

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Innovation Considerations

#### Determining the Need for Innovation—

Innovative treatments mentioned in this document are widely accepted best practices that have been tested to solve a specific problem with specific set of circumstances. In most instances standard design treatments will work just fine. Innovative bicycle treatments should not be considered until traditional design methods have been explored. The decision to pursue an innovative treatment must be based on sound engineering judgment and the treatment may require an engineering study or a trial period.



Above: New York City signage.



Above: Paris, France intersection markings.



Above: Madison, Wisconsin trail signage.



Above: Montreal intersection markings.



Above: New York City pavement marking.



Above: Portland, Oregon buffered bike lane.



Above: Berkeley bicycle boulevard signage.

## Bicycle Facility Design Guidelines Chapter 9—Innovation

### Innovation Considerations

**Request to Experiment**—An innovative treatment is defined as a pavement marking, sign, signal, or any other traffic control device that is not prescribed for use in the Minnesota Manual on Uniform Traffic Control Devices (MMUTCD). This chapter includes a list of innovative treatments and techniques, most of which require FHWA permission to install. This chapter considers treatments that are not recognized by the 2005 MMUTCD or the 2009 FHWA manual.

#### Traffic Control Devices:

According to the Minnesota Manual on Uniform Traffic Control Devices (MMUTCD), a traffic control device should meet five basic requirements:

- A. Fulfill a need,
- B. Command attention,
- C. Convey a clear, simple meaning,
- D. Command respect from road users, and
- E. Give adequate time for proper response.



**Request to Experiment:** The Minnesota Manual on Uniform Traffic Control Devices (MMUTCD) has outlined a process called “request for experimentation” to install innovative treatments. A proposal is sent to the Federal Highway Administration requesting that the treatment be tested and evaluated. The Manual states:

*“The request for permission should contain the following:*

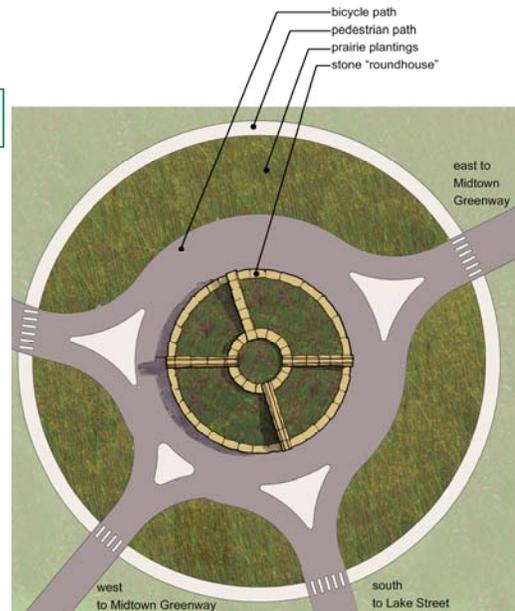
- A) *A statement indicating the nature of the problem.*
- B) *A description of the proposed change to the traffic control device or application of the traffic control device, how it was developed, the manner in which it deviates from the standard, and how it is expected to be an improvement over existing standards.*
- C) *Any illustration that would be helpful to understand the traffic control device or use of the traffic control device.*
- D) *Any supporting data explaining how the traffic control device was developed, if it has been tried, in what ways it was found to be adequate or inadequate, and how this choice of device or application was derived.*
- E) *A legally binding statement certifying that the concept of the traffic control device is not protected by a patent or copyright. (An example of a traffic control device concept would be countdown pedestrian signals in general. Ordinarily an entire general concept would not be patented or copyrighted, but if it were it would not be acceptable for experimentation unless the patent or copyright owner signs a waiver of rights acceptable to the FHWA. An example of a patented or copyrighted specific device within the general concept of countdown pedestrian signals would be a manufacturer’s design for its specific brand of countdown signal, including the design details of the housing or electronics that are unique to that manufacturer’s product. As long as the general concept is not patented or copyrighted, it is acceptable for experimentation to incorporate the use of one or more patented devices of one or several manufacturers.)*
- F) *The time period and location(s) of the experiment.*
- G) *A detailed research or evaluation plan that must provide for close monitoring of the experimentation, especially in the early stages of its field implementation. The evaluation plan should include before and after studies as well as quantitative data describing the performance of the experimental device.*
- H) *An agreement to restore the site of the experiment to a condition that complies with the provisions of this Manual within 3 months following the end of the time period of the experiment. This agreement must also provide that the agency sponsoring the experimentation will terminate the experimentation at any time that it determines significantly safety concerns are directly or indirectly attributable to the experimentation. The FHWA’s Office of Transportation Operations has the right to terminate the experimentation at any time if there is an indication of safety concerns. If, as a result of the experimentation, a request is made that this Manual be changed to include the device or application being experimented with, the device or application will be permitted to remain in place until an official rulemaking action has occurred.*
- I) *An agreement to provide semiannual progress reports for the duration of the experimentation, and an agreement to provide a copy of the final results of the experimentation to the FHWA’s Office of Transportation Operations within 3 months following completion of the experimentation. The FHWA’s Office of Transportation Operations has the right to terminate approval of the experimentation if reports are not provided in accordance with this schedule.”*

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**Bicycle Roundabouts**—Bicycle Roundabouts provide an alternative to traditional trail intersections by not requiring one or more legs of the intersection to stop. Bicycle Roundabouts can handle a significant amount of bicycle traffic but can be challenging for pedestrians. Bicycle roundabouts also create a place for plantings and other amenities and are ideal gathering spots. The drawing on the right shows a proposed roundabout at the intersection of the Midtown Greenway and the LRT Trail, which was not constructed due to financial and space constraints.



#### Bicycle Roundabout Criteria:

- Bicycle Roundabouts are ideal for two high volume intersecting trails, improving safety and mobility.
- Bicycle Roundabouts should only be used if there is adequate right-of-way available.
- Bicycle Roundabouts should consider design speed and pedestrian volume when setting the inner radius.
- Bicycle Roundabouts should be treated as a traffic control device and not as a traffic calming device.
- Bicycle Roundabouts should be designed so that users travel in a counterclockwise direction.
- Good sightlines must be preserved near the roundabout; kiosks, benches, and other amenities should be placed outside the roundabout.
- Trail Roundabouts may be used to improve safety by sorting bicycles and pedestrians thus reducing conflicts.
- Capital and operating costs must be considered and compared to a traditional trail intersection.



**Right:** Photos of Bicycle Roundabouts in Centennial, Colorado.

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**Bicycle Roundabouts** — Bicycle roundabouts allow bicyclists to travel through an intersection without stopping. This creates a more comfortable route for cyclists by using less energy and effort stopping and starting. Bicycle roundabouts also can handle significant numbers of bicyclists and are ideal at college and university campuses where volumes are high. It is recommended that the roundabout diameter be designed to allow for at least 10 mph bicycle traffic. Landscaping or kiosks may be placed in the middle of the roundabout and pedestrian integration must also be considered.

**Right:** Davis, California bicycle roundabout (also called a bike circle). Photo courtesy UC Davis.



**Above:** Midtown Greenway at CEPRO site. Although this is not a true bicycle “roundabout” this treatment is a good example of a trail intersection where users do not need to slow down or stop.

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### Off-Street Treatments

**Bicycle Detection** — Counting bicycles is a necessary task to determine bicycle use and bicycle mode share. These statistics are often used to justify new facilities, to determine funding priorities, and to examine trends. There are several technologies that are currently being used to detect bicycles. One of the most reliable techniques is to use an inductive loop. The loop (placed in the pavement) is sensitive enough to detect the metal in bicycles. The data is stored on a memory chip in a nearby cabinet and the information is downloaded on a routine basis. Other more experimental counting techniques use video or infrared detection.

**Below/Right:** Midtown Greenway Counting Station between Humboldt Avenue and Hennepin Avenue.



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**Cycle Tracks**—Cycle tracks are separated off-street designated bikeways between the street and sidewalk. Cycle tracks are often a different color than the surrounding pavement and are typically 5-6 feet wide.

Advantages/Disadvantages: Cycle tracks are commonly used throughout Europe and the pavement is often colored red, blue, or green. Cycle tracks can be integrated with on-street bike lanes and are typically reserved for busier streets with limited right-of-way. The advantage of a one-way cycle track is greater separation from motor vehicles and pedestrians. Two-way cycle tracks are similar to multi-use trails, however only one-way cycle tracks are recommended for use in the United States because of intersection conflicts. Even one-way cycle tracks can pose problems at intersections where right turning motorists cannot see bicyclists coming up on their right. Cycle Tracks Criteria: Cycle tracks are an experimental treatment in the United States that requires FHWA approval for installation.

- Cycle tracks should only be used where a bike lane, multi-use trail, or separated trail will not adequately address bicycle safety.
- Cycle tracks should be located on urban minor arterials and collector streets between 5,000 and 20,000 vehicles per day.
- Cycle track widths must be at least 5 feet per direction and should be adequately signed.
- Colored cycle tracks must be red or green.



Above: Helsinki, Finland cycle track.



Above: Copenhagen, Denmark cycle track.



Above: Stockholm, Sweden cycle track.



Above: Helsinki, Finland cycle track.

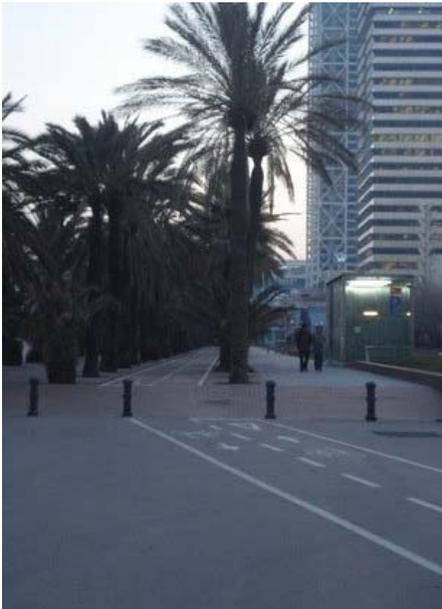


Above: Paris, France cycle track.

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**Off-Street Treatments**

**Cycle Tracks - Examples of cycle tracks.**



**Above:** This cycle track in Barcelona is striped on a sidewalk plaza near a high density area. In this photo, bollards have been placed next to a roadway to keep motor vehicles off of the cycle track.



**Above:** Barcelona, has one of the best bicycle networks in Europe. This facility is intended to keep bicycles separated from pedestrians along a linear corridor with a tree alley.



**Above:** Cycle tracks located within pedestrian plazas should follow trail design standards with regard to lane widths, horizontal curves, and striping specifications.



**Above:** This signalized Berlin intersection separates bicycles from pedestrians at the crossing. Red pavement markings help delineate where to ride. Not all crossings have the supplemental colorization.



**Above:** This wide non-signalized Berlin intersection includes a cycle track crossing. The colorization helps to show bicyclists where to ride and highlights the conflict zone.



**Above:** Berlin's cycle tracks are often built with colored paver bricks and are located between the boulevard and sidewalk. This design is a safety issue for crossing pedestrians.

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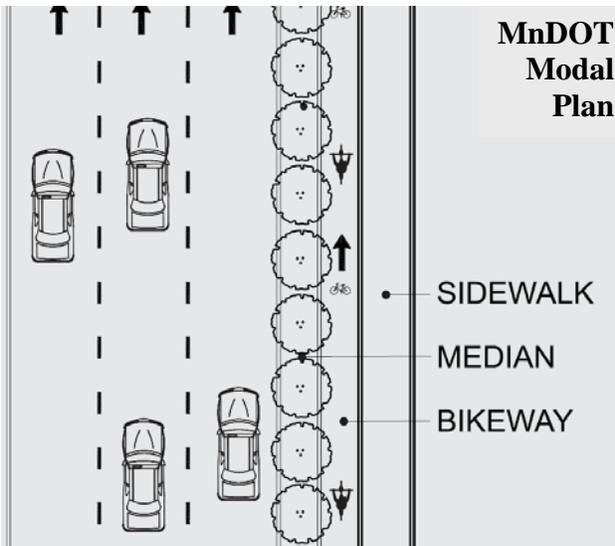
**One-Way Cycle Tracks**—One-way cycle tracks provide separation between the bicyclists and a motor vehicle. A one-way cycle track must be 5 feet in width and must have a matching lane in the other direction within the same roadway corridor. Special attention must be given to intersections to ensure that right turning vehicles can see crossing bicyclists.



**Above:** This innovative cycle track in Münster, Germany sorts bicyclists in advance of the intersection.



**Above:** This Münster, Germany street has dedicated space for the cycle track, bike parking, and pedestrians.



**Above:** This crossing in Utrecht, Netherlands uses elephant foot pavement markings to improve visibility. Narrower markings are used at pedestrian crossings.



**Above:** This One-Way cycle track in Amsterdam, Netherlands demonstrates how vertical elements can help provide separation between modes.



**Above:** This cycle track crossing in Utrecht also uses elephant foot pavement markings in addition to shark teeth. The shark teeth point to the mode that must yield.

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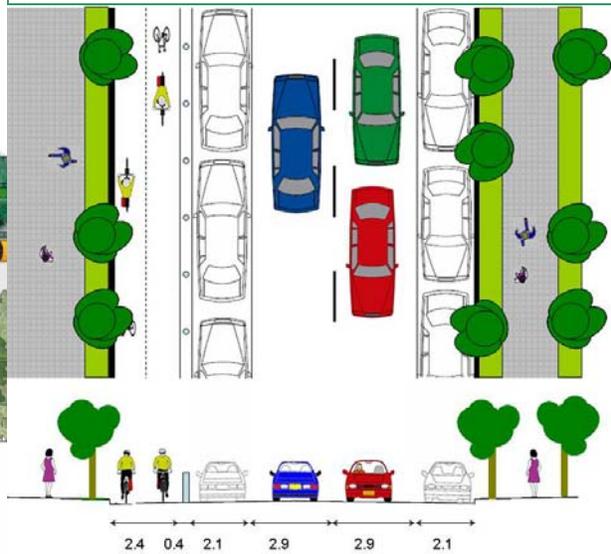
**Two-Way Cycle Tracks**— Two-Way Cycle Tracks allow bicycle movement in both directions. Two-Way Cycle Tracks must be at least 10 feet in width and resemble multi-use trails. Two-Way Cycle Tracks are typically found in urban areas and are well signed and marked.



**Above:** The photo above shows a two-way cycle track in Stockholm, Sweden.



**Above:** The diagram above is an example of a two-way cycle track in Sydney, Australia along Union Street.



**Above:** The layout above is an example of a two-way cycle track from Sydney, Australia.



**Above:** Shown is an example of a colored two-way cycle track roadway crossing in Münster, Germany.

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**Two-Way Cycle Tracks** —Two-Way cycle tracks are often located at the same grade as the roadway and are separated by striping, a concrete median, or a boulevard. The photos show Two-Way Cycle Tracks in Montreal.



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### Off-Street Treatments

**Dismount Zone**—Dismount zones are often needed when bicycles and pedestrians can not safely share the same space. Signage and pavement markings are often helpful in informing bicyclists, however in some areas it is not practical or necessary to sign or mark the dismount zone because of a known statute or ordinance. Dismount signage and pavement markings should be minimized and should only be used when one or more of the following criteria are met:

- The location presents a clear safety problem such as a narrow sidewalk or a steep slope. Clear zones, sight distances, and crash history should be evaluated.
- The location has a substantial number of pedestrians such as a college campus or a sidewalk in front of numerous businesses. Both pedestrian and bicycle volumes and level-of-service should be considered and compared.
- The location is in an area with a high number of children or elderly pedestrians.
- The location has a suitable alternative route for bicycles within a reasonable distance.

Minneapolis ordinance prohibits bicyclists from riding on sidewalks in commercial areas. These areas include all of Downtown Minneapolis, Uptown, and Dinkytown. Riding on sidewalks is allowed in residential areas.



Above: Berkeley, CA marking.



Above: Uptown pavement marking.



Above: Vancouver, BC signage.



Above: Berkeley, CA signage.



Above: Berkeley, CA signage.



Above: Washington, DC signage.

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**Lighted Signage**—Lighted signage enhances a standard warning or regulatory sign at a high volume or high speed intersection with a trail crossing. Lighted signage must be placed carefully as to not distract drivers and to convey a clear message at any time of the day.

Lighted Signage Criteria: Lighted signage is an experimental treatment which requires FHWA approval.

- Lighted signage must enhance an MUTCD approved sign type.
- Lighted signage should only be used for at-grade trail crossings with high bicycle volumes and poor intersection visibility.
- Operation and maintenance costs must be considered when installing this type of treatment.
- Lighted signage may also be used at trail crossings with a high percentage of bicycle crashes.
- Lighted signage must be treated as an enhancement to an intersection and not the primary traffic control device in case power were to go out or if the light would burn out.
- Lighted signage is just as important during daytime hours as nighttime hours. Placement of the sign relative to the direction of sunlight need to be considered.

The City of Minneapolis and the U of M have experimented with these types of signs. They are not recommended for future installation.



Above: University of Minnesota Transitway.



Above: University of Minnesota Transitway.



Above: University of Minnesota Transitway.



Above: Midtown Greenway at 5th Avenue.

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**Median Trail**—A median trail is a multi-use trail placed in a wide landscaped median between moving lanes of traffic. Tree canopies must be high enough for bikers to see oncoming vehicles. A median trail also requires a sufficient amount of space on both sides of the trail to allow for a safe crossing at an intersection. Median trails should be signed at roadway crossings and there must be clear visibility at intersections. A median trail should have at least 5 feet of clearance on both sides of the facility. A median should be at least 20 feet wide to accommodate a 10-foot wide multi-use trail, 22 feet wide to accommodate a 12-foot wide trail and so on.



**Above:** Median Trail in Lima, Peru.



**Above:** Median Trail in Barcelona, Spain.

**Below:** Victory Parkway in Minneapolis.



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**Mode Signage and Markings**—Mode Signage helps bikers, pedestrians, and roller bladers determine which path to use along a trail system. This type of signage is also useful when bicycles share a trail corridor with horses or with dog walkers. There are dozens of examples of innovative (but often nonconforming) mode signage throughout the United States. Although this type of signage may be unique to a municipality, it is important to think about uniformity and consistency in signage design.



Above: Mode Markings in Portland, OR.



Above: Mode Signage in Denver, CO.

Above: Mode Markings in Vancouver, BC.



Above: Mode Markings in San Francisco, CA.



Above: Mode Signage in Mesa, AZ.



Above: Mode Signage in St. Louis, MO.

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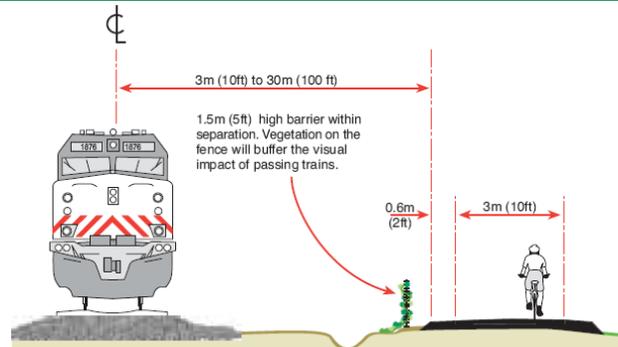
### Off-Street Treatments

**Rails with Trails**—Although it is common to place a trail in an abandoned railroad corridor, it is much more difficult to place a trail along an active rail corridor. Working to meet the requirements of the operating railroads may be difficult and may require innovative solutions. Federal law requires an 8.5-foot minimum setback from the centerline of a railroad track to an obstruction such as a fence. Factors that should be used to determine setback distances include type, speed, and frequency of trains, sight distance, topography, maintenance requirements, historical issues, and separation technique.

**Diagram on right:** Setbacks from rail are highly dependant on operating railroad requirements. It is recommended that trails be at least 10 feet away from a railroad with higher setbacks for faster or busier rail. Diagram courtesy FHWA and Alta Planning + Design.



**Above:** The Edmonton, Alberta Streetcar Society operates electric street cars next to the Ribbon of Steel



**Above:** Freight rail next to the Cedar Lake Trail



**Above:** Freight rail next to a trail in White Rock, BC.



**Above:** LRT next to a trail in Edmonton, Alberta



**Above:** Trail on the Steel Bridge in Portland, OR.

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### On-Street Treatments

**Advance Stop Lines (Bike Boxes)**— Advance Stop Lines (commonly known as Bike Boxes) provide a place for bicycles to gather in advance of motor vehicles at a signalized intersection. Bike boxes may improve safety by making bicyclists more visible at intersections and make it easier for a bicyclists to transition from one side of the road to the other.

#### Bike Box Criteria:

- Bike Boxes should only be used when traditional intersection treatments do not adequately address bicycle safety or mobility.
- Bike Boxes are an experimental treatment and require FHWA approval before they are installed.
- Bike Boxes have been used at intersections with high left turn and right turn crash rates.
- Bike Boxes may be used in conjunction with experimental bicycle signals to give bicyclists preference on a given roadway.
- Colored bike boxes have been used for extra visibility. Green markings may be used, however maintenance needs must be considered. Blue bike box pavement markings are no longer recommended for use in the US.



**Above:** A green bike box in Portland, OR



**Above:** A green bike box in Portland, OR



**Above:** An example of a colored bike box in Victoria, BC. In this case the bike box is blue. Blue pavement are not recommended since the color is designated for hospital and handicapped use in the US.



**Above:** Bike box signage in Portland, OR. This signage is part of an education campaign to teach drivers and bicyclists how to use bike boxes.



**Above:** This Bike Box in Madison, Wisconsin is located on a two way street with no bike lane. Bikers may use the bike box to more easily make a left turn.

# Bicycle Facility Design Guidelines

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### On-Street Treatments

#### Advance Stop Lines (Bike Boxes) - Examples



**Above:** Several bicyclists are waiting in this Münster Germany bike box. The size of the bike box should be based on observed and projected bicycle volumes.



**Above:** This Bike Box in London, UK is located at an intersection adjacent to St. Paul's Cathedral. Note that the bike box has been placed behind the crosswalk.



**Above:** This Bike Box in Münster, Germany demonstrates the need for education and enforcement as a vehicle has pulled into the bike box.



**Above:** This Brussels, Belgium bike box is located adjacent to a contra-flow bike lane. The bike box helps improve visibility for bikes traveling in both directions.



**Above:** Bike Box at an intersection in Erlangen, Germany. This intersection uses a red sealcoat to highlight the bike lane and to improve visibility. There is enough space for several bikes to queue up behind the stop bar.



**Above:** Bike Box at an intersection in Erlangen, Germany. This intersection uses a red sealcoat to highlight the bike lane and to improve visibility. There is enough space for several bikes to queue up behind the stop bar.

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## On-Street Treatments

### Advance Stop Lines (Bike Boxes) - Examples



**Above:** This hybrid bike box in Vancouver, BC also acts as a right pocket zone for left turning bikes.

**Left:** This bike box in Portland, OR has been installed in conjunction with a left-sided bike lane. There is a contra-flow bike lane in the opposite direction.



**Photo:** Münster, Germany signal with an Advance Stop Line (Bike Box). The photos show before and after the signal has changed.

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**Advisory Bike Lanes**— Advisory Bike Lanes are placed on local streets where there is not enough room for bicycle lanes in addition to parking and two moving lanes. Advisory Bike Lanes are striped with a skip dash on both sides and are 5-6 feet in width. Vehicles are allowed to enter the bike lane when trying to pass one another. In some locations colored pavement has been used to increase the visibility of the Advisory Bike Lane. Advisory Bike Lanes should only be used on narrow local streets where parking can not be removed. Advisory Bike Lanes are not permitted on MSA, CSA, and TH Routes.



**Above:** Advisory Bike Lane near the Stone Arch bridge. In this case a solid line was striped instead of a skip dash line along this very low volume roadway.



**Above:** Advisory Bike Lane in Utrecht, Netherlands



**Above:** Advisory Bike Lane in Utrecht, Netherlands.



**Above:** Advisory Bike Lane in Utrecht, Netherlands

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**Bicycle Climbing Lanes**—Bicycle climbing lanes are bicycle lanes on one side of a roadway that are placed to assist bicyclists with steep hills. Bicycle climbing lanes are typically placed in an uphill direction, which provides bicyclists with more room as they tend to sway more when traveling up a hill. Similar to uphill truck lanes, the lane allows vehicles to safely pass slower bicyclists. Regular bicycle lanes on both sides of the road should be considered before placing a lane in one direction unless there is not enough room for bike lanes in both directions. Shared use pavement markings may also be considered. Bicycle climbing lanes may be used when roadway slopes exceed 5%. It is also common to divert a bike route away from a steep hill to a more moderately sloped route within a reasonable distance.



Above: Climbing Bike Lanes in Seattle, WA.



Above: Climbing Bike Lanes in Seattle, WA.



Above: Climbing Bike Lanes in Seattle, WA.

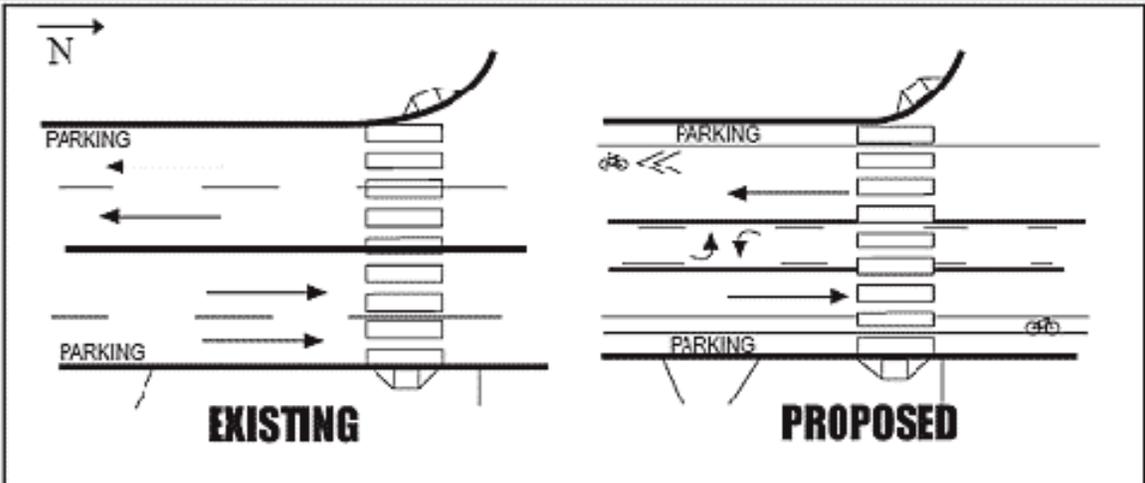
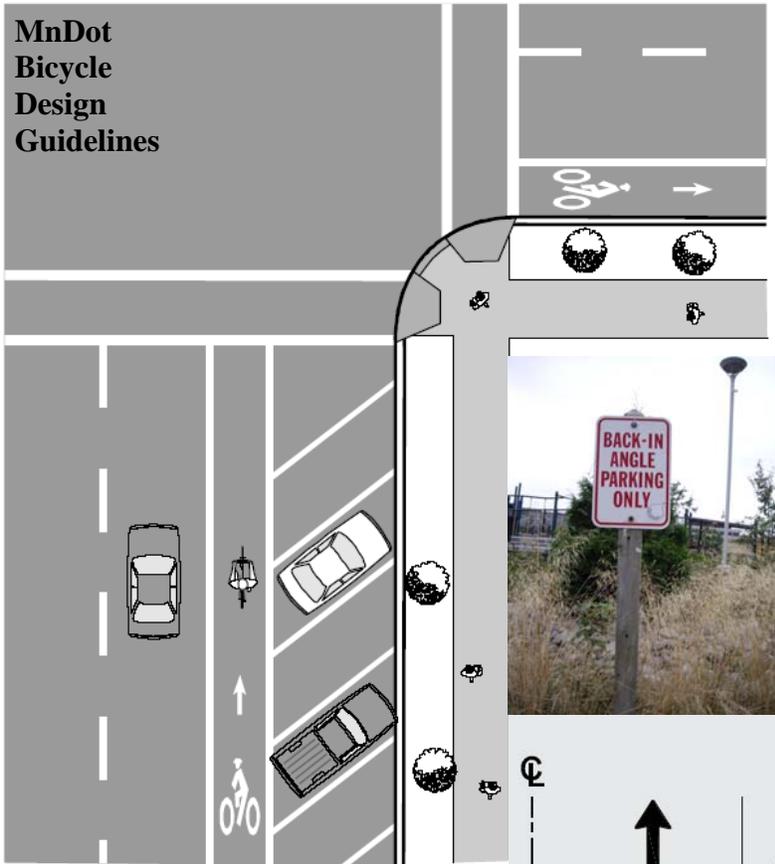


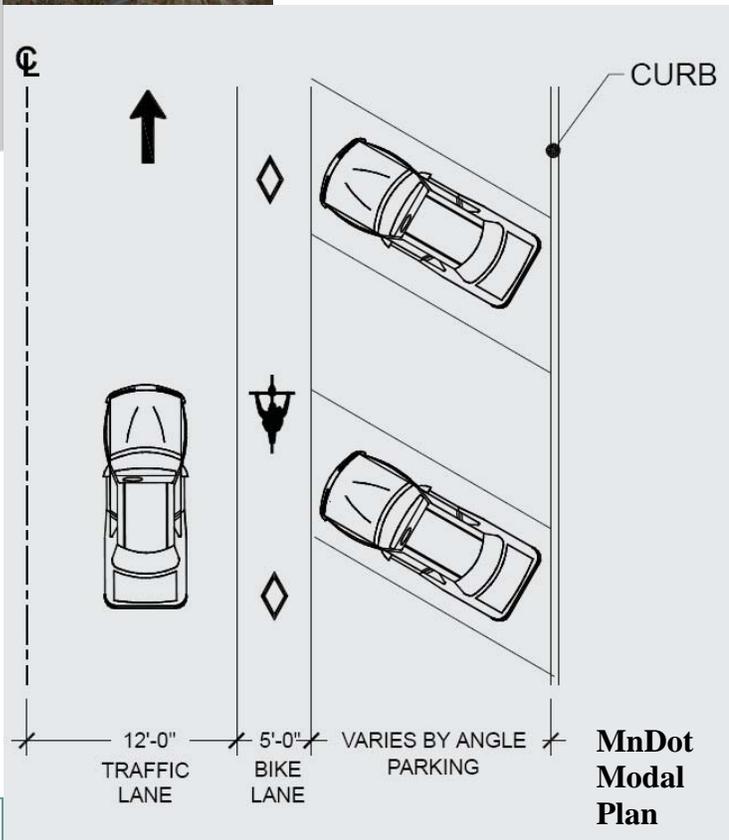
Diagram: Stone Way North of 40th Street proposed section; Courtesy of the City of Seattle.

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**Bike Lane Adjacent to Angled Parking**—Bicycle lanes should not be striped between a moving lane and angled parking. Although bicyclists are less likely to be doored, this treatment presents a number of challenges including the inability for drivers backing out of a parking stall to see a bicyclist. This treatment is especially risky when the angled parking is located adjacent to businesses with high customer turnover such as a post office or a video store. Although limited angled parking exists throughout the city, this treatment is not recommended within the City of Minneapolis.

**Bike Lane Adjacent to Back-In Angled Parking**—One of the ways to mitigate the problem of vehicles backing out of angled parking stalls is to create back-in angled parking. This treatment often results in vehicles sticking out into the sidewalk making it more difficult for pedestrians and disabled users. Although this treatment improves visibility, it should only be used on low volume, low speed roadways. It is not common to stripe back-in angled parking, which may result in confusion and wrong way driving. A traffic study should be completed before implementation.



**Above:** Signage in Seattle, Washington.

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**Bike Lane Enhancements**—Bike Lane Enhancements are additions to the bicycle lane to make bicyclists more visible in the bicycle lane. Enhancements shown include lighted bike lanes, reflectors, and rubber separators. These treatments have not been well researched in the United States, however there are several examples in other countries.



**Above:** Lighted bike lane in Dresden, Germany.



**Above:** Bike Lane Reflectors in Santiago, Chile help distinguish a bicycle lane at night. The major disadvantage to this treatment is the vertical obstruction at the edge of the bike lane. It is recommended that highly reflective pavement markings be used instead for this reason.



**Above:** A 2009 ITE study conducted on 3 streets in Melbourne, Australia concluded that providing a bike lane separator reduced motor vehicle bike lane encroachment by 50%. Cyclist surveys concluded that bicyclists who used these facilities also felt safer. Separators were only used where there was no on-street parking adjacent to the bike lane. Snow plowing and sweeping were recognized as challenges. Photos courtesy of Malcolm Daff and Sinclair Knight Merz. Study published by Institute of Transportation Engineers (ITE).

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**Buffered Bike Lane** — Buffered Bike Lanes are striped spaces between bike lanes and traffic lanes that provide additional separation between bicycles and pedestrians. Bike lane separation can be accomplished in a number of different ways including the removal a 12-foot travel lane to create a 6-foot bike lane next to a 6-foot buffer zone or by narrowing an adjacent 13-foot traffic lane to an 11-foot lane to allow for a 3-foot buffer. Maintenance needs must be considered. Special attention must be given to snow plowing and sweeping challenges that result when debris and snow accumulate in the buffer zone. Enforcement is also needed to keep cars from driving in the buffered areas.



**Above:** This bike lane in New York City was created by taking a moving lane of traffic away to create a buffer zone next to bicycle lane. This treatment is recommended on streets where there is enough capacity to keep the street at level-of-service D or better. Photo courtesy of the New York City DOT.



**Above:** Bruges, Belgium buffered bike lane. Although intended to provide greater separation between cars and bicycles, buffered bike lanes may be designed to allow bicyclists to pass each other or to ride two abreast.



**Above:** Buffered bike lane in Portland, Oregon. Buffered bike lanes provide space for bicyclists to safely pass parked cars without the risk of being doored. The buffered area may also be placed between the bike lane and the parking lane to prevent pedestrians from walking in the bike lane

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**Buffered Bike Lane** — Examples of buffered bike lanes from across North America. In many cases a traffic lane is removed to create a buffered bike lane.



Above: Buffered bike lane in New York City.



Above: Buffered bike lane in New York City.



Above: Buffered bike lane in Portland, Oregon.



Above: Buffered bike lane in Seattle, Washington.



Above: Buffered bike lane in New York City.



Above: Buffered bike lane in New York City.

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**Bicycle/Pedestrian Street**—Bicycle/Pedestrian Streets are streets or plazas where bicyclists and pedestrians have priority over motor vehicles. In some cases motorists may be permitted on Bicycle/Pedestrian Streets for certain periods or functions such as business deliveries.

Advantages/Disadvantages: Clearly the major advantage to this treatment is that bicycles and pedestrians are given space to traverse with minimal motor vehicle conflicts. This concept may result in the reduction of overall traffic capacity in an area and may also result in parking shortages. Some cities in Europe have numerous streets within a zone that are dedicated for bikes and pedestrians.

Bicycle/Pedestrian Street Criteria: Bicycle/Pedestrian Streets should be located in dense areas with high bicycle and pedestrian volumes. Care should be taken to minimize conflicts with pedestrians, especially conflicts in commercial/retail zones where a high number of pedestrians may be entering and exiting a building. Time regulations may also be considered to maximize the use in a given area. For instance, delivery vehicles may be permitted on a Bicycle/Pedestrian Street during early morning hours or during overnight hours. Bicycle parking should also be considered for these areas. When vehicles are permitted, speeds should be posted at 10 mph or slower.

**Photos:** The top photo shows a Bicycle/Pedestrian Street in Münster, Germany. The middle photo shows a nearby Pedestrian/Bicycle Street that allows delivery vehicles during off-peak periods. The bottom photo shows another Münster, Germany plaza where bicycles are only allowed during off-peak hours to give priority to pedestrians.



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**Bicycle/Pedestrian Street**—Bicycle/Pedestrian Streets can take the form of a plaza or greenway corridor. In both cases bicycles and pedestrians take priority over other modes.

**Right**—In Minneapolis the closest example of a bicycle zone would be the Chicago Avenue Plaza near the Guthrie Theatre. In addition to biking and walking, vehicles are permitted to enter/exit the zone to get to a nearby residential parking garage in addition to a weekly farmer’s market on the plaza. Most plazas in Minneapolis are intended for pedestrians only.

**Below**—The photo above shows Milwaukee Avenue in Minneapolis where a former street has been converted into a greenway where only bicycles and pedestrians are allowed. Bicycle/pedestrian streets are typically short in length (1-2 blocks), however longer corridors have proposed in collaboration with storm water projects.



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**Bicycle/Pedestrian Street**—Woonerfs or “home zones” can be found in the Netherlands, Great Britain, and in Germany. Similar to bicycle boulevards, woonerfs have lower speed limits and bicycles/pedestrians have priority over motorists. Woonerfs are located on local streets with special signage and pavement treatments.



**Above:** Vehicles are allowed on this Kiel, Germany street, but must yield to bikes.



**Above:** Bicycle/pedestrian street signage in Dresden, Germany.



**Above:** This signage in Utrecht, Netherlands tells drivers and bicyclists that there is a diverter at this end of this street, which allows bicyclists to pass but not cars.



**Above:** Do Not Enter Except Bicycle Signage in Brussels, Belgium. This type of signage must be coupled with enforcement to be effective.

## Bicycle Facility Design Guidelines Chapter 9—Innovation

### On-Street Treatments

**Bicycle Signalization** — Bicycle Signalization is an innovative way to give bicycles priority at an intersection. Often coupled with bike boxes, bicycle signals allow bicyclists to enter the intersection on a green light before motor vehicles are given the green. The advanced time given to bicyclists allows for a biker to change lanes or to safely turn without conflict. Bicycle signalization is used commonly throughout Europe where bicycle mode share is considerably higher than in the United States. Bicycle signalization involves a supplemental signal head with red, yellow, and green indications.



Above: Münster, Germany Bike Signal



Advantages/Disadvantages: Bicycle Signalization allows a bicycle a head start at an intersection. This head start allows bicyclists the opportunity to change lanes or to make a turn before motor vehicles, therefore reducing potential conflicts. The major disadvantage to this treatment is the possible reduction in level-of-service. Creating dedicated time for a bicycle signal phase either takes green time away from motorists or creates a longer cycle length. This type of treatment may not be possible where multiple signals are coordinated. This treatment can also create confusion amongst bicyclists and motorists and requires significant education and enforcement.

Bicycle Signalization Criteria: Bicycle Signalization is considered experimental and requires FHWA approval.

- This treatment must address a specific problem that other more standard treatments do not address.
- A capacity analysis should be completed to determine if the bicycle signal reduces the level of service at a given intersection.
- Bicycle signalization should not significantly reduce intersection level-of-service. This treatment should not be pursued if the signal level-of-service is less than D. The bicycle phase must be significant enough to allow bicycles to make a lane transition.
- Crash statistics need to be monitored very closely.
- This treatment must be accompanied by appropriate signage to reduce confusion.
- Bicycle signalization should only be installed when a dedicated bike lane and an advance stop line (bike box) is present at an intersection.
- Bicycle volumes should exceed 500 per day.
- Maintenance/capital costs must be



Above: Bike Signal in Kiel, Germany

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Bicycle Signalization**—Only a handful of American cities have experimented with bicycle signalization. Shown are two American examples of how bicycle signalization can be used.



**Above:** New York City trail crossing where bicycle signalization has been used.

**Above:** Close-up of bicycle signal at intersection below.



**Above:** Bicycle scramble at a signal in Portland, Oregon. This intersection has a trail terminate at the corner of the intersection. A special signal phase allows bikes to safely enter the intersection and travel in either direction.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Bicycle Signalization** — Shown are examples of Bicycle Signalization throughout Europe.



**Above:** Close up of bicycle signal head in Cologne, Germany. In this case the signal serves a dual purpose. LED technology is commonly used to reduce electricity costs. This type of bicycle signalization is often used in conjunction with cycle tracks but may also be considered at trail crossings.



**Above:** This intersection in Amsterdam shows how a bicycle signal can be used along a cycle track with a protected right turn phase for traffic. Note that there is also a bicycle actuation pedestal for on-street bicyclists.



**Above:** Münster, Germany signal. This type of signal may be used in conjunction with dedicated left turn lanes for bicycles. This treatment should be limited to locations with extremely high left turning bicycle volumes and where vehicle level-of-service will not be severely compromised. In Germany this type of signal is used in conjunction with cycle tracks and can reduce the risk of crashes.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Colored Bike Lanes** — Colored Bike Lanes are intended to make bicyclists more visible, resulting in fewer crashes. For years Minneapolis has used a red sealcoat treatment on bike lanes downtown, particularly along corridors with left side bike lanes and reverse flow bus lanes to enhance visibility and safety.

Advantages/Disadvantages: There are many advantages and disadvantages to using colored pavement markings. Bicyclists have often stated that colored markings make them more comfortable riding on the streets by better delineating the bike lane. Colored pavement markings in conflict zones also enhance bicycle visibility, but it is unclear at this point as to whether colored pavement markings actually reduce crashes. Colored pavement markings can be expensive to maintain as well. Colored concrete or colored sealcoat is preferred over paint since paint often gets slippery and can be chipped by snow plows. In Minneapolis red bike lanes are to be reserved for left-sided bike lanes only. Green bike lanes may be used in other locations in the city.

Colored Bike Lane Criteria: Colored Bike Lanes are considered experimental and require FHWA approval.

- Colored bike lane must be green. Blue pavement markings are reserved for handicap uses.
- Colored bike lanes may be used for the entire length of a bike a lane or may be used only in conflict zones. A corridor must consistently use one or the other approach.
- Colored paint, colored concrete, or a colored sealcoat should be considered as the preferred treatment.
- Maintenance costs must be considered.
- Colored bike lanes must be restored after construction with the same pre-construction colored treatment type. For instance, a bike lane with a red sealcoat must have the color restored so that there is not a color patchwork in the bike lane.



Above: Colored bike lane in Chicago.



Above: Colored bike lane in Copenhagen.



Above: Colored bike lane in New York City.



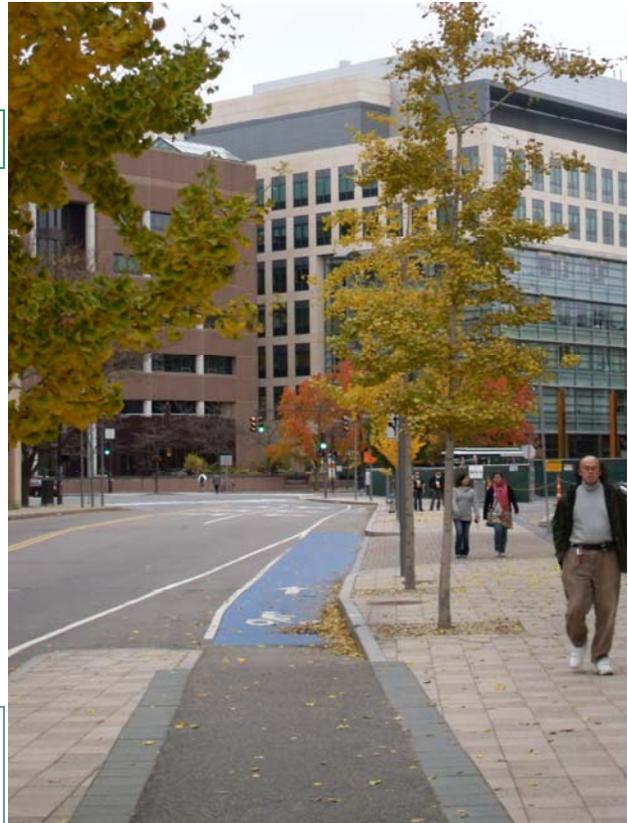
Above: Colored bike lane in Luxembourg.

## Bicycle Facility Design Guidelines Chapter 9—Innovation

### On-Street Treatments

**Colored Bike Lanes** — Colored Bike Lanes may be used exclusively at conflict zones to warn bicyclists of possible turning vehicles and to increase the visibility of bicycles. Conflict zones may include exit or entrance ramps, roadway intersections, or driveways. It is recommended that green pavement be used in lieu of blue so there is no confusion about handicapped or hospital uses, which are typically signed and marked in blue. It is important to supplement the colored pavement markings with appropriate yield signage and to keep the markings well maintained.

**Photos:** Examples of colored bike lanes in conflict zones located in Cambridge, Massachusetts. Note that green conflict zones are now being used instead of blue.



# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

ITE

### On-Street Treatments

**Combined Turn Lane**— This design converts a right or left turn lane into a designated shared turn lane where there is not enough space for a designated bicycle lane.

Advantages/Disadvantages: In many locations there is not enough room for a traffic lane, a turn lane, and a bike lane to fit side by side. Most urban turn lanes are designed to be 10-12 feet wide so reducing turn lane widths will not yield enough space for a 5-foot or 6-foot bike lane. By combining a bike lane into a right turn lane, a biker has a recommended place to ride and drivers are more likely to predict bicycle behavior. Bicyclists traveling straight through an intersection are expected to be right of through traffic. This treatment also clearly delineates the right-of-way for both bicycles and drivers entering an intersection. This treatment is not recommended on most routes. It can be argued that it is safer to do nothing rather than encourage bikers traveling straight to mix with turning vehicles. This treatment can also be very confusing and has not been tested in many locations.

Combined Turn Lane Criteria: Combined shared turn lanes are considered experimental and require FHWA approval. The following implementation criteria should be followed:

- Implemented at locations where the bicycle volumes meet or exceed the volumes of turning vehicles.
- Pursued in cases where right-of-way can not be increased.
- Other options should be studied before using this treatment including turn lane removal, lane reductions, and using through right or through left turn lanes.
- A skip dash line must be used through the turn lane to help guide bicyclists.



Photos: Combined right turn lane in Eugene, Oregon



Photos: Combined right turn lane in Washington, DC.



Photos: Combined left turn lanes in New York City.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Contra-Flow Bike Lanes** — Contra-Flow (Reverse Flow) Bike Lanes allow bicyclists to travel in the opposite direction of motor vehicles in the same roadway corridor. Often coupled with reverse flow bus lanes, reverse flow bike lanes provide a more direct and convenient route for bicyclists. Special signage and pavement markings are required to prevent confusion and to clearly demarcate the lane. In many cases, reverse flow bike lanes allow bicyclists better access to adjacent land uses or provides a logical shortcut.

#### Contra-Flow Bike Lane Criteria:

- Reverse Flow Bike lanes should only be pursued on corridors with a significant amount of bicyclists (500 or more). High volumes of wrong way bicycling on a one-way street may indicate the need for a reverse flow bike lane. Vehicle volumes, the number of turn movements/conflict points, and signal capacity should also be considered.
- A reverse flow bicycle lane should have a matching bike lane in the opposite direction on a parallel street or on the same street.
- A reverse flow bicycle lane must have logical endpoints and must provide added mobility to bicyclists.
- Reverse flow bicycle lanes should not be pursued if traditional bike lanes in the same direction of traffic make sense.



**Photos:** Reverse-flow bike lane along 5th Street SE.



**Photos:** Reverse-flow bike along Hennepin Avenue (prior to two-way operation).



**Photos:** Reverse-flow bike lane in Madison, WI.



**Photos:** Reverse-flow bike lane along 4th Street S.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Contra Flow Bike Lanes**—Contra Flow Bike Lanes are typically not striped adjacent to parking lanes in the United States, however some communities have allowed this practice on one-way streets. These photos show contra flow bike lanes in Montreal. This practice is not allowed in Minneapolis due to potential conflicts with motor vehicles and to minimize confusion.



**NOT PERMITTED**



**NOT PERMITTED**



**NOT PERMITTED**

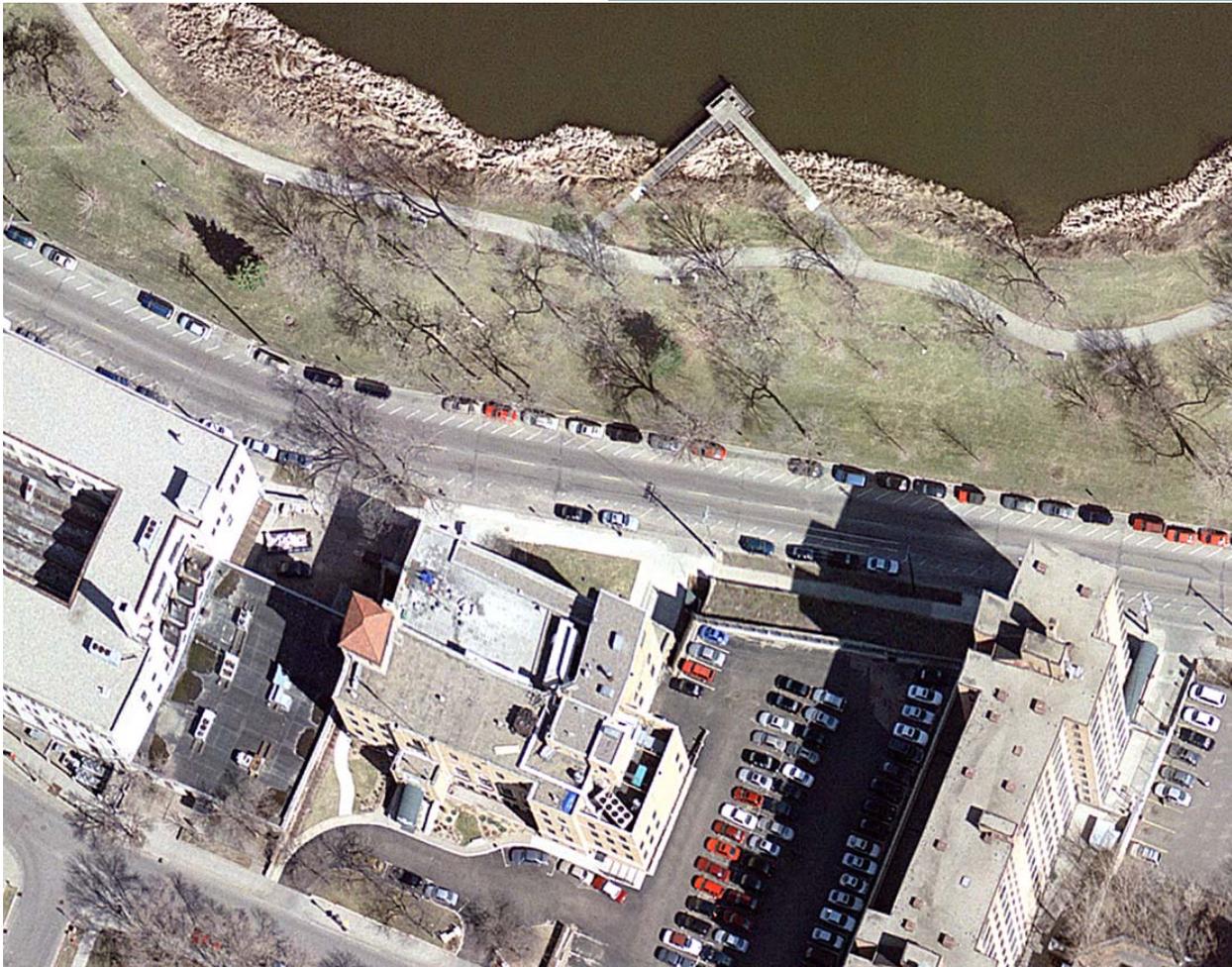
## Bicycle Facility Design Guidelines Chapter 9—Innovation

### On-Street Treatments

**Diagonal Striping**—Diagonal Striping is a treatment that is used in areas where there is not enough space for a standard bike lane. The 4 inch wide white pavement marking is placed diagonally every 6 feet and is coupled with “Share the Road” signage. The pavement markings are placed between a moving lane and the parking lane where a standard bicycle lane would be placed. The pavement marking has been found to keep drivers closer to the centerline of the road and vehicles parked closer to the curb, especially around curves. One of the disadvantages to Diagonal Striping is the proximity of the striping to the door zone.



**Photos:** Diagonal Striping along 15th Street in the Loring Park Neighborhood. This experimental pavement marking has since been removed because of the high costs associated with maintaining it.



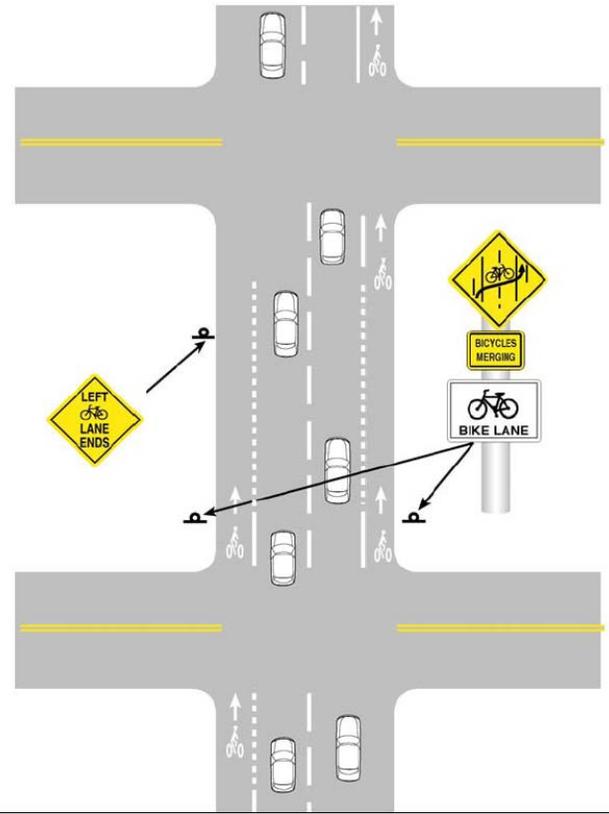
# Bicycle Facility Design Guidelines Chapter 9—Innovation

## On-Street Treatments

**Double Sided Bike Lane (Transition Zone)**— Double sided bike lanes are intended to provide a transition zone for bicycles along a one way street. Typically the treatment is one block in length and allows bicycles to take advantages of traffic gaps to move from one side of the road to the other. This is especially useful when a left sided bike lane must transition to a traditional right sided bike lane. Hybrid warning signage should be used to explain the movement to driver and cyclists. This treatment is best used along signalized corridors.

**Diagram:** San Francisco Design Guidelines  
Courtesy: Alta Planning and Design

**Photos:** Eugene, Oregon signage and striping.

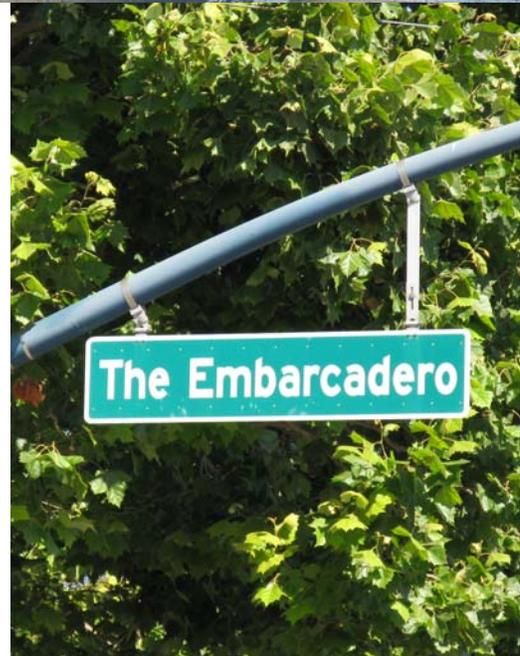
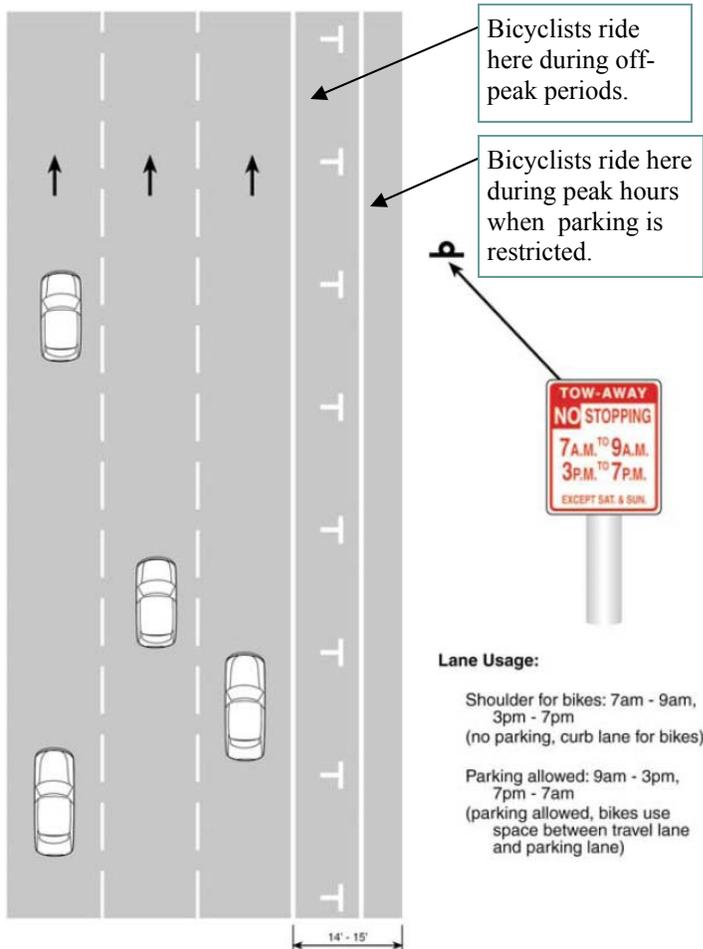


# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Floating Bike Lanes**—In some locations capacity or parking needs during peak periods dictate how space in the right-of-way is allocated. In corridors with high bicycle use it is possible to maximize the space by adding a floating bike lane. A floating bike lane allows for an additional traffic lane during peak periods and preserves parking during off-peak periods without eliminating space for bicyclists. This treatment may be confusing to understand and requires education and enforcement in order to be successful. Improperly parked cars also present visibility and special challenges for bicycles.



**Diagram/Photos:** The configuration on the left is used along the Embarcadero in San Francisco, California. Curbside parking is not allowed during peak periods so that a bicyclists can ride next to the curb. During off-peak periods when parking is allowed, bicyclists use the space between the travel lane and parking lane. Diagram from the 2003 SF Bikeway Design Guidelines.

## Bicycle Facility Design Guidelines Chapter 9—Innovation

### On-Street Treatments

**Half Closure**—When collector and minor arterial roadways connect to local streets it may be appropriate to force vehicles to turn on to intersecting collector or minor arterial streets. Half closures are innovative ways to allow a bike route to stay intact without diverting bikes. This treatment allows bikes to proceed through an intersection while prohibiting other traffic.

Advantages/Disadvantages: Half closures require vehicles to turn right at an intersection reducing left turn conflicts. Commonly used along bicycle boulevards, this forced diversion of traffic is intended to reduce traffic volumes along linear bicycle routes. Half closures are problematic in cold weather climates, especially when concrete medians are used to delineate the right turn lane from the bike lane. Snow and ice are difficult to clear and sand and debris can often get trapped. Permanent half closures are also more costly than many other traffic calming measures.

Criteria: The following criteria must be met when considering a half closure:

- Half closures must consider operations and maintenance concerns such as snow plowing, sweeping, and pavement markings.
- Half closures must consider emergency vehicle routes and potential reductions in response time.
- The right turn lane and bike lanes must be standard widths for the type of roadway and jurisdiction the facility is located on.
- A traffic study should be conducted to examine if there are any safety or mobility issues that are created with the installation of a half closure.
- Special consideration should be given for turning buses and trucks.



**Above:** This Portland half closure includes a median diverter. Motorists must turn right, bikes may go straight.



**Photos:** Example of a half closure at a Berkeley intersection. Curb medians separate the right turn lane from the through bike lane. Inductive loops in the pavement are often used to detect bicyclists.



**Photos:** Example of a half closure in Palo Alto, California along Bryant Street. This half closure uses a curb treatment and signage to delineate the bike lane from the right turn lane. In cold weather climates, pavement markings may be used in lieu of concrete medians so that efficient snow plowing can take place.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Intersection Markings**—Intersection markings aid bicyclists through busy intersections and are intended to improve bicycle visibility. Markings should be easy to understand and maintain. In Europe a number of intersection treatments are used to track bicyclists through a major intersection.

Intersection Marking Criteria: Bicycle intersection markings through intersections are considered experimental and require FHWA approval.

- If a bicycle lane approaches a major intersection, a pair of skip dash lines may be considered for use through the intersection.
- Colored pavement (green) may be used to improve visibility and to highlight conflict zones, especially in high crash or high volume locations .
- A repeating pattern of Shared Use Pavement Markings may be used across the intersection if the approaching bikeway is a signed or shared use route.
- Intersection tracking must use pavement markings with standardized bicycle pavement markings in accordance with the MMUTCD.
- Intersection markings must be separated from crosswalk markings and the bikeway markings should not resemble a crosswalk.



**Above:** This intersection in Paris, France uses a white pavement marking placed on green pavement squares to help improve visibility. Note the separation between bicycles and pedestrians at this crossing.



**Above:** This photo from Montreal demonstrates the importance of repetition in the design.



**Above:** A repeating pattern of Shared Use Pavement Markings were used at this Paris intersection.



**Above:** This intersection in Copenhagen, Denmark shows how colored pavement markings can be used.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Left-Sided Bicycle Lanes**—Left sided bike lanes are a mirror image of traditional right sided bike lanes. Most left-sided bike lanes are placed on one-way streets.

Advantages/Disadvantages: There are several reasons to place a bicycle lane on the left side of the road.

Many of the advantages include:

- Fewer bus stop conflicts: This is one of the primary reasons to consider left-sided bike lanes.
- Better visibility: Drivers are better able to see bicyclists in the driver’s side mirror than on the passenger side. There is also a large blind spot on the passenger side of most vehicles.
- Fewer rush hour parking restrictions: Rush hour parking restrictions create right-turn lanes and add capacity during peak periods. Having the bicycle lane on the left side ensures a consistent facility during all times of the day.
- Fewer dooring incidences: Since most commuters drive alone there are relatively few passenger doors swinging open. Having the bike lane on the left side considerably reduces a bicyclist’s chance of being doored.

Some of the disadvantages include:

- Confusion: Left-sided bike lanes can cause confusion especially when a biker is expected to be on the right side of the roadway. Confusion can lead to crashes or a reduction in the number of bikers who are not comfortable riding the route.
- If parking is permitted, bicyclists may be in a blind spot.
- Left-sided bike lanes only serve more experienced riders and many cyclists’ mirrors are on the left side.
- Left-sided bike lanes can create problems at intersection, especially when the perpendicular route has a bike lane on the right side of the road. To mitigate this, bike boxes or transition lanes may be used to help bicyclists change lanes.

The locations of loading zones need to be considered in addition to truck turning volumes.



**Above:** Left-sided bike lane along Portland Avenue.



**Above:** Left-sided bike lane along 4th Street South.



**Above:** Left-sided bike lane along 4th Street South.



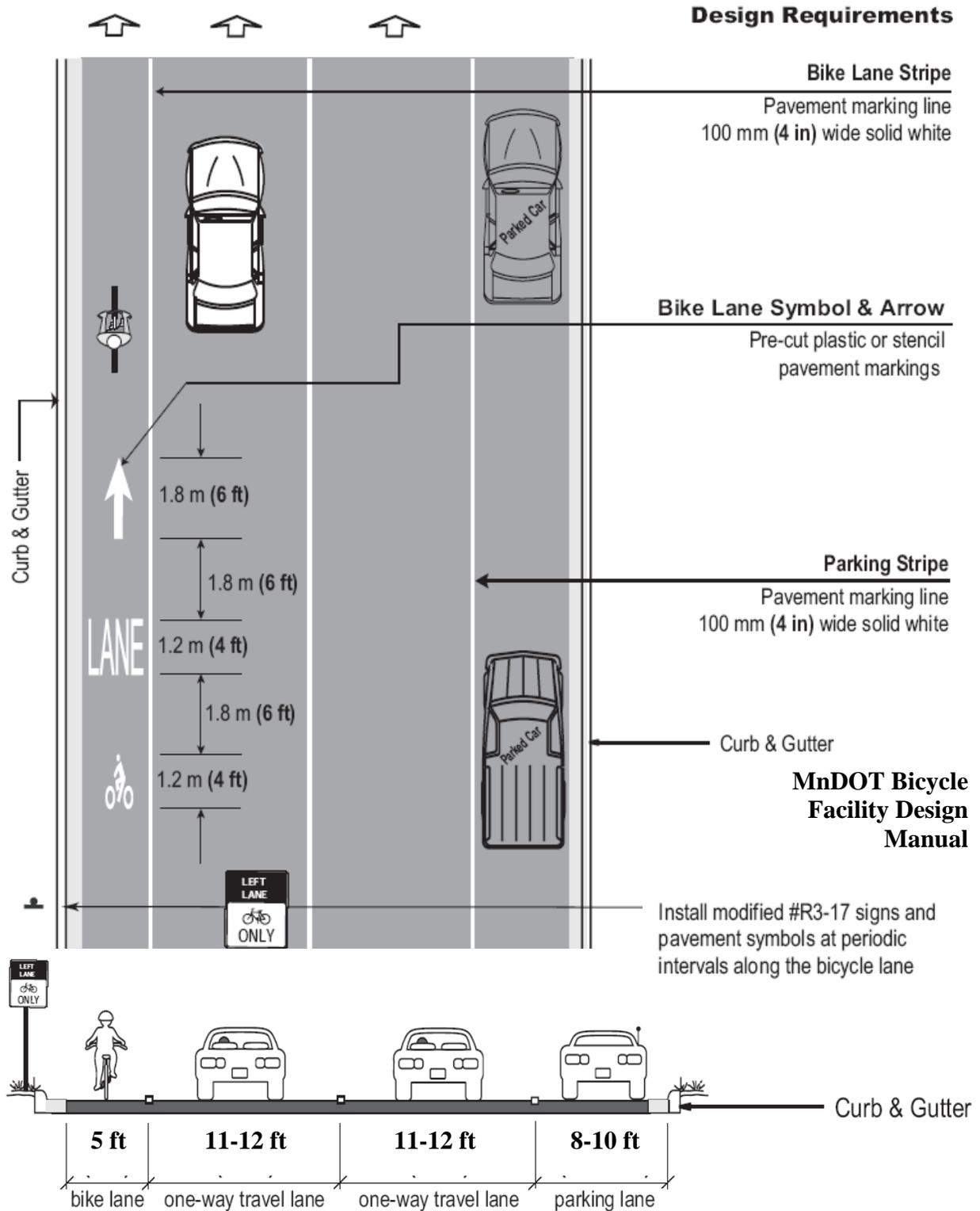
**Above:** Left-sided bike lane along 4th Street South. There are also left-sided bike lanes along 9th St S, 10th St S, 12th St S, and Park Avenue.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

Left-Sided Bicycle Lanes—Below is some guidance for Left-Sided Bicycle Lanes



# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Left Turn Lanes for Bicycles Only (Left Pocket)**—Left Pocket Zones have been used at locations where two major bicycle routes intersect or when a roadway/bike route jogs. The advantage of a Left Pocket Zone is added visibility and greater separation between cars and bikes. This treatment is only appropriate when the volumes of bicyclists are very high and there are sufficient gaps in traffic. Left Pocket Zones must be at least 5 ft wide in each direction and must be placed on roadways with sufficient width to also accommodate two moving traffic lanes. A striped or curbed taper is required in advance of this type of left turn lane. This should only be installed on streets with speeds not greater than 30 mph. Below are example of several types of Left Turn Lanes for Bicycles. Often called Left Pocket Zones, these areas are separated from motor vehicles and allow bicycles to store. It is important to design these facilities so they can be plowed and swept.



**Above:** This Portland, Oregon intersection has a left turn lane for bicycles at a jogged intersection with high bicycle volumes. The jogged perpendicular cross streets are bicycle routes.



**Above:** This Vancouver intersection has both a left turn lane and a right turn lane for bicycles.



**Above:** This Seattle intersection has a left turn lane for bicycles in the median.



**Above:** This Seattle intersection is wide enough to allow for a left pocket zone between lanes of traffic.



**Above:** This Left Turn Lane for bicycles is located near the Galloping Goose Trail in Victoria, BC.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

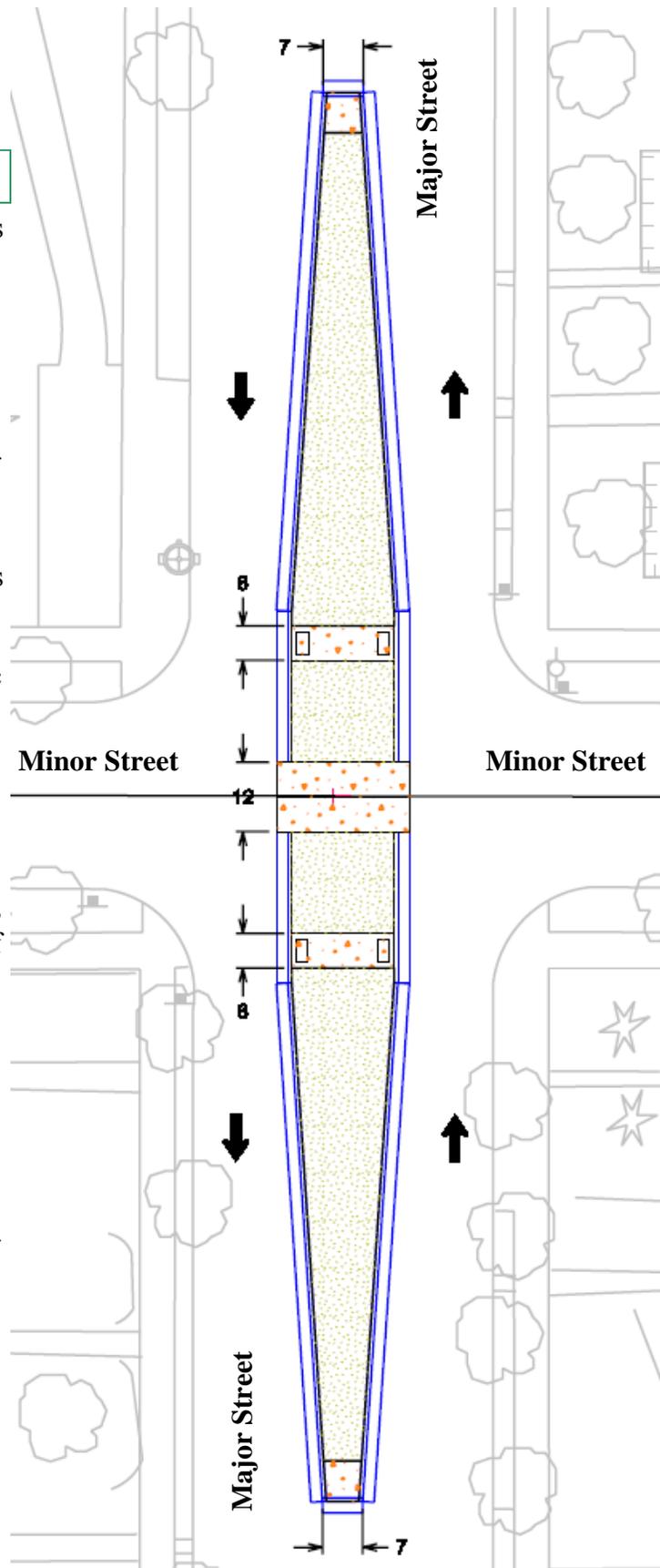
### On-Street Treatments

**Median Diverters** – Roadway Medians may be used to divert traffic from local streets on to a collector or minor arterial street. This treatment involves the construction of a concrete median and must include provisions for bicycles and pedestrians to pass through. Medians can be landscaped or can be a paved surface.

Advantages/Disadvantages: The primary advantage to a traffic median is that through traffic along the local street must be diverted to a collector or minor arterial street. In addition, traffic medians provide a refuge area for bicyclists and pedestrians and reduce the amount of roadway space a pedestrian or bicyclist needs to cross. There are several potential disadvantages however, including additional maintenance, risk of vehicles hitting the median nose, and removal of parking on both sides of the roadway.

Median Criteria: Several criteria must be satisfied before installing a traffic median:

- The major street must be wide enough to accommodate the 10 foot median, two 15 foot lanes (includes reaction distances), and curb and gutter. Parking may remain if the road is wide enough and an edgeline is required.
- The median should not be located at an intersection with a bus stop. If a median is installed the bus stop should be relocated.
- This treatment should only be used along busy bicycle/pedestrian routes.
- Landscaping should not exceed 3 ft.

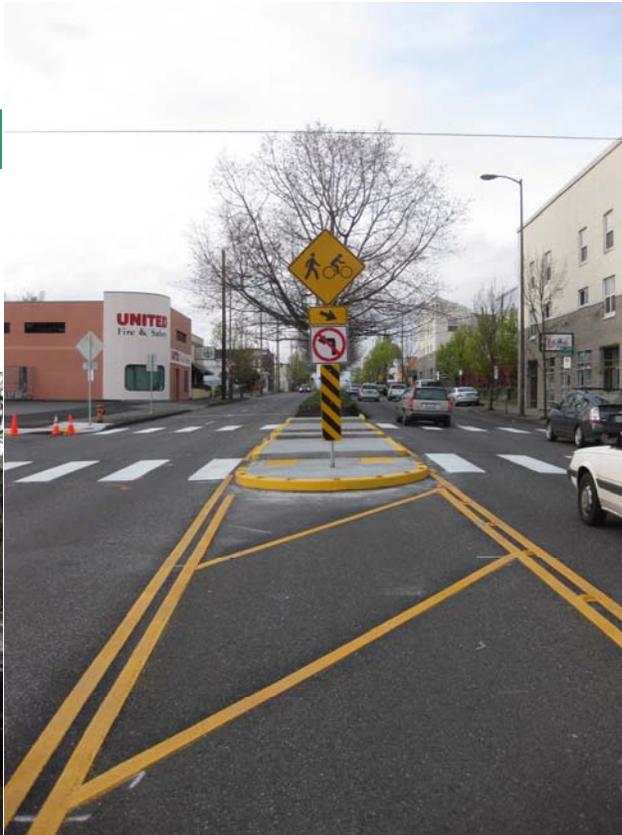


# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Median Diverters** – Shown are examples of median diverters in Portland, OR. In all cases a bicyclist is able to pass through the diverter, but motorists are forced to turn right at an intersection.



# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**On-Street Cycle Track**—On-Street Cycle Tracks position bicycles between moving lanes and parked vehicles. Although this provides bicyclists protection from moving cars, bikers visibility may be reduced at intersections. This treatment requires vehicles to park correctly and may require parking enforcement.



**Above:** On-Street Cycle Track along 1st Ave N during off-peak hours.



**Above:** Portland, Oregon on-street cycle track. There is a buffer zone between the parked cars and bike lane.



**Above:** During peak periods parking is removed along 1st Ave N resulting in a traditional curb-side bike lane.



**Above:** This street in Copenhagen has a cycle track between the curb and parked cars. This cycle track has a high level of parking compliance.



**Above:** This photo shows the signage along 1st Ave N in Downtown Minneapolis. To maximize capacity, parking is removed during peak periods.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Pervious Pavement**—Pervious pavement may be used along some bikeways to minimize runoff and to manage storm water. There are several benefits and challenges associated with pervious pavement.



**Benefits:** Pervious pavement allows water to seep through large void spaces created by a high percentage of large aggregate in the concrete mix. The primary benefit to pervious pavement is the ability to minimize runoff into local lakes and streams and to prevent erosion during major rainfall events. Pervious pavement is also designed to trap vehicular pollutants and sediments thereby minimizing groundwater contamination. It is also better for boulevard tree growth.



**Maintenance:** Pervious pavement requires special attention with regard to maintenance. A custom vacuum sweeper is needed to pick up the fine particles that accumulate over time on the pavement surface. This can be a challenge since fine particles can be a safety hazard for bicyclists and vacuum sweeping on a regular basis can be time consuming and expensive. Pervious pavement is not recommended (for the safety of roller bladers) along trails. However, pervious pavement may be considered for on-street routes.



**Challenges:** Pervious pavement has some drawbacks including the possibility of frost heave underneath the roadway surface, salt and debris buildup in the concrete pores, and weight restrictions. The inability for water to seep once pores have been clogged can create localized flooding unless a redundant storm water collection system has been devised. It is still unproven as to whether this type of pavement can last as long or is as cost effective as traditional paving materials and methods.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Raised Bicycle Lanes** — Raised Bicycle Lanes provide vertical and horizontal separation from motor vehicles and from pedestrians. Similar to a cycle track, raised bike lanes provide a dedicated lane that is separated from pedestrians but is closer to moving motor vehicles and is not separated by a boulevard or parked cars. Raised bike lanes are typically concrete forms, however the raised lane may be paved with asphalt.

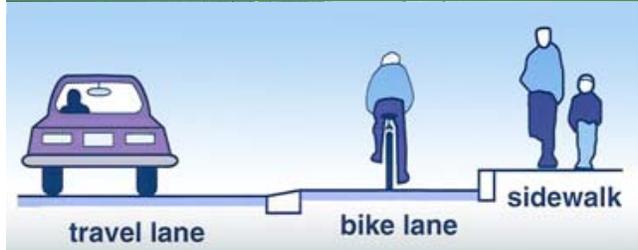
Advantages/Disadvantages: There are several advantages and disadvantages to using raised bike lanes. One major advantage is that this treatment keeps motorists from easily entering the bike lane, protecting bicyclists. This treatment can be expensive to construct and is also difficult to maintain, especially in climates with snow and ice. There are also safety concerns relating to bicyclists who decide to enter or exit the bike lane with the mountable curb. Bicyclists who are not careful may end up in a crash.

Raised Bike Lane Criteria: Raised Bike Lanes are considered experimental and require FHWA approval.

- Raised bike lanes should only be used where there is a history of rear end bicycle crashes and a documented speeding problem. This treatment is used on roadways with numerous curves.
- This treatment should be limited to areas that have no off-street parking for long segments and few curb cuts.
- Mountable curbs require special consideration at intersections so that bicyclists can safely transition the slope.
- Operating costs and maintenance challenges must be considered.
- A different color pavement material may be used to distinguish the raised bike lane..



Above: Raised Bicycle Lane in Vancouver, BC.



Above: Raised Bicycle Lane typical section.



Above: Raised Bicycle Lane in Eugene, OR.



Above: Raised Bicycle Lane in Eugene, OR.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Right Pocket Zone**—A Right Pocket Zone is a place where bicyclist can wait (off to the right of moving traffic) to make a left turn. A bicyclist waits for a signal to change or traffic to pass before entering the intersection. This right pocket zone must be large enough to accommodate several bicyclists and does not work well with a tight intersection radius. The advantage to this treatment is that a bicyclist does not need to weave into traffic lanes to make a left turn. Many Right Pocket Zones are often marked with colored pavement.



**Photo Above:** A right-pocket zone in Munster Germany that allows bicycles to safely wait for a signal to turn in the perpendicular direction. This treatment does not require bicycles to weave into traffic to make a safe left turn.



**Photo Above:** This right-pocket in Portland, OR is located to the right of the bike lane.



**Photo Above:** A well marked right-pocket zone in Erlangen, Germany using colored pavement.



**Photos Above:** A right-pocket zone in Vancouver on Burrard Street. In this situation the street bulbs out a T-intersection to allow for bicycle storage. A skip-dash marking provides guidance for where to cross.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Roundabouts**—The MUTCD does not permit bicycle lanes in roundabouts and recommends off street bicycle accommodations. Shown are bike facilities in roundabouts from Europe.



**Photo:** This roundabout in Nijmegen, Netherlands includes a clearly marked wide outside bicycle lane next to a wide traffic lane.



**Photo:** This roundabout in Utrecht, Netherlands contains a bicycle lane on the outside rim of the roundabout. The bicycle lane is colored for better visibility.



**Photo:** Roundabouts like this one in Nijmegen, Netherlands have a wide radius to allow for turning trucks and buses. It also keeps cars out of the bike lane.



**Photo:** This roundabout in Nijmegen, Netherlands includes an off-street one-way cycle track separated by a trimmed hedge.



**Above:** In Denmark blue is the color of choice to delineate bicycle/vehicle conflict zones. This roundabout in Saksøbing, Denmark is no exception.



**Above:** This roundabout in Rødby, Denmark is designed with the pedestrian/bicycle accommodations on the perimeter with well marked crosswalks.

# Bicycle Facility Design Guidelines Chapter 9—Innovation

## On-Street Treatments

**Shared Use Pavement Markings**— Shown are innovative applications of shared use pavement markings that are used across the US. Although the Shared Use Pavement marking is now permitted in the MUTCD, applications such as these are experimental.



Above: Marking in Seattle, WA.



Above: Marking in Long Beach, CA.



Above: Marking in New York City.



Above: Marking in Chicago, IL

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Seasonal Bike Lane**—Some corridors are not wide enough to allow for two moving lanes, two bike lanes, and parking on both sides. Curb-side seasonal bike lanes have been used to provide a compromise between residents who need on-street parking in the winter (especially during snow emergencies) and bicyclists who primarily ride during warmer months. This concept is no longer practiced since many bicyclists continue to bike in the winter and closing a bike lane for a season sends a poor message. In some corridors parking may be removed on one side of the road to accommodate bike lanes, therefore shifting the centerline 4-5 feet.



**Above:** Seasonal bicycle lane on 20th Avenue South.



**Above:** This seasonal bicycle lane on 20th Avenue South allows vehicles to park in the bike lane from November 15 to April 1. Seasonal bike lanes are no longer installed in Minneapolis.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Toucan**—Toucan signals are designed to accommodate both pedestrians and bicyclists, particularly where volumes of both modes are high. Motorized traffic is not allowed to proceed through the intersection and must turn right, whereas bicycles are allowed to travel through the intersection. This treatment may be used in conjunction with a bicycle boulevard corridor, resulting in fewer vehicles using the bicycle route. Toucans are basically half closures with a special signal system that allows for protected movements through the use of separate bicycle and pedestrian signal heads. The system can be either designed with push button pedestals for bicycles or with inductive loops. Pedestrians use traditional push button devices. The Tucson, Arizona Toucan crossing shown uses bollards and red pavement to distinguish modal placement.



Above: Tucson, AZ Toucan crossing.



Above: Tucson, AZ Toucan crossing.



Above: This Tucson, AZ intersection has a special bicycle signal phase that allows bicycles to proceed through the intersection. TOUCAN stands for TwO GroUps CAN cross.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Traffic Calming for Bicyclists**— There are several methods and devices to slow bicyclists down or to divert them to other locations. Shown are several types of treatments.



**Photos Above:** Utrecht, Netherlands traffic choker.



**Photos Above:** This device in Copenhagen, Denmark prohibits bicycles from riding on the sidewalk. These types of barriers are quite common on narrow sidewalks where bicyclists are encouraged to ride on the street.



**Photos Above:** A speed hump has been placed along this Copenhagen trail near an intersection. The speed hump slows bicyclists down and informs them of the changed condition ahead.



**Photo Above:** Colorized pavement in a conflict zone has become a common treatment in many cities, which improves the visibility of a bicyclist and informs the biker of a changed condition. What's unique about this Nijmegen, Netherlands intersection is that the pavement type has also changed from asphalt to concrete. By changing riding mediums the bicyclist is more likely to slow down and pay more attention to the surroundings.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Two-Way Bike Lanes**—Two-way bicycle lanes have been installed throughout the city in an attempt to make a street more “bicycle friendly”, however this treatment is no longer recommended and should be removed.

Advantages/Disadvantages: Although there are perceived advantages to striping two-way bicycle lanes, it is better to do nothing at all. Two-way bicycle lanes increase the number of conflict points at an intersection and often result in wrong way bicycle riding in the traffic lane.

**Photos:** There is not enough physical space to allow two bike to pass each other in the photos on the right. This also creates a dangerous situation at intersections. The photo below shows a restricted street, which minimizes the number of conflicts with vehicles, however a two way street configuration should have bicycle lanes to the right of the moving lanes regardless of traffic volumes.



# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### On-Street Treatments

**Wayfinding Signage**—The photos shown are worldwide examples of innovative wayfinding signage. Many countries including the United States have uniform signage standards.



Above: Wayfinding signage in Germany.



Above: Wayfinding signage in Australia.



Above: Wayfinding signage in Paris, France.



Above: Wayfinding signage in Italy.



Above: Wayfinding signage in Germany.



Above: Wayfinding signage in Germany.



Above: Wayfinding signage in Austria.

# Bicycle Facility Design Guidelines

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### Bicycle Parking

**Creative Bicycle Parking**—Creative bicycle racks are a fun way to promote bicycling and give communities and businesses incentives to install bicycle parking. Care must be taken to avoid sharp or pointed objects.



**Above:** Creative bicycle parking at the Uptown Transit Hub



**Above:** Creative bicycle parking at the Weisman Art Museum.



**Above:** Creative bicycle parking at the Welna Ace Hardware store.



**Above:** Creative bicycle parking at Orchestra Hall.



**Above:** Creative bicycle parking in Uptown.



**Above:** Creative bicycle parking at the U of M Farmers Market.



**Above:** Creative bicycle parking at the Bryant Lake Bowl.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycle Parking

**Indoor Bicycle Parking—Parking Ramp** entrances and exits present special challenges for bicyclists. This is especially true in Downtown Minneapolis where over half of the available bicycle parking spaces are in ramps.

Indoor Bicycle Parking Criteria: Parking ramps can be great places for bicycle parking if done correctly. The following criteria must be adhered to with regard to indoor bicycle parking:

- Indoor bicycle parking must be lit to prevent crimes such as theft and assault. It is also recommended that bicycle racks be under surveillance.
- Indoor bicycle parking should not be placed in ramps where the entrance and exit ramps exceed a 5% grade.
- Buildings should place sensors for bicycles in the pavement or provide a keycard entry so that bicyclists do not have to wait for a motor vehicle before the door is opened.
- Bicycle parking should not be permitted on the ramp itself.
- Bicycle parking should be located away from indoor loading docks.



**Above:** A keycard pad allows bicycles to enter a ramp. This keypad is located in one of the Ameriprise Buildings in Downtown Minneapolis. Many parking garages detect motor vehicle but do not detect bicycles.



**Above:** This ramp exit in Minneapolis has poor sightlines and requires bicycles to travel against traffic to get to the bicycle parking around the corner. Bicycle parking should be avoided in ramps with spirals or with poor lighting.



**Above:** This ramp entrance/exit is a good example of a bicycle friendly ramp with less than a 5% slope, good sightlines, and is well lit.



**Above:** This ramp entrance/exit in Australia accommodates both bicycles and pedestrians and separates them from motor vehicles.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycle Parking

**Indoor Bicycle Parking**—Indoor bicycle parking keeps bicycles out of the elements and provides a higher level of security than outdoor bicycle parking. Indoor bicycle parking is often placed at parking ramps, which allows for convenient access. However, some ramps may be unsafe for bicyclists, especially where visibility is obstructed or slopes are steep. Many companies have established bicycle storage rooms in addition to changing rooms for bikers.



**Above:** Bollards protect bike parking at a loading dock.



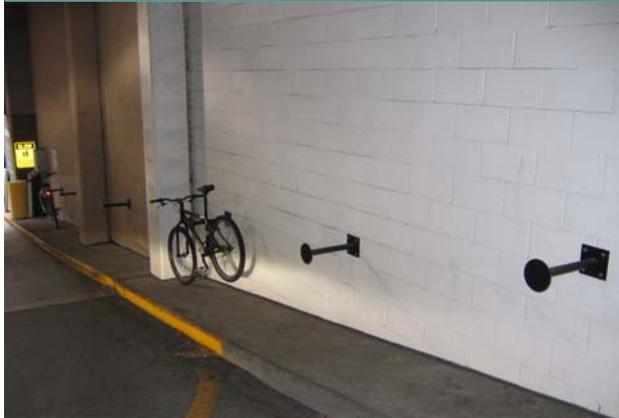
**Above:** Designated bicycle parking area within a ramp.



**Above:** Some companies have bike rooms or corrals.



**Above:** Indoor bike parking must be lighted and secure.



**Above:** Ramp entries are not always safe for bikes.



**Above:** Wall mounted bicycle parking at a ramp.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycle Parking

**On-Street Bicycle Parking** — In some locations finding place to put a bike rack is very difficult, especially in commercial zones where there is little sidewalk space. One creative way to solve this problem is to remove an on-street parking stall and replace it with bicycle parking.

Advantages/Disadvantages: The primary advantage to this treatment is the added number of bicycle parking stalls created in a location that may have no other space for bike racks. However, removing parking can be controversial in areas with a parking shortage or may result in a revenue decrease where parking is metered. This also presents a safety challenge, which can be mitigated with barriers or a clearly delineated area for bikes.

#### On-Street Bicycle Parking Criteria:

- This treatment should only be pursued when there is a shortage of off-street locations to place bicycle parking.
- This treatment may be appropriate where bicycle riding is not permitted on sidewalks or where there are narrow sidewalks.
- Removing metered stalls should be avoided when possible.
- Safety concerns should be mitigated with clear signage, markings, or barriers.



Above: On-street bike parking in Portland, Oregon.



Above: On-street bike parking in Bruges, Belgium.



Above: On-street bicycle parking in Uptown.



Above: On-street bike parking in Portland, OR.



Above: On-street bicycle parking in Idaho.

## Bicycle Facility Design Guidelines Chapter 9—Innovation

### Bicycle Parking

**Ramps**—Bicycle Parking Ramps are a necessary and innovative way to efficiently serve thousands of bicycles in one area. In some cities in Europe over 1/3 of all people bike every day. Facilities such as the one shown in Amsterdam may be constructed at train stations, downtown business districts, and at college campuses to accommodate huge numbers of cyclists. Bicycle ramps are expensive to construct and to operate so a fee is often charged.



# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycle Parking



**Signage and Markings**—Shown are various worldwide bicycle parking signage and pavement marking treatments. Shown on the right is the USA standard sign.



Above: San Francisco signage



Above: Bicycle shelter and signage in Japan



Above: Brussels, Belgium markings.



Above: Paid bicycle parking in Japan.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycles and Transit

**Separated Bus Stop**—The primary goal of separating bicycles and buses is to prevent crashes and fatalities, especially in high volume bus/bike corridors. To accomplish separation, cycle tracks may be designed to go around bus stops.



**Above:** This One-Way cycle track in Erlangen, Germany goes around a bus stop. Cycle track placement can not interfere with bus loading/unloading.



**Above:** This Erlangen, Germany shared use bus/bike lane has a cycle track split off behind a bus stop to prevent conflicts between bikes, buses, and pedestrians.



**Above:** This intersection in Münster, Germany shows a cycle track that is placed behind a bus stop. Care must be taken to make sure there is no conflict with pedestrians that are getting on and off the bus.



**Above:** This Erlangen, Germany cycle track is placed behind the bus stop to prevent conflicts between buses and bicycles. There is a clear zone between the curb and cycle track to prevent bike/pedestrian conflicts.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycles and Transit

**Shared Bus/Bike Lanes** — Often there is competition for space in the public right-of-way. A shared bus lane helps maximize available space and helps give buses and bicycles priority in a given corridor.

Considerations: Bicycle volumes, bus frequency, and available space typically dictate the need for a shared bike/bus facility. Safety is a significant consideration when planning a shared use facility. Although professional bus drivers are less likely to get into a crash with bicyclists, bus/bike crashes are more severe. The placement and frequency of bus stops should be considered to minimize potential conflicts. Space to accommodate either buses or bikes passing on the left should be considered. Time restrictions may be necessary when peak hour bus volumes create too many potential conflicts. Separated bike lanes adjacent to a bus lane should be considered if there is enough roadway width. It is recommended that a 15 to 18-foot wide lane be constructed when bikes and buses share an exclusive lane. The minimum allowed lane width for a shared facility is 12 feet.



Above: Shared bus/bike lane in San Francisco.



Above: Shared bus/bike lane in Paris, France.



Above: Copenhagen shared bus/bike lane.



Above: Shared bus/bike lane in Philadelphia.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycles and Transit

**Shared Bus/Bike Lanes**—Below are some examples of signage applications along Shared Bus/Bike Lanes. Many Shared Bus/Bike lanes are only in use during peak periods.



Above: Signage in Adelaide, Australia.



Above: Signage in Brussels, Belgium.



Above: Signage in Minneapolis, MN.



Above: Signage in Vancouver, BC.



Above: Signage in Münster, Germany.



Above: Signage in Seattle, WA.

# Bicycle Facility Design Guidelines

## Chapter 9—Innovation

### Bicycles and Transit

**Shared Bus/Bike Lanes**—Shared Bus/Bike Lanes are intended to provide separation from motor vehicles, therefore improving safety and mobility. The photos below show some of the creative solutions that have been pursued by cities to solve challenging situations presented by installing Shared Bus/Bike Lanes.



**Above:** This far-side San Francisco bus stop is placed to the right of the bike lane. Buses pulling out into traffic must share space with cyclists.



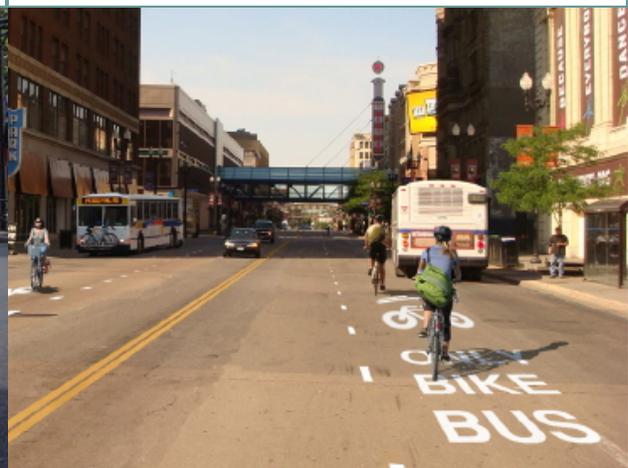
**Above:** This Shared Bus/Bike Lane in Copenhagen, Denmark has an enforcement problem. Vehicles can not park in a Shared Bus/Bike Lane.



**Above:** Bicycles are not welcome on this Paris, France bus lane. A cycle track has been constructed adjacent to the bus lane to accommodate bicycles.



**Above:** This Shared Bus/Bike Lane in Paris, France uses white checkerboard pavement markings across an intersection to increase visibility. Similar green markings are often used to denote bicycle lanes.



**Above:** Minneapolis, Minnesota has installed a Shared Bus/Bike Lane along Hennepin Avenue as part of a two-way conversion project. Right turning vehicles are allowed to use the lane as well.