

# Appendix F: Bicycle and Pedestrian Facility Design Guide

## 1 Introduction

This technical handbook is intended to assist Washington State University and the City of Pullman in the selection and design of pedestrian and bicycle facilities. The following chapters pull together best practices by facility type from public agencies and municipalities nationwide. Within the design sections, treatments are covered within a single sheet tabular format relating important design information and discussion, example photos, schematics (if applicable), and existing summary guidance from current standards. Existing standards are referenced throughout and should be the first source of information when seeking to implement any of the treatments featured here.

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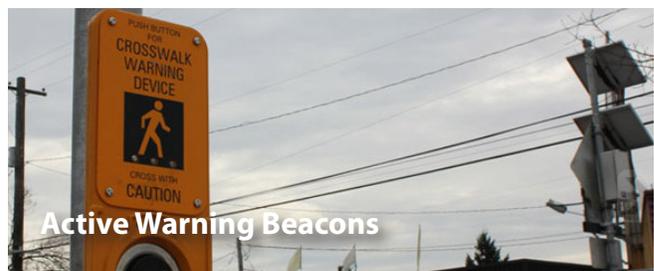
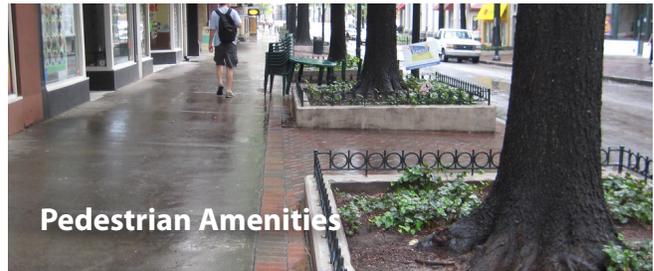
## Pedestrian Facility Design

Pedestrian facilities are important for safe, comfortable walking in developed areas.

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 both urban and suburban environments.

Additional design elements such as curb extensions and median islands enhance the pedestrian realm for safety and simplified crossings.

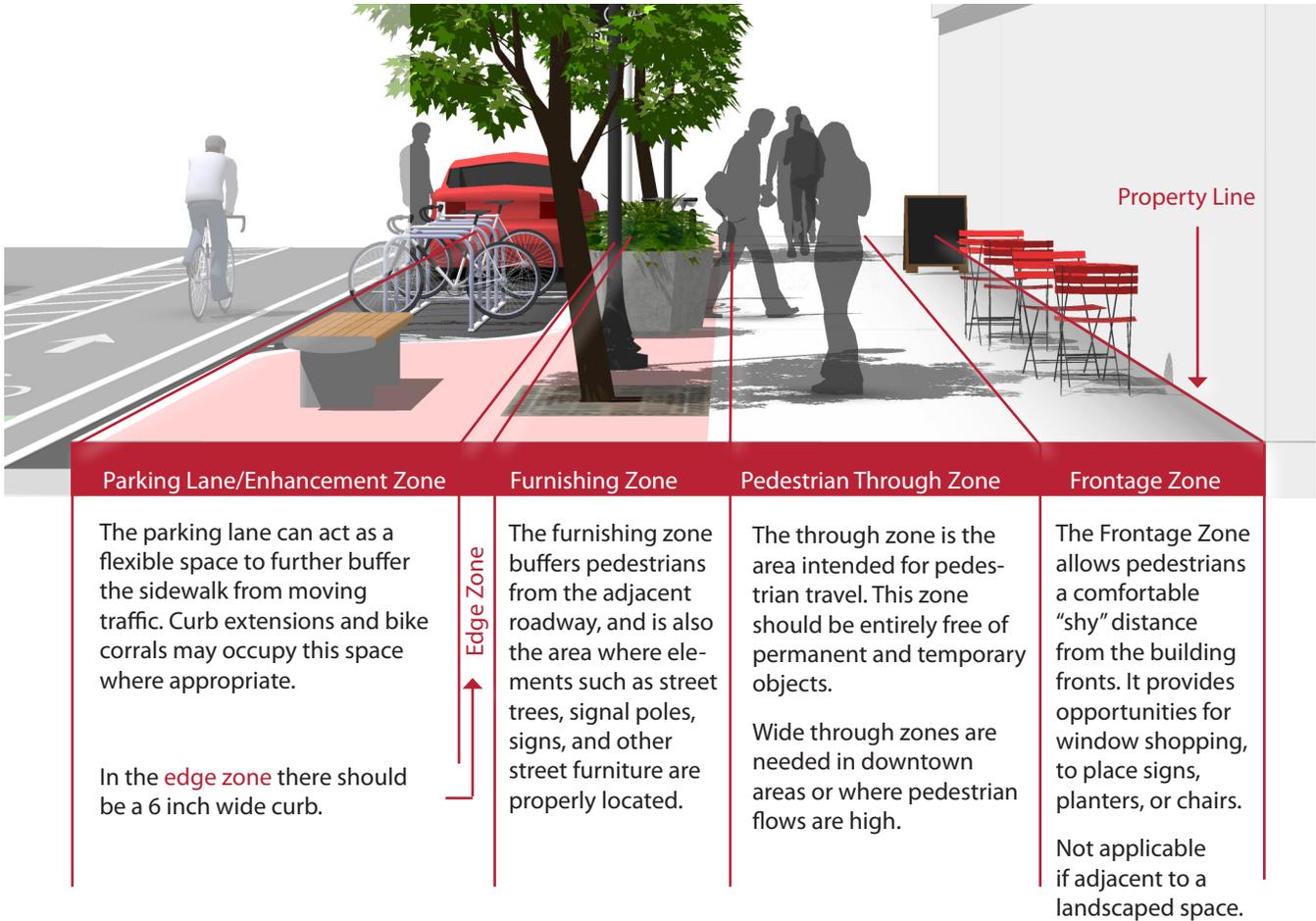
Crossing beacons and signals facilitate crossings of roadways for pedestrians and bicyclists. Beacons make crossing intersections safer by clarifying when to enter an intersection and by alerting motorists to the presence of pedestrians and bicyclists.



# Zones in the Sidewalk Corridor

## Description

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel separated from vehicle traffic. A variety of considerations are important in sidewalk design. Providing adequate and accessible facilities can lead to increased numbers of people walking, improved safety, and the creation of social space.



## Discussion

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. Sidewalks should contribute to the character of neighborhoods and business districts, strengthen their identity, and be an area where adults and children can safely participate in public life.

## Additional References and Guidelines

USDOJ. (2010). ADA Standards for Accessible Design.  
 United States Access Board. (2011). Proposed Accessibility Guidelines for Pedestrian Facilities in the Public-Right-of-Way (PROWAG).  
 AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.

## Materials and Maintenance

Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped space. Colored, patterned, or stamped concrete can add distinctive visual appeal.

## Pedestrian Amenities

### Description

A variety of streetscape elements can define the pedestrian realm, offer protection from moving vehicles, and enhance the walking experience. Key features are presented below.

### Street Furniture

Providing benches at key rest areas and viewpoints encourages people of all ages to use the walkways by ensuring that they have a place to rest along the way. Benches should be 20" tall to accommodate elderly pedestrians comfortably. Benches can be simple (e.g., wood slats) or more ornate (e.g., stone, wrought iron, concrete). If alongside a parking zone, street furniture should be placed to minimize interference with passenger loading.

### Green Features

Green stormwater strategies may include bioretention swales, rain gardens, tree box filters, and pervious pavements (pervious concrete, asphalt and pavers).

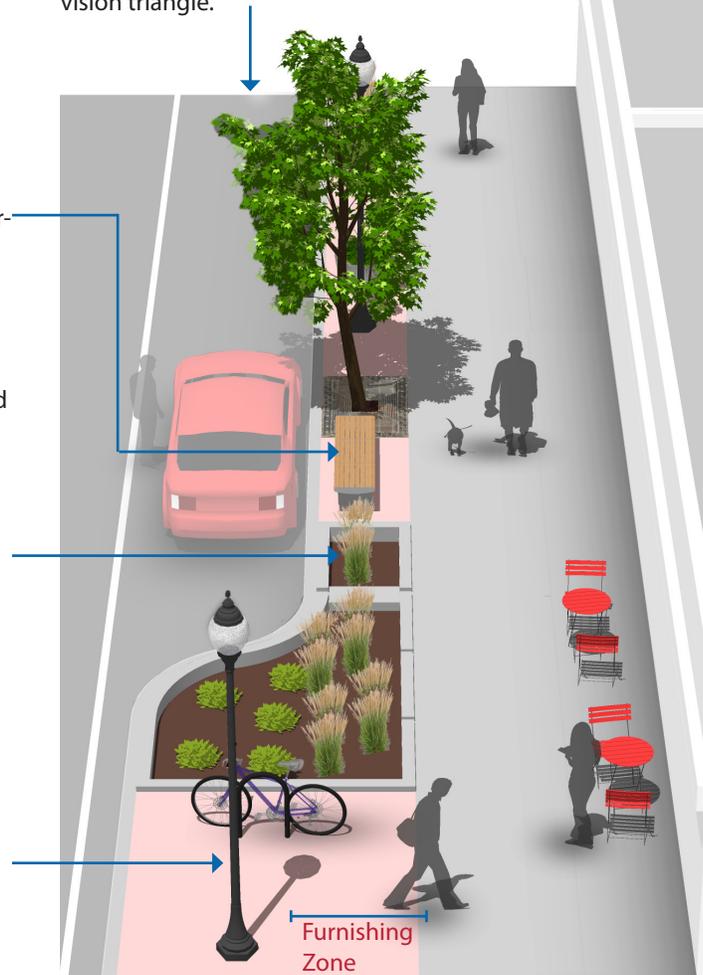
Bioswales are natural landscape elements that manage water runoff from a paved surface. Plants in the swale trap pollutants and silt from entering a river system.

### Lighting

Pedestrian scale lighting improves visibility for both pedestrians and motorists - particularly at intersections. Pedestrian scale lighting 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.

### Street Trees

In addition to their aesthetic and environmental 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. It is important that trees do not block light or the vision triangle.



### Discussion

Additional pedestrian amenities such as banners, public art, special paving, along with historical elements and cultural references, 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.

Pedestrian amenities should be placed in the furnishing zone on a sidewalk corridor. See **Zones in the Sidewalk Corridor** for a discussion of the functional parts of a sidewalk. Signs, meters, tree wells should go between parking spaces.

### Additional References and Guidelines

United States Access Board. (2011). Proposed Accessibility Guidelines for Pedestrian Facilities in the Public-Right-of-Way (PROWAG).

### Materials and Maintenance

Establishing and caring for your young street trees is essential to their health. Green features may require routine maintenance, including sediment and trash removal, and clearing curb openings and overflow drains.

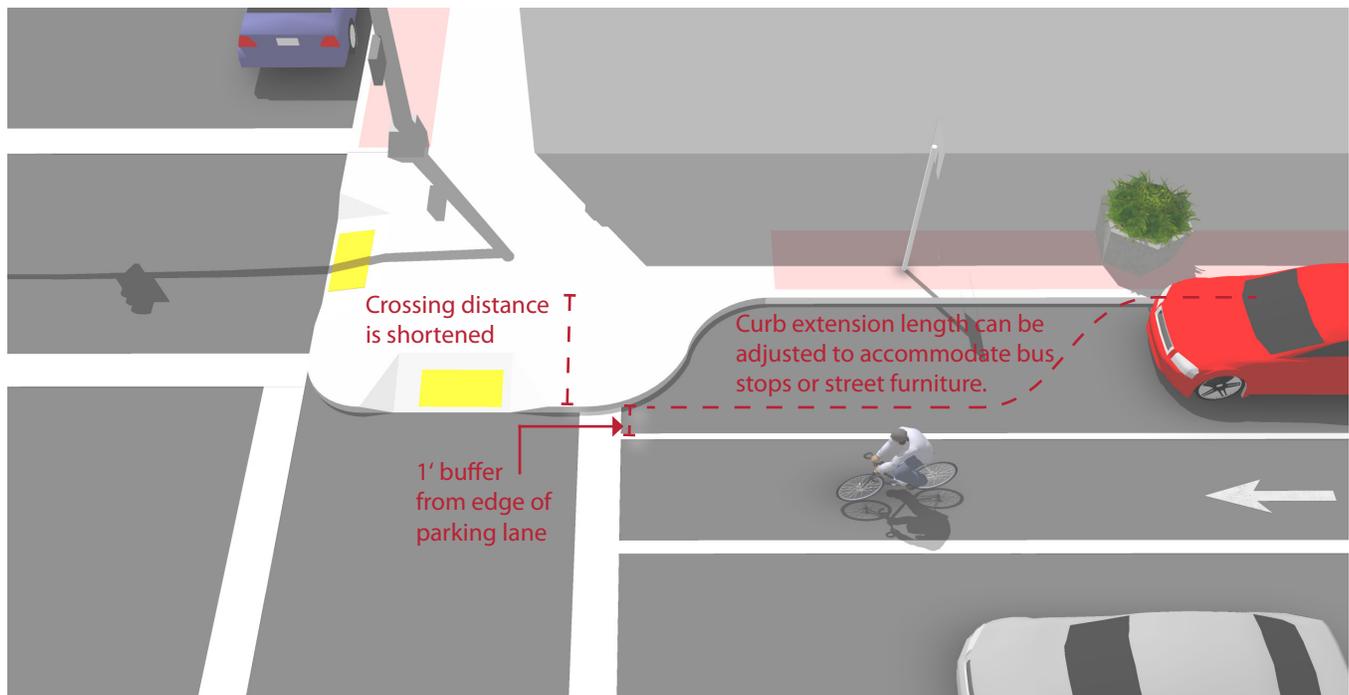
# Curb Extensions

## Description

Curb extensions minimize pedestrian exposure during crossing by shortening crossing distance and giving 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.

## Guidance

- 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 feet and the two radii should be balanced to be nearly equal.
- Curb extensions should terminate one foot short of the parking lane to maximize bicyclist safety.



## Discussion

If there is no parking lane, adding curb extensions may be a problem for bicycle travel and truck or bus turning movements.

## Additional References and Guidelines

AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.  
 AASHTO. (2004). A Policy on Geometric Design of Highways and Streets.

## Materials and Maintenance

Planted curb extensions may be designed as a bioswale, a vegetated system for stormwater management.

# Median Refuge Islands

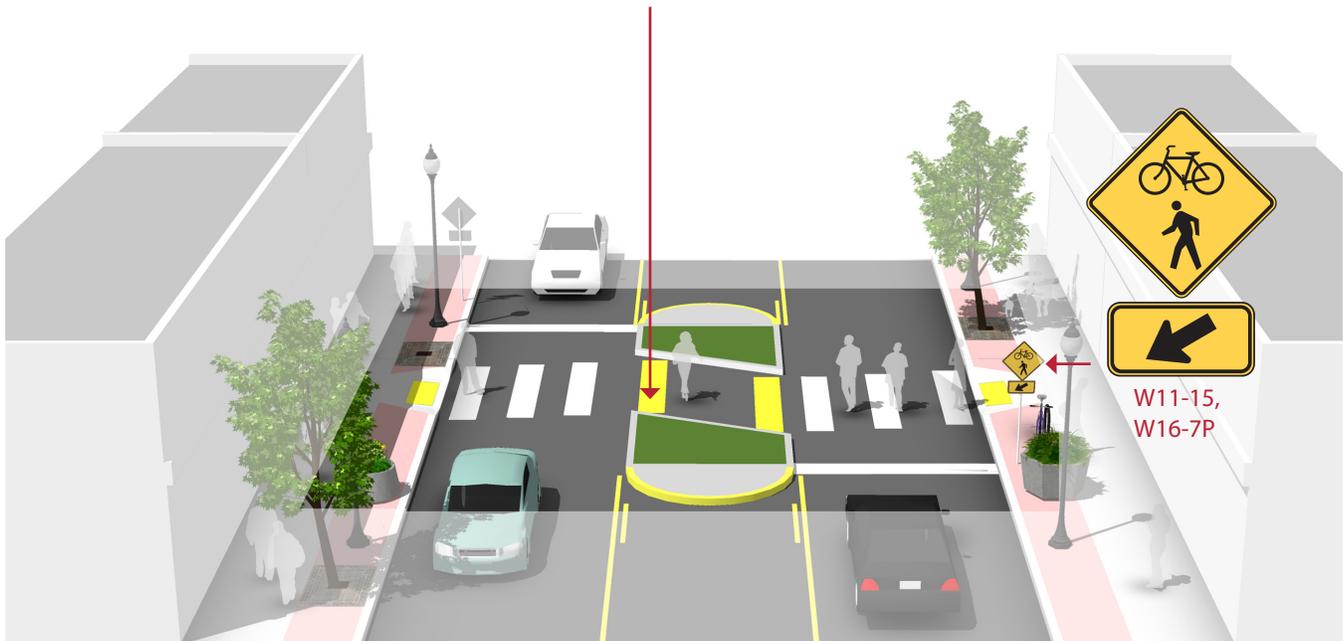
## Description

Median refuge islands are located at the mid-point of a marked crossing and help improve pedestrian safety by allowing pedestrians to cross one direction of traffic at a time. Refuge islands minimize pedestrian exposure by shortening crossing distance and increasing the number of available gaps for crossing.

## Guidance

- Can be applied on any roadway with a left turn center lane or median that is at least 6 feet wide.
- Appropriate 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.
- The island should be at least 6 feet wide between travel lanes (to accommodate bikes with trailers and wheelchair users) and at least 20 feet long.
- On streets with speeds higher than 25 mph there should also be double centerline marking, reflectors, and “KEEP RIGHT” signage.

Cut through median islands are preferred over curb ramps, to better accommodate bicyclists.



## Discussion

If a refuge island is landscaped, the landscaping should not compromise the visibility of pedestrians crossing in the crosswalk. Shrubs and ground plantings should be no higher than 1 feet 6 inches.

On multi-lane roadways, consider configuration with **active warning beacons** for improved yielding compliance.

## Additional References and Guidelines

- FHWA. (2009). Manual on Uniform Traffic Control Devices.
- AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.
- NACTO. (2012). Urban Bikeway Design Guide.

## Materials and Maintenance

Refuge islands may collect road debris and may require somewhat frequent maintenance. Refuge islands should be visible to snow plow crews and should be kept free of snow berms that block access.

## Active Warning Beacons

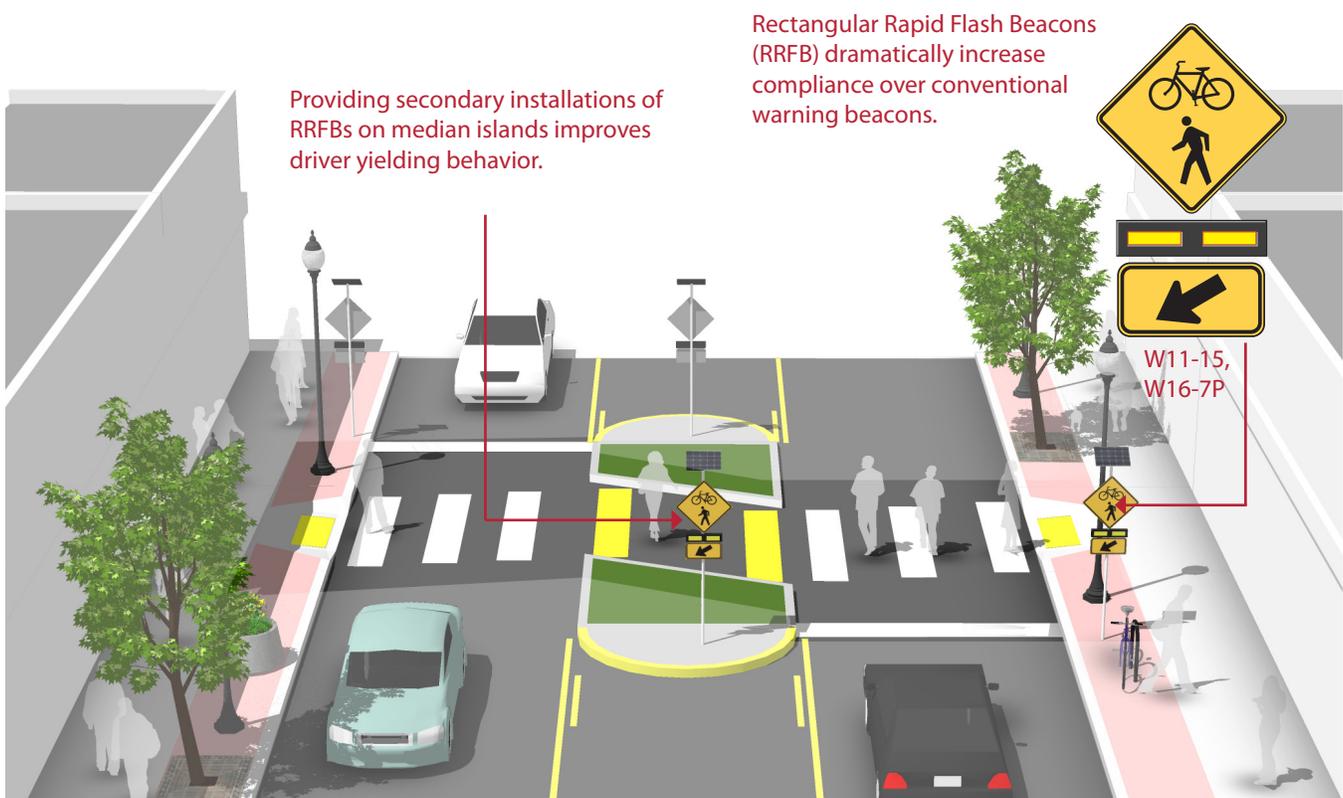
### Description

Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi-lane or high volume roadways.

Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or Rectangular Rapid Flash Beacons (RRFB).

### Guidance

- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic signals.
- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.



### Discussion

Rectangular rapid flash beacons have the most increased compliance of all the warning beacon enhancement options.

A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent. Additional studies over long term installations show little to no decrease in yielding behavior over time.

### Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.  
 FHWA. (2009). Manual on Uniform Traffic Control Devices.  
 FHWA. (2008). MUTCD - Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)

### Materials and Maintenance

Depending on power supply, maintenance can be minimal. If solar power is used, RRFBs should run for years without issue.

## Hybrid Beacon for Mid-Block Crossing

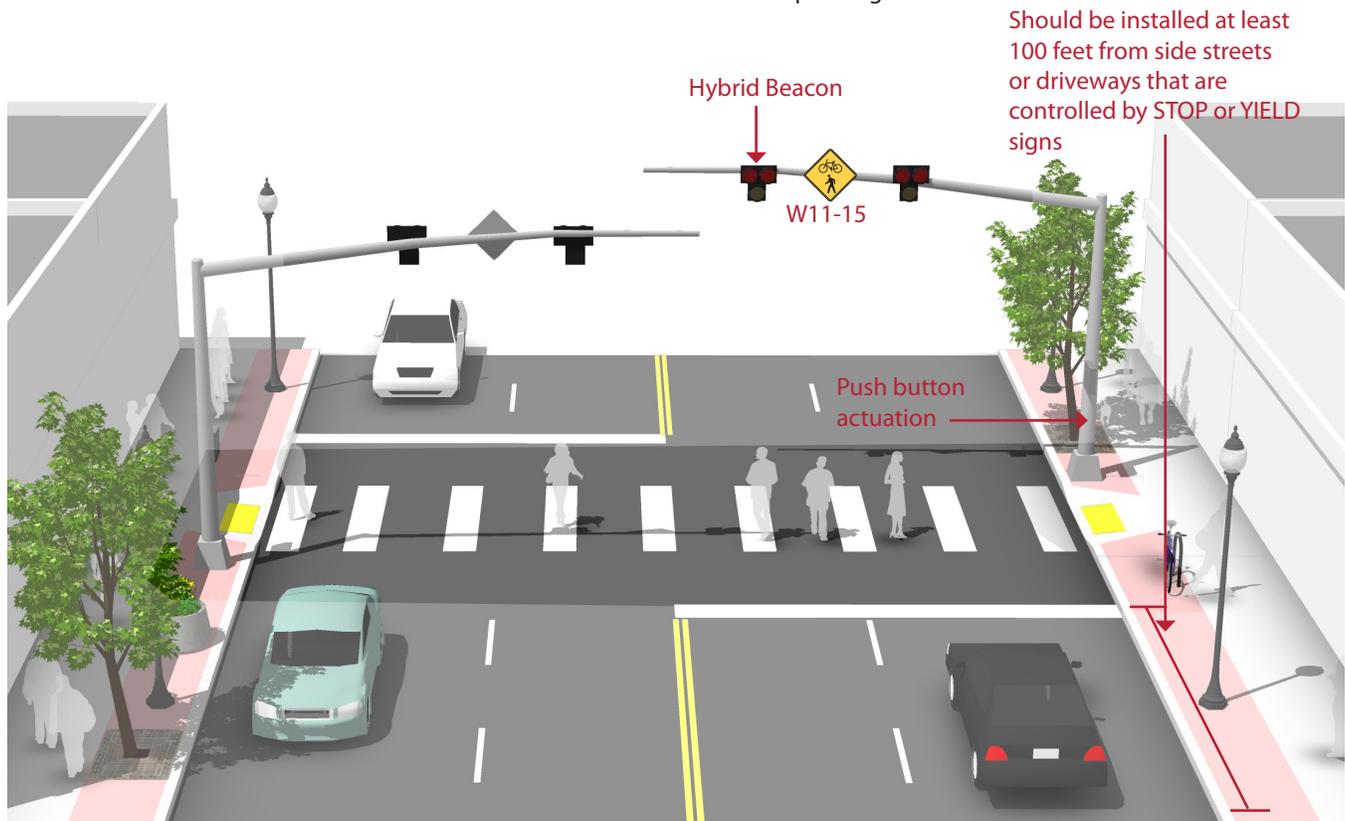
### Description

Hybrid beacons are used to improve non-motorized crossings of major streets. A hybrid beacon consists of a signal-head with two red lenses over a single yellow lens on the major street, and a pedestrian signal head for the crosswalk.

### Guidance

Hybrid beacons may be installed without meeting traffic signal control warrants if roadway speed and volumes are excessive for comfortable pedestrian crossings.

- If installed within a signal system, signal engineers should evaluate the need for the hybrid signal to be coordinated with other signals.
- Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk to provide adequate sight distance.



### Discussion

Hybrid beacon signals are normally activated by push buttons, but may also be triggered by infrared, microwave or video detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street.

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.

### Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.  
NACTO. (2012). Urban Bikeway Design Guide.

### Materials and Maintenance

Hybrid beacons are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

## On-Street Bikeways

On-street bikeways may be divided into two main categories: Shared Roadways and Separated Bikeways

### Shared Roadways

On shared roadways, bicyclists and motor vehicles use the same roadway space. These facilities are typically used on roads with low speeds and traffic volumes, however they can be used on higher volume roads with wide outside lanes or shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

Shared roadways employ a large variety of treatments from simple signage and shared lane markings to more complex treatments including directional signage, traffic diverters, chicanes, chokers, and/or other traffic calming devices to reduce vehicle speeds or volumes.

Neighborhood greenways are a special class of shared roadways designed for a broad spectrum of bicyclists. They are low-volume local streets where motorists and bicyclists share the same travel lane. Treatments for neighborhood greenways are selected as necessary to create appropriate automobile volumes and speeds, and to provide safe crossing opportunities of busy streets.

### Separated Bikeways

Designated exclusively for bicycle travel, separated bikeways are segregated from vehicle travel lanes by striping, and can include pavement stencils and other treatments. Separated bikeways are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation.

Separated bikeways can increase safety and promote proper riding by:

- Defining road space for bicyclists and motorists, reducing the possibility that motorists will stray into the bicyclists' path.
- Discouraging bicyclists from riding on the sidewalk.
- Reducing the incidence of wrong way riding.
- Reminding motorists that bicyclists have a right to the road.



Marked Shared Roadway



Neighborhood Greenways



Conventional Bicycle Lanes



Uphill Bike Lane Treatments



Buffered Bike Lanes



Cycle Tracks

# Marked Shared Roadway

## Description

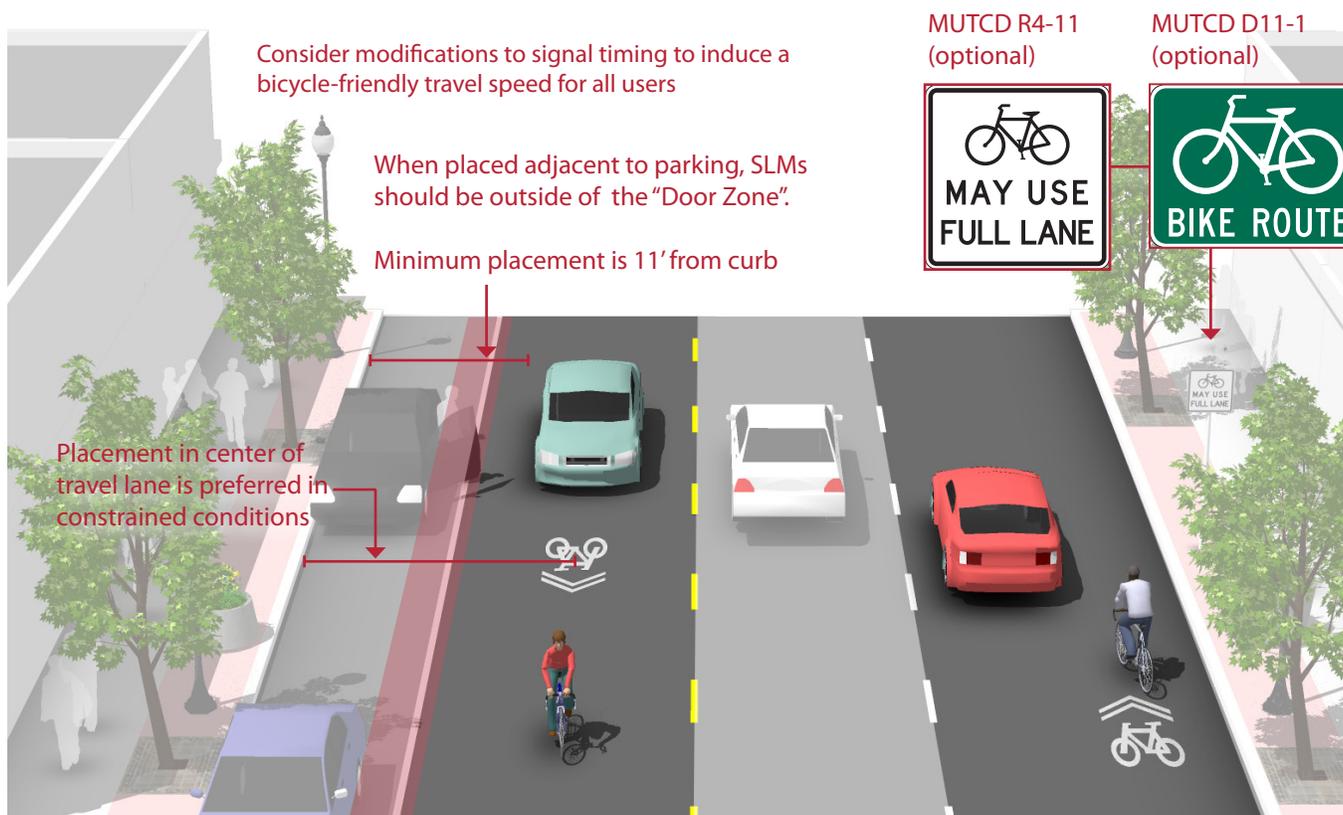
A marked shared roadway is a general purpose travel lane marked with shared lane markings (SLM) used to encourage bicycle travel and proper positioning within the lane.

In constrained conditions, the SLMs are placed in the middle of the lane to discourage unsafe passing by motor vehicles. On a wide outside lane, the SLMs can be used to promote bicycle travel to the right of motor vehicles.

In all conditions, SLMs should be placed outside of the door zone of parked cars.

## Guidance

- In constrained conditions, preferred placement is in the center of the travel lane to minimize wear and promote single file travel.
- Minimum placement of SLM marking centerline is 11 feet from edge of curb where on-street parking is present, 4 feet from edge of curb with no parking. If parking lane is wider than 7.5 feet, the SLM should be moved further out accordingly.



## Discussion

**Bike Lanes** should be considered on roadways with outside travel lanes wider than 15 feet, or where other lane narrowing or removal strategies may provide adequate road space. SLMs shall not be used on shoulders, in designated **Bike Lanes**, or to designate **Bicycle Detection** at signalized intersections. (MUTCD 9C.07)

This configuration differs from a **Neighborhood Greenway** due to a lack of traffic calming, wayfinding, and other enhancements designed to provide a higher level of comfort for a broad spectrum of users.

## Additional References and Guidelines

- AASHTO. (2012). Guide for the Development of Bicycle Facilities.
- FHWA. (2009). Manual on Uniform Traffic Control Devices.
- NACTO. (2012). Urban Bikeway Design Guide.

## Materials and Maintenance

Placing SLMs between vehicle tire tracks will increase the life of the markings and minimize the long-term cost of the treatment.

# Bicycle Boulevard

## Description

Bicycle boulevards are low-volume, low-speed streets modified to enhance bicyclist comfort by using treatments such as signage, pavement markings, traffic calming and/or traffic reduction, and intersection modifications. These treatments allow through movements of bicyclists while discouraging similar through-trips by non-local motorized traffic.

## Guidance

- Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard.
- Bicycle boulevards should have a maximum posted speed of 25 mph. Use traffic calming to maintain an 85th percentile speed below 22 mph.
- Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day.
- Intersection crossings should be designed to enhance safety and minimize delay for bicyclists.

**Signs and Pavement Markings** identify the street as a bicycle priority route.



**Enhanced Crossings** use signals, beacons, and road geometry to increase safety at major intersections.

**Partial Closures** and other volume management tools limit the number of cars traveling on the bicycle boulevard.

**Speed Humps** manage driver speed.

**Curb Extensions** shorten pedestrian crossing distance.

**Mini Traffic Circles** slow drivers in advance of intersections.



## Discussion

Bicycle boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without treatments for bicyclists, these intersections can become major barriers along the bicycle boulevard and compromise safety.

Traffic calming can deter motorists from driving on a street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

## Additional References and Guidelines

Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.  
 BikeSafe. (No Date). Bicycle countermeasure selection system.  
 Ewing, Reid. (1999). Traffic Calming: State of the Practice.  
 Ewing, Reid and Brown, Steven. (2009). U.S. Traffic Calming Manual.

## Materials and Maintenance

Vegetation should be regularly trimmed to maintain visibility and attractiveness.

# Bicycle Lane

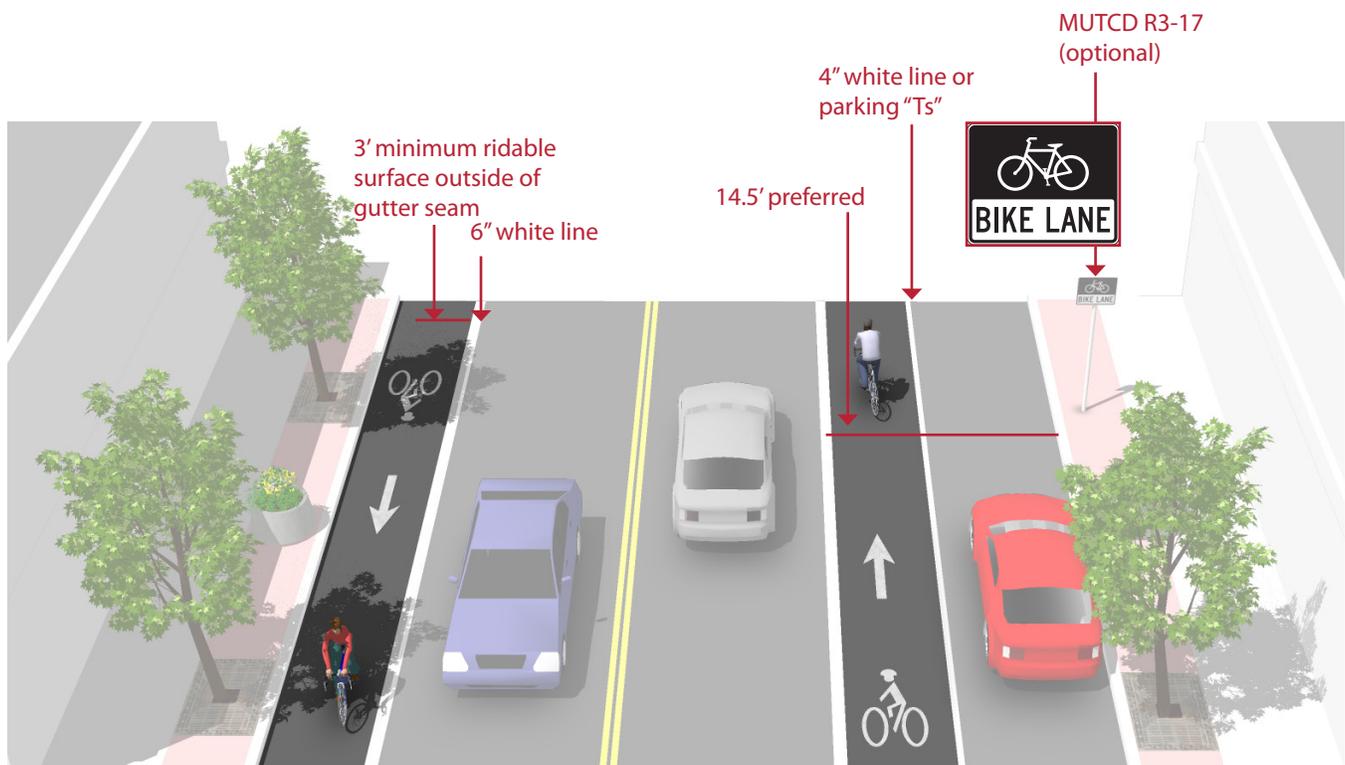
## Description

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is located adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge or parking lane.

Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bikeway than if they are expected to share a lane with vehicles.

## Guidance

- 4 foot minimum when no curb and gutter is present.
- 5 foot minimum when adjacent to curb and gutter or 3 feet more than the gutter pan width if the gutter pan is wider than 2 feet.
- 14.5 foot preferred from curb face to edge of bike lane. (12 foot minimum).
- 7 foot maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane.



## Discussion

Wider bicycle lanes are desirable in certain situations such as on higher speed arterials (45 mph+) where use of a wider bicycle lane would increase separation between passing vehicles and bicyclists. Appropriate signing and stenciling is important with wide bicycle lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane. Consider **Buffered Bicycle Lanes** when further separation is desired.

## Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.  
 FHWA. (2009). Manual on Uniform Traffic Control Devices.  
 NACTO. (2012). Urban Bikeway Design Guide.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.



# Buffered Bike Lane

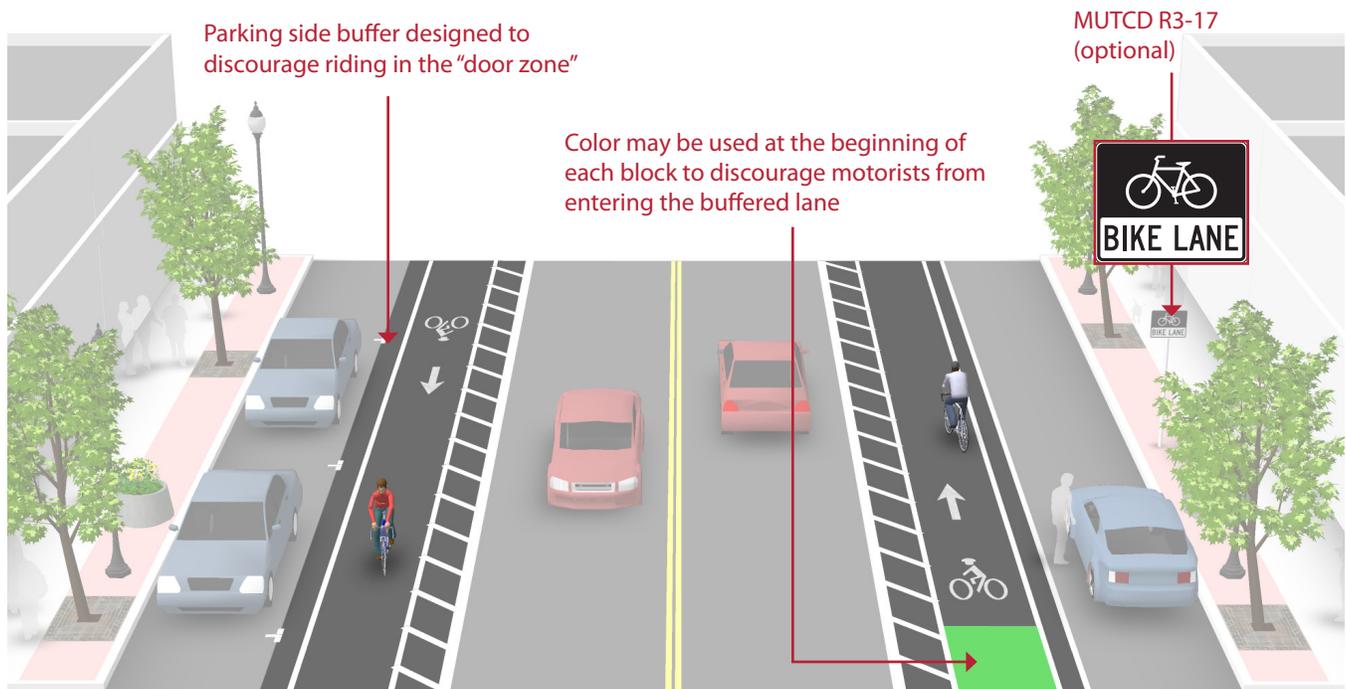
## Description

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. Buffered bike lanes are allowed as per MUTCD guidelines for buffered preferential lanes (section 3D-01).

Buffered bike lanes are designed to increase the space between the bike lane and the travel lane or parked cars. This treatment is appropriate for bike lanes on roadways with high motor vehicle traffic volumes and speed, adjacent to parking lanes, or a high volume of truck or oversized vehicle traffic.

## Guidance

- Where bicyclist volumes are high or where bicyclist speed differentials are significant, the desired bicycle travel area width is 7 feet.
- Buffers should be at least 2 feet wide. If 3 feet or wider, mark with diagonal or chevron hatching. For clarity at driveways or minor street crossings, consider a dotted line for the inside buffer boundary where cars are expected to cross.



## Discussion

Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection. Commonly configured as a buffer between the bicycle lane and motor vehicle travel lane, a parking side buffer may also be provided to help bicyclists avoid the 'door zone' of parked cars.

## Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.  
 FHWA. (2009). Manual on Uniform Traffic Control Devices. (3D-01)  
 NACTO. (2012). Urban Bikeway Design Guide.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

# Cycle Tracks

## Guidance

Cycle tracks should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.

### One-Way Cycle Tracks

- 7 foot recommended minimum to allow passing. 5 foot minimum width in constrained locations.

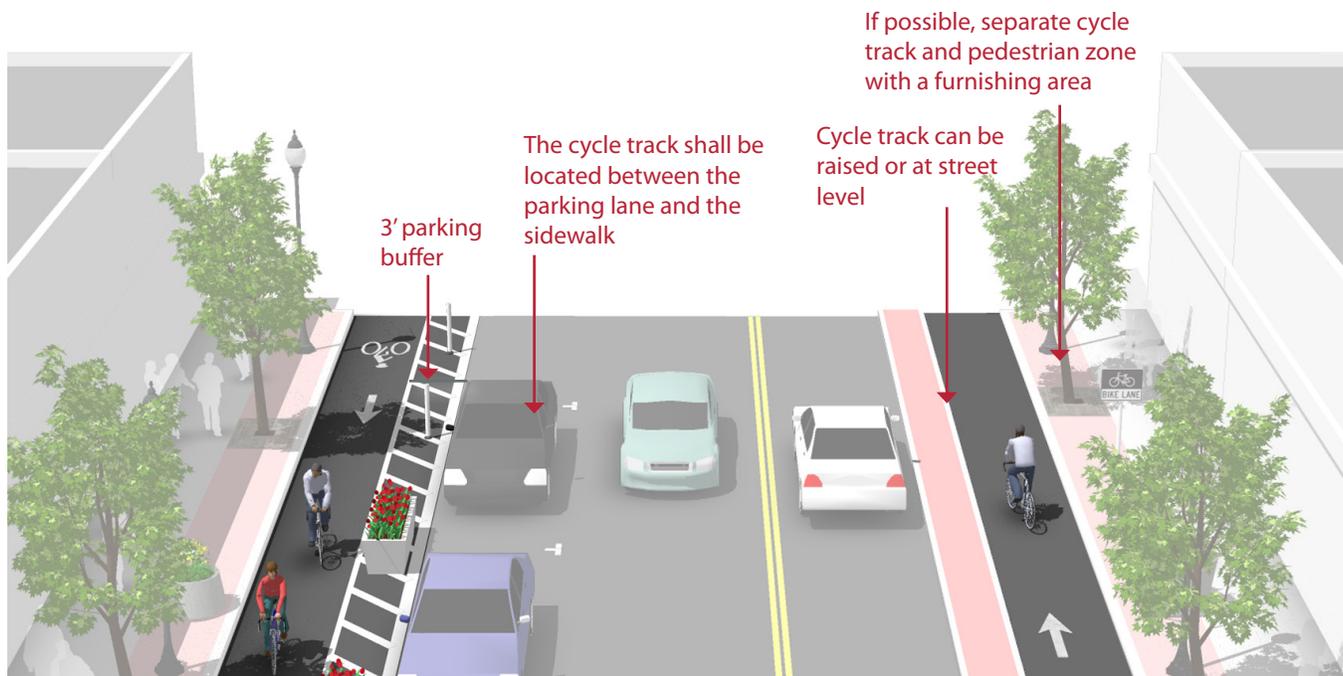
### Two-Way Cycle Tracks

- Cycle tracks located on one-way streets have fewer potential conflict areas than those on two-way streets.
- 12 foot recommended minimum for two-way facility. 8 foot minimum in constrained locations

## Description

A cycle track is an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. A cycle track is physically separated from motor traffic and distinct from the sidewalk. Cycle tracks have different forms but all share common elements—they provide space that is intended to be exclusively or primarily used by bicycles, and are separated from motor vehicle travel lanes, parking lanes, and sidewalks.

Raised cycle tracks may be at the level of the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to separate the cycle track from the pedestrian area.



## Discussion

Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. Driveways and minor street crossings are unique challenges to cycle track design. Parking should be prohibited within 30 feet of the intersection to improve visibility. Yield markings and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic. If configured as a raised cycle track, the crossing should be raised so that the sidewalk and cycle track maintain their elevation through the crossing.

## Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.

## Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.