driveway*



*Entire sidewalk dips at driveway*

## 1.5. Sidewalk Maintenance

**Design Summary**

Sidewalk surfaces that have settled or heaved over time can be a significant barrier for pedestrians. Surfaces that are smooth when newly installed may not stay that way, particularly where masonry units are installed without an adequate subbase. Knowledgeable design, wise material selection, good construction practices, and regular maintenance procedures can help ensure that differences in level between adjacent units do not exceed the limits of usability. Surface provisions for an accessible route limit allowable vertical differences in level between abutting surfaces.

### 1.5.1. Root Protection

Most sidewalk damage is caused as subsurface roots become thicker, lifting up the concrete slabs. To prevent extensive sidewalk damage, the appropriate rootstocks should be chosen for trees planted at each location. Trees and rootstocks that have extensive, shallow root systems should not be planted adjacent to sidewalks. Also, tree selection should be made based on the available soil, water and light conditions, and most importantly, the width of the planting strip.

*Subsurface tree roots can lift concrete sidewalk slabs, causing the surface to become uneven*

### 1.5.2. Plantings

Street trees are a highly desirable part of the pedestrian environment, especially large-canopied shade trees. Tree limbs should be trimmed to leave at least eight feet of clear space above the sidewalk. Where mature trees are in place, root barriers, root pruning techniques, and interlocking sidewalk pavers could be used to minimize damage.

### 1.5.3. Grates

All grates within the sidewalk should be flush with the level of the surrounding sidewalk surface, and should be located outside the Through Pedestrian Zone. Ventilation grates and tree well grates shall have openings no greater than ½" in width.

Designers should consider using tree well grates or treatments such as unit pavers in high pedestrian use areas.

*Tree well grates can create uneven sidewalk conditions*

### 1.5.4. Hatch Covers

Hatch covers should be located within the sidewalk Furnishings Zone. Hatch covers must have a surface texture that is rough, with a slightly raised pattern. The surface should be slip-resistant even when wet. The cover should be flush with the surrounding sidewalk surface.

# 2. Intersections

## Design summary

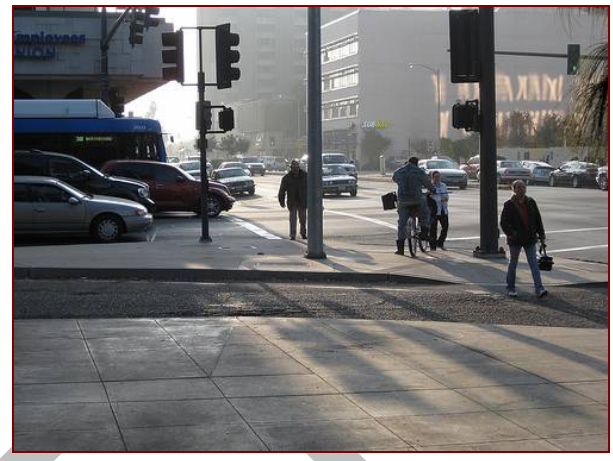
Attributes of pedestrian-friendly intersection design include:

- Clear Space — Corners should be clear of obstructions. They should also have enough room for curb ramps, for transit stops where appropriate, and for street conversations where pedestrians might congregate.
- Visibility — It is critical that pedestrians on the corner have a good view of vehicle travel lanes and that motorists in the travel lanes can easily see waiting pedestrians.
- Legibility — Symbols, markings, and signs used at corners should clearly indicate what actions the pedestrian should take.
- Accessibility — All corner features, such as curb ramps, landings, call buttons, signs, symbols, markings, textures, must meet accessibility standards.
- Separation from Traffic — Corner design and construction must be effective in discouraging turning vehicles from driving over the pedestrian area.

## Discussion

In general, pedestrians are not inclined to travel very far out-of-direction to access a designated crosswalk, so providing sufficient crossings is critical for a safe pedestrian environment. Crosswalks can also be designed for increased visibility of pedestrians, and curb ramps and vehicle turning radii should also be considered for the pedestrian environment.

In areas of high pedestrian use, the convenience and travel time of pedestrians deserves special consideration when considering signal placement and timing. In these locations, pedestrian mobility and access may need to be weighted against the efficiency of vehicle progression.



*Intersections with many user types should provide good crossing opportunities and clearly delineate crossing patterns*

**Table 2. Frequency of Crossing Treatments**

| Where | Generally not farther apart than | Generally not closer together than |
|---|---|---|
| Mixed-use streets and other High Pedestrian Use Areas | 200 – 300 ft (60 – 90 m) where blocks are longer than 400 ft (120 m) | 150 ft (45 m) |
| Residential streets, Local Street Walkways, Low Pedestrian Use Areas | Varies, based on adjacent uses. Do not prohibit for more than 400 ft (120 m). | 150 ft (45 m) |

## Additional Guidance

Frequency of Crossing Opportunities

In general, whatever their mode, people will not travel out of direction unless it is necessary. This behavior is observed in pedestrians, who will cross the street wherever they feel it is convenient. The distance between comfortable opportunities to cross a street should be related to the frequency of uses along the street that generate crossings (shops, High Pedestrian Use areas, etc.). In areas with many such generators, opportunities to cross should be very frequent. In areas where generators are less frequent, good crossing opportunities may also be provided with less frequency. Table 2 shows the recommended frequency of crossing treatments

## 2.1. Marked Crosswalks

### Design Summary

At signalized intersections, all crosswalks should be marked.

At un-signalized intersections, crosswalks should be marked in order to:

- Help orient pedestrians in finding their way across a complex intersection, or
- Help show pedestrians the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts, or
- Help position pedestrians where they can best be seen by oncoming traffic.

At mid-block locations, crosswalks are marked where:

- There is a demand for crossing,
- There are no nearby marked crosswalks.

*Parallel markings are the most basic crosswalk marking type, and are applied where textured concrete crosswalks are used .*

### Discussion

Crosswalk markings indicate to pedestrians the appropriate route across traffic, to facilitate crossing by the visually impaired and remind turning drivers of potential conflicts with pedestrians.

Use ladder pavement markings for all crosswalks in Tacoma, including :

- School crossings
- Across arterial streets for pedestrian-only signals
- At mid-block crosswalks
- Where the crosswalk crosses a street not controlled by signals or stop signs.

A ladder pavement marking consists of 2 ft (610 mm) wide bars spaced 3 ft apart and located between 1 ft wide parallel stripes that are 10 ft apart.

*Ladder pavement markings (shown), and European type crossings are the preferred crosswalk design for Tacoma*

### Additional Guidance

Additional considerations for marked crosswalks include:

- Where the Sidewalk Corridor is wider than 12 ft (3.7 m) crosswalks may be wider than the standard width to match the Sidewalk Corridor width.
- At mid-block locations, marked crosswalks are always accompanied by signing to warn drivers of the unexpected crosswalk.
- The crosswalk should be located to align as closely as possible with the Through Pedestrian Zone of the Sidewalk Corridor.
- Where traffic travel lanes are adjacent to the curb, crosswalks should be set back a minimum of 2 ft (610 mm) from the edge of the travel lane.
- Where there is poor motorist awareness of an existing crossing or at high-use locations, high-visibility crosswalks can increase safety for pedestrians and bicyclists. High-visibility crosswalks are particularly important along routes to school to improve visibility of school children.
- Pedestrian activated traffic signals can be used in high pedestrian usage areas.

In-pavement flashers may be appropriate on undivided roadways in densely developed areas that do not offer median refuges for crossing pedestrians. This measure should be used at higher risk crossing areas such as mid-block crossings or intersections with high automobile or pedestrian volumes (additional information available at: http://www.walkinginfo.org/faqs/answer.cfm?id=3903)

## 2.1. Marked Crosswalks

### 2.1.1. Raised Crosswalk or Raised Intersection

A raised crosswalk or intersection can eliminate grade changes from the pedestrian path and give pedestrians greater prominence as they cross the street. Raised crosswalks should be used only in very limited cases where a special emphasis on pedestrians is desired; review on case-by-case basis.

Additional guidelines include:

- Use detectable warnings at the curb edges to alert vision-impaired pedestrians that they are entering the roadway.
- Approaches to the raised crosswalk may be designed to be similar to speed humps, or may be designed so they do not have a slowing effect (for example, on emergency response routes).

Raised crosswalks can also be used as a traffic calming treatment, as described later in this document.

*Raised crosswalk*

### 2.1.2. Flashing Warning Signs

Flashing warning signs increase the visibility of a crossing by calling attention to the pedestrian crossing location. They can be continuous, timed for rush hours, or activated by a pedestrian push-button.

*Flashing warning sign*

### 2.1.3. In-Street "Yield to Pedestrians" Signs

In-Street Yield to Pedestrian Signs are flexible plastic "paddle" signs installed in the center of a roadway to enhance a crosswalk at uncontrolled crossing locations.


*In-Street yield to pedestrians signage*

## 2.2. Reducing Crossing Distance

**Design Summary**

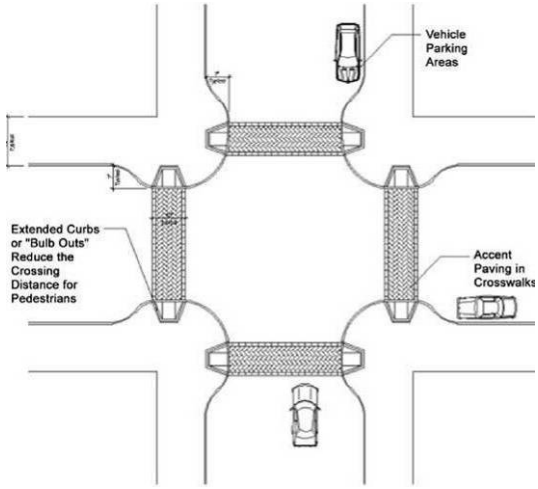
Crossing the street is both safer and more convenient when the crossing distance is short. Pedestrian exposure to travel lanes should be minimized to the greatest extent possible. What constitutes a short crossing distance will vary given the surroundings. In general, 50 ft (15 m) is the longest uninterrupted crossing a pedestrian should encounter at an unsignalized crosswalk.

### 2.2.1. Curb Extension

Curb extensions minimize pedestrian exposure during crossing by shortening crossing distance and give pedestrians a better chance to see and be seen before committing to crossing. They are appropriate for any crosswalk where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb. (Note that if there is no parking lane, the extensions may be a problem for bicycle travel and truck or bus turning movements.)

Guidelines for use:

- In most cases, the curb extensions should be designed to transition between the extended curb and the running curb in the shortest practicable distance.
- For purposes of efficient street sweeping, the minimum radius for the reverse curves of the transition is 10 ft (3 m) and the two radii should be balanced to be nearly equal.
- Curb extensions should stop one foot short of the parking zone for bicycle safety.




*Curb extensions*

### 2.2.2. Median Refuge Island

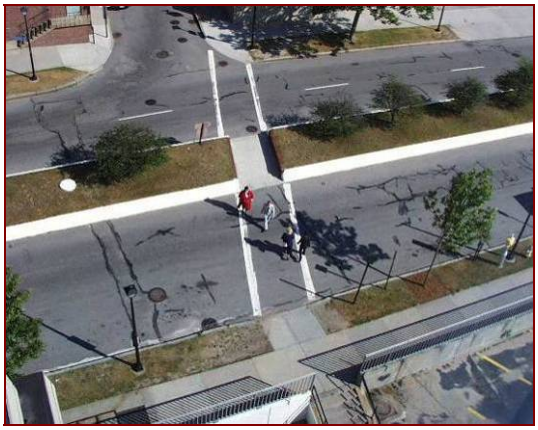
Median refuge islands minimize pedestrian exposure during crossing by shortening crossing distance and increasing the number of available gaps for crossing. They help improve safety by providing a crossing refuge, allowing pedestrians to gauge safe crossing of "one direction" of traffic at a time, and slowing motor vehicle traffic.

This treatment is appropriate where the roadway to be crossed is greater than 50 ft (15.2 m) wide or more than four travel lanes; can be used where distance is less to increase available safe gaps. Use at signalized or unsignalized crosswalks. The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.

Refuge islands at intersections should have a median "nose" that gives protection to the crossing pedestrian (see photo).

A median refuge island should be at least 6 ft (1.8 m) wide between travel lanes and at least 20 ft (6.1 m) long. On streets with speeds higher than 25 mph there should also be double centerline marking, reflectors, and "KEEP RIGHT" signage.

If a refuge island is landscaped, the landscaping should not compromise the visibility of pedestrians crossing in the crosswalk. Tree species should be selected for small diameter trunks and tree branches should be no lower than 14 ft. Shrubs and ground plantings should be no higher than 1 ft 6 in.



*Median refuge islands break up a crossing and allow pedestrians to cross one side of a street at a time*

# 2.2. Reducing Crossing Distance

## 2.2.3. Minimizing Curb Radius

In general, the smaller the curb radius, the better for pedestrians. In comparison to a large curb radius, a tight curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crosswalk, and requires vehicles to slow more as they turn the corner.

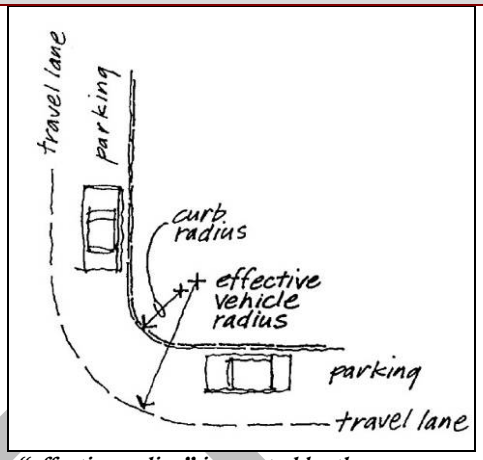
A small curb radius is also beneficial for street sweeping operations. The presence of a lane for parking or bicycles creates an "effective radius" that allows the designer to choose a radius for the curb that is smaller than the turning radius required by the design vehicle.

Choosing a Curb Radius

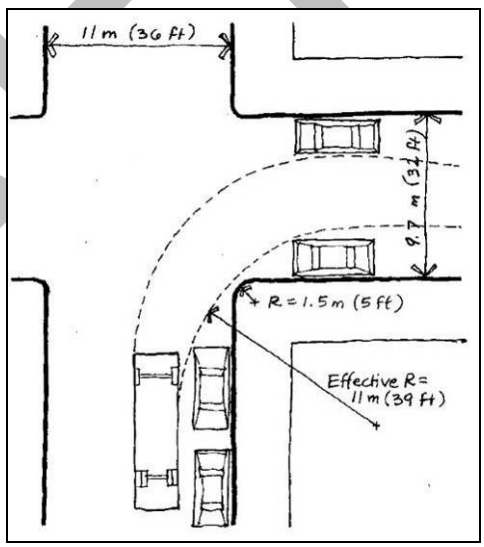
Several factors govern the choice of curb radius in any given location. These include the desired pedestrian area of the corner, traffic turning movements, the turning radius of the design vehicle, the geometry of the intersection, the street classifications, and whether there is parking or a bike lane (or both) between the travel lane and the curb.

The designer must balance all the factors, keeping in mind that the chosen radius should be the smallest possible for the circumstances. The radius may be as small as 3 ft (900 mm) where there are no turning movements, or 5 ft (1.5 m) where there are turning movements and there is adequate street width and a larger effective curb radius created by parking or bike lanes.

Designers sometimes consider that on-street parking will begin or end at the point of tangency or point of curvature of the corner radius. In practice, however, this point is not always evident in the field. Parking control should not be a factor in selecting curb radius.




*An "effective radius" is created by the presence of a parking lane or bike lane.*




*Where there is an effective curb radius sufficient for turning vehicles, the actual curb radius may be as small as 5 ft (1.5 m).*

# 2.3. Minimizing Conflict with Automobiles

## 2.3.1. Parking Control

Parking control improves visibility in the vicinity of the crosswalk.

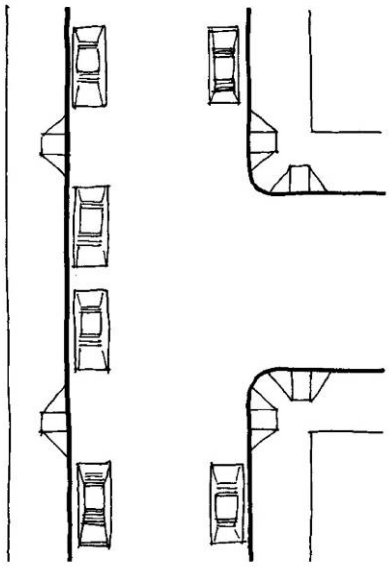
Parking is prohibited within all intersections and crosswalks unless otherwise signed.

At "T" and offset intersections, where the boundaries of the intersection may not be obvious, this prohibition should be made clear with signage.

In areas where there is high parking demand (as determined by the City Traffic Engineer), parking for compact vehicles may be allowed within "T" or offset intersections and on either side of the crosswalk. At these locations, signs will be placed to prohibit parking within the designated crosswalk areas, and additional enforcement should be provided, particularly when the treatment is new.

Parking shall not be allowed within any type of intersection adjacent to schools, school crosswalks, and parks. This includes "T" and offset intersections.

Installation of parking signage to allow and/or prohibit parking within any given intersection will occur at the time that the Parking Control section is undertaking work at the intersection.



*In areas with high parking demand, compact parking may be permitted within the intersection, but crosswalks should be kept clear.*

## 2.3.2. Advance Stop Bars

Advance stop bars increase pedestrian comfort and safety by stopping motor vehicles well in advance of marked crosswalks, allowing vehicle operators a better line of sight of pedestrians and giving inner lane motor vehicle traffic time to stop for pedestrians. Pedestrians feel more comfortable since motor vehicles are not stopped adjacent to the crosswalk. The multiple threat of motor vehicles is reduced, since vehicles in the inner travel lane have a clearer line of sight to pedestrians entering the sidewalk. Without an advance stop bar, the vehicle in the outer lane may stop for the pedestrian, but the vehicle in the inner lane proceeds, increasing the possibility of a vehicle-pedestrian conflict.

Advanced stop bars should be used:

- On streets with at least two travel lanes in each direction.
- Prior to a marked crosswalk
- In one or both directions of motor vehicle travel
- Recommended 30 ft. in advance of the crosswalk.

A "Stop Here for Pedestrians" sign must accompany the advance stop bar.

*Advance stop bars alert motorists of pedestrians*

## 2.4. ADA-Compliant Curb Ramps

### Design Summary

- every ramp must have a landing at the top and at the bottom
- maximum ramp slope is 1:12 (8.3%) with a cross slope of no more than 1:50 (2.0%)
- minimum width of a ramp should be 3'-0".

### Discussion

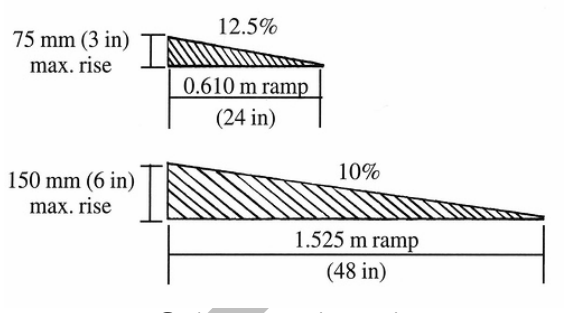
Curb ramps are the design elements that allow all users to make the transition from the street to the sidewalk. There are a number of factors to be considered in the design and placement of curb ramps at corners. Properly designed curb ramps ensure that the sidewalk is accessible from the roadway. A sidewalk without a curb ramp can be useless to someone in a wheelchair, forcing them back to a driveway and out into the street for access.

The ADA defines two types of curb ramp systems, "perpendicular ramps" and "parallel ramps." The first provides a ramp into a crosswalk, while the second provides a ramp into a landing that is flush with the street surface, sometimes called a "dropped landing."

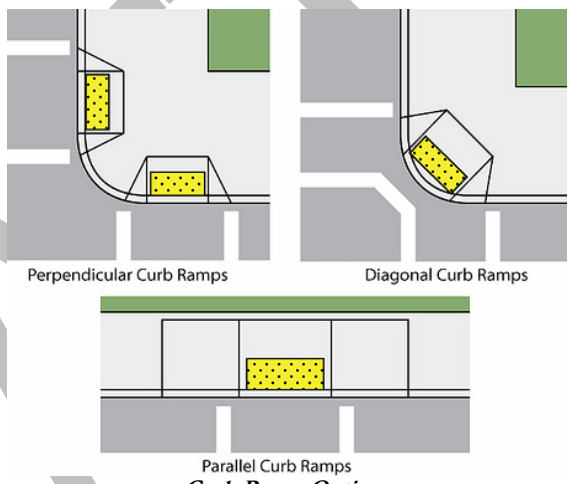
The landing at the top of a ramp should be at least 4'-0" long and at least the same width as the ramp itself. It should slope no more than 1:50 (2.0%) in any direction. If the ramp runs directly into a crosswalk, the landing at the bottom will be in the roadway. The landing, 4'-0" long, should be completely contained within the crosswalk and should not have a running slope of greater than 1:20 (5.0%).

If the ramp lands on a dropped landing within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 5'-0" long and at least as wide as the ramp, although a width of 5'-0" is preferred. The landing should not slope more than 1:50 (2.0%) in any direction. A single landing may serve as the top landing for one ramp and the bottom landing for another.

The City's ADA Transition Plan provides guidelines for updating curb ramps throughout the city. City offices and programs must be accessible to people with disabilities. In addition, all newly constructed or altered streets, roads and highways must contain curb ramps or other sloped areas at any intersection having curbs or other barriers to entry from a street-level pedestrian walkway.




*Curb ramp maximum rise*




*Curb Ramp Options*

*Example of an ADA-compliant perpendicular curb ramp*

# 2.4. ADA-Compliant Curb Ramps

## 2.4.1. Raised Tactile Devices Used as Detectible Warnings

Raised tactile devices (also known as truncated domes) alert people with visual impairments to changes in the pedestrian environment. They are used at:

- The edge of depressed corners
- The border of raised crosswalks and intersections
- The base of curb ramps
- The border of medians
- The edge of transit platforms where railroad tracks cross the sidewalk

Contrast between the raised tactile device and the surrounding infrastructure is important so that the change is readily evident. These devices are most effective when adjacent to smooth pavement so the difference is easily detected. The devices must provide color contrast so partially sighted people can see them.

*A diagonal ADA-compliant curb ramp*

The ADAAG standards for detectable warnings are:

- Bottom diameter: 23mm (0.9 in)
- Top diameter: 10 mm (0.4 in)
- Height: 5 mm (0.2 in)
- Center-to-center spacing: 60 mm (2.35 in)
- Visual contrast: not specified

The US Access Board recommends:

- Visual contrast of at least 70 percent
- Width: 610 mm (24 in)
- Location: 152 mm to 200 mm (6 in to 8 in) from the bottom of the ramp

Raised Tactile Devices Used for Wayfinding

In addition to use at curbs, raised tactile devices can be used for wayfinding along a pathway or across a road. This is particularly useful to visually impaired pedestrians in areas where the pedestrian environment is unpredictable. Complex intersections, roundabouts, wide intersections and open plazas are areas where raised tactile devices could be considered. No standards or guidelines for these devices have been adopted nationally. Raised devices with bar patterns can indicate the proper walking direction. Textured pavement that provides enough material and color contrast can be used to mark the outside of crosswalks, in addition to white paint or thermoplastic.

## 2.4.2. Curb Ramp Maintenance

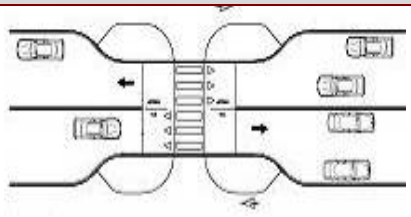
It is critical that the interface between a curb ramp and the street be maintained adequately. Asphalt street sections typically have a shorter life cycle than a concrete ramp, and can develop potholes in the at the foot of the ramp, which can catch the front wheels of a wheelchair. Existing ramps, and crossings without ramps, must be brought to current ADA standards during reconstruction periods (see ADA Transition Plan).

In some cases, existing ramps and streets create a tipping hazard because of a sharp change in slope. As an interim solution, this sharp transition can be eased with a tapered infill of asphalt at the foot of the ramp.

## 2.5. Half Signalized Crossings

### 2.5.1. Mid-block Crosswalk

Mid-block crossings provide a crossing opportunity where there is no intersection. At mid-block locations, crosswalks are marked where there is a demand for crossing, and there are no nearby marked crosswalks. Mid-block crosswalks are always indicated with pavement markings and warning signs.



*Mid-block crosswalk*

### 2.5.2. Pelican (Pedestrian Light Control Activated crossing) Signals

A Pelican signal has the following phases

- The standard red-yellow-green light rests in green.
- A pedestrian who wishes to cross presses the button.
- The signal changes to yellow, then red, while WALK is shown to the pedestrian.

The signal can be installed with one- or two-stages, based on the street's characteristics. In a two-stage crossing, the pedestrian crosses to a median island and is then channelized along the median to a second independent signalized crossing point. The two crossings only delay the pedestrian minimally and allow the signal operation to fit into the arterial synchronization, thus reducing the potential for stops, delays, accidents, and air quality issues.


*Pelican signal*

### 2.5.3. Puffin Signals (Pedestrian User Friendly Intelligent)

A Puffin signal consists of traffic and pedestrian signals with push-buttons and infrared or pressure mat detectors. When the pedestrian pushes the button,

- A detector verifies the presence of the pedestrian at the curbside, eliminating false signal calls.
- The pedestrian is given the WALK signal, and a motion detector can extend the WALK interval to allow slower pedestrians time to cross safely.

Puffin signals are designed to be crossed in a single movement by the pedestrian, unlike the Pelican signal.

*Puffin signal*

### 2.5.4. HAWK Signals (High-Intensity Activated Crosswalk)

A HAWK signal is a combination of a beacon flasher and traffic control signaling technique for marked crossings. The beacon signal consists of a traffic signal head with a red-yellow-red lens. The phasing of the signal is:

- The unit is off until activated by a pedestrian.
- A pedestrian presses a button and the signal begins with a flashing yellow light to warn approaching drivers.
- A solid yellow, advising the drivers to prepare to stop, follows the flashing yellow.
- The signal changes to a solid red, at which time the pedestrian is shown a WALK indicator.
- The beacon signal converts to an alternating flashing red, allowing the drivers to proceed after stopping at the crosswalk, while the pedestrian is shown the flashing DON'T WALK signal.


*HAWK signal*

# 2.6. Accommodating Pedestrians at Signals

## 2.6.1. Pedestrian Push Buttons

Pedestrian push buttons are used to permit the signal controller to detect pedestrians desiring to cross. They can be used at an actuated or semi-actuated traffic signal at intersections with low pedestrian volumes, and at mid-block crossings

When push buttons are used, they should be:

- Located so that someone in a wheelchair can reach the button from a level area of the sidewalk without deviating significantly from the natural line of travel into the crosswalk.
- Marked (for example, with arrows) so that it is clear which signal is affected.

Signalized crossings in areas of high pedestrian use may automatically provide a pedestrian crossing phase during every signal cycle, excluding the need for pedestrian push-buttons. However, the pedestrian classification must be balanced with the other functions of the street. In High Pedestrian Use areas, there should be a demonstrated benefit for actuated signals before push buttons are installed. The following are some criteria for that benefit:

- the main street carries through traffic or transit, such as a major city traffic or transit street, or a district collector
- traffic volumes on the side street are considerably lower than on the main street
- the pedestrian signal phase is long (for example, on a wide street) and eliminating it when there is no demand would significantly improve the level of service of the main street

Where push buttons must be installed in high pedestrian use areas, designers should consider operating the signal with a regular pedestrian phase during off-peak hours. U.S. Access Board recommends buttons be raised above or flush with their housing, and large enough for people with visual impairments to see, min. 2 in. U.S. Access Board also recommends the force to activate the signals should be no more than 5 lbf (22.2 N).


*Example standard pedestrian push button (Polara Navigator)*

## 2.6.2. Pedestrian Signal Indication ("Ped Head")

Pedestrian signal indicators indicate to pedestrians when to cross at a signalized crosswalk. All traffic signals should be equipped with pedestrian signal indications except where pedestrian crossing is prohibited by signage.

Countdown pedestrian signals are particularly valuable for pedestrians, as they indicate whether a pedestrian has time to cross the street before the signal phase ends.


*Pedestrian signal indication*

## 2.6.3. Audible Pedestrian Traffic Signals

## 2.6. Accommodating Pedestrians at Signals

Audible pedestrian traffic signals provide crossing assistance to pedestrians with vision impairment at signalized intersections. To be considered for audible signals, the location must first meet the following basic criteria:

- The intersection must already be signalized.
- The location must be suitable to the installation of audible signals, in terms of safety, noise level, and neighborhood acceptance.
- There must be a demonstrated need for an audible signal device. The need is demonstrated through a user request.
- The location must have a unique intersection configuration and characteristics.

Audible signals should be activated by a pedestrian signal push button with at least a one second-delay to activate the sound.

*Speaker on pedestrian traffic signal*

### 2.6.4. Pedestrian Signal Phases

Special pedestrian phases can be used to provide greater visibility or more crossing time for pedestrians at certain intersections. Examples include a pre-timed signal, leading pedestrian interval, and pedestrian scramble phase, described below.

Pre-Timed Signal

Pre-timed signals accommodate pedestrian crossings through automatic "phasing" concurrent with parallel vehicle traffic while at actuated signals, pedestrians usually push an activation button to trigger the walk signal. Providing adequate pedestrian crossing time is a critical element of the walking environment at signalized intersections. The MUTCD recommends traffic signal timing to assume a pedestrian walking speed of 4' per second, meaning that the length of a signal phase with parallel pedestrian movements should provide sufficient time for a pedestrian to safely cross the adjacent street. At crossings where older pedestrians or pedestrians with disabilities are expected, crossing speeds as low as 3' per second may be assumed.

Leading Pedestrian Interval (LPI)

At intersections where there are conflicts between turning vehicles and pedestrians, pedestrians are given a "walk" designation a few seconds before the associated green phase for the intersection begins.

Exclusive Pedestrian Phase ("Scramble" Signal)

In areas with very heavy pedestrian traffic, an all-pedestrian signal phase gives pedestrians free passage in the intersection while no vehicle traffic is allowed. Pedestrian 'scramble' phases are only recommend where pedestrian volumes are very high and should be used sparingly, given that the additional phase increases wait times for all modes

*A pedestrian scramble signal*

Source: http://www.tsc.berkeley.edu/newsletter/winter05-06/scramble.html

## 2.7. Other Types of Crossings

### 2.7.1. Grade-Separated Crossing

Grade-separated crossings completely separate pedestrian travel from vehicular travel. They should be used only where it is not possible to provide an at-grade facility. Examples include crossing a freeway or major highway, a rail yard, or a waterway.

Guidelines for grade-separated crossings:

- The crossing must be accessible.
- Grade changes should be minimized to the greatest extent possible.
- Shared bicycle/pedestrian facilities should have a clear passage width of at least 12 ft (3.7 m).

*Grade-separated undercrossing*

### 2.7.2. No Pedestrian Crossing

Pedestrian crossings may prohibited to avoid conflicts between pedestrians and traffic in situations that are especially dangerous. Prohibiting crossing should be considered only in very limited circumstances, for example:

- Where it would be dangerous for pedestrians to cross, as where visibility (for pedestrians or motorists) is obstructed and the obstruction cannot be reasonably removed.
- Where so many legal crosswalks exist that they begin to conflict with other modes, as on an arterial street with multiple offset intersections.
- Where there are unique considerations at a particular intersection and pedestrian mobility is not disproportionately affected by the closure.

Guidelines:

- Do not close crosswalks at "T" and offset intersections unless there is a safer crosswalk within 100 ft of the closed crosswalk.
- Use "Pedestrians Use Marked Crosswalk" signs for crosswalks closed to reduce an excess of crosswalks on a street with "T" or offset intersections.
- Use "No Pedestrian Crossing" signs for crosswalks closed for pedestrian safety.

*No Pedestrian Crossing sign (MUTCD sign R9-3a)*

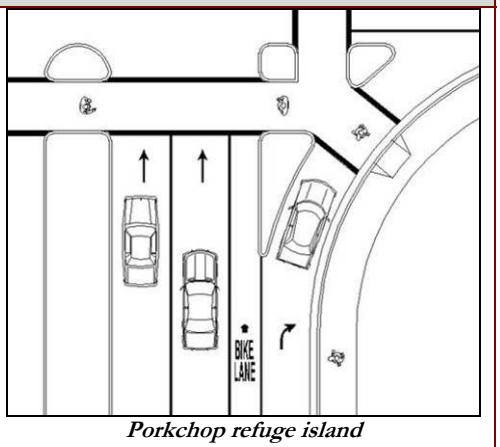
### 2.7.3. Porkchop Refuge Island

Porkchop refuge islands shorten crossing distances and provide a refuge for pedestrians between separated traffic movements. They should be used with right turn slip lanes, modern roundabouts, or other intersection treatments where pedestrians benefit from a refuge. Can also use at "T" intersections between right-turning and left-turning travel lanes. Note that right-turn slip lanes are not recommended in areas of high pedestrian use.

Guidelines:

- Refuge must be accessible.
- Crosswalks should be indicated with pavement markings to show pedestrians and motorists the correct crossing location.
- Generally, the crosswalk should be set back 20 ft (6.1 m) from the point where the traffic merges, so that pedestrians cross behind the first vehicle, and should be oriented perpendicular to the line of vehicle travel.

See also median refuge island for additional information.




*Porkchop refuge island*

## 2.8. Traffic Calming

**Design Summary**

Traffic calming interventions slow traffic by modifying the physical environment of a street. The City of Tacoma has employed a variety of traffic calming measures, including speed humps, chokers, traffic circles and both full and partial street closures. Research into the efficacy of traffic calming devices to improve pedestrian safety has shown that traffic calming can reduce the number of automobile collisions. A Vancouver study published in 1997 showed an average collision reduction of 40 percent in four neighborhoods that used a combination of the traffic calming types described below.[2]

### 2.8.1. Street Trees

In addition to their aesthetic value, street trees can slow traffic and improve safety for pedestrians. Trees add visual interest to streets and narrow the street's visual corridor, which may cause drivers to slow down. Guidance for the use of street trees includes:

- If the sidewalk corridor is not wide enough to accommodate street trees, adding tree plantings in the parking lane is possible. These trees will have shortened life spans.
- The placement of plantings should consider potential for conflict with street sweeping and drainage.
- Street trees should be planted on both sides of all residential streets in order to provide visual interest and comfort for pedestrians and other street users (from RCCSDG).

### 2.8.2. Raised Crosswalks

Raised crosswalks are similar to speed humps, but are installed at intersections to elevate crosswalks. Raised sidewalks eliminate grade changes from the pedestrian path and give pedestrians greater prominence as they cross the street.

- Use detectable warnings at the curb edges to alert vision-impaired pedestrians that they are entering the roadway.
- May be designed so they do not have a slowing effect (for example, on emergency response routes).

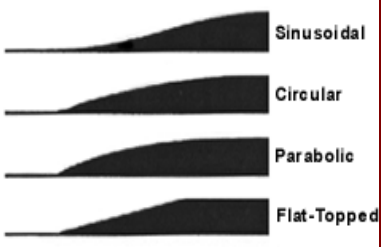
*Source: www.walkinginfo.org*

### 2.8.3. Speed Humps

Speed humps are elevated, sloped sections of pavement that require drivers to slow down. Speed humps should not be used on emergency response routes or transit corridors.

Speed humps are generally 12-22' long and 3-4" high. There are four speed hump shapes – sinusoidal, circular, parabolic and flat-topped, as shown to right. The sinusoidal are much smoother to drive over at the intended speed, and are also more friendly to bicyclists. Speed humps of the parabolic shape provide a more pronounced bump when driving over them

Gaps can be provided in a speed hump, which a bicyclist can pass through without slowing significantly but that require slower motor vehicle speeds. This improves conditions for bicyclists, who may be unsteady while crossing a speed hump.




[2] Zein, S. R.; Geddes, E.; Hemsing, S.; Johnson, M., "Safety Benefits of Traffic Calming," Transportation Research Record Vol: #1578 pp. 3-10.

# 2.8. Traffic Calming

## 2.8.4. Chicanes

Chicanes are a series of bulb-outs or narrowings that create an S-shaped route, causing traffic to slow down.

With no major pedestrian issues, chicanes can provide additional landscaping and street buffer area. Care should be taken to ensure that chicanes do not affect bicycle mobility.

## 2.8.5. Traffic Calming Circles

Traffic calming circles are circular islands in the middle of an intersection. Traffic circles slow traffic by altering the route of vehicles and by reducing the distance a driver can see down the street, which also causes traffic to slow.

- Unlike full roundabouts, traffic circles maintain the crosswalks at the intersection corners.
- However, in some cases it is necessary to move the crosswalks back to accommodate the turning radius of larger vehicles around the circle. In these cases the crosswalks are no longer aligned directly perpendicular with the corner, which could cause difficulty for persons with visual impairments
- Care should be taken to ensure that any landscaping in the circles uses low-growing shrubs that maintain visibility for pedestrians, particularly those in wheelchairs.

## 2.8.6. Pinch Point (Queuing Street/Neckdown/Choker)

This is a residential traffic calming treatment that narrows the travel lane for motorists by installing curb extensions or islands to create a narrow channel. A separated bicycle travel-way segregates the bicycles and motor vehicles as they travel through the device. This design slows automotive traffic while retaining priority movement for bicycles. The intent is to calm and discourage non-local traffic on bicycle boulevards.

## 2.8.7. Street Closures/Diverters

There are three types of street closures:

- Diverters force automobile traffic to turn right or left.
- 'Half roadway closures' allow only one-way traffic to continue through an intersection.
- 'Full roadway closures' completely close a street segment to motor vehicle traffic from an intersection.

All types of closures benefit pedestrians and residents by diverting traffic from residential streets. Where possible, a route should be provided for bicyclists and pedestrians to continue in a straight line. However, diverted traffic flows may be problematic on other streets. On streets with closures, emergency vehicle access may be limited.

# 3. Pedestrian Travel in Construction Zones

## Design Summary

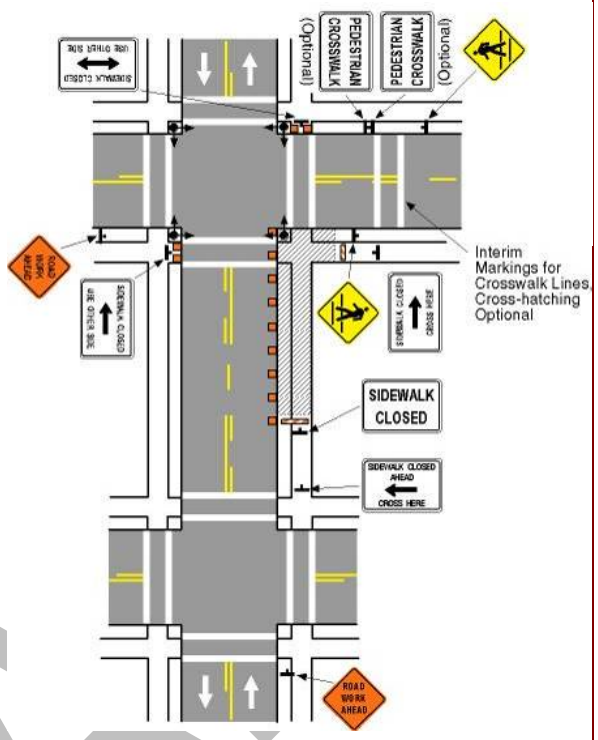
Measures should be taken to provide for the continuity of a pedestrian's trip through a closure. Only in rare cases should pedestrians be detoured to another street when travel lanes remain open.

## Discussion

The removal, even for a short time, of a pedestrian access route, curb ramp, or pedestrian street crossing may severely limit or totally preclude pedestrians, especially those with a disability, from navigating in the public right-of-way. It might also preclude access to buildings, facilities, or sites on adjacent properties.

In order to accommodate pedestrians through various lane closures and detours, the following guidelines are recommended:

- Pedestrians should not be led into conflicts with work site vehicles, equipment, moving vehicles, or temporary construction signage.
- Pedestrians should be provided with a safe, accessible, convenient path that replicates as nearly as practical the most desirable characteristics of the existing sidewalk(s) or a footpath(s).
- Signage related to construction activities shall be placed in a location that does not obstruct the path of bicycles or pedestrians, including bicycle lanes, wide curb lanes, or sidewalks




*Recommendations for accommodating pedestrian and bicycle travel through construction zones*

## Additional Guidance

The alternate circulation path shall be parallel the disrupted pedestrian access route, be located on the same side of the street, and accommodate the disabled. In rare cases where access is not available on the same side of the street, the alternate pedestrian route may be located on the opposite side of the street as long as the distance of the disrupted pedestrian route does not exceed 300 ft (91.4 m). The alternate pedestrian route should include sidewalks and pedestrian access routes, curb ramps, pedestrian crossings, lighting, and all other elements included in these standards. It should have a width of 5 ft (1.5m) minimum, and an additional foot of width for each vertical element along the route.

# 4. Pedestrians at Transit Stops

**Design Summary**

- All bus stops should have a hard flat boarding surface
- All stops must meet ADA requirements

**Discussion**

Pedestrian friendly design encourages transit use. In order to be a successful alternative to the automobile, transit service must be frequent, reliable, convenient, comfortable and affordable.

A hard flat surface is required for safe boarding, alighting, waiting and accessibility. A safe boarding surface shall consist of a concrete pad, cement squares, or brick allowing for wheelchair use in all weather. These stops should be marked with the international accessible symbol on the bus stop sign, and also stenciled with blue paint on the sidewalk to indicate the appropriate boarding position.

*Example of a good transit stop*

**Additional Guidance**

Amenities

When designing or improving a transit stop, certain amenities are desired for the stop to accommodate transit passengers. The amenities include:

- Bus stop markers/signs that are oriented to the pedestrian, rather than to passing vehicles,
- Bus schedules and route map display areas
- Seating for transit passengers, placed so that the waiting passengers are visible to the bus driver
- A shelter to shield passengers from the weather
- Pedestrian scale lighting to increase security and visibility for riders and transit operators
- A trash container

An improved hardscape surface that extends from the curb to the sidewalk. Hardscape surfaces may include paving materials other than poured concrete. The surface should be large enough to accommodate both seated and standing passengers, extend to the street curb, and meet any applicable disabled access regulations. New sidewalk connections from the transit stop to the nearest improved sidewalk should be provided.

Approach

High-visibility crosswalks are often appropriate, particularly at high-usage transit stops. Even if transit riders access the station from one side only, they all will need to cross the street to access or leave the bus stop.

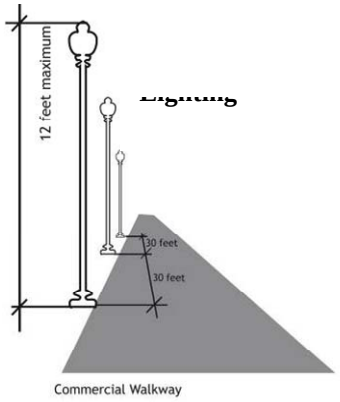
# 5. Pedestrian Amenities

## 5.1.1. Lighting

Pedestrian scale lighting improves visibility and can provide a vertical buffer between the sidewalk and the street, defining pedestrian areas. Pedestrian scale lighting should be used in areas of high pedestrian activity and where feasible based on available right of way, utilities and cost. A guideline for a pedestrian way is illumination of between 0.5 foot-candle to 1 foot-candle. Pedestrian scale lighting is a significant capital improvement and should be provided only where it will have a maximum benefit, such as public safety.

When installing pedestrian scaled lighting, the following details should also be considered:

- Need for strong structures to withstand vandalism
- Materials should fit with City standards and areas' character
- Glare to adjacent residents
- Color of light: High pressure sodium lamps have the longest life and lowest maintenance cost with a yellow light quality. Metal halide lights produce a white light quality but have shorter lamp life.




## 5.1.2. Pedestrian-Scale Furniture

Providing benches at key rest areas and viewpoints encourages people of all ages to use the shared-use path by ensuring that they have a place to rest along the way. Benches can be simple (e.g., wood slates) or more ornate (e.g., stone, wrought iron, concrete).

## 5.1.3. Green Stormwater Features

Green stormwater features, also known as low impact development (LID) strategies may include bioretention swales, rain gardens, tree box filters, and pervious pavements (pervious concrete, asphalt and pavers).

Bioswales are natural landscape elements that manage water runoff from a paved surface, such as a shared-use path. Plants in the swale trap pollutants and silt from entering a river system. Biorentention areas, or 'rain gardens,' provide water quality benefits and an aesthetic quality to the roadside. Pervious pavements allow water to infiltrate rather than run into storm drains.

The MUCCSDG states that, "Green Streets should be planned and designated as part of a 'green infrastructure' system, based on factors including their potential to enhance habitat connectivity with adjacent natural areas, as well as traffic demands and other considerations." The document contains additional guidance for these treatments.

# 6. Shared-Use Paths

## Design Summary

Shared-use paths can provide a desirable facility particularly for novice riders, recreational trips, and cyclists of all skill levels preferring separation from traffic. Shared-use paths should generally provide new travel opportunities.

## Discussion

Shared-use paths serve bicyclists and pedestrians and provide additional width over a standard sidewalk. Facilities may be constructed adjacent to roads, through parks, or along linear corridors such as active or abandoned railroad lines or waterways. Regardless of the type, paths constructed next to the road must have some type of vertical (e.g., curb or barrier) or horizontal (e.g., landscaped strip) buffer separating the path area from adjacent vehicle travel lanes.

*Shared-use paths (also referred to as "trails" and "multi-use paths") are often viewed as recreational facilities, but they are also important corridors for utilitarian trips*

## Additional Guidance

Elements that enhance shared-use path design include:

- Providing frequent access points from the local road network; if access points are spaced too far apart, users will have to travel out of direction to enter or exit the path, which will discourage use
- Placing directional signs to direct users to and from the path
- Building to a standard high enough to allow heavy maintenance equipment to use the path without causing it to deteriorate
- Limiting the number of at-grade crossings with streets or driveways
- Terminating the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street. If poorly designed, the point where the path joins the street system can put pedestrians and cyclists in a position where motor vehicle drivers do not expect them
- Identifying and addressing potential safety and security issues up front
- Whenever possible, and especially where heavy use can be expected, separate bicycle and pedestrian ways should be provided to reduce conflicts

Sidewalks as Shared-Use Paths

Utilizing a sidewalk as a shared-use path is unsatisfactory because sidewalks are designed for pedestrian speeds and maneuverability and are not safe for higher bicycle speeds. Conflicts are common between pedestrians traveling at low speeds (e.g., exiting stores, parked cars, etc.) and bicyclists, as are conflicts with fixed objects (e.g., utility poles, mailboxes, parked cars extending into the sidewalk from a driveway). Walkers, joggers, skateboarders and in-line skaters can (and often do) change their speed and direction almost instantaneously, leaving bicyclists insufficient reaction time to avoid collisions.

Similarly, pedestrians often have difficulty predicting the direction an oncoming cyclist will take. At intersections, motorists are often not looking for bicyclists who are traveling at higher speeds than pedestrians) entering a crosswalk area, particularly when motorists are making a turn. Sight distance is often impaired by buildings, walls, fences and shrubs along sidewalks, especially at driveways. In addition, bicyclists and pedestrians often prefer to ride or walk side-by-side when traveling in pairs. Sidewalks are typically too narrow to enable this to occur without serious conflict between users.

It should also be noted that developing extremely wide sidewalks does not necessarily add to the safety of sidewalk bicycle travel. Wide sidewalks might encourage higher speed bicycle use and can increase the potential for conflicts with motorists at intersections, as well as pedestrians with fixed objects.

## 6.1. Shared-Use Paths Along Roadways

### Design Summary

The AASHTO *Guide for the Development of Bicycle Facilities* generally recommends against the development of shared-use paths directly adjacent to roadways.

### Discussion

Also known as "sidepaths", these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in wrong-way riding where cyclists enter or leave the path. This can create an unsafe situation where motorists entering or crossing the roadway do not notice bicyclists coming from their right, as they are not expecting traffic from that direction. Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may frequently block path crossings. Bicyclists coming from the left may also be unnoticed, particularly if sight distances are poor.


*Example of a substandard sidepath in Molalla, OR*

### Additional Guidance

Additional concerns about shared-use paths directly adjacent to roadways (with minimal separation) are:

- When the path ends, cyclists riding against traffic tend to continue to travel on the wrong side of the street, as do cyclists making their way to the path. Wrong-way bicycle travel is a major cause of vehicle/bicycle crashes.
- At intersections, motorists crossing the path often do not notice bicyclists approaching from certain directions, especially where sight distances are poor.
- Bicyclists on the path are required to stop/yield at cross-streets or driveways, unless posted.
- Stopped vehicles on a cross-street or driveway may block the path.
- Because of the closeness of vehicle traffic to opposing bicycle traffic, barriers are often necessary to separate motorists from cyclists. These barriers serve as obstructions, complicate facility maintenance and waste available right-of-way.
- Paths directly adjacent to high-volume roadways diminish users' experience by placing them in an uncomfortable environment. This could lead to a path's underutilization.

As bicyclists gain experience and realize some of the advantages of riding on the roadway, some riders stop using paths adjacent to roadways. Bicyclists may also tend to prefer the roadway as pedestrian traffic on the shared-use path increases due to its location next to an urban roadway. When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to not provide adequate shoulder or bike lane width on the roadway, as the on-street bicycle facility will generally be superior to the "sidepath" for experienced cyclists and those who are cycling for transportation purposes. Bike lanes should be provided as an alternate (more transportation-oriented) facility whenever possible.

Shared-use paths may be considered along roadways under the following conditions:

- The path will generally be separated from all motor vehicle traffic
- Bicycle and pedestrian use is anticipated to be high
- To provide continuity with an existing path through a roadway corridor
- The path can be terminated at each end onto streets with good bicycle and pedestrian facilities, or onto another well-designed path
- There is adequate access to local cross-streets and other facilities along the route
- Any needed grade separation structures do not add substantial out-of-direction travel
- The total cost of providing the proposed path is proportionate to the need

## 6.2. Shared-Use Path Design

### Design Summary

Width:

- 10' is the minimum allowed for a two-way shared-use path and is only recommended for low traffic situations.
- 12' is recommended in most situations
- 12' or greater is recommended for heavy use situations with high concentrations of multiple users such as joggers, bicyclists, rollerbladers and pedestrians.

Lateral Clearance:

- A 2' or greater shoulder on both sides

Overhead Clearance:

- Clearance to overhead obstructions should be 8' minimum, with 10' recommended.

Separation From Roadway:

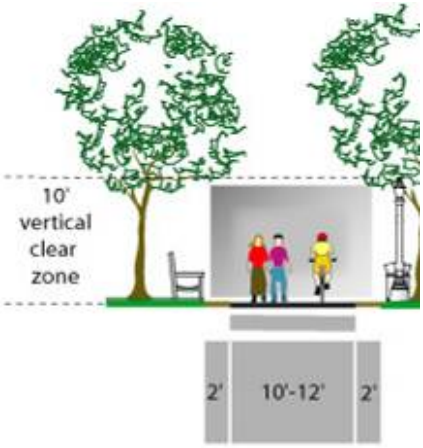
- Where a shared-use path must be adjacent to a roadway, a five foot minimum buffer should separate the path from the edge of the roadway, or a physical barrier of sufficient height should be installed.

### Discussion

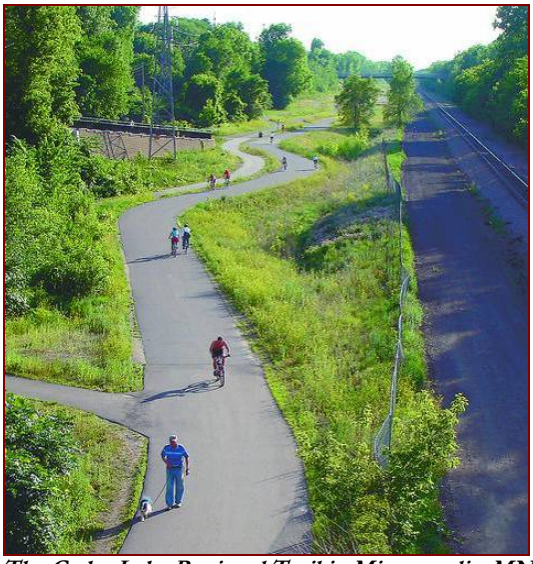
Asphalt is the most common surface for shared-use paths. However, the material composition and construction methods used can substantially affect the longevity of the pathway. Thicker asphalt sections and a well-prepared subgrade will reduce deformation over time and reduce long-term maintenance costs.

The use of concrete surfacing for paths has proven to be the most suitable for long-term use. Using modern construction practices, concrete provides a smooth ride with low maintenance costs. Concrete paths can be placed with a slip-form paver. The surface must be cross-broomed. Crack-control joints should be saw-cut, not troweled. Concrete paths cost more to build than asphalt paths but do not become brittle, cracked and rough with age, or deformed by roots

Shared-use paths should be designed with sufficient surfacing structural depth for the subgrade soil type to support maintenance and emergency vehicles. Where the path must be constructed over a very poor subgrade (wet and/or poor material), treatment of the subgrade with lime, cement or geotextile fabric should be considered.




*Recommended shared-use path design*



*The Cedar Lake Regional Trail in Minneapolis, MN has sufficient width to accommodate a variety of users*

## 6.3. Path/Roadway Crossings

### Design Summary

At-grade path/roadway crossings generally will fit into one of four basic categories:

- Type 1: Marked/Unsignalized; Type 1+: Marked/Enhanced
- Type 2: Route Users to Existing Signalized Intersection
- Type 3: Signalized/Controlled
- Type 4: Grade-separated crossings

### Discussion

While at-grade crossings create a potentially high level of conflict between path users and motorists, well-designed crossings have not historically posed a safety problem, as evidenced by the thousands of successful paths around the United States with at-grade crossings. In most cases, path crossings can be properly designed at-grade to a reasonable degree of safety and meet existing traffic and safety standards.

*An offset crossing forces pedestrians to turn and face the traffic they are about to cross*

Evaluation of path crossings involves analysis of vehicular and anticipated path user traffic patterns, including vehicle speeds, traffic volumes (average daily traffic and peak hour traffic), street width, sight distance and path user profile (age distribution, destinations served). Crossing features for all roadways include warning signs both for vehicles and path users. The type, location, and other criteria are identified in the AASHTO's Guide for the Development of Bicycle Facilities and the MUTCD.

Consideration must be given for adequate warning distance based on vehicle speeds and line of sight, with visibility of any signing absolutely critical. Catching the attention of motorists jaded to roadway signs may require additional alerting devices such as a flashing light, roadway striping or changes in pavement texture. Signing for path users must include a standard "STOP" sign and pavement marking, sometimes combined with other features such as bollards or a kink in the pathway to slow bicyclists. Care must be taken not to place too many signs at crossings lest they begin to lose their impact.

A number of striping patterns have emerged over the years to delineate path crossings. A median stripe on the path approach will help to organize and warn path users. The actual crosswalk striping is a matter of local and State preference, and may be accompanied by pavement treatments to help warn and slow motorists. The effectiveness of crosswalk striping is highly related to local customs and regulations. In areas where motorists do not typically defer to pedestrians in crosswalks, additional measures may be required.

The following section identifies several path/roadway crossing treatments that should be considered for Tacoma's shared-use path system.

The proposed intersection approach that follows is based on established standards, published technical reports,[3] and experiences from cities around the country.[4]



[3] Federal Highway Administration (FHWA) Report, "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations."
[4] In particular, the recommendations in this report are based in part on experiences in cities like Portland (OR), Seattle (WA), Tucson (AZ), and Sacramento (CA), among others

## 6.3. Path/Roadway Crossings

**Summary of Path/Roadway At-Grade Crossing Recommendations[5]**

| Roadway Type | Vehicle ADT ≤ 9,000 | | | Vehicle ADT > 9,000 to 12,000 | | | Vehicle ADT > 12,000 to 15,000 | | | Vehicle ADT > 15,000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Speed Limit ** | | | | | | | | | | | |
| | **30 mph** | **35 mph** | **40 mph** | **30 mph** | **35 mph** | **40 mph** | **30 mph** | **35 mph** | **40 mph** | **30 mph** | **35 mph** | **40 mph** |
| 2 Lanes | 1 | 1 | 1/1+ | 1 | 1 | 1/1+ | 1 | 1 | 1+/3 | 1 | 1/1+ | 1+/3 |
| 3 Lanes | 1 | 1 | 1/1+ | 1 | 1/1+ | 1/1+ | 1/1+ | 1/1+ | 1+/3 | 1/1+ | 1+/3 | 1+/3 |
| Multi-Lane (4 +) w/ raised median*** | 1 | 1 | 1/1+ | 1 | 1/1+ | 1+/3 | 1/1+ | 1/1+ | 1+/3 | 1+/3 | 1+/3 | 1+/3 |
| Multi-Lane (4 +) w/o raised median | 1 | 1/1+ | 1+/3 | 1/1+ | 1/1+ | 1+/3 | 1+/3 | 1+/3 | 1+/3 | 1+/3 | 1+/3 | 1+/3 |

*__General Notes:__ Crosswalks should not be installed at locations that could present an increased risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding which treatment to use.**

For each pathway-roadway crossing, an engineering study is needed to determine the proper location. For each engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites.

** Where the speed limit exceeds 40 mi/h marked crosswalks alone should not be used at unsignalized locations.

*** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and AASHTO guidelines. A two-way center turn lane is not considered a median.

1= Type 1 Crossings. Ladder-style crosswalks with appropriate signage should be used.

1/1+ = With the higher volumes and speeds, enhanced treatments should be used, including marked ladder style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

1+/3 = Carefully analyze signal warrants using a combination of Warrant 2 or 5 (depending on school presence) and EAU factoring. Make sure to project pathway usage based on future potential demand. Consider Pelican, Puffin, or Hawk signals in lieu of full signals. For those intersections not meeting warrants or where engineering judgment or cost recommends against signalization, implement Type 1 enhanced crosswalk markings with marked ladder style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

### 6.3.1. Type 1: Marked/Unsignalized Crossings

A marked/unsignalized crossing (Type 1) consists of a

[5] This table is based on information contained in the U.S. Department of Transportation Federal Highway Administration Study, " Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations," February 2002.

## 6.3. Path/Roadway Crossings

crosswalk, signage, and often no other devices to slow or stop traffic. The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, path traffic, use patterns, vehicle speed, road type and width, and other safety issues such as proximity to schools. The following thresholds recommend where unsignalized crossings may be acceptable:

Maximum traffic volumes:

- ≤9,000-12,000 Average Daily Traffic (ADT) volumes
- Up to 15,000 ADT on two-lane roads, preferably with a median.
- Up to 12,000 ADT on four-lane roads with median.

Maximum travel speed:

- 35 MPH

Minimum line of sight:

- 25 MPH zone: 155 feet
- 35 MPH zone: 250 feet
- 45 MPH zone: 360 feet


*Type 1 Crossing*

**Discussion**

If well-designed, crossings of multi-lane higher-volume arterials over 15,000 ADT may be unsignalized with features such as a combination of some or all of the following: excellent sight distance, sufficient crossing gaps (more than 60 per hour), median refuges, and/or active warning devices like flashing beacons or in-pavement flashers. These are referred to as "Type 1 Enhanced" (Type 1+). Such crossings would not be appropriate; however, if a significant number of schoolchildren used the path. Furthermore, both existing and potential future path usage volume should be taken into consideration.

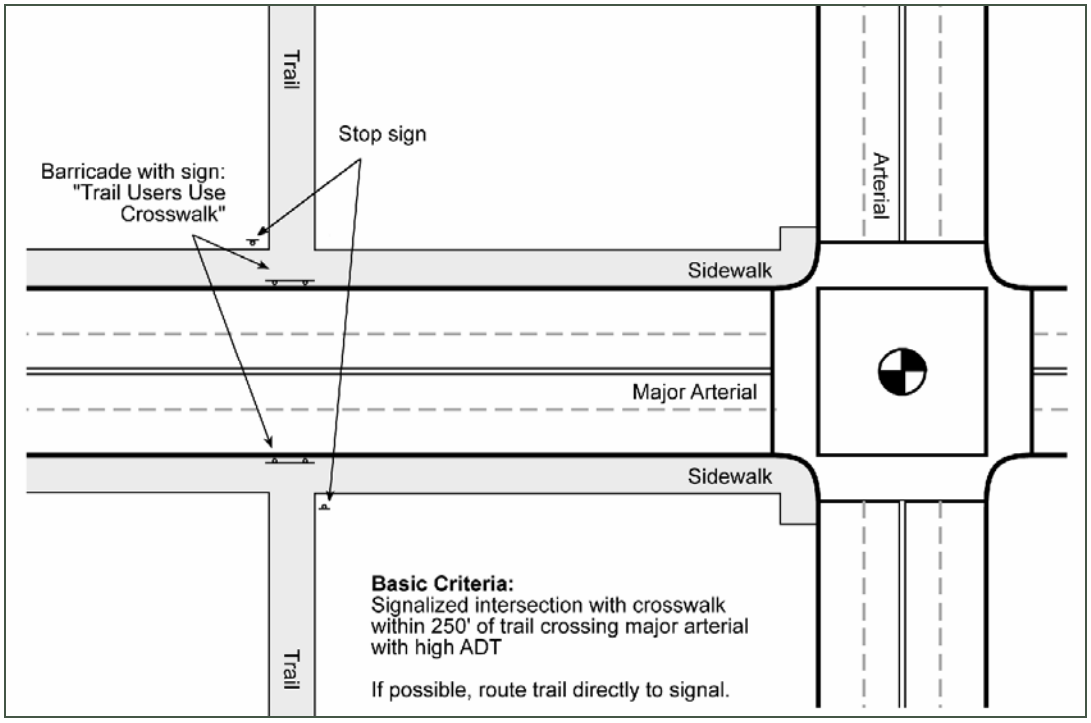
On two-lane residential and collector roads below 15,000 ADT with average vehicle speeds of 35 MPH or less, crosswalks and warning signs ("Path Xing") should be provided to warn motorists, and stop signs and slowing techniques (bollards/geometry) should be used on the path approach. Curves in paths that orient the path user toward oncoming traffic are helpful in slowing path users and making them aware of oncoming vehicles. Care should be taken to keep vegetation and other obstacles out of the sight line for motorists and path users. Engineering judgment should be used to determine the appropriate level of traffic control and design.

On roadways with low to moderate traffic volumes (<12,000 ADT) and a need to control traffic speeds, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety. These crosswalks are raised 75 millimeters above the roadway pavement (similar to speed humps) to an elevation that matches the adjacent sidewalk. The top of the crosswalk is flat and typically made of asphalt, patterned concrete, or brick pavers. Brick or unit pavers should be discouraged because of potential problems related to pedestrians, bicycles, and ADA requirements for a continuous, smooth, vibration-free surface. Detectable warning strips are needed at the sidewalk/street boundary so that visually impaired pedestrians can identify the edge of the street.

### 6.3.2. Type 2: Route Users to Existing Signalized Intersection

## 6.3. Path/Roadway Crossings

Crossings within 250 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection for safety purposes. For this option to be effective, barriers and signing may be needed to direct shared-use path users to the signalized crossings. In most cases, signal modifications would be made to add pedestrian detection and to comply with ADA.




*Type 2 Crossing Treatment*

### 6.3.3. Type 3: Signalized/Controlled Crossings

New signalized crossings may be recommended for crossings that meet pedestrian, school, or modified warrants, are located more than 250 feet from an existing signalized intersection and where 85th percentile travel speeds are 40 MPH and above and/or ADT exceeds 15,000 vehicles. Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

Shared-use path signals are normally activated by push buttons, but also may be triggered by motion detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street. The signals may rest on flashing yellow or green for motorists when not activated, and should be supplemented by standard advanced warning signs. As described in the "Half Signalized Crossings" section earlier in this chapter, various types of pedestrian signals exist and can be used at Type 3 crossings.

*Type 3 Crossing*

### 6.3.4. Type 4: Grade-separated Crossings

## 6.3. Path/Roadway Crossings

Grade-separated crossings may be needed where existing bicycle/pedestrian crossings do not exist, where ADT exceeds 25,000 vehicles, and 85th percentile speeds exceed 45 MPH. Safety is a major concern with both overcrossings and undercrossings. In both cases, shared-use path users may be temporarily out of sight from public view and may have poor visibility themselves. Undercrossings, like parking garages, have the reputation of being places where crimes occur. Most crime on shared-use paths, however, appears to have more in common with the general crime rate of the community and the overall usage of the shared-use path than any specific design feature.

Design and operation measures are available which can address shared-use path user concerns. For example, an undercrossing can be designed to be spacious, well-lit, equipped with emergency cell phones at each end and completely visible for its entire length prior to entering. Other potential problems with undercrossings include conflicts with utilities, drainage, flood control, and maintenance requirements. Overcrossings pose potential concerns about visual impact and functional appeal, as well as space requirements necessary to meet ADA guidelines for slope.

*Type 4 Grade-Separated Undercrossing*

*Type 4 Grade-Separated Overcrossing*

## 6.4. Path Signage

### Design Summary

Three types of signage appropriate for shared-use path use include:

- Wayfinding (top right)
- Regulatory (bottom right)
- Warning (traffic signage)

### Discussion

Directional signing may be useful for pathway users and motorists alike. For motorists, a sign reading "Path Xing" along with a Tacoma emblem or logo helps both warn and promote use of the path itself. For path users, directional signs and street names at crossings help direct people to their destinations. The directional signing should impart a unique theme so path users know which path they are following and where it goes. The theme can be conveyed in a variety of ways: engraved stone, medallions, bollards, and mile markers. A central information installation at trailheads and major crossroads also helps users find and acknowledge the rules of the path. They are also useful for interpretive education about plant and animal life, ecosystems, and local history.

The 2003 *Tacoma Downtown Streetscape Study and Design Concepts*) made wayfinding recommendations for downtown Tacoma. Recommended locations for pedestrian signs include:

- All LINK stations, including the Tacoma Dome station.
- Key bus transfer points.
- The museum corridor/Union Station vicinity.
- UWT entries on Pacific Avenue and, if pedestrian volumes warrant, Market Street.
- Convention Center entries at Broadway/S. 15th Street and Pacific/S. 19th Street.
- Tacoma Avenue and S. 11th Street.
- Near S. 7th Street and St. Helens Avenue.
- Broadway and S. 11th Street.

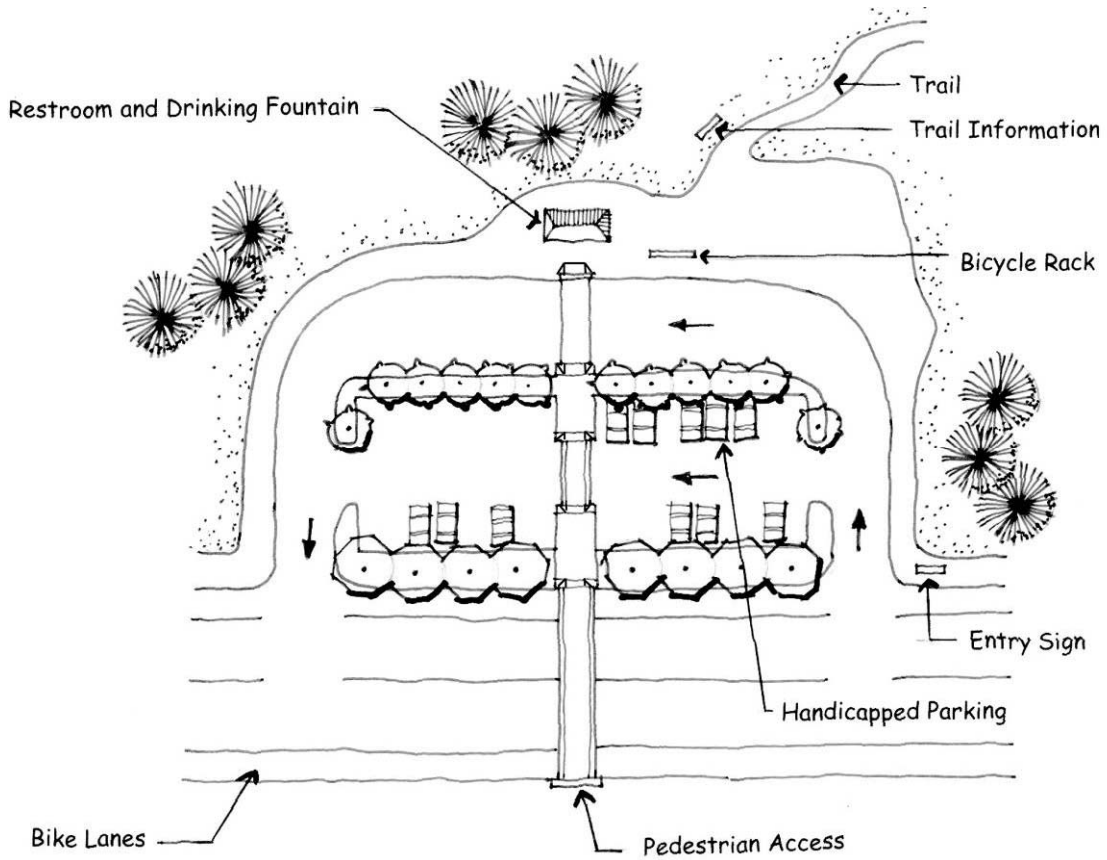
(source: http://www.mrsc.org/govdocs/T3StreetscapeStudy.pdf


*Directional and Shared-Use Path Etiquette Signage*

## 6.5. Trailheads

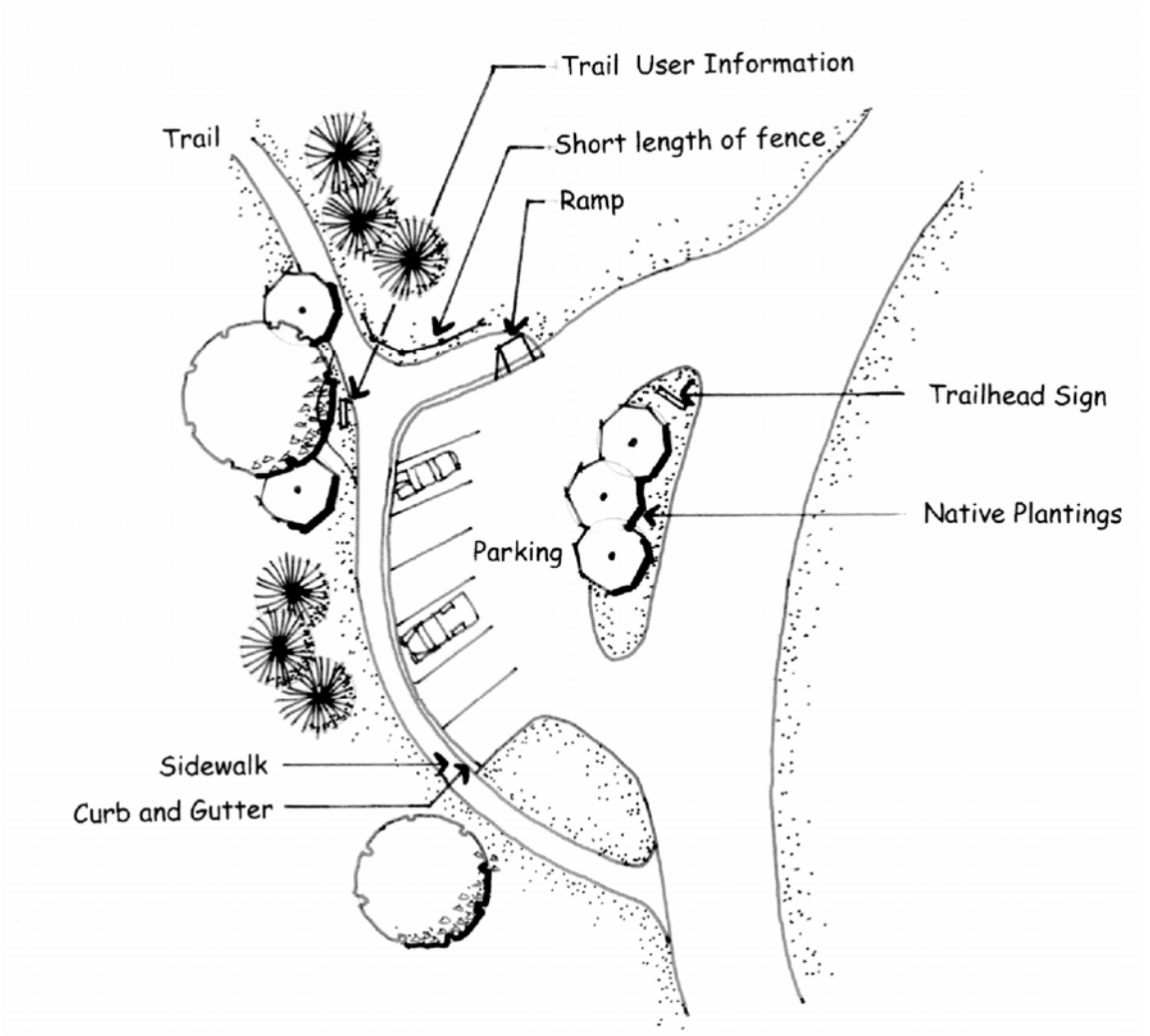
Good access to a path system is a key element for its success. Trailheads (formalized parking areas) serve the local and regional population arriving to the path system by car, transit, bicycle or other modes. Trailheads provide essential access to the shared-use path system and include amenities like parking for vehicles and bicycles, restrooms (at major trailheads), and posted maps. A central information installation also helps users find their way and acknowledge the rules of the path. They are also useful for interpretive education about plant and animal life, ecosystems and local history.

### 6.5.1. Major Trailhead



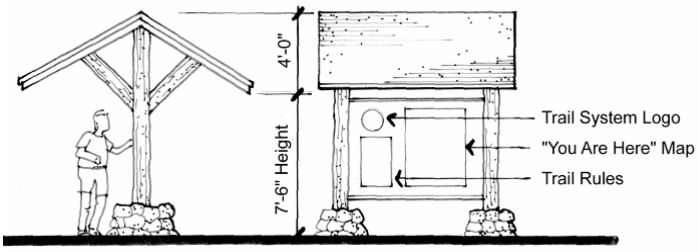

### 6.5.2. Trailhead with Small Parking Area

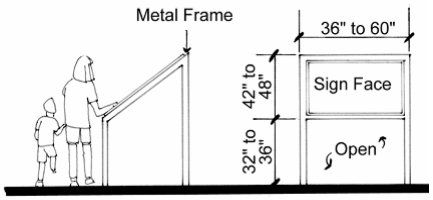
## 6.5. Trailheads




Trailheads with a small parking area should additionally include bicycle parking.

### 6.5.3. Informational Kiosk and Informational Sign




## 6.6. Path Amenities

## 6.6. Path Amenities

A variety of amenities can make a path inviting to the user. The following table highlights some common items that make path systems stand out. Costs vary depending on the design and materials selected for each amenity.

### 6.6.1. Interpretive Installations

Interpretive installations and signs can enhance the users experience by providing information about the history of Tacoma and the surrounding area. Installations can also discuss local ecology, environmental concerns, and other educational information.

### 6.6.2. Water Fountains and Bicycle Parking

Water fountains provide water for people (and pets, in some cases) and bicycle racks allow recreational users to safely park their bikes if they wish to stop along the way, particularly at parks and other desirable destinations.

### 6.6.3. Pedestrian-Scale Lighting and Furniture

Pedestrian-scale lighting improves safety and enables the facility to be used year-round. It also enhances the aesthetic of the pathway. Lighting fixtures should be consistent with other light fixtures in the city, possibly emulating a historic theme.

Providing benches at key rest areas and viewpoints encourages people of all ages to use the pathway by ensuring that they have a place to rest along the way. Benches can be simple (e.g., wood slates) or more ornate (e.g., stone, wrought iron, concrete).

### 6.6.4. Maps and Signage

A comprehensive signing system makes a bicycle and pedestrian system stand out. Informational kiosks with maps at trailheads and other pedestrian generators can provide enough information for someone to use the network with little introduction – perfect for areas with high out-of-area visitation rates as well as the local citizens.

## 6.6. Path Amenities

### 6.6.5. Art Installations

Local artists can be commissioned to provide art for the pathway system, making it uniquely distinct. Many pathway art installations are functional as well as aesthetic, as they may provide places to sit and play on.

### 6.6.6. Landscaping

Landscape features, including street trees or trees along paths, can enhance the visual environment and improve the path user experience. Trees can also provide shade from heat and also provide protection from rain.

### 6.6.7. Restrooms

Restrooms benefit path users, especially in more remote areas where other facilities do not exist. Restrooms can be sited at major trailheads or at other strategic locations along the path system.

### 6.6.8. Bollards

Bollards are posts that can be used to block vehicle access to the path and that can provide information such as mile markings, wayfinding for key destinations, or small area maps.

Where used, bollards should be high-visibility with reflective tape or paint, and should not be low enough to be unnoticed. Cyclists using the shared-use path can bump into a bollard, particularly in low light conditions. Bollards should be placed in the middle of the path, with sufficient space for path users to pass. They can create bottlenecks with path users at intersections, and should be used with caution.

## 6.7. Path Safety and Security

### Design Summary

Various design and programmatic measures can be taken to address safety issues on a shared-use path. This table summarizes key safety issues and strategies for minimizing impacts.

### Discussion

Privacy of adjacent property owners

- Encourage the use of neighborhood friendly fencing and also planting of landscape buffers.
- Clearly mark path access points.
- Post path rules that encourage respect for private property.
- Strategically placed lighting.

Unwanted vehicle access on the path

- Utilize landscaping to define the corridor edge and path, including earth berms or boulders.
- Use bollards at intersections (see guidelines above)
- Pass a motorized vehicle prohibited ordinance and sign the path.
- Create a Path Watch Program and encourage citizens to photograph report illegal vehicle use of the corridor.
- Lay the shared-use path out with curves that allow bike/ped passage, but are uncomfortably tight for automobile passage

Litter and dumping

- Post rules encouraging pack-it-out practices.
- Place garbage receptacles at trailheads.
- Strategically-placed lighting, utilizing light shields to minimize unwanted light in adjacent homes.
- Manage vegetation to allow visual surveillance of the path from adjacent properties and from roadway/path intersections.
- Encourage local residents to report incidents as soon as they occur.
- Remove dumpsites as soon as possible.

Trespassing

- Clearly distinguish public path right-of-way from private property through the use of vegetative buffers and the use of good neighbor type fencing.
- Post rules encouraging respect for property.

Local on-street parking

- Designate residential streets as parking for local residents only to discourage user parking.
- Place "no outlet" and "no parking" signs prior to path access points.

*Surveillance from nearby buildings and pedestrian-scale lighting can increase shared-use path safety*

Crime

- Manage vegetation to ensure visibility from adjacent streets and residences.
- Select shrubs that grow below 3 ft in height and trees that branch out greater than 6 ft in height.
- Place lights strategically and as necessary.
- Place benches and other amenities at locations with good visual surveillance and high activity.
- Provide mileage markers every ¼ mile and clear directional signage for orientation.
- Create a "Path Watch Program" involving local residents.
- Proactive law enforcement. Utilize the corridor for mounted patrol training.

Private use of corridor

- Attempt to negotiate win/win solutions with property owners.
- Eliminate where detrimental impact to path cannot be reasonably ameliorated.

Vandalism

- Select benches, bollards, signage and other site amenities that are durable, low maintenance and vandal resistant.
- Respond through removal or replacement in rapid manner.
- Keep a photo record of all vandalism and turn over to local law enforcement.
- Encourage local residents to report vandalism.
- Create a Trail Watch Program; maintain good surveillance of the corridor.
- Involve neighbors in path projects to build a sense of ownership.
- Place amenities in well used and visible areas.

# 6.7. Path Safety and Security

## 6.7.1. Community Involvement with Safety on the Path

### Design Summary

Creating a safe path environment goes beyond design and law enforcement and should involve the entire community. The most effective and most visible deterrent to illegal activity on Tacoma's path system will be the presence of legitimate path users. Getting as many "eyes on the corridor" as possible is a key deterrent to undesirable activity.

### Discussion

Provide good access to the path

Access ranges from providing conveniently located trailheads along the path, to encouraging the construction of sidewalks to accommodate access from private developments adjacent to the path. Access points should be inviting and signed so as to welcome the public onto the path.

Good visibility from adjacent neighbors

Neighbors adjacent to the path can potentially provide 24-hour surveillance of the path and can become Tacoma's biggest ally. Though some screening and setback of the path is needed for privacy of adjacent neighbors, complete blocking out of the path from neighborhood view should be discouraged. This eliminates the potential of neighbors' "eyes on the path," and could result in a "tunnel effect" on the path.

High level of maintenance

A well-maintained path sends a message that the community cares about the public space. This message alone will discourage undesirable activity along the path.

Programmed events

Community events along the path will help increase public awareness and thereby attract more people to use the path. Neighbors and residents can help organize numerous public events along the path which will increase support for the path. Events might include a day-long path clean up or a series of short interpretive walks led by long time residents or a park naturalist.

Community projects

Nearby businesses, community institutions, and residential neighbors often see the benefit of their involvement in the path development and maintenance. Businesses and developers may view the path as an integral piece of their site planning and be willing to take on some level of responsibility for the path. Creation of an adopt-a-path program should be explored to capitalize on this opportunity and build civic pride.

*'Share the Path' and other community programs raise awareness of safety and other shared-use path issues*

Adopt-a-Path Program

Nearby businesses, community institutions, and residential neighbors often see the benefit of their involvement in the path development and maintenance. Businesses and developers may view the path as an integral piece of their site planning and be willing to take on some level of responsibility for the path. Creation of an adopt-a-path program should be explored to capitalize on this opportunity and build civic pride.

Path Watch Program

Partnering with local and county law enforcement, a path watch program would provide an opportunity for local residents to become actively involved in crime prevention along Tacoma's path system. Similar to Neighborhood Watch programs, residents are brought together to get to know their neighbors, and are educated on how to recognize and report suspicious activity.

## 6.8. Accessways

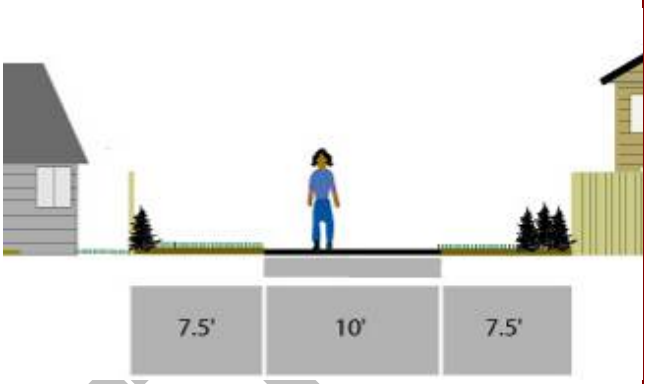
### Design Summary

Accessways provide direct routes between residential areas, retail and office areas, institutional facilities, industrial parks, transit streets, neighborhood activity centers, and transit oriented developments.

Width

The appropriate width of an accessway depends on the predicted usage.

- 12' right-of-way with a centered 8' wide paved surface and two 2' planter strips is appropriate for a heavily-used accessway
- 8' is the minimum width generally recommended
- Narrower widths can be acceptable in less-heavily trafficked physically-constrained areas. If such a shared-use path is long, bulb-outs should be provided to allow pedestrians to pass each other.




*Preferred accessway design*

*This accessway connects two cul-de-sac streets*

### Discussion

Accessways are necessary where routes for pedestrians and bicyclists are not otherwise provided by the street system, particularly in neighborhoods with a disconnected street grid that requires both out-of-direction travel and walking or biking on a major street. Accessways should be considered when 'desire lines' or informal, unauthorized and unmaintained paths have been created. These routes are intended to provide safe, direct, and convenient connections to reduce out-of-direction travel and make walking and bicycling easier.

The design of accessways varies according to the functional classification of the facility as well as the expected user group. Safety for bicyclists and pedestrians on these routes is paramount, as they often intersect busy roadways, are located in residential areas without regular surveillance, and can be quite dark.

### Additional Guidance

Surface

Pervious surface materials such as pervious concrete and interlocking pavers are ideal for accessways, as they reduce rainwater runoff into neighboring yards. If the accessway is built to accommodate all users, including pedestrians with disabilities, bicyclists, strollers, and roller-skaters, it should not exceed a 5% slope. Where accessways connect to sidewalks, provide ramps to the curb at each side.

Fencing

As a general policy, fencing requests should be reviewed on case-by-case bases. If credible evidence suggests that trespassing and crime issues on a specific property result from an accessway, then installation of fencing should be considered. There are numerous fencing types that can be considered. Solid fencing that does not allow any visual access to the shared-use path should be discouraged. Fencing that allows a balance between the need for privacy, while simultaneously allowing informal surveillance of the accessway should be encouraged. If fencing is requested purely for privacy reasons, vegetative buffers should be considered.

# 7. Shoulder Bikeways

## Design Summary

Typically found in less-dense areas, shoulder bikeways are paved roadways with lstriped shoulders (4'+) wide enough for bicycle travel. Shoulder bikeways often, but not always, include signage alerting motorists to expect bicycle travel along the roadway.

The choice of bike lane facilities, whether bike lanes should be striped or if a road should be a shared-use roadway, can be a simple quantitative matter of the speed and volume of traffic on the roadway. It can also be a much more complicated analysis that includes consideration of facility users, key connections, type of traffic, as well as other qualitative factors. The table to the right provides guidance for making facility type decisions.

## Discussion

In many cases, the opportunity to develop a full standard bike lane on a street where it is desirable may be many years. It is possible to stripe the shoulder in lieu of bike lanes if the area is 50 percent of the desirable bike lane width and the outside lane width can be reduced to the AASHTO minimum. If the available bike lane width is 2/3 of the desirable bike lane width, the full bike lane treatment of signs, legends, and an 8" bike lane line would be provided. Where feasible, extra width should be provided with pavement resurfacing jobs, but not exceeding desirable bike lane widths.

Wide Outside Lanes

A wide outside lane may be sufficient accommodation for bicyclists on streets with insufficient width for bike lanes but which do have space available to provide a wider (14'-16') outside travel lane.

*Shoulder bikeways are appropriate along wide roads where vehicles can avoid passing close to bicyclists*

### Context for Shoulder Bikeways vs. Bike Lanes

| Variable | Effect on Need for Bike Lanes |
|---|---|
| 1. Land Use indicators | |
| Urban Center, CBD | Decreases |
| Suburban | Increases |
| Buildings at back of sidewalk | Decreases |
| Buildings set back from roadway (parking lots front street) | Increases |
| On Street Parking | Decreases |
| Short block length | Decreases |
| Long block length | Increases |
| 2. Traffic speed/volume indicators | |
| Signal coordination timed at higher than posted speeds | Increases |
| Signal coordination timed at lower than posted speeds | Decreases |
| Peak Hourly Traffic Volume > 10% | Increases |
| 3. Roadway characteristics | |
| Wide roadway / multiple travel lanes | Increases |
| Steep grades: uphill | Increases |
| Steep grades: downhill | Decreases |
| 4. Bicycling demand indicators | |
| Popular Route to School | Increases |
| Provides continuity of bike lanes, routing or trail | Increases |
| Other high-use indicators | Increases |

Source: *Oregon Bicycle and Pedestrian Plan, 2008 Draft Update*

# 8. Bike Lanes

## Design Summary

Designated exclusively for bicycle travel, bike lanes are separated from vehicle travel lanes with striping and also include pavement stencils. Bike lanes are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation.

| Type of Bike Lane | Recommended Width (Min-Max) |
|---|---|
| Adjacent to on-street parallel parking | 6' (4'-7') |
| Adjacent to on-street diagonal parking | 6' (5'-7') |
| Without on-street parking, no gutter | 6' (4'-7') |
| Without on-street parking, curb & gutter | 6' (5'-8') |


*Bike lanes with signage on a popular commuting and recreational route in California*

## Discussion

Most commuter bicyclists would argue that bike lanes are the safest and most functional facilities for bicycle transportation. Bicyclists have stated their preference for marked on-street bike lanes in numerous national surveys. The fact is that many bicyclists – particularly less experienced riders – are far more comfortable riding on a busy street if it has a striped and signed bike lane. Part of the goal of this Plan is to encourage new riders, and providing marked facilities such as bike lanes is one way of helping to persuade residents to try bicycling.

If properly designed, bike lanes can increase safety and promote proper riding. For this reason, bike lanes are desirable for bicycle commute routes along major roadways. Bike lanes help to define the road space for bicyclists and motorists, reduce the chance that motorists will stray into the cyclists' path, discourage bicyclists from riding on the sidewalk, and remind motorists that cyclists have a right to the road. One key consideration in designing bike lanes in an urban setting is to ensure that bike lanes and adjacent parking lanes have sufficient width so that cyclists have enough room to avoid a suddenly opened vehicle door.

*Bike lane pavement markings in Portland, OR provide character to the roadway*

## Additional Guidance

The AASHTO Guide for the Development of Bicycle Facilities guidance notes that "longitudinal pavement markings should be used to define bicycle lanes." The guideline states that "if used, the bicycle lane symbol marking shall be placed immediately after an intersection and other locations as needed. The bicycle lane symbol marking shall be white. If the word or symbol pavement markings are used, Bicycle Lane signs shall also be used, but the signs need not be adjacent to every symbol to avoid overuse of the signs."

The following pages describe guidelines for implementing bike lanes on streets with on-street parking (both parallel and diagonal) and without parking. Additional sheets highlight particular considerations for bike lanes, including conflicts with right-turning motorists, left-turning bicycle movements, bike lanes at intersections, and innovative techniques for improving bike lane visibility (including colored bike lanes and bike boxes). The following sections discuss a variety of methodologies for retrofitting bike lanes to existing roadways.

# 8.1. Bike Lane Configurations

## 8.1.1. Bike Lane Adjacent to On-Street Parallel Parking

### Design Summary

Bike Lane Width:

- 6' recommended when parking stalls are marked
- 4' minimum in constrained locations
- 5' acceptable if parking not marked
- 7' maximum (may encourage vehicle loading in bike lane)

Travel Lane Width

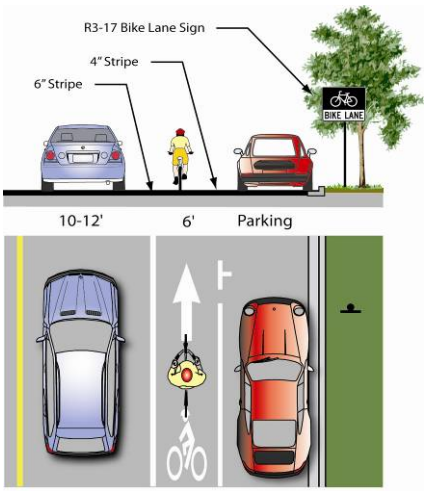
- 12' for a shared lane adjacent to a curb face, or 11' minimum for a shared bike/parking lane where parking is permitted but not marked on streets without curbs

### Discussion

Bike lanes adjacent to on-street parallel parking are common in the United States and can be dangerous for bicyclists if not designed properly. Crashes caused by a suddenly opened vehicle door are a common hazard for bicyclists using this type of facility. Wide bike lanes may encourage the cyclist to ride farther to the right (door zone) to maximize distance from passing traffic. Wide bike lanes may also cause confusion with unloading vehicles in busy areas where parking is typically full. Some alternatives include:

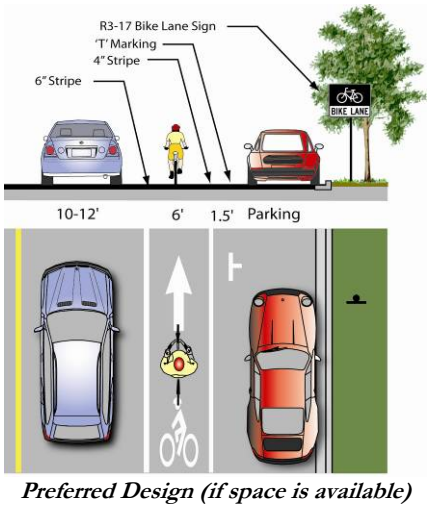
- Installing parking "T's" and smaller bike lane stencils placed to the left (see graphic at top left).
- Using diagonal stripes to encourage cyclists to ride on the left side of the bike lane (shown top right; this treatment is not standard and should be studied before use)
- Provide a buffer zone (preferred design; shown lower right) Bicyclists traveling in the center of the bike lane will be less likely to encounter open car doors. Motorists have space to stand outside the bike lane when loading and unloading

Note: while AASHTO allows 5' bike lanes and recommends 6', the WSDOT design guidelines specifies a minimum bike lane width of 6' adjacent to marked parking.




*Minimum Design*


*Maximum Width*




*Preferred Design (if space is available)*

# 8.1. Bike Lane Configurations

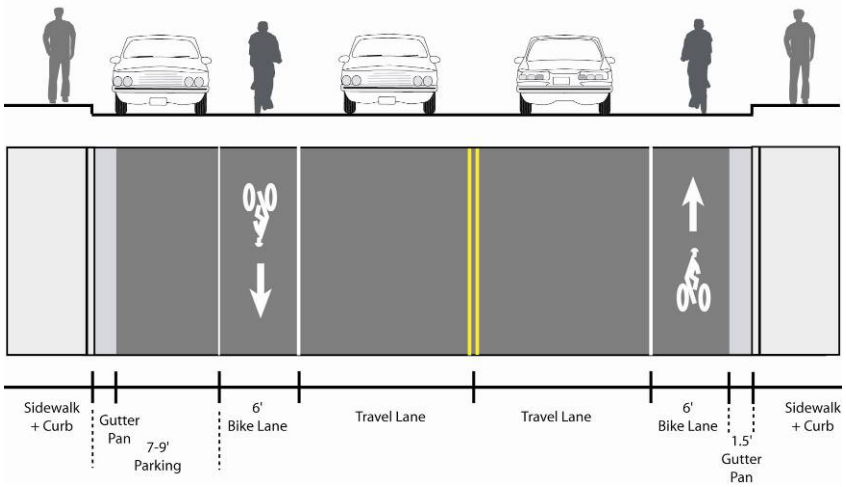
## Additional Discussion - Bike Lane Adjacent to On-Street Parallel Parking

From AASHTO *Guide for the Development of Bicycle Facilities*:

- *"If parking is permitted, the bike lane should be placed between the parking area and the travel lane and have a minimum width of 5'. Where parking is permitted but a parking stripe or stalls are not utilized, the shared area should be a minimum of 11' without a curb face and adjacent to a curb face. If the parking volume is substantial or turnover is high, an additional 1'- 2' of width is desirable."*

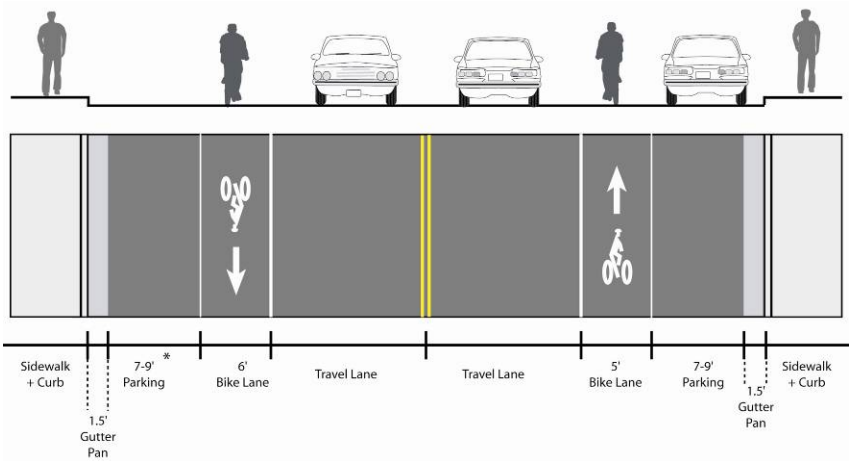

***This bike lane provides parking "T's" to minimize the danger of 'dooring'***

## Recommended Designs




***Two Lane Cross-Section with Parking Both Sides***

*Inclusive of gutter pan




***Two Lane Cross-Section with Parking One Side****

*Bike lane on non-parking side can be 4' in constrained locations

# 8.1. Bike Lane Configurations

## 8.1.2. Bike Lane Adjacent to On-Street Diagonal Parking

### Design Summary

Bike Lane Width:

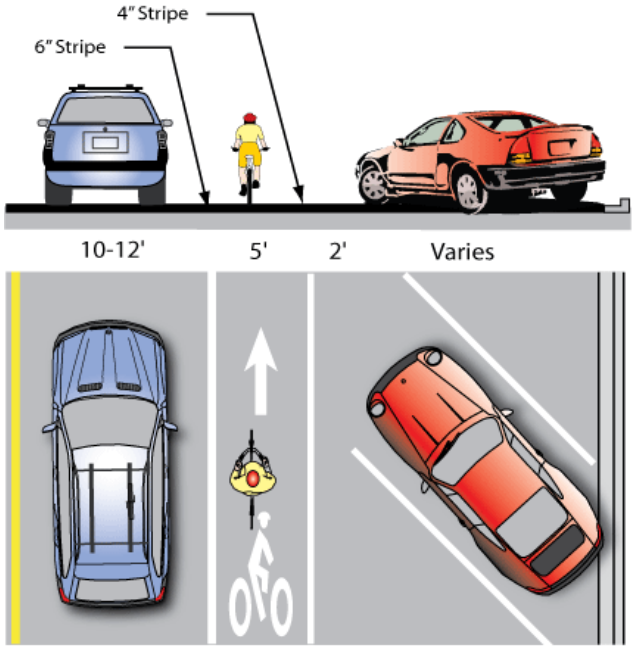
- 5' minimum
- White 4" stripe separates bike lane from parking bays
- Parking bays are sufficiently long to accommodate most vehicles (vehicles do not block bike lane)

### Discussion

In areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply. Conventional "head-in" diagonal parking is not recommended in conjunction with high levels of bicycle traffic or with the provision of bike lanes as drivers backing out of conventional diagonal parking spaces have poor visibility of approaching bicyclists.

The use of 'back-in diagonal parking' or 'reverse angled parking' is recommended over head-in diagonal parking. This design addresses issues with diagonal parking and bicycle travel by improving sight distance between drivers and bicyclists and has other benefits to vehicles including: loading and unloading of the trunk occurs at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb, no door conflict with bicyclists. While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier maneuver than conventional parallel parking.

This treatment is currently slated for inclusion in the 2009 AASHTO *Guide for the Development of Bicycle Facilities*




*Recommended Design*

*'Back-in' diagonal parking is safer for cyclists than 'head-in' diagonal parking due to visibility*

## 8.1.3. Bike Lane Without On-Street Parking

# 8.1. Bike Lane Configurations

## Design Summary

**Bike Lane Width:**

- 4' minimum when no curb & gutter is present
- 5' minimum when adjacent to curb and gutter (3' more than the gutter pan width if the gutter pan is wider than 2')

**Recommended Width:**

- 6' where right-of-way allows

**Maximum Width:**

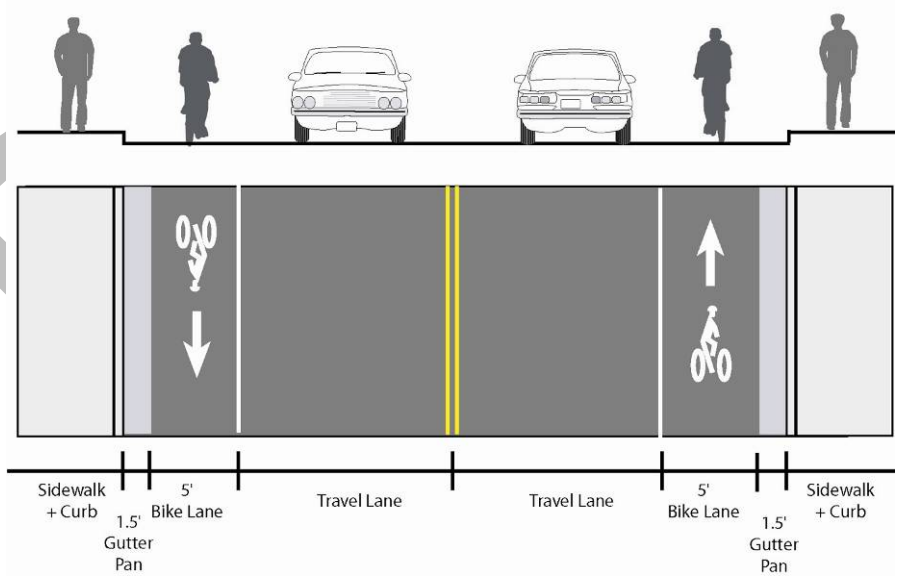
- 8' Adjacent to arterials with high travel speeds (45 mph+)


*Recommended Design*

## Discussion

Wider bike lanes are desirable in certain circumstances such as on higher speed arterials (45 mph+) where a wider bike lane can increase separation between passing vehicles and cyclists. Wide bike lanes are also appropriate in areas with high bicycle use. A bike lane width of 6 to 8 feet makes it possible for bicyclists to ride side-by-side or pass each other without leaving the bike lane, increasing the capacity of the lane. Appropriate signing and stenciling is important with wide bike lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane.

## Recommended Design




*Two Lane Cross-Section with No Parking**

*Bike lanes may be 4' in width under constrained circumstances

# 8.2. Bike Lanes at Intersections

## 8.2.1. Bicycle Detection at Intersections

### Design Summary

- Facilitate bicycle movement at intersections

### Discussion

Changing how intersections operate also can help make them more "friendly" to bicyclists. Improved signal timings for bicyclists, bicycle-activated loop detectors, and camera detection make it easier and safer for cyclists to cross intersections.

Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal. This allows the cyclist to stay within the lane of travel and avoid maneuvering to the side of the road to trigger a push button.

Most demand-actuated signals in Tacoma currently use loop detectors, which can be attuned to be sensitive enough to detect any type of metal, including steel and aluminum.

Current and future loops that are sensitive enough to detect bicycles should have pavement markings to instruct cyclists how to trip them, as well as signage (see right).

Detection Cameras

Video detection cameras can also be used to determine when a vehicle is waiting for a signal. These systems use digital image processing to detect a change in the image at the location. Cameras can detect bicycles, although cyclists should wait in the center of the lane, where an automobile would usually wait, in order to be detected. Video camera system costs range from $20,000 to $25,000 per intersection.

Detection cameras are currently used for cyclists in the City of San Luis Obisbo, CA, where the system has proven to detect pedestrians as well.

Remote Traffic Microwave Sensor Detection (RTMS)

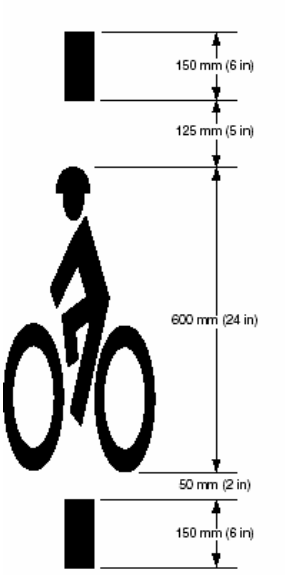
RTMS is a system developed in China, which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method is marked with a time code which gives information on how far away the object is. The RTMS system is unaffected by temperature and lighting, which can affect standard detection cameras.

Bicycle loops and other detection mechanisms can provide cyclists extra green time before the light turns yellow, so that cyclists of all abilities can make it through the light.

Additional technical detail is available online at:

Use of loop detectors
www.humantransport.org/bicycledriving/library/signals/detection.htm

ITE Guidance for Bicycle—Sensitive Detection and Counters:
http://www.ite.org/councils/Bike-Report-Ch4.pdf




*Recommended Design*

*Example bicycle actuator marking*


*Instructional Sign (MUTCD Sign R10-15)*

# 8.2. Bike Lanes at Intersections

## 8.2.2. Bike Lanes With Right Turn Pockets

### Design Summary

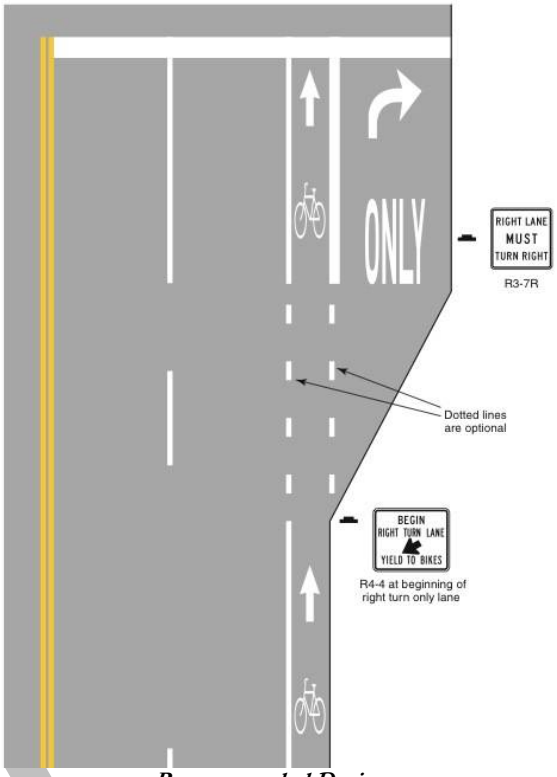
**Bike Lane Width:**

- Continue existing bike lane width; standard width of 5' to 6' or 4' in constrained locations.

### Discussion

The appropriate treatment at right-turn lanes is to place the bike lane between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to drop the bike lane entirely approaching the right-turn lane. The design (right) illustrates a bike lane pocket, with signage indicating that motorists should yield to bicyclists through the conflict area. While the dashed lines in this area are currently an optional treatment, it is recommended that they be an integral part of any intersection with this treatment in Tacoma.

Dropping the bike lane is not recommended, and should only be done when a bike lane cannot be accommodated at the intersection.




*Recommended Design*


*Continuing a bike lane straight while providing a right-turn pocket reduces bicycle/motor vehicle conflicts*

# 8.2. Bike Lanes at Intersections

## 8.2.3. Shared Bicycle/Right Turn Lane

### Design Summary

Width:

- Shared turn lane – min. 12'width
- Bike Lane pocket – min. 4'-5' preferred

### Discussion

This treatment is recommended at intersections lacking sufficient space to accommodate a standard bike lane and right turn lane.

The shared bicycle/right turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positing within the lane.

Case studies cited by the Pedestrian and Bicycle Information Center indicate that this treatment works best on streets with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less).

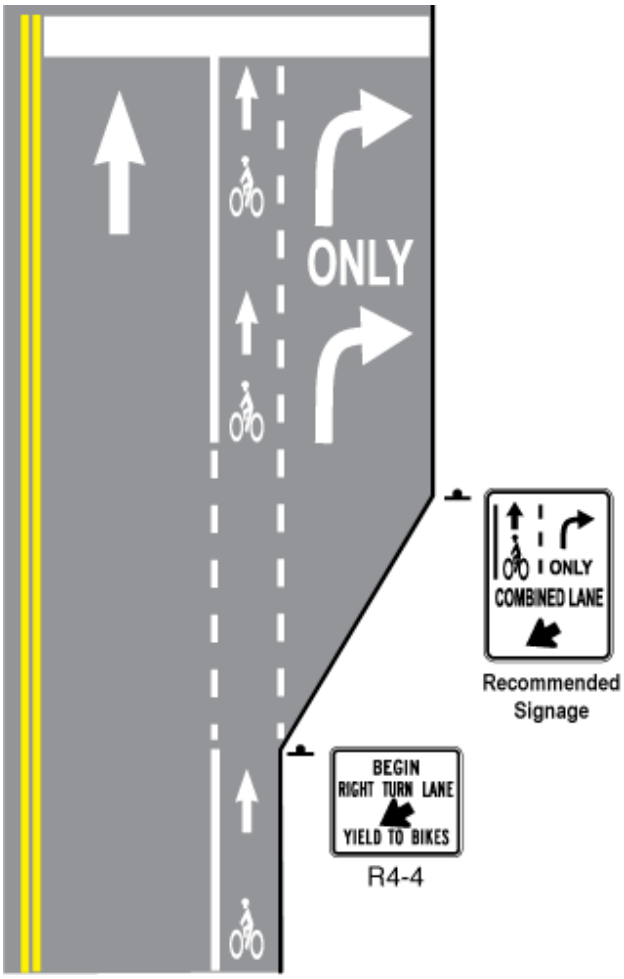
Advantages of the shared bicycle/right turn lane:

- Aids in correct positioning of cyclists at intersections with a dedicated right turn lane without adequate space for a dedicated bike lane.
- Encourages motorists to yield to bicyclists when using the right turn lane.
- Reduces motor vehicle speed within the right turn lane.

Disadvantages/potential hazards:

- May not be appropriate for high-speed arterials or intersections with long right turn lanes.
- May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

This treatment has coverage in the draft 2009 AASHTO *Guide For the Development of Bicycle Facilities.* It has been previously implemented in the Cities of San Francisco, CA and Eugene, OR.




*Recommended Design*


*Shared bike-right turn lanes require warning signage as well as pavement markings*

# 8.2. Bike Lanes at Intersections

## 8.2.4. Bike Box

### Design Summary

**Bike Box Dimensions:**

- 14' deep to allow for bicycle positioning.

**Signage:**

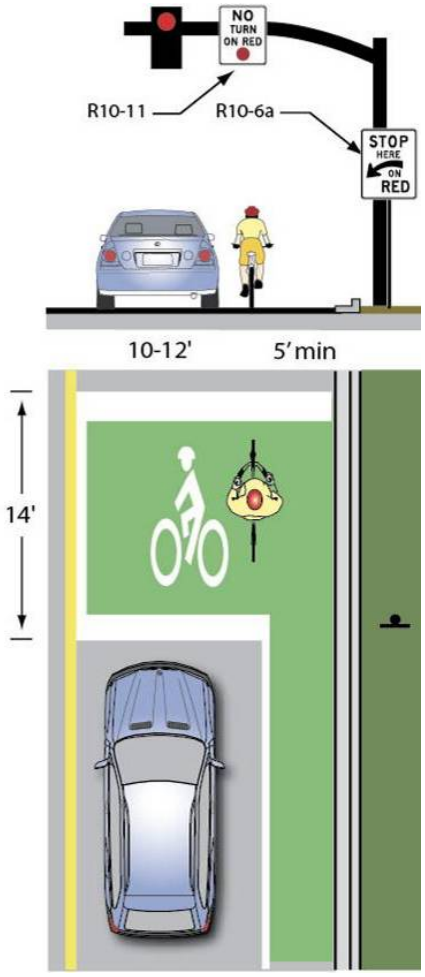
- Appropriate signage as recommended by the MUTCD applies. Signage should be present to prohibit 'right turn on red' and to indicate where the motorist must stop.

### Discussion

A bike box is generally a right angle extension of a bike lane at the head of a signalized intersection. The bike box allows bicyclists to move to the front of the traffic queue on a red light and proceed first when that signal turns green. Motor vehicles must stop behind the white stop line at the rear of the bike box.

Bike boxes can be combined with dashed lines through the intersection for green light situations to remind right-turning motorists to be aware of bicyclists traveling straight, similar to the colored bike lane treatment described earlier. Bike Boxes can be installed with striping only or with colored treatments to increase visibility.

Bike Boxes should be located at signalized intersections only, and right turns on red should be prohibited. On roadways with one travel lane in each direction, the bike box also facilitates left turning movements for cyclists.




*Recommended Design*

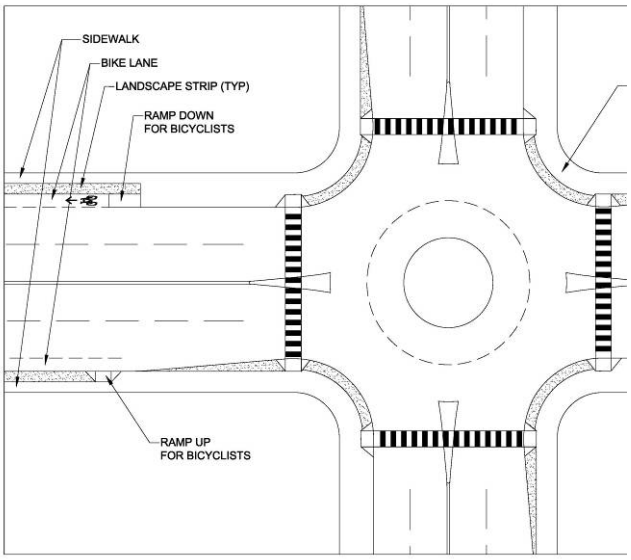

*Bike boxes have been installed at several intersections in Portland, OR where right-turning motorists conflict with through bicyclists*

# 8.2. Bike Lanes at Intersections

## 8.2.5. Bike Lanes at Roundabouts

### Design Summary

- Reduce the speed differential between circulating motorists and bicyclists (25 mph maximum circulating design speed)
- Design approaches/exits to the lowest speeds possible, to reduce the severity of potential collisions with pedestrians.
- Encourage bicyclists navigating the roundabout like motor vehicles to "take the lane."
- Maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks.
- Provide separated facilities for bicyclists who prefer not to navigate the roundabout on the roadway.
- Indicate to drivers and bicyclists the correct way for them to circulate through the roundabout through appropriately-designed signage, pavement markings and geometric design elements.
- Indicate to drivers, bicyclists and pedestrians the right-of-way rules through appropriately -designed signage, pavement markings and geometric design elements.




*Recommended Design*

***(Source:*** **UC Berkeley Traffic Safety Center for Caltrans,** ***Identifying Factors that Determine Bicyclist and Pedestrian-Involved Collision Rates and Bicyclist and Pedestrian Demand at Multi-Lane Roundabouts, 2009)***

### Discussion

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may significantly increase safety problems for these users.

Multi-lane roundabouts pose the following challenges to bicyclists riding in a bike lane:

- Bicyclists must take the lane before they enter the roundabout to avoid becoming caught in a "right hook," a situation in which a motorist turns right, across the path of a bicyclist traveling straight. Entry leg speeds must be slow enough for bicyclists to be able to take the lane safely.
- Theoretically, once motor vehicle volumes reach a certain magnitude, there are no gaps in traffic large enough to accommodate a bicyclist.
- Bicyclists must be able to correctly judge the speed of circulating motorists to find a gap that is large enough for them to safely enter the roundabout. This task is particularly difficult if the circulating motorists are traveling at a much higher speed than the bicyclists. In addition, if circulating speeds in a roundabout are much higher than 20 mph, drivers behind a bicyclist may become impatient, and may pass the bicyclist and turn in front of him, creating more risks for the bicyclist.
- As a circulating bicyclist approaches an entry lane, a driver waiting to enter must notice the bicyclist, properly judge the bicyclist's speed, and yield to him/her if necessary. In a location where there are few bicyclists, motorists may not even register that there is a bicyclist approaching. If a bicyclist is hugging the curb, s/he may be outside the motorist's cone of vision.

## 8.3. Shared Bicycle/Bus Lane

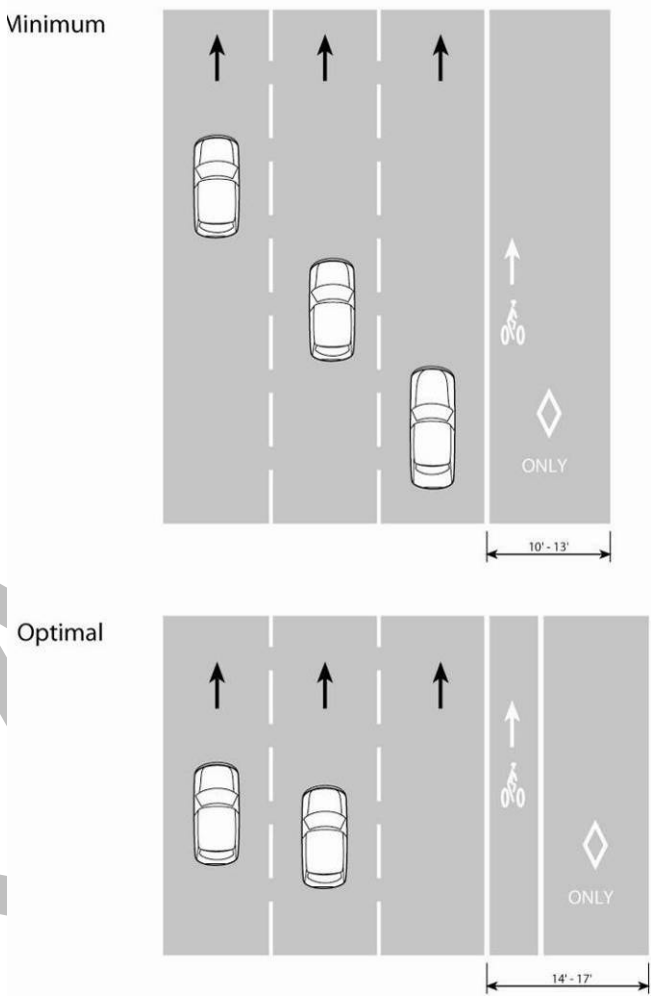
### Design Summary

The shared bus/bicycle lane should be used where width is available for a bus lane, but not a bus and bike lane. The dedicated lane attempts to reduce conflicts between bicyclists, buses, and automobiles. Various cities have experimented with different designs and there is currently no evidence of one design being more effective than the others.

### Discussion

Shared bike/bus lanes can be appropriate in the following applications:

- On auto-congested streets, moderate or long bus headways
- Moderate bus headways during peak hour
- No reasonable alternative route



## 8.4. Colored Bike Lanes in Conflict Areas

### Discussion

Cyclists are especially vulnerable at locations where the volume of conflicting vehicle traffic is high, and where the vehicle/bicycle conflict area is long. Some cities are using colored bike lanes to guide cyclists through major vehicle/bicycle conflict points. These conflict areas are locations where motorists and cyclists must cross each other's path (e.g., at intersections or merge areas). Colored bike lanes typically extend through the entire bicycle/vehicle conflict zone (e.g., through the entire intersection, or through the transition zone where motorists cross a bike lane to enter a dedicated right turn lane.

Guidance

Although colored bike lanes are not an official standard at this time, they continue to be successfully used in cities, including Portland, OR, Philadelphia, PA, Cambridge, MA, Toronto, Ontario, Vancouver, BC and Tempe, AZ. This treatment typically includes signage alerting motorists of vehicle/ bicycle conflict points. Portland's *Blue Bike Lane* report found that significantly more motorists yielded to bicyclists and slowed or stopped before entering the conflict area after the application of the colored pavement.

Color Considerations:

There are three colors commonly used in bike lanes: blue, green, and red. All help the bike lane stand out in conflict areas. Green is the color recommended for use in Tacoma.

Advantages of colored bike lanes at conflict points

- Draws attention to conflict areas
- Increases motorist yielding behavior
- Emphasizes expectation of bicyclists on the road

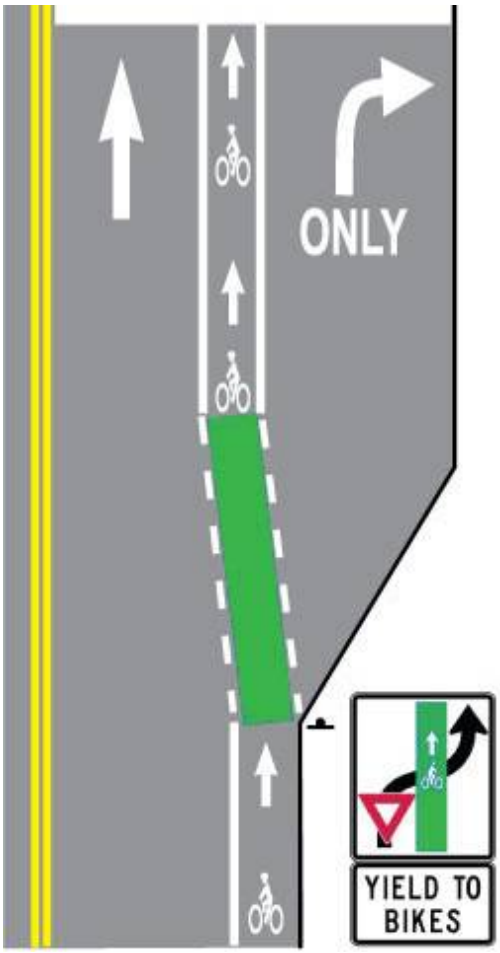
Disadvantages / potential hazards

- Not currently an adopted standard marking in the U.S.

This treatment is not currently present in any state or federal design standards.

The City of Colombia, MO is currently testing this application for possible inclusion In the 2009 MUTCD update.

Portland Office of Transportation (1999). *Portland's Blue Bike Lanes: Improved Safety through Enhanced Visibility*. Available: www.portlandonline.com/shared/cfm/image.cfm?id=58842




*Recommended Design*


*Portland, OR has implemented blue bike lanes and has since changed to green*

# 8.5. Buffered Bike Lanes

## Discussion

Bike lanes on high-volume or high-speed roadways can be dangerous or uncomfortable for cyclists, as automobiles pass or are parked too close to bicyclists. Buffered bike lanes are designed to increase the space between the bike lanes and the travel lane or parked cars.

This treatment is appropriate on bike lanes with high automobile traffic volumes and speed, bike lanes adjacent to parked cars, and bike lanes with a high volume of truck or oversized vehicle traffic. Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection.

Guidance

Guidelines for buffer width varies:

- 2.6 feet/80 cm (London and Brussels)
- 1.6-2.5 feet/50-75 cm (CROW Guide)
- 6 feet (Portland, OR)

Advantages of buffered bike lanes:

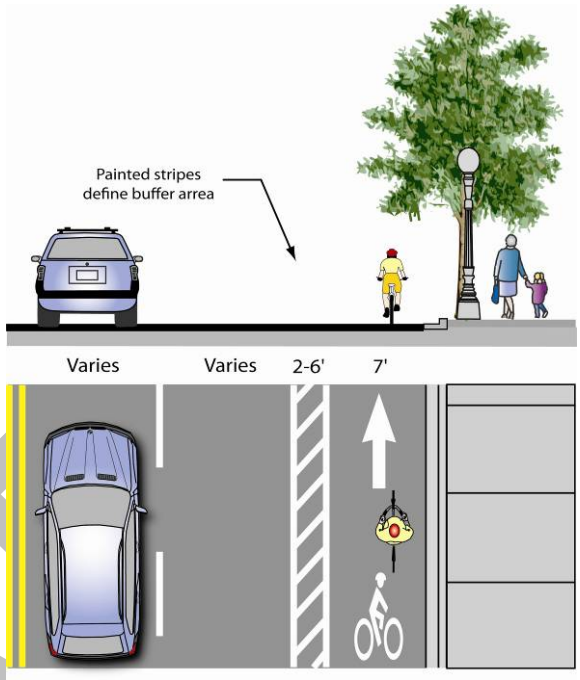
- Provides cushion of space to mitigate friction with motor vehicles on streets with narrow bike lanes.
- Provides space for cyclists to pass one another without encroaching into the travel lane.
- Provides space for cyclists to avoid potential obstacles in the bike lanes, including drainage inlets, manholes, trash cans or debris.
- Parking side buffer provides cyclists with space to avoid the 'door zone' of parked cars.
- Provides motorists greater shy distances from cyclists in the bike lane.

Disadvantages / potential hazards

- Requires additional roadway space.
- Requires additional maintenance for the buffer striping.
- Frequency of parking turnover should be considered prior to installing buffered bike lanes.

This treatment is not currently present in any state or federal design standards.

The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan. Buffered bike lanes are currently used in Brussels & Bruges, Belgium, Budapest, Hungary, London, UK, Seattle, WA, San Francisco, CA, New York, NY, and Portland, OR.




*Recommended Design*

*Seattle uses buffered bike lanes to protect cyclists from fast-moving traffic*
*(source: http://seattle.gov/transportation/bikesmart.htm)*

## 8.6. Floating Bike Lanes

### Discussion

This treatment maintains the bicycle facility when an extra travel lane (for automobiles) is added during peak hours. A single lane can function as a parking lane or an exclusive bike lane. During peak hours, parking is not allowed and cyclists use a curbside bike lane. During off-peak hours, cyclists travel in the space between the motorized traffic lane and parked cars.

This treatment can be used on primary bicycle routes during peak hours or on streets warranting bike lanes with high parking demand where there is insufficient space to provide both standard bike lane and parking.

Guidance

It is important to provide adequate space to minimize the risk of "doorings" when parking is permitted. The bicycle symbol may be used curbside or sharrow markings in lieu of bike lane striping (San Francisco).

In San Francisco, parking is permitted during off-peak times: 9am-3pm and 7pm to 7am.

Advantages of buffered bike lanes:

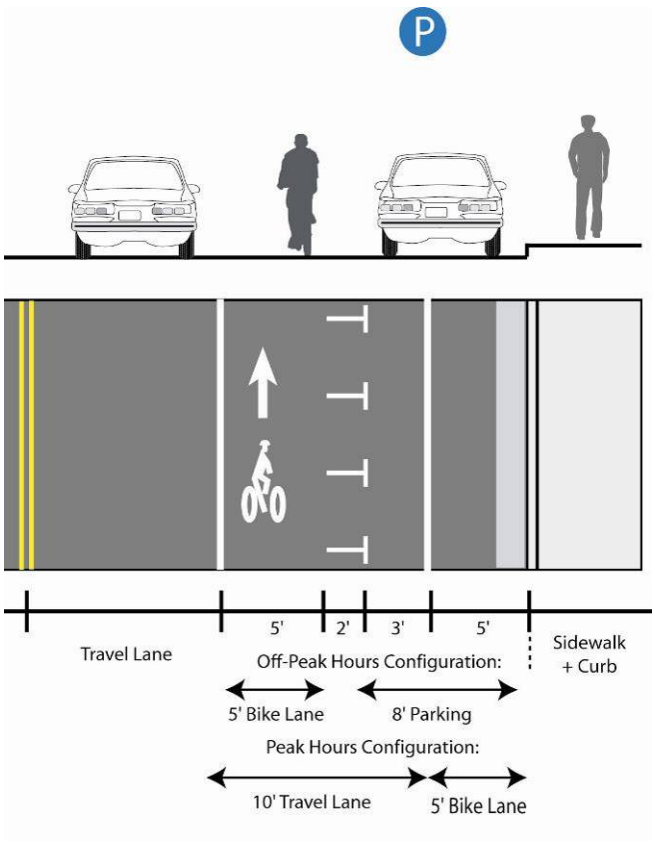
- Can accommodate bicycles at all times, even when parking is permitted.
- Provides bicycle facilities on streets with constrained rights-of-way.

Disadvantages / potential hazards

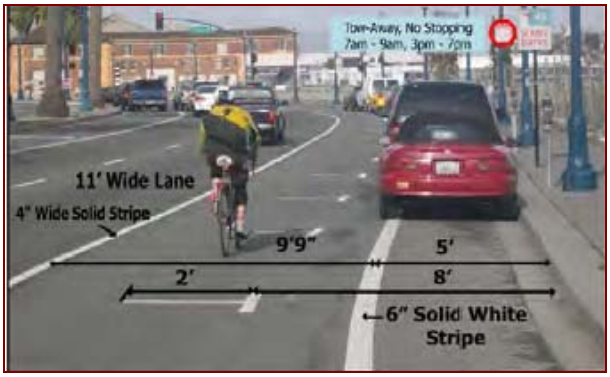
- Unorthodox design can be confusing to both cyclists and motorists.
- Enforcement is required.

This treatment is not currently present in any state or federal design standards.

The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan. Floating bike lanes are currently used in San Francisco, CA.




*Recommended Design*




*Floating Bike Lane when parking is allowed on The Embaradero, San Francisco*

*Source: sfmta.org*

# 8.7. Advisory Bike Lanes

## Discussion

This treatment uses dotted white lines on both sides of a narrow roadway to delineate bicycle areas. It should be used on a road where the automobile zone is not sufficiently wide for two cars to pass in both directions.

Motorists may enter the bicycle zone when no bicycles are present. Motorist must overtake with caution due to traffic traveling in the opposite direction.

Guidance

Advisory bike lanes can be used on roadways where:

- Motor vehicles traffic: <4000 vehicles per day
- Motor vehicle speed: 25 mph or less
- Roadways is straight with few bends, inclines or sightline obstructions
- Two-way streets
- No centerline on roadway

The bike lanes should have colored pavement to discourage encroachment by motorists or parked vehicles. See bike lane standards for width guidance. Minimum travel lane width of 13 feet.

Advantages of advisory bike lanes:

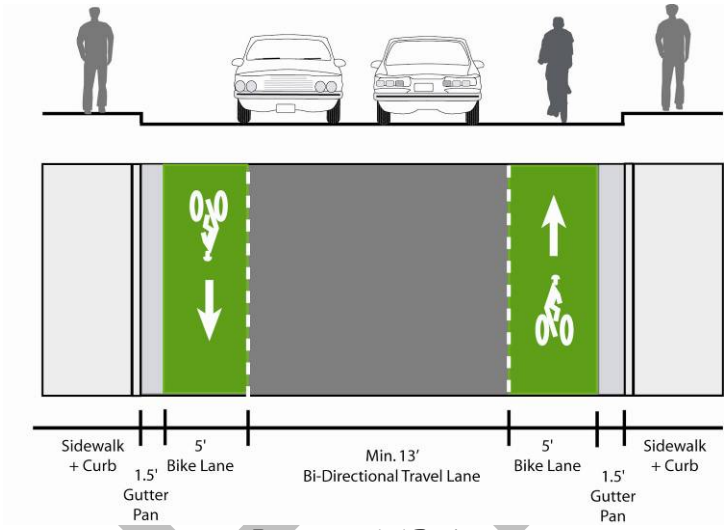
- Option when cross-section is too narrow for mandatory bike lanes
- Striping offers visual separation on a low traffic roadway
- Motorists tend to travel slower due to friction created with oncoming vehicles.

Disadvantages / potential hazards

- Unorthodox design can be confusing to both cyclists and motorists.
- Enforcement is required.

This treatment is not currently present in any state or federal design standards.

The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan. Advisory bike lanes are currently used in the Netherlands, Germany and London, England.




***Recommended Design***

***Advisory bike lanes in the Netherlands***

*Source: Portland Bureau of Transportation*

## 8.8. Bike Passing Lane

### Discussion

In locations with substantial bicycle traffic or steep uphill grades, bicyclists will tend to ride at differing speeds, and room should be provided so that faster cyclists can pass slower-moving cyclists without moving into traffic. Bike passing lanes are also appropriate after signals, where bicycle platoons form.

Guidance

Adequate space should be provided for two cyclists to pass each other without encroaching into the travel lane (ten feet minimum total width). Use skip striping between the two bike lanes and double bike lane symbols to minimize the chances of a motorist mistaking the passing lane for a vehicle lane.

Advantages of bike passing lanes:

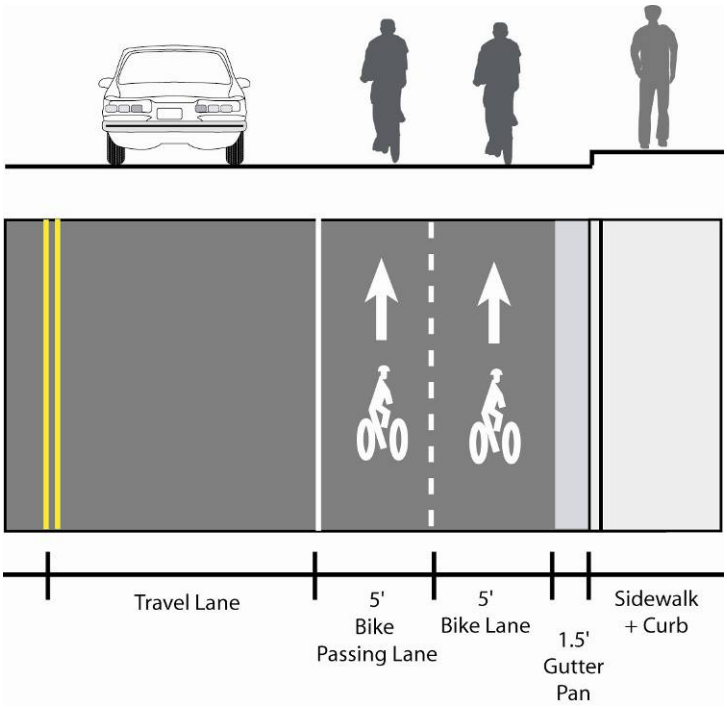
- Reduces the length of bicycle platoons
- Reduces the number of fast-moving cyclists that merge with automobile traffic to pass slower cyclsits

Disadvantages / potential hazards

- Space requirements may require reallocation of roadway space from parking or travel lanes

This treatment is not currently present in any state or federal design standards.

The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan.




*Recommended Design*

*Copenhagen and Portland, OR use bike passing lanes on bridges and other popular bicycle routes*

# 8.9. Contraflow Bike Lane

## Discussion

Contraflow bike lanes provide bi-directional bicycle access along a roadway that is one-way for automobile traffic. This treatment can provide direct access and connectivity for bicyclists, avoiding detours and reducing travel distances for cyclists.

Guidance

The contraflow lane should be 5.0 feet to 6.5 feet and marked with a solid double yellow line and appropriate signage. Bike lane markings should be clearly visible to ensure that contraflow lane is exclusively for bicycles. Coloration should be considered on the bike lane.

Advantages of contraflow bike lanes:

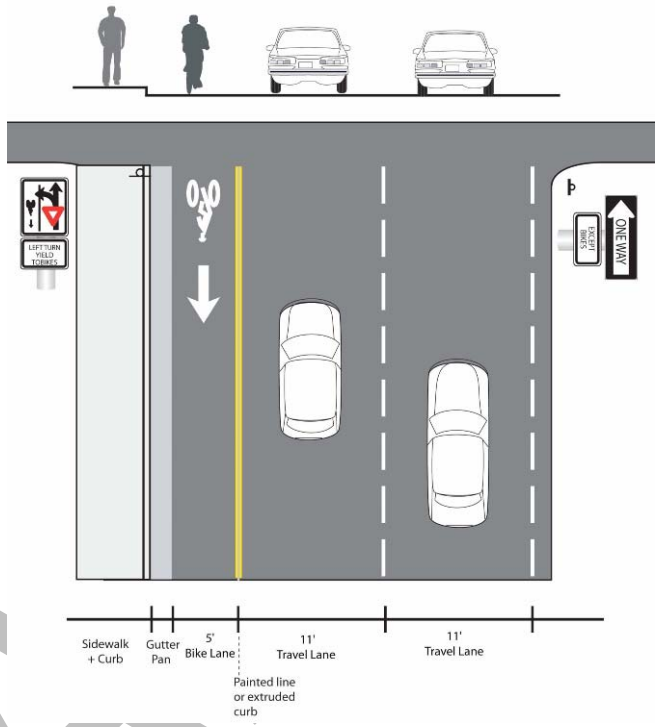
- Provides direct access and connectivity for bicycles traveling in both directions.
- Influences motorist choice of routes without limiting bicycle traffic.
- Cyclists do not have to make detours as a result of one-way traffic.

Disadvantages / potential hazards

- Parking should not be provided on the far side of the contraflow bike lane.
- Space requirements may require reallocation of roadway space from parking or travel lanes.
- The lane could be illegally used by motorists for loading or parking.
- Conversion from a two-way street requires elimination of one direction of automobile traffic
- Public outreach should be conducted prior to implementation of this treatment.

This treatment is a federally-recognized design standard, and present in some state DOT manuals, such as the Wisconsin Bicycle Facility Design Handbook.

The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan. Contraflow bike lanes are currently used in Olympia and Seattle, WAm as well as Madison, WI, Cambridge, MA, San Francisco, CA, and Portland, OR.




*Recommended Design*

*This contraflow bike lane in Madison, WI uses a physical barrier from traffic at the intersection*

# 8.10. Retrofitting Existing Streets with Bike Lanes

| Design Summary | Discussion |
|---|---|
| This section describes several strategies for retrofitting bike lanes to existing streets. Treatments include:<br>▪ Roadway widening<br>▪ Lane narrowing<br>▪ Lane reconfiguration<br>▪ Parking reduction<br>Although largely intended for major streets, these measures may be appropriate on some lower-order streets where bike lanes would best accommodate cyclists. | Most major streets in Tacoma are characterized by conditions (e.g., high vehicle speeds and/or volumes) for which dedicated bike lanes are appropriate to accommodate safe and comfortable riding. Although opportunities to add bike lanes through roadway widening may exist in some locations, most major streets in Tacoma pose physical and other constraints requiring street retrofit measures within existing curb-to-curb widths. As a result, many of the recommended measures effectively reallocate existing street width through striping modifications to accommodate dedicated bike lanes. |

## 8.10.1. Roadway Widening

**Design Summary**

Bike Lane Width:

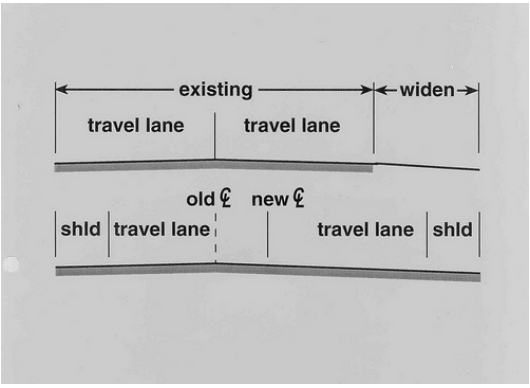
- 6' preferred
- 4' minimum (see bike lane guidance)

**Discussion**

Bike lanes could be accommodated on several streets with excess right-of-way through shoulder widening. Although street widening incurs higher expenses compared with re-striping projects, bike lanes could be added to streets currently lacking curbs, gutters and sidewalks without the high costs of major infrastructure reconstruction.

As a long-term measure, the City of Tacoma should find opportunities to add bike lanes to other major streets where they are needed. Opportunities include adding bike lanes as streets and bridges are widened for additional auto capacity or as property development necessitates street reconstruction.

Guidance for this treatment comes from the AASHTO *Guide for the Development of Bicycle Facilities.*




*Design guidance for widening roadway shoulders to accommodate bicycles*

*Roadway widening is preferred on roads lacking curbs, gutters and sidewalks*

# 8.10. Retrofitting Existing Streets with Bike Lanes

## 8.10.2. Lane Narrowing (Road Diet 1)

### Design Summary

Vehicle Lane Widths:

- Before: 12 to 15 feet; after: 10 to 11 feet

Bike Lane Width:

- See bike lane design guidance

### Discussion

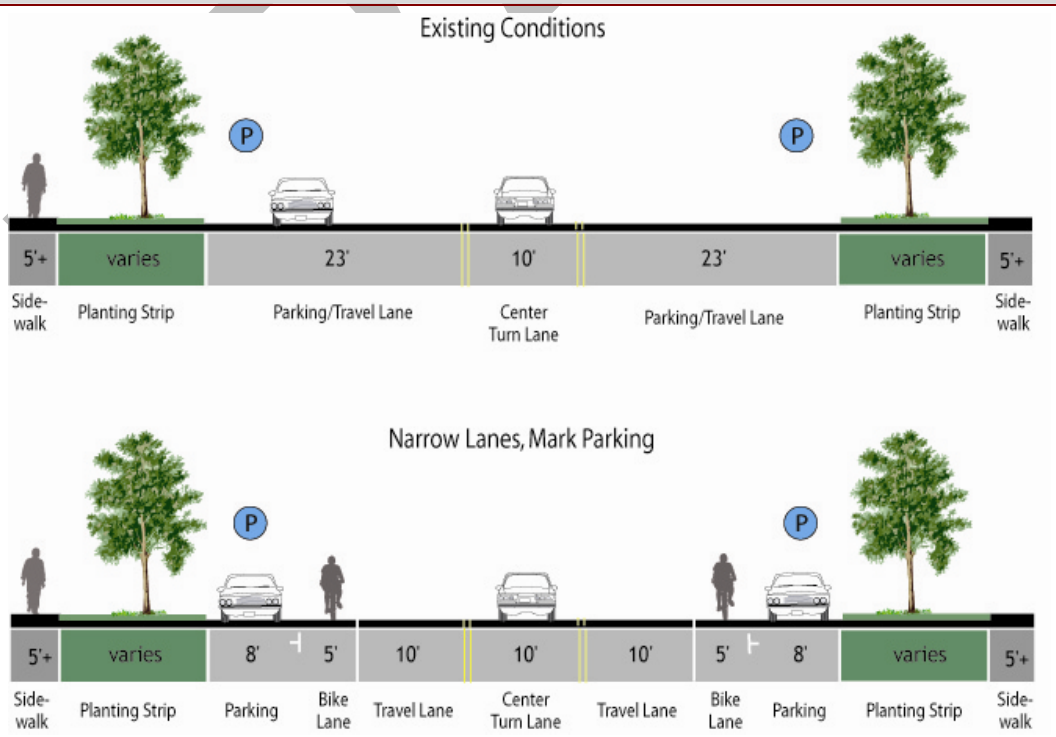
Also called a 'Road Diet', lane narrowing utilizes roadway space that exceeds minimum standards to create the needed space to provide bike lanes. Many Tacoma roadways have existing lanes that are wider than those prescribed in local and national roadway design standards, or which are not marked. Most standards allow for the use of 11-foot and sometimes 10-foot wide travel lanes to create space for bike lanes.

Special consideration should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in some situations to free up pavement space for bike lanes.

### Design Example

*This street previously had 13' lanes, which were narrowed to accommodate bike lanes without removing a lane*

### Illustrative Example




*Example of vehicle travel lane narrowing to accommodate bike lanes*

# 8.10. Retrofitting Existing Streets with Bike Lanes

## 8.10.3. Lane Reconfiguration (Road Diet 2)

### Design Summary

Vehicle Lane Widths:

- Width depends on project. No narrowing may be needed if a lane is removed.

Bike Lane Width:

- See bike lane design guidance

### Discussion

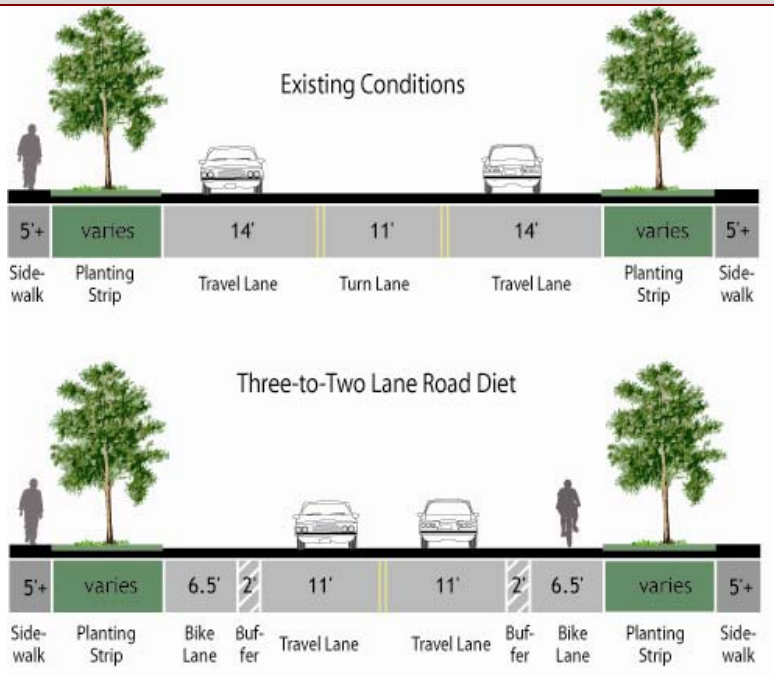
The removal of a single travel lane will generally provide sufficient space for bike lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bike lane retrofit projects. Depending on a street's existing configuration, traffic operations, user needs, and safety concerns, various lane reduction configurations exist. For instance, a four-lane street (with two travel lanes in each direction) could be modified to include one travel lane in each direction, a center turn lane, and bike lanes. Prior to implementing this measure, a traffic analysis should identify impacts.

This treatment is currently slated for inclusion in the 2009 AASHTO *Guide for the Development of Bicycle Facilities.*

### Design Example

*This road was re-striped to convert four vehicle travel lanes into three travel lanes with bike lanes*

### Illustrative Example




*Example of vehicle travel lane reconfiguration to accommodate bike lanes*

# 8.10. Retrofitting Existing Streets with Bike Lanes

## 8.10.4. Parking Reduction (Road Diet 3)

### Design Summary

Vehicle Lane Widths:

Width depends on project. No narrowing may be needed depending on the width of the parking lane to be removed.

Bike Lane Width:

See bike lane design guidance

### Discussion

Bike lanes could replace one or more on-street parking lanes on streets where excess parking exists and/or the importance of bike lanes outweighs parking needs. For instance, parking may be needed on only one side of a street (as shown below and at right). Eliminating or reducing on-street parking also improves sight distance for cyclists in bike lanes and for motorists on approaching side streets and driveways. Prior to reallocating on-street parking for other uses, a parking study should be performed to gauge demand.

*Some streets may not require parking on both sides*

### Illustrative Example


*Example of parking removal to accommodate bike lanes*

# 9. Shared Lane Markings

## Design Summary

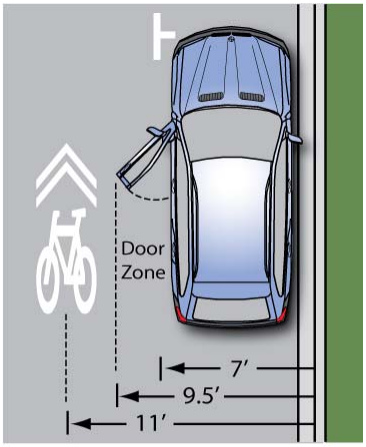
Shared lane markings (also known as "sharrows") are high-visibility pavement markings that help position bicyclists within the travel lane. These markings are often used on streets where dedicated bike lanes are desirable but are not possible due to physical or other constraints. Sharrows are placed strategically in the travel lane to alert motorists of bicycle traffic, while also encouraging cyclists to ride at an appropriate distance from the "door zone" of adjacent parked cars. Placed in a linear pattern along a corridor (typically every 100-200 feet), sharrows also encourage cyclists to ride in a straight line so their movements are predictable to motorists. These pavement markings have been successfully used in many communities throughout the U.S. Shared lane markings made of thermoplastic tend to last longer than painted ones.

Door Zone Width:

The width of the door zone is generally assumed to be 2.5 feet from the edge of the parking lane.

Recommended Placement:

- At least 11' from face of curb (or shoulder edge) on streets with on-street parking
- At least 4' from face of curb (or shoulder edge) on streets without on-street parking



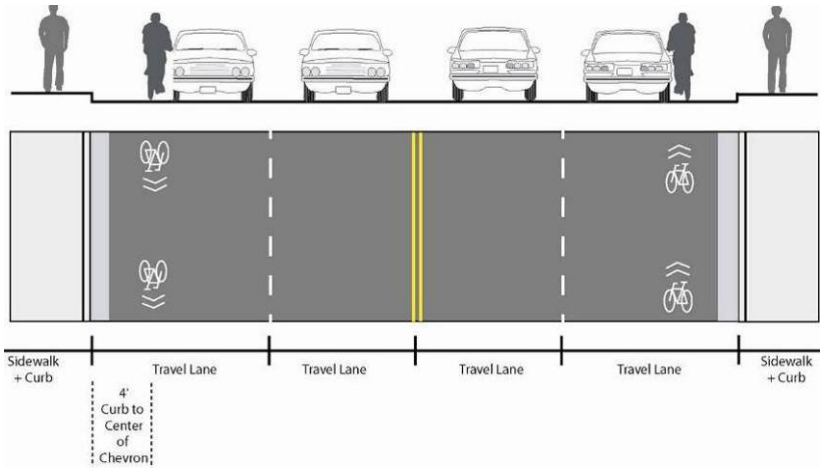

*Shared lane marking placement guidance for streets with on-street parking*

*Shared lane markings can be used minor and major roadways*

## Discussion

The Draft 2009 MUTCD language notes that sharrows should not be placed on roadways with a speed limit over 35 MPH, and that when used the marking should be placed immediately after an intersection and spaced at intervals no greater than 250 feet thereafter. Placing shared lane markings between vehicle tire tracks (if possible) will increase the life of the markings.

## Recommended Design




*Recommended Shared Lane Markings*

# 10. Bicycle Boulevards

## Design Summary

Bicycle Boulevards are low-volume streets where motorists and bicyclists share the same space. Treatments for Bicycle Boulevards include five "application levels" based on their level of physical intensity, with Level 1 representing the least physically-intensive treatments that could be implemented at relatively low cost. Identifying appropriate application levels for individual Bicycle Boulevard corridors provides a starting point for selecting appropriate site-specific improvements.

## Discussion

Traffic calming and other treatments along the corridor reduce vehicle speeds so that motorists and bicyclists generally travel at the same speed, creating a safer and more-comfortable environment for all users. Bicycle Boulevards incorporate treatments to facilitate safe and convenient crossings where the route crosses a major street. They work best in well-connected street grids where riders can follow reasonably direct and logical routes and when higher-order parallel streets exist to serve thru vehicle traffic.

*Bicycle boulevards are low-speed streets that provide a comfortable and pleasant experience for cyclists*

## Additional Guidance

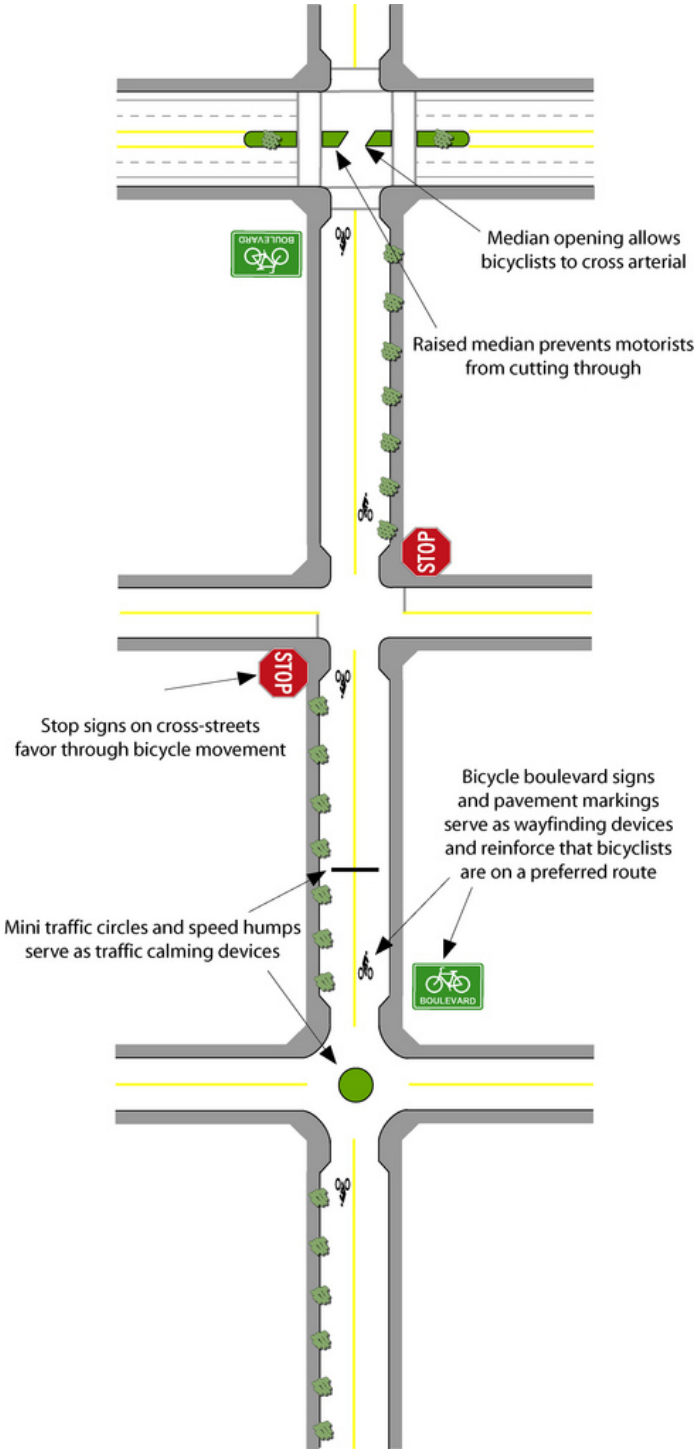
Bicycle Boulevards serve a variety of purposes:

- Parallel major streets lacking dedicated bicycle facilities: Higher-order streets such as arterials and major collectors typically include major bicyclist destinations (e.g., commercial and employment areas, and other activity centers). However, these corridors often lack bike lanes or other dedicated facilities thereby creating an uncomfortable, unattractive and potentially unsafe riding environment. Bicycle Boulevards serve as alternate parallel facilities allowing cyclists to avoid major streets for longer trip segments.
- Parallel major streets with bicycle facilities that are uncomfortable for some users: Some users may not feel comfortable using bike lanes on major streets for various reasons, including high traffic volumes and vehicle speeds, conflicts with motorists entering and leaving driveways, and/or conflicts with buses occupying the bike lane while loading and unloading passengers. Children and less-experienced riders might find these environments especially challenging. Utilizing lower-order streets, Bicycle Boulevards provide alternate route choices for bicyclists uncomfortable using the major street network. It should be noted however that bike lanes on major streets provide important access to key land uses, and the major street network often provides the most direct routes between major destinations. For these reasons, Bicycle Boulevards should complement a bike lane network and not serve as a substitute.
- Ease of implementation on most local streets: Bicycle Boulevards incorporate cost-effective and less physically-intrusive treatments than bike lanes and cycle tracks. Most streets could be provided relatively inexpensive treatments like new signage, pavement markings, striping and signal improvements to facilitate bicyclists' mobility and safety. Other potential treatments include curb extensions, medians, and other features that can be implemented at reasonable cost and are compatible with emergency vehicle accessibility.
- Benefits beyond an improved bicycling environment: Residents living on Bicycle Boulevards benefit from reduced vehicle speeds and thru traffic, creating a safer and more-attractive environment. Pedestrians and other users can also benefit from boulevard treatments (e.g., by improving the crossing environment where boulevards meet major streets).

Bicycle Boulevards can employ a variety of treatments from signage to traffic calming and pavement stencils. The level of treatment provided at a specific location depends on several factors, discussed following.

# 10. Bicycle Boulevards

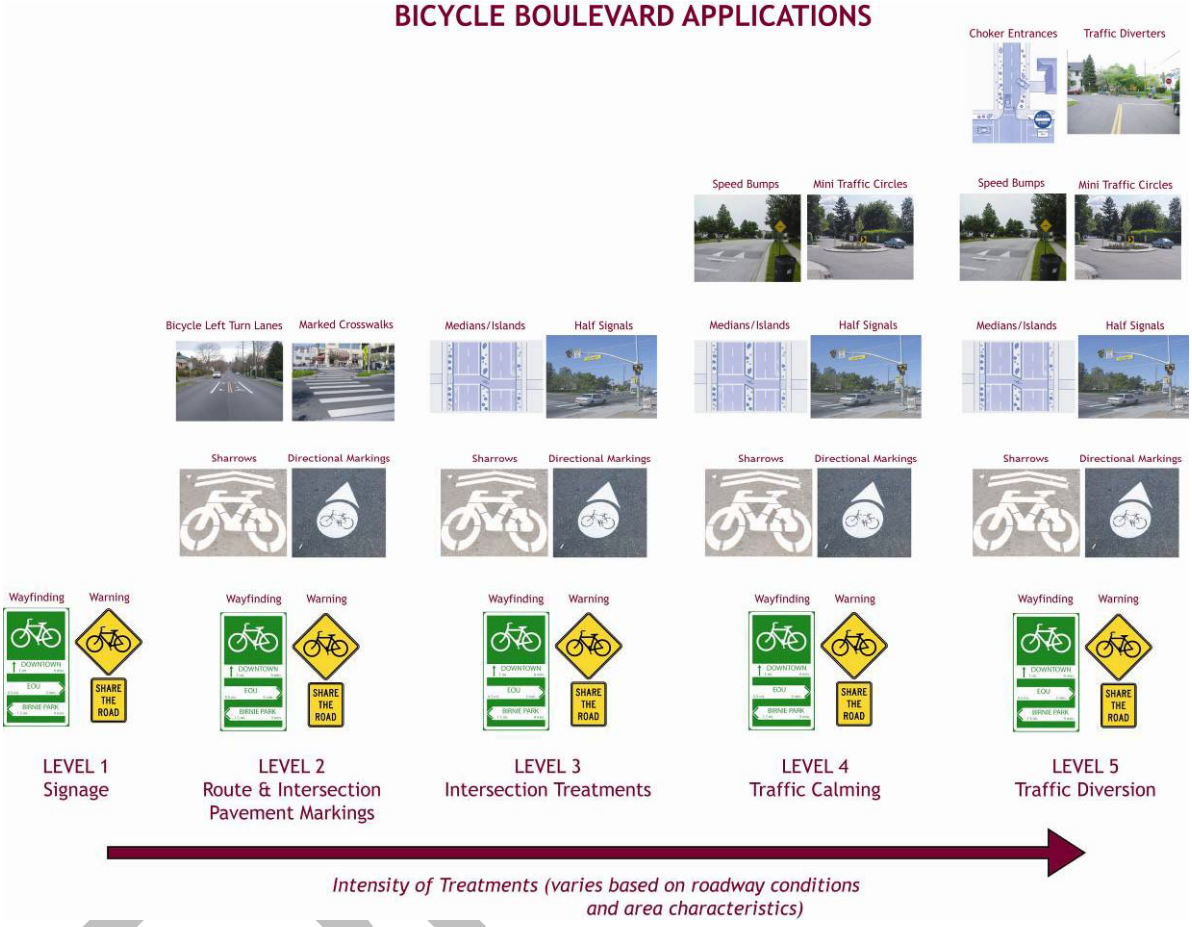
**Additional Guidance (continued)**




*Sample Bicycle Boulevard Treatments*

# 10. Bicycle Boulevards

**Additional Guidance (continued)**




It should be noted that corridors targeted for higher-level applications would also receive relevant lower-level treatments. For instance, a street targeted for Level 3 applications should also include Level 1 and 2 applications as necessary. It should also be noted that some applications may be appropriate on some streets while inappropriate on others. In other words, it may not be appropriate or necessary to implement all "Level 2" applications on a Level 2 street. Furthermore, several treatments could fall within multiple categories as they achieve multiple goals. To identify and develop specific treatments for each Bicycle Boulevard, the City of Tacoma should involve the bicycling community and neighborhood groups. Further analysis and engineering work may also be necessary to determine the feasibility of some applications.

# 10.1. Level 1: Bicycle Boulevard Signing

**Design Summary**

Signage is a cost-effective yet highly-visible treatment that can improve the riding environment on a Bicycle Boulevard network.

## 10.1.1. Wayfinding Signs

Wayfinding signs are typically placed at key locations leading to and along Bicycle Boulevards, including where multiple routes intersect and at key bicyclist "decision points." Wayfinding signs displaying destinations, distances and "riding time" can dispel common misperceptions about time and distance while increasing users' comfort and accessibility to the Boulevard network.

Wayfinding signs also visually cue motorists that they are driving along a bicycle route and should correspondingly use caution. Note that too many signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards.


*Wayfinding signs help bicyclists stay on designated bicycle routes*

## 10.1.2. Warning signs

Warning signs advising motorists to "share the road" and "watch for bicyclists" may also improve bicycling conditions on shared streets. These signs are especially useful near major bicycle trip generators such as schools, parks and other activity centers. Warning signs should also be placed on major streets approaching Bicycle Boulevards to alert motorists of bicyclist crossings.


*'Bicycles Allowed Use of Full Lane ' signage can remind both bicyclists and motorists to watch for other vehicles*

# 10.2. Level 2: Bicycle Boulevard Pavement Markings

## 10.2.1. On-Street Parking Delineation

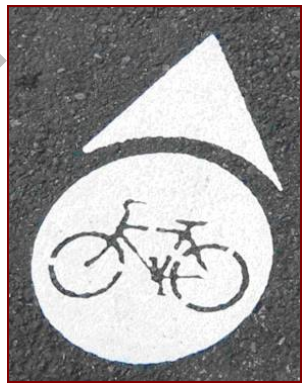
Delineating on-street parking spaces with paint or other materials clearly indicates where a vehicle should be parked, and can discourage motorists from parking their vehicles too far into the adjacent travel lane. This helps cyclists by maintaining a wide enough space to safely share a travel lane with moving vehicles while minimizing the need to swerve farther into the travel lane to maneuver around parked cars. In addition to benefiting cyclists, delineated parking spaces also promote the efficient use of on-street parking by maximizing the number of spaces in high-demand areas.


*Example of On-Street Parking Delineation*

## 10.2.2. Bicycle Boulevard/Directional Pavement Markings

Directional pavement markings (also known as "Bicycle Boulevard markings") lead cyclists along a Boulevard and reinforce that they are on a designated route. Markings can take a variety of forms, such as small bicycle symbols placed every 600-800 feet along a linear corridor, as currently used on Portland, Oregon's Boulevard network.

When a Bicycle Boulevard follows several streets (with multiple turns at intersections), additional markings accompanied by directional arrows are provided to guide cyclists through turns and other complex routing areas. Directional pavement markings also visually cue motorists that they are traveling along a bicycle route and should exercise caution.



*Bicycle Boulevard directional marker*

## 10.2.3. Shared Lane Markings

As previously discussed, shared lane markings are often used on streets where dedicated bike lanes are desirable but not possible due to physical or other constraints. Such markings delineate specifically where bicyclists should operate within a shared vehicle/bicycle travel lane.

Shared Lane Markings could be used as Bicycle Boulevard markings. See Shared Lane Marking Design Guidelines for additional information on this treatment.

*Shared lane marking*

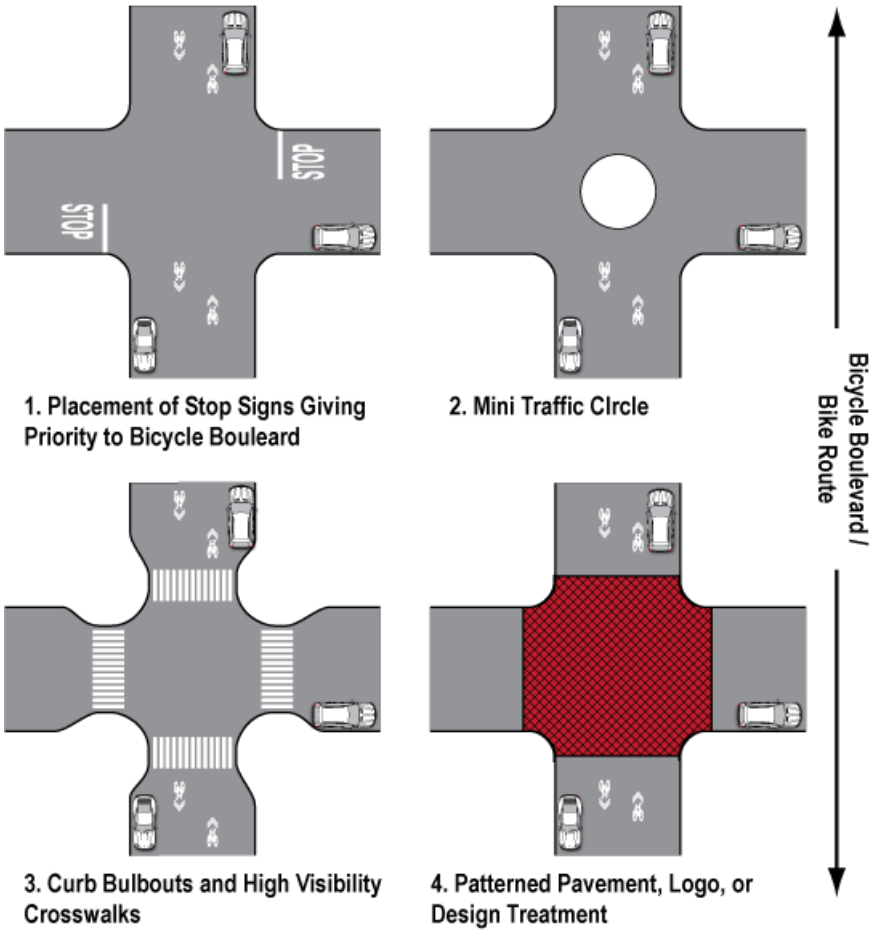
## 10.3. Level 3: Bicycle Boulevard Intersection Treatments

### Design Summary

Intersection treatments represent a critical component of Bicycle Boulevards. Intersection traffic controls favoring thru bicycle movement on the boulevard facilitate continuous and convenient bicycle travel. Intersection treatments also provide convenient and safe crossings where boulevards intersect major roads. The following sections discuss various intersection improvement tools.

Guidance from: Berkley Bicycle Boulevard Design Tools and Guidelines, available at: webserver.ci.berkeley.ca.us/uploadedFiles/Public_Works/Level_3_-_General/ch4_.pdf

*Intersection treatments are critical to bicyclists' safety on Bicycle Boulevards*




*Levels of Bicycle Boulevard intersection treatments*

# 10.3. Level 3: Bicycle Boulevard Intersection Treatments

## 10.3.1. Stop Sign on Cross-Street

The installation of a stop sign on cross streets along the Bicycle Boulevard maximizes thru bicycle connectivity and momentum and forces motorists crossing the facility to stop and proceed when safe.

This treatment should be used judiciously. It can be combined with traffic-calming efforts to prevent excessive vehicle speeds on the Bicycle Boulevard,

Stop signs are a relatively inexpensive treatment that is quite effective at minimizing bicycle and cross-vehicle conflicts. However, placing stop signs at all intersections along Bicycle Boulevards may be unwarranted as a traffic control device.


*Stop signs effectively minimize conflicts*

## 10.3.2. Mini Traffic Circle

Typically mini traffic circles are implemented where the Bicycle Boulevard intersects a local street or even a Collector if ADT is less than 2,000. Stop signs may be added on the cross streets if necessary, otherwise all traffic yields. Signage and striping treatments should be implemented based on expected traffic volumes.

For example, the circle itself may be appropriate for local intersections with very low ADT, while increased signage and splitter striping may be appropriate experiencing higher traffic volumes. Mini traffic circles can be landscaped for added visual impact and traffic calming effect. This treatment should be designed with adequate curb radii for emergency vehicle access.

Mini traffic circles are very effective at reducing though bicycle and cross vehicle conflicts and add overall traffic calming in all directions. Mini traffic circles have a moderate cost (approx $20,000 per intersection).

*Mini traffic circles require that both bicyclists and motorists slow down and watch for conflicts*

# 10.3. Level 3: Bicycle Boulevard Intersection Treatments

## 10.3.3. Curb Bulb-Outs and High-Visibility Crosswalks

This treatment is appropriate for Bicycle Boulevards near activity centers that may generate large amounts of pedestrian activity such as schools or commercial areas. The bulb-outs should only extend across the parking lane and should not obstruct bicyclists' path of travel or the travel lane. This treatment may be combined with a stop sign on the cross street if necessary.

Curb bulb-outs and high-visibility crosswalks both calm traffic and also increase the visibility of pedestrians waiting to cross the street. However, they may impact on-street parking.

*Curb bulb-outs can be a good location for pedestrian amenities, including street trees*

## 10.3.4. Patterned Pavement, Logo, or Design Treatment

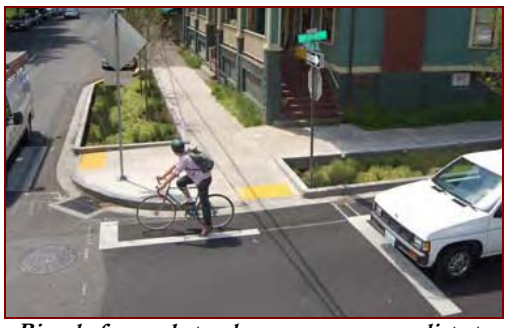
Intersections that also serve as gateways to neighborhoods, schools, or commercial centers may be treated with a special design consisting of colored pavers, imprinted asphalt, or other adhesive patterns to provide added emphasis. This treatment adds special attention to an intersection and acts as a traffic calming device.

Patterned pavement acts as a traffic calming device and also enhances the look and feel of an intersection. These treatments can be community-building activities and provide a sense of place.

*Example of patterned pavement used for traffic calming purposes*

## 10.3.5. Forward Stop Bar

A second stop bar for cyclists placed closer to the centerline of the cross street than the first stop bar increases the visibility of cyclists waiting to cross a street. This treatment is typically used with other crossing treatments (i.e. curb extension) to encourage cyclists to take full advantage of crossing design. They are appropriate at unsignalized crossings where fewer than 25 percent of motorists make a right turn movement.

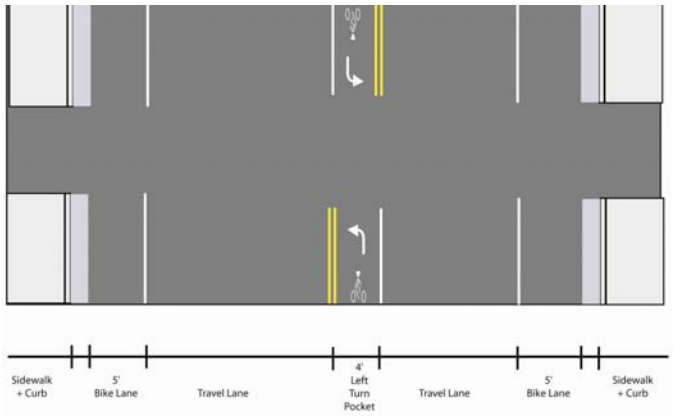


*Bicycle forward stop bars encourage cyclists to wait to cross where they are visible to drivers*

# 10.3. Level 3: Bicycle Boulevard Intersection Treatments

## 10.3.6. Bicycle Left-Turn Lane

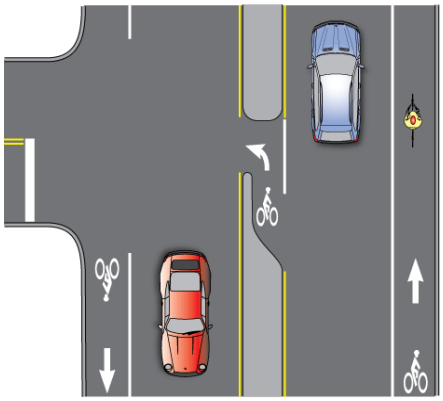
Bicycle Boulevards crossing major streets at offset intersections can incorporate "bicycle left-turn lanes" to facilitate easier bicyclist crossings. Similar to medians/refuge islands, bicycle left-turn lanes allow the crossing to be completed in two phases. A bicyclist on the Bicycle Boulevard could execute a right-hand turn onto the cross-street, and then wait in a delineated left-turn lane (if necessary to wait for a gap in oncoming traffic). The bike turn pockets should be at least 5 feet wide, with a total of 11 feet for both turn pockets and center striping.




*Example of a bicycle left-turn pocket*

## 10.3.7. Bicycle Left Turn Pocket

A bike-only left-turn pocket permits bicyclists to make left turns while restricting vehicle left turns. If the intersection is signal-controlled, a left arrow signal may be appropriate, depending on bicycle and vehicle volumes. Signs should be provided prohibiting motorists from turning. Ideally, the left turn pocket should be protected by a raised curb, but the pocket may also be defined by striping if necessary. Because of the restriction on vehicle left-turning movements, this treatment also acts as traffic diversion.



*This bike-only left-turn pocket guides cyclists along a popular bike route*

# 10.3. Level 3: Bicycle Boulevard Intersection Treatments

## 10.3.8. Bicycle Signal Warrant

A bicycle signal may be considered for use only when the volume and collision or volume and geometric warrants have been met:

- 1. VOLUME. When W = B x V and W > 50,000 and B > 50. Where W is the volume warrant, B is the number of bicycles at the peak hour entering the intersection, and V is the number of vehicles at the peak hour entering the intersection. (same peak hour)
- 2. COLLISION. When 2 or more bicycle/vehicle collisions of types susceptible to correction by a bicycle signal have occurred over a 12-month period and the responsible ACHD official determines that a bicycle signal will reduce the number of collisions.
- 3. GEOMETRIC. (a) Where a separate bicycle/multi use path intersects a roadway. (b) At other locations to facilitate a bicycle movement that is not permitted for a motor vehicle


## 10.3.9. Half-Signals

In situations where there are few crossable gaps and where vehicles on the major street do not stop for pedestrians and cyclists waiting to cross, “half signals” could be installed to improve the crossing environment. Half signals include pedestrian and bicycle activation buttons and may also include bicycle loop detectors on the Bicycle Boulevard approach. Many of these models have been used successfully for years overseas, and their use in the U.S. has increased dramatically over the last decade.

## 10.3.10. Medians/Refuge Islands

At uncontrolled intersections of Bicycle Boulevards and major streets, a bicycle crossing island can be provided to allow cyclists to cross one direction of traffic at a time when gaps in traffic allow. The bicycle crossing island should be at least 8’ wide (measured perpendicular to the centerline of the major road) to be used as the bike refuge area. Narrower medians can accommodate bikes if the holding area is at an acute angle to the major roadway, which allows stopped cyclists to face oncoming motorists. Railings can also be provided so bicyclists do not have to put their feet down, thus making it quicker to start again. Crossing islands can be placed in the middle of the intersection, thus prohibiting left and thru vehicle movements.

## 10.4. Level 4: Bicycle Boulevard Traffic Calming

Traffic calming treatments on Bicycle Boulevards improve the bicycling environment by reducing vehicle speeds to the point where they generally match cyclists' operating speeds, enabling motorists and cyclists to safely co-exist on the same facility. Specific traffic calming treatments are described below.

### 10.4.1. Chicanes

Chicanes are a series of raised or delineated curb extensions on alternating sides of a street forming an S-shaped curb, which reduce vehicle speeds through narrowed travel lanes (see right). Chicanes can also be achieved by establishing on-street parking on alternate sides of the street. These treatments are most effective on streets with narrower cross-sections.

### 10.4.2. Mini Traffic Circles

Mini traffic circles are raised or delineated islands placed at intersections, reducing vehicle speeds through tighter turning radii and narrowed vehicle travel lanes (see right). These devices can effectively slow vehicle traffic while facilitating all turning movements at an intersection. Mini traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.

### 10.4.3. Speed Humps

Shown right, speed humps are rounded raised areas of the pavement requiring approaching motor vehicles to reduce speed. These devices also discourage thru vehicle travel on a street when a parallel route exists.

Speed humps should never be constructed so steep that they may cause a bicyclist to lose control of the bicycle or be distracted from traffic. In some cases, a gap could be provided, whereby a bicyclist could continue on the level roadway surface, while vehicles would slow down to cross the barrier.

## 10.5. Level 5: Bicycle Boulevard Traffic Diversion

Traffic diversion treatments maintain thru bicycle travel on a street while physically restricting thru vehicle traffic. These treatments direct thru vehicle traffic onto parallel higher-order streets while accommodating bicyclists and local vehicle traffic on the Bicycle Boulevard. Traffic diversion is most effective when higher-order streets can sufficiently accommodate the diverted traffic associated with these treatments.

### 10.5.1. Choker Entrances

Choker entrances are intersection curb extensions or raised islands allowing full bicycle passage while restricting vehicle access to and from a Bicycle Boulevard. When they approach a choker entrance at a cross-street, motorists on the Bicycle Boulevard must turn onto the cross-street while cyclists may continue forward. These devices can be designed to permit some vehicle turning movements from a cross-street onto the Bicycle Boulevard while restricting other movements.


### 10.5.2. Traffic Diverters

Similar to choker entrances, traffic diverters are raised features directing vehicle traffic off the Bicycle Boulevard while permitting thru travel.

Advantages:

- Provides safe refuge in the median of the major street so that bicyclists only have to cross one direction of traffic at a time; works well with signal-controlled traffic platoons coming from opposite directions
- Provides traffic calming and safety benefits by preventing left turns and/or thru traffic from using the intersection

Disadvantages:

- Potential motor vehicle impacts to major roadways, including lane narrowing, loss of some on-street parking and restricted turning movements
- Crossing island may be difficult to maintain and may collect debris

# 11. Cycle Tracks

## Design Summary

A cycle track is an exclusive bicycle facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. Recommended Cycle Track width:

- 7 foot minimum to allow passing
- 12 foot minimum for two-way facility

## Discussion

Cycle tracks can be either one-way or two-way, on one or both sides of a street, and are separated from vehicles and pedestrians by pavement markings or coloring, bollards, curbs/medians or a combination of these elements.

Cycle tracks provide:

- Increased comfort for bicyclists
- Greater clarity about expected behavior
- Fewer conflicts between bicycles and parked cars as cyclists ride inside the parking lane
- Space to reduce the danger of "car dooring."

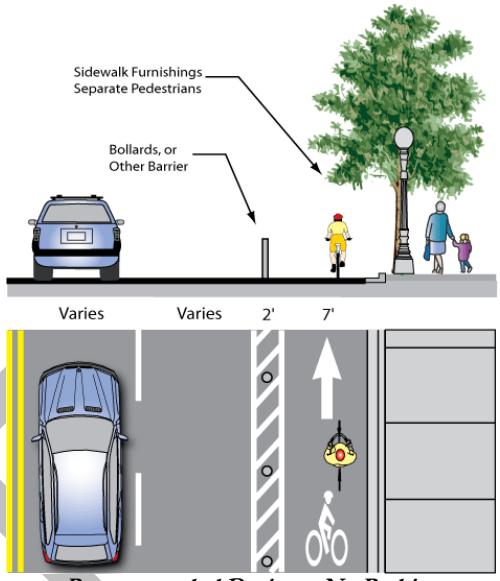
Danish research has shown that cycle tracks can increase bicycle ridership 18-20%, compared with the 5-7% increase associated with bike lanes.

However, disadvantages of cycle tracks include:

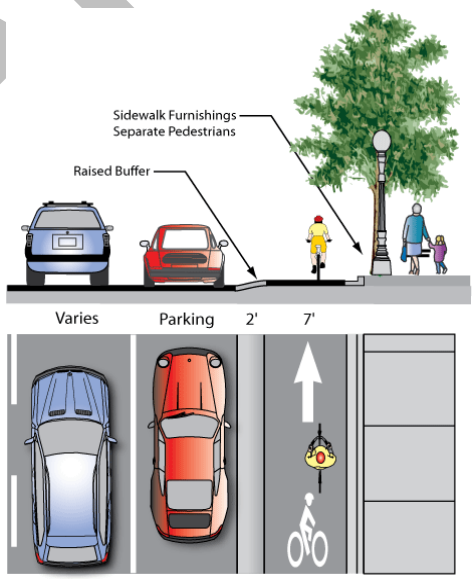
- Increased vulnerability at intersections
- Regular street sweeping trucks cannot maintain the cycle track; requires smaller sweepers.
- Conflicts with pedestrians and bus passengers can occur, particularly on cycle tracks that are un-differentiated from the sidewalk or that are between the sidewalk and a transit stop.

While recently implemented in the United States, cycle tracks have been used in European countries for several decades. The cycle track design guidance following was developed using European experience applied to American situations.

*Medians, driveway consolidation, or restricted movements reduce the potential for conflict.*




*Recommended Design – No Parking*




*Recommended Design– On-Street Parking*

# 11. Cycle Tracks

## Separation

Cycle tracks can be separated from vehicle traffic by a barrier or through grade-separation. Physical barriers can include bollards, parking, a planter strip, an extruded curb, or parking. Cycle tracks using barrier separation typically share the same elevation as adjacent travel lanes.

Openings in the barrier or curb are needed at driveways or other access points. The barrier should be dropped at intersections to allow vehicle crossing. Grade-separated cycle tracks should incorporate a rolled curb (right), which allows cyclists to enter or leave the cycle track at will, and enables motorists to drive over it at intersections and crossings.

When on-street parking is present, it should separate the cycle track from the roadway. The cycle track should be placed with a 2' buffer between parking and the sidewalk to minimize the hazard of 'dooring' cyclists.

*This cycle track in Cambridge, MA is separated from traffic by parking, light poles and grade*

## Placement

Cycle tracks should be placed along slower speed urban/suburban streets with long blocks and few driveways or mid-block access points for vehicles. Cycle tracks located on one-way streets will have fewer potential conflicts than those on two-way streets. A two-way cycle track is desirable when there are more destinations on one side of a street or if the cycle track will connect to a shared-use path or bicycle facility on one side of the street.

Cycle tracks should only be constructed along corridors with adequate right-of-way. Sidewalks or other pedestrian facilities should not be narrowed to accommodate the cycle track as pedestrians will likely walk on the cycle track if sidewalk capacity is reduced. Visual and physical cues (e.g., pavement markings) should be present that make it easy to understand where bicyclists and pedestrians should be moving.

## Intersections

Cycle tracks separate cyclists and motor vehicles to a greater degree than bike lanes. This produces added comfort for cyclists on the cycle track, but it creates additional considerations at intersections that must be addressed. A right-turning motorist conflicting with cycle track users represents the most common conflict. Both roadway users have to expand their visual scanning to see potential conflicts. To address this issue, several treatments can be applied at intersections:

- **Protected Phases at Signals** requires additional signal phases and could increase vehicle delays. With this treatment, turning movements are separated from conflicting thru movements. The use of a bicycle signal head is required to ensure all users know which signals to follow. Demand-only bicycle signals can be implemented to reduce vehicle delay and prevent an empty signal phase from regularly occurring. With this scenario, a push button or imbedded loop within the cycle track should be available to actuate the signal. If many cyclist left turns are expected, this movement should be given its own signal phase and push button.
- **Advanced Signal Phases** can be set to provide cycle track users an advance green phase.
- **Access Management:** Cycle tracks should be clearly marked where cars will cross them
- **Unsignalized Treatments**: Warning signs, special markings and the removal of on-street parking (if present) in advance of the intersection can all raise visibility of cyclists.

# 12. Bicycle Parking

**Design Summary**

Bicycle parking can be broadly defined as either short-term or long-term parking:

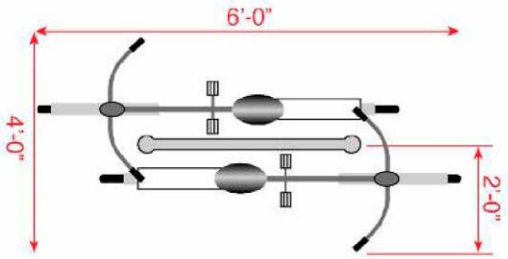
- **Short-term parking:** parking meant to accommodate visitors, customers, messengers and others expected to depart within two hours; requires approved standard rack, appropriate location and placement, and weather protection.
- **Long-term parking:** parking meant to accommodate employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

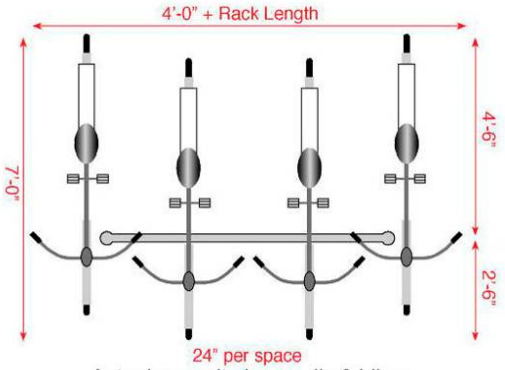
## 12.1. Short-Term Parking

Short-term bicycle parking facilities include racks which permit the locking of the bicycle frame and at least one wheel to the rack and support the bicycle in a stable position without damage to wheels, frame or components. Short-term bicycle parking is currently provided at no charge at various locations in Tacoma. Such facilities should continue to be free, as they provide minimal security, but encourage cycling and promote proper bicycle parking.

*Standard bicycle rack*

**Ribbon, Spiral, or Freestanding Racks**
(with access from only one side)




Actual capacity is usually 3 bikes

# 12. Bicycle Parking

**Bicycle Rack Placement Guidelines**

| Design Issue | Recommended Guidance |
|---|---|
| Minimum Rack Height | To increase visibility to pedestrians, racks should have a minimum height of 33 inches or be indicated or cordoned off by visible markers. |
| Signing | Where bicycle parking areas are not clearly visible to approaching cyclists, signs at least 12 inches square should direct them to the facility. The sign should include the name, phone number, and location of the person in charge of the facility, where applicable. |
| Lighting | Lighting of not less than one foot-candle illumination at ground level should be provided in all bicycle parking areas. |
| Frequency of Racks on Streets | In popular retail areas, two or more racks should be installed on each side of each block. This does not eliminate the inclusion of requests from the public which do not fall in these areas. Areas officially designated or used as bicycle routes may warrant the consideration of more racks. |
| Location and Access | Access to facilities should be convenient; where access is by sidewalk or walkway, ADA-compliant curb ramps should be provided where appropriate. Parking facilities intended for employees should be located near the employee entrance, and those for customers or visitors near main public entrances. (Convenience should be balanced against the need for security if the employee entrance is not in a well traveled area). Bicycle parking should be clustered in lots not to exceed 16 spaces each. Large expanses of bicycle parking make it easier for thieves to be undetected. |
| Locations within Buildings | Provide bike racks within 50 feet of the entrance. Where a security guard is present, provide racks behind or within view of a security guard. The location should be outside the normal flow of pedestrian traffic. |
| Locations near Transit Stops | To prevent bicyclists from locking bikes to bus stop poles - which can create access problems for transit users, particularly those who are disabled - racks should be placed in close proximity to transit stops where there is a demand for short-term bike parking. |
| Locations within a Campus-Type Setting | Racks are useful in a campus-type setting at locations where the user is likely to spend less than two hours, such as classroom buildings. Racks should be located near the entrance to each building. Where racks are clustered in a single location, they should be surrounded by a fence and watched by an attendant. The attendant can often share this duty with other duties to reduce or eliminate the cost of labor being applied to bike parking duties; a cheaper alternative to an attendant may be to site the fenced bicycle compound in a highly visible location on the campus. For long-term parking needs of employees and students, attendant parking and/or bike lockers are recommended. |
| Retrofit Program | In established locations, such as schools, employment centers, and shopping centers, the City should conduct bicycle audits to assess bicycle parking availability and access, and add additional bicycle racks where necessary. |

### 12.1.1. On-Street Parking

# 12. Bicycle Parking

Where the placement of racks on sidewalks is not possible (due to narrow sidewalk width, sidewalk obstructions, etc.), bicycle parking can be provided in the street where on-street vehicle parking is allowed. Racks can be clustered in a parking space, or they can be located on sidewalk curb extensions where adequate sight distance exists. Installing bicycle parking directly in a car parking space incurs only the cost of the racks and bollards or other protective devices.

A curb extension is more expensive to install, and can be prohibitively expensive if substantial drainage and/or utility work is necessary. Costs may be less if the curb extension is installed as part of a larger street improvement project. While on-street bicycle parking may take space away from automobile parking, it is possible to mitigate auto parking loss by creating auto parking spaces through driveway consolidation, moving fire hydrants, or otherwise permitting auto parking where it is currently prohibited. Options for combining bicycle and motorcycle parking also exist.

*On-street bicycle parking may be installed at intersection corners or at mid-block locations*

## 12.2. Long-Term Parking

Long-term bicycle parking facilities are intended to provide secure long-term bicycle storage. Long-term facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain. Examples include lockers, check-in facilities, monitored parking, restricted access parking, and personal storage.

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free. Potential locations for long-term bicycle parking include transit stations, large employers and institutions where people use their bikes for commuting, and not consistently throughout the day.

### 12.2.1. Bike Lockers

# 12. Bicycle Parking

Bicycle lockers provide space to store a few accessories or rain gear in addition to containing the bicycle. Some lockers allow access to two users - a partition separating the two bicycles can help ensure users feel their bike is secure. Lockers can also be stacked, reducing the footprint of the area, although that makes them more difficult to use.

New federal security requirements mandating that locker contents be visible has highlighted a tradeoff between security and perceived safety. Though these measures are designed to increase station security, bicyclists will perceive the contents of their locker to be less safe if they are visible and will be more reluctant to use them.

Traditionally, bicycle lockers have been available on a sign-up basis, whereby cyclists are given a key or a code to access a particular locker. Computerized on-demand systems allow users to check for available lockers or sign up online. Models from eLocker and CycleSafe allow keyless access to the locker with the use of a SmartCard or cell phone. With an internet connection, centralized computerized administration allows the transit agency to monitor and respond to demand for one-time use as well as reserved lockers.

Lockers available for one-time use have the advantage of serving multiple users a week. Monthly rentals, by contrast, ensure renters that their own personal locker will always be available.

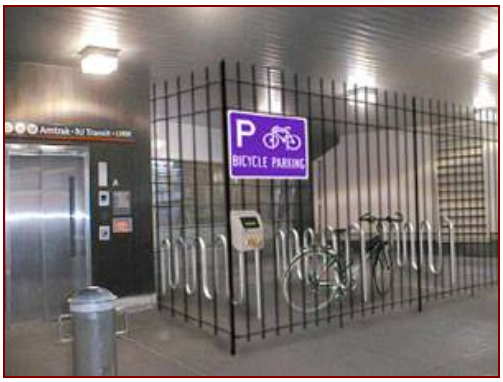
*Bike lockers at a transit station*

### 12.2.2. Racks Inside a Cage or Room

A higher-security variation on basic racks is a bike cage that restricts access to bicyclists. The cage can be fitted with a gate and an electronic passcard access to provide unsupervised parking. When there is a high demand for parking, several small cages provide more security than one larger one can, as they reduce the number of people who have access to each room.

Parking inside an enclosed room is more secure, but also more expensive than cages. The downside of both is that bicyclists must have a key or know a code prior to using the parking facilities, which is a barrier to incidental use.

A cage of 18.5 feet by 18 feet can accommodate up to 20 bicycles and uses the space of approximately two automobile parking spots.




*Bike Cage in Penn Station*

### 12.2.3. Automated Bicycle Parking

# 12. Bicycle Parking

An alternative to lockers, automated bicycle parking provides secure, unmonitored outdoor parking. There are several different types of automated parking in use around the world. Most of them have a hook, slot, or other mechanism, on which the user places the bicycle, and which removes the bicycle from street level. These units can be accessible at all hours of the day for users to retrieve their bicycles. Automated parking is a good option for a location that requires bicycle parking to have a small footprint or in situations where surveillance may be difficult.

Bike Trees use the *smart card* technology and move bicycles up into an umbrella-shaped cover, to reduce theft and vandalism. They can be a symbol of the organization's commitment to high-quality facilities for bicyclists. They do not provide space to store accessories. Bike Trees are not available in the US at present.

Spain and Japan have developed multi-level automated bicycle parking facilities to store a large number of bicycles. Bicibergs are automated systems that store the locker underground. They have the advantage that the user can store bags and raingear in the locker without fear of theft. In Japan, the bicycle is rolled onto a platform, which descends into the parking facility and is rolled into an underground storage unit. Usage fees are often minimal.

***Bike Tree***
Source: www.biketree.com

## 12.2.4. Bike Depot

Bike depots generally refer to full-service parking facilities typically located at major transit locations that offer secure bicycle parking and other amenities. There is no universally accepted terminology to describe different types of full-service bicycle parking facilities. While each depot is unique, they often provide:

- Attended or restricted-access parking spots
- Shared-use bicycle rentals
- Access to public transportation
- Commute trip-planning information

The company BikeStation™, which runs several parking facilities in California and Washington, offers free parking during business hours and key-card access after-hours for members. Paying members enjoy a number of services. Services, which differ by location, may include bicycle repairs, bicycle rentals, sales and accessories, restrooms, changing rooms and showers, and access to vehicle-sharing, such as ZipCar. They can also incorporate restaurants or other services.

Seattle Bikestation™ members receive discounted ZipCar and Bicycle Alliance of Washington memberships, as well as access to repair services, rentals, and a library of bicycling resources. They also offer a guaranteed ride home program, which reduces the fear of being stranded by a flat tire or other malfunction.

The King George Square Cycle Center in Brisbane provides laundry and ironing services.


***One of the original BikeStations in the Puget Sound***

# 13. Bikeway Maintenance

This section presents guidelines for incorporating bicycle facilities into construction, maintenance and repair activities. The guidelines are presented as a menu of options and considerations for maintenance activities, and not strict guidelines.

## 13.1. Street Construction and Repair

Safety of all roadway users should be considered during road construction and repair. Wherever bicycles are allowed, measures should be taken to provide for the continuity of a bicyclist's trip through a work zone area. Only in rare cases should pedestrians and bicyclists be detoured to another street when travel vehicle lanes remain openThe following actions are recommended:

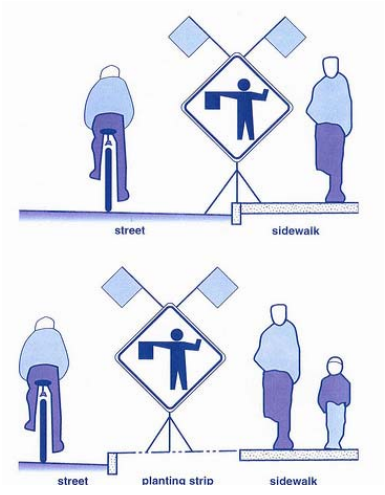
- Bicyclists should not be led into conflicts with work site vehicles, equipment, moving vehicles, open trenches or temporary construction signage.
- Efforts should be made to re-create a bike lane (if one exists) to the left of the construction zone.
- Where there is insufficient space to provide a bike lane adjacent to the construction zone, then a standard wide travel lane should be considered. If steel plating is used, special care should be taken to ensure that bicyclists can traverse the plates safely.
- Contractors performing work for Tacoma should be made aware of the needs of bicyclists and be properly trained in how to safely route bicyclists through or around work zones.

**Signage Actions:**

Construction signage should be placed in a location that does not obstruct the path of bicyclists or pedestrians, including bike lanes, wide curb lanes, or sidewalks. In areas where there are grades, signs may be placed at the street-side edge of sidewalks so as not to encroach onto a bike lane.
Detour and closure signage related to bicycle travel may be included on all bikeways where construction activities occur. Signage should also be provided on all other roadways.
The following MUTCD signs should be used:

W21-4A: Road Work Ahead
W20-5: Right Lane Closed

- W4-2: Lane Shift, Left Sign
  W11-1: Bicycle Warning Sign
  W16-1: Share The Road




### 13.1.1. Open Trenches

Plates used to cover trenches tend to not be flush with pavement and have a 1"-2" vertical transition on the edges. This can puncture a hole in a bicycle tire and cause a cyclist to lose control. Bicyclists often are left on their own to merge with vehicles in the adjacent travel lane.

Although it is common to use steel plates during non-construction hours, these plates can be dangerously slippery, particularly when wet.

The City of Tacoma should consider:

- Ensuring that steel plates do not have a vertical edge greater than ¼" without an asphalt lip
- Using non-skid steel plates w/o a raised steel bar
- Requiring temporary asphalt (cold mix) around plates to create a smooth transition
- Using steel plates only as a temporary measure during construction, not for extended periods
- Use warning signage where steel plates are in use.

# 13. Bikeway Maintenance

## 13.2. Bikeway Maintenance – Regular Maintenance

Regular bicycle facility maintenance includes sweeping, maintaining a smooth roadway, ensuring that the gutter-to-pavement transition remains relatively flat, and installing bicycle-friendly drainage grates. Pavement overlays are a good opportunity to improve bicycle facilities. The following recommendations provide a menu of options for Tacoma to consider as it augments and enhances its maintenance regimen. Many of the recommendations listed below are already part of Tacoma's regular maintenance activities.

**Recommended Walkway and Bikeway Maintenance Activities**

| Maintenance Activity | Frequency |
|---|---|
| Inspections | Seasonal – at beginning and end of Summer |
| Pavement sweeping/blowing | As needed, weekly in Fall |
| Pavement sealing | 5 - 15 years |
| Pothole repair | 1 week – 1 month after report |
| Culvert and drainage grate inspection | Before Winter and after major storms |
| Pavement markings replacement | 1 – 3 years |
| Signage replacement | 1 – 3 years |
| Shoulder plant trimming (weeds, trees, brambles) | Twice a year; middle of growing season and early Fall |
| Tree and shrub plantings, trimming | 1 – 3 years |
| Major damage response (washouts, fallen trees, flooding) | As soon as possible |

### 13.2.1. Sweeping

Bicyclists often avoid shoulders and bike lanes filled with gravel, broken glass and other debris; they will ride in the roadway to avoid these hazards, causing conflicts with motorists. Debris from the roadway should not be swept onto sidewalks (pedestrians need a clean walking surface), nor should debris be swept from the sidewalk onto the roadway. A regularly scheduled inspection and maintenance program helps ensure that roadway debris is regularly picked up or swept.

Action items involving sweeping activities include:

- Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes
- Sweep walkways and bikeways whenever there is an accumulation of debris on the facility
- In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders
- Pave gravel driveway approaches to minimize loose gravel on paved roadway shoulders
- Provide extra sweeping in the Fall in areas where leaves accumulate

# 13. Bikeway Maintenance

### 13.2.2. Roadway Surface

Bicycles are much more sensitive to subtle changes in roadway surface than are motor vehicles. Various materials are used to pave roadways, and some are smoother than others. Compaction is also an important issue after trenches and other construction holes are filled. Uneven settlement after trenching can affect the roadway surface nearest the curb where bicycles travel. Sometimes compaction is not achieved to a satisfactory level, and an uneven pavement surface can result due to settling over the course of days or weeks.

Recommended action items involving maintaining the roadway surface include:

- On all bikeways, use the smallest possible chip for chip sealing bike lanes and shoulders
- During chip seal maintenance projects, if the pavement condition of the bike lane is satisfactory, it may be appropriate to chip seal the travel lanes only.
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼"
- Maintain a smooth surface on all bikeways that is free of potholes
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred

### 13.2.3. Gutter-to-Pavement Transition

On streets with concrete curbs and gutters, 1'-2' of the curbside area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, the bikeway is situated near the transition between the gutter pan and the pavement edge. It is at this location that water can erode the transition, creating potholes and a rough surface for travel.

The pavement on many streets is not flush with the gutter, creating a vertical transition between these segments. This area can buckle over time, creating a hazardous environment for bicyclists. Since it is the most likely place for bicyclists to ride, this issue is significant for bike travel.

Action items related to maintaining a smooth gutter-to-pavement transition include:

- Ensure that gutter-to-pavement transitions have no more than a ¼" vertical transition
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets

### 13.2.4. Drainage Grates

Drainage grates are typically located in the gutter area near the curb of a roadway. Drainage grates typically have slots through which water drains into the municipal wastewater system. Many grates are designed with linear parallel bars spread wide enough for a tire to become caught so that if a bicycle were to ride on them, the front tire would become caught and fall through the slot. This would cause the cyclist to tumble over the handlebars and sustain potentially serious injuries.

The City of Tacoma should consider the following:

- Continue to require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires do not fall through the vertical slats
- Creating a program to inventory all existing drainage grates, and replace hazardous grates as necessary – temporary modifications such as installing rebar horizontally across the grate is not alternative to replacement

# 13. Bikeway Maintenance

### 13.2.5. Pavement Overlays

| | |
|---|---|
| Pavement overlays represent good opportunities to improve conditions for cyclists if done carefully. A ridge should not be left in the area where cyclists ride (this occurs where an overlay extends part-way into a shoulder bikeway or bike lane). Overlay projects offer opportunities to widen a roadway, or to re-stripe a roadway with bike lanes. | Action items related to pavement overlays include:<br>▪ Extend the overlay over the entire roadway surface to avoid leaving an abrupt edge<br>▪ If there is adequate shoulder or bike lane width, it may be appropriate to stop at the shoulder or bike lane stripe, provided no abrupt ridge remains<br>▪ Ensure that inlet grates, manhole and valve covers are within ¼ inch of the pavement surface<br>▪ Pave gravel driveways to property line to prevent gravel from spilling onto shoulders or bike lanes |

### 13.2.6. Signage

| | |
|---|---|
| Bike lanes, shared shoulders, Bicycle Boulevards and paths all have different signage types for wayfinding and regulations. Such signage is vulnerable to vandalism or wear, and requires regular maintenance and replacement as needed. | The City of Tacoma should consider the following:<br>▪ Check regulatory and wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear<br>▪ Replace signage along the bikeway network as-needed<br>▪ Perform a regularly-scheduled check on the status of signage with follow-up as necessary<br>▪ Create a Maintenance Management Plan |

### 13.2.7. Landscaping

| | |
|---|---|
| Bikeways can become inaccessible due to overgrown vegetation. Shoulder plants should be trimmed twice a year. After a flood or major storm, bikeways should be checked along with other roads, and fallen trees or other debris should be removed promptly. | Landscaping maintenance action items include:<br>▪ Ensure that shoulder plants do not hang into or impede passage along bikeways<br>▪ After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible |

### 13.2.8. Maintenance Management Plan

| | |
|---|---|
| Bikeway users need accommodation during construction and maintenance activities when bikeways may be closed or unavailable. Users must be warned of bikeway closures and given adequate detour information to bypass the closed section. Users should be warned through the use of standard signing approaching each affected section (e.g., “Bike Lane Closed,” “Trail Closed”), including information on alternate routes and dates of closure. Alternate routes should provide reasonable directness, equivalent traffic characteristics, and be signed. | Action items related to a Maintenance Management Plan include:<br>▪ Provide fire and police departments with map of system, along with access points to gates/bollards<br>▪ Enforce speed limits and other rules of the road<br>▪ Enforce all trespassing laws for people attempting to enter adjacent private properties |

# 14. Bikeway Wayfinding Signage

## Design Summary

Costing about $125 each, wayfinding signs are a relatively cost-effective means for improving the walking and bicycling environment.

## Discussion

The ability to navigate through a city is informed by landmarks, natural features, and other visual cues. Signs throughout the city should indicate to bicyclists:

- Direction of travel
- Location of destinations
- Riding time/distance to those destinations

These signs will increase users' comfort and accessibility to the bicycle system.


*Wayfinding Signage Concept*

Wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. Too many road signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards.

Signage can serve both wayfinding and safety purposes including:

- Helping to familiarize users with the bikeway system
- Helping users identify the best routes to destinations
- Helping to address misperceptions about time and distance
- Helping overcome a "barrier to entry" for people who do not bicycle often (e.g., "interested but concerned" cyclists)

A community-wide Bicycle Wayfinding Signage Plan would identify:

- Sign locations along existing and planned bicycle routes
- Sign type – what information should be included and design features
- Destinations to be highlighted on each sign – key destinations for bicyclists
- Approximate distance and riding time to each destination