# Design Guidelines

Design standards are a critical component in the Network implementation process. They help ensure a consistent, safe level of service for users and protect local government agencies from liability issues in the event of injury. NYC DOT is in the process of developing Bicycle Facility Design Standards. This chapter of the *Plan* offers the following Design Guidelines to be used while the DOT Standards are being developed.

The Design Guidelines are a compilation of national guidelines and examples of existing and proposed facilities in New York City. The Guidelines are intentionally broad, providing designers with the flexibility that is often required in a locale as complex as New York City.

Most local design guidelines have been based in whole or in part on national and state standards. The national standards are listed below.

1. *Guide to the Development of Bicycle Facilities*, AASHTO

Released in 1981, and updated in 1991, the AASHTO Guide has become the basic reference for facility designers across the country.

2. *Manual on Uniform Traffic Control Devices (MUTCD)*, Federal Highway Administration

Released in 1935, and updated in 1988, the MUTCD is the national manual for streets and highways. Conformance with the manual's standards is required in nearly every state by statute (New York included).

3. *Guidelines for Greenways*, The Greenway Collaborative

This document provides detailed advice on the planning, design and maintenance of multi-use paths and trails.

4. *Design & Maintenance Manual for Multi-use Trails*, Rails-to-Trails Conservancy

This document provides information similar to that found in Guidelines for Greenways, but with an emphasis on abandoned rail corridors and canal tow paths.

5. *Guidelines for Establishing In-Line Skate Trails in Park and Recreation Areas*, International In-Line Skating Association

As noted on page 5, bicycle facilities are divided into the following three categories:

**Multi-use Path**, separated from motor vehicle traffic

**On-Street Bicycle Lane**, designated by lane markings and signs

**Signed Bicycle Route**, designated by signs only

## On-Street Facilities

### Bicycle Lanes - Width

AASHTO: The minimum bicycle lane width requirement is **4 feet**. However, certain edge conditions dictate additional desirable bicycle lane width, see Figures A - C.

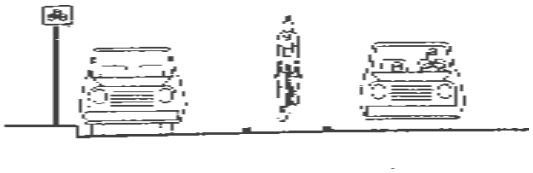


*Figure A: Curbed street with parking*

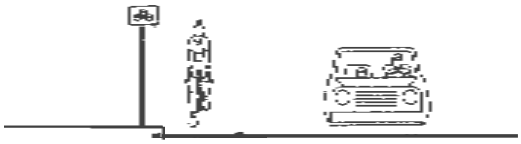


*Figure B: Curbed street without parking*

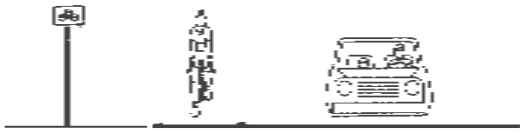


*Figure C: Street without curb and gutter*

Figure A depicts bicycle lanes on an urban curbed street with a parking lane. The recommended bicycle lane width for this location is **5 feet**. Bicycle lanes should never be located between the curb and parking lane, since visibility at intersections and driveways would be reduced and left turns would be prohibited.

Where parking is permitted but a parking lane is not provided, the combination lane, intended for both motor vehicle parking and bicycle use, should have a minimum width of **12 feet**. However, it is preferable to designate separate parking and bicycle lanes if the combination is used as an additional motor vehicle lane.

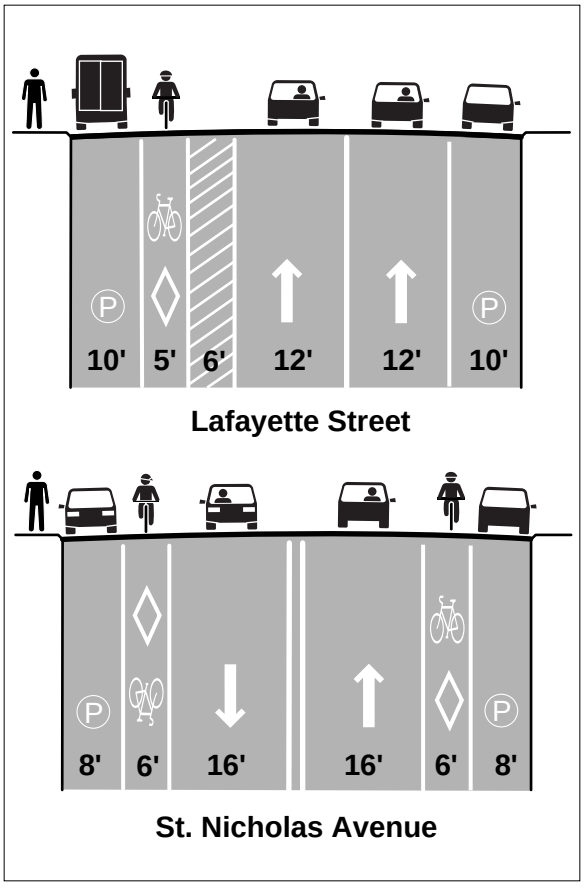
Figure B depicts bicycle lanes along the curb line of an urban street where parking is prohibited. Cyclists do not generally ride near a curb because of the possibility of debris or hitting a pedal on the curb. In addition, distinctive gutter pavement (i.e., concrete), which differs from the roadway pavement, can be hazardous for cyclists. In this case, there must be a **4 foot clearance** between the edge of the gutter pavement and the motor vehicle lane.

Figure C depicts bicycle lanes on a highway without curb or gutter. Bicycle lanes should be located between the motor vehicle lanes and the roadway shoulders. Bicycle lanes may have a minimum width of **4 feet**, where the shoulder can provide additional maneuvering width. A width of **5 feet** or greater is preferable; additional widths are desirable where substantial truck traffic is present, or where vehicle speeds exceed 35 mph.

*New York City*: The 1978 *Bikeway Planning and Policy Guidelines for New York City*, released two years prior to the AASHTO guidelines, recommended a minimum bicycle lane width of 3'6", and a recommended width of 4'. The Broadway, First, Fifth and Sixth Avenues lanes in Manhattan were based on these guideline.

However, recently implemented on-street lanes have surpassed the AASHTO recommendations. Manhattan's Lafayette Street bicycle lane, implemented in 1994, has a lane width which varies between **5 and 6 feet and a buffer** between the lane and vehicle traffic. The buffer, which has an average width of **6 feet**, provides greater protection from motor vehicles and space for deliveries. Space for the lane and buffer were provided by eliminating a lane of motor vehicle traffic.

More recently, the new St. Nicholas Avenue bicycle lane in Upper Manhattan has a width of **6 feet**. This width is made possible by reconfiguring the roadway's lane striping. In the future, on-street bicycle lane widths may need to increase even further to accommodate the growing number of in-line skaters.




*Schematic design for new on-street bicycle lanes that surpass AASHTO recommendations.*

### Signed Bicycle Routes

Two types of signed bicycle routes, are identified by AASHTO: The short route, which essentially provides continuity to other bicycle facilities; and the long, or touring, route. Signed routes are usually identified only by MUTCD signage. For touring routes, a standard bicycle route marker with a numerical designation in accordance with the MUTCD can be used in place of a bicycle route sign. The number may respond to a parallel highway, indicating the route is a preferred alternate route for cyclists.

A number of routes have been designated in New York City, including Riverside Drive in Manhattan and Bay Street in Staten Island. Street width limitations usually neccessitate the designation of signed routes rather than lanes.

### Width

Roadways with shoulders or wide curb lanes are often appropriate for signed routes. AASHTO recommends a minimum shoulder width of **4 feet** for the designation of a bicycle route. The minimum width increases as the percentage of trucks, buses and vehicle speeds increase. **12 feet** is the minimum width and **14 feet** is the preferred width for the designation of bicycle routes in wide curb lanes.

## Signs and Pavement Markings

The design and use of signs and pavement markings these devices are specified by state statute, and must be consistent with the national standards of the MUTCD. The three MUTCD sign categories affecting motorists, pedestrians and cyclists are: Regulatory, Warning and Guidance.

*Regulatory:* The regulatory signs convey traffic laws or regulations which would not otherwise be apparent. Designated bicycle lane signs should be located prior to the beginning of a marked designated bicycle lane to warn motorists of the presence of cyclists.

*Warning:* These signs warn motorists or cyclists of potentially hazardous conditions on or adjacent to the road or path. The use of warning signs should be limited to areas where the condition might not be apparent to avoid overuse of a sign.

*Guidance:* These signs provide cyclists with information relating to route identification and direction to ensure that the route is accurately followed.

Most states have followed the MUTCD in developing pavement markings. Although most states have a lane striping width of 4 - 6 inch lane striping, Oregon and Florida have implemented 8 inch lane striping for greater visibility. A common marking material is thermoplastic paint with glass beads. This material has better visibility and wearing characteristics than paint. As shown in Figure D, DOT recently began installing an MUTCD thermoplastic symbol on on-street lanes.

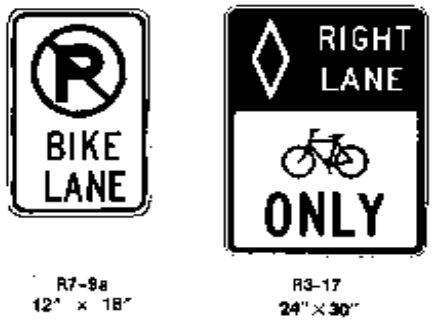



*Figure A: Regulatory signs*

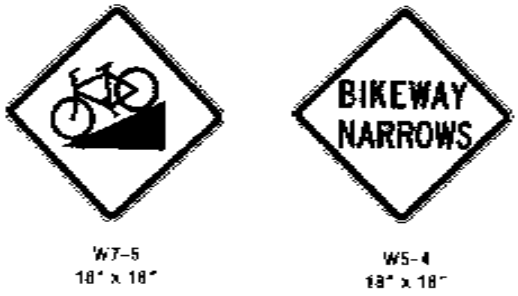



*Figure B: Warning signs*

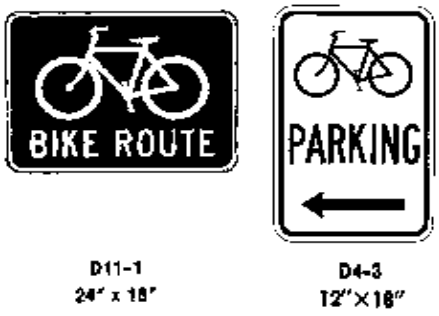



*Figure C: Guidance signs*

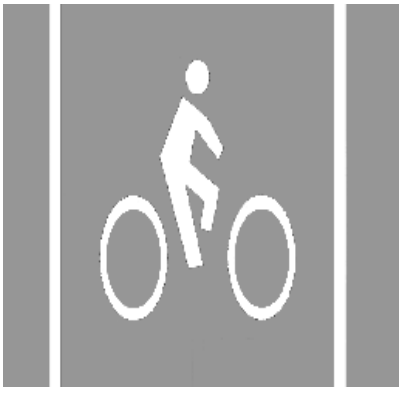


*Figure D: MUTCD lane and symbol marking, adopted by DOT in 1995.*

## Intersections

*Right-turning Motorists:* Cyclists proceeding straight through intersections can cross the path of motorists turning right. According to AASHTO, striping and signing configurations which encourage these crossings in advance of the intersection, in a merging fashion, are preferable to those that force the crossing in the immediate vicinity of the intersection. AASHTO-recommended designs for bicycle lanes approaching a motor vehicle right-turn-only lane are shown in Figures A - D.

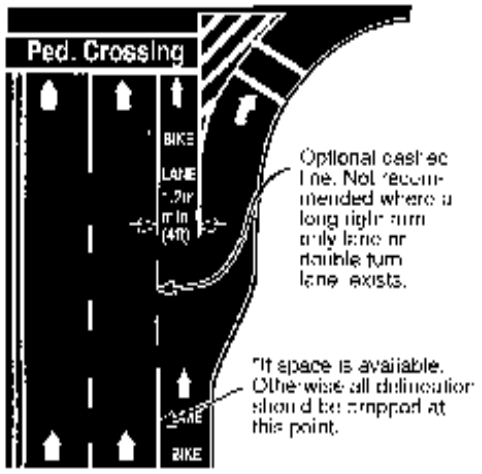



*Figure A: Right-turn-only lane*

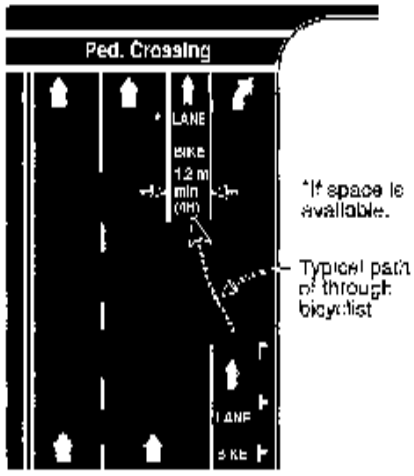



*Figure B: Parking lane becomes right-turn-only lane*

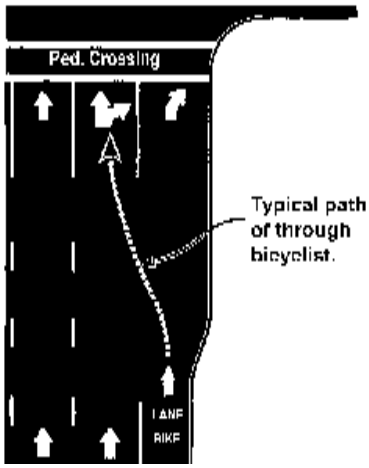



*Figure C: Double right-turn-only lane*

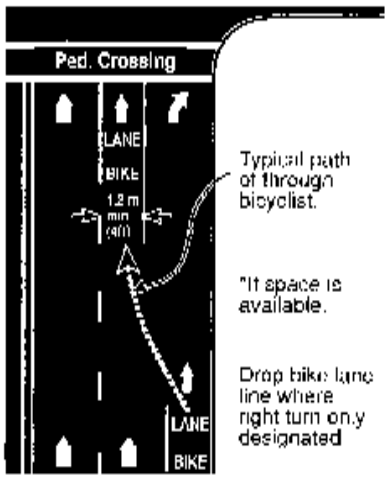
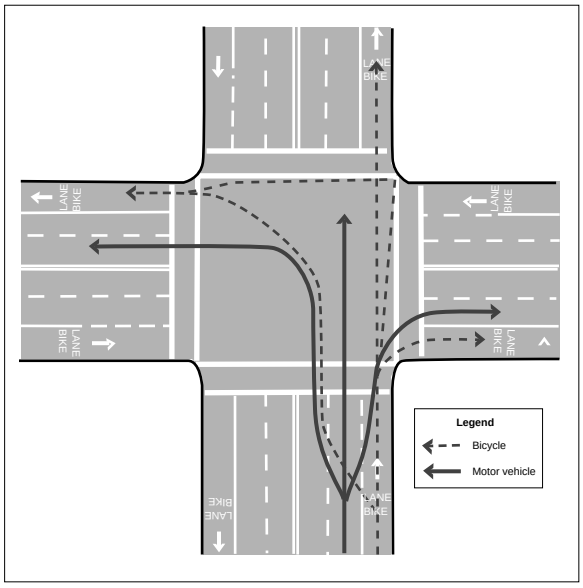



*Figure D: Right lane becomes right-turn-only lane*

*Left-turning cyclists:* Most vehicle codes allow the cyclist the option of making either a "vehicular style" left turn (where the cyclist merges to the same lane used for motor vehicle left turn lanes) or a "pedestrian style" left turn (where the cyclist proceeds straight through the intersection, turns left at the far side, then proceeds across the intersection again on the cross street).



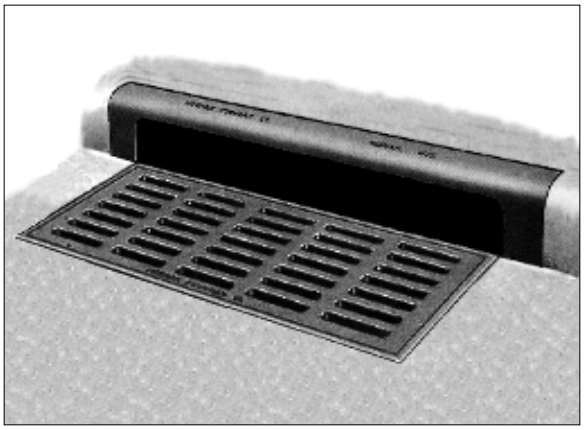

*Typical traffic movements thourgh an intersection. Cyclists can turn left as a vehicle or as a pedestrian.*

## Drainage Grates

Drainage inlets with grate openings which are parallel to traffic can trap the front wheel of a bicycle, causing loss of steering control, resulting in serious damage to the bicycle wheel and frame and/or injury to the cyclist. Such grates should be replaced with bicycle-safe and hydraulically efficient ones, as below.

A temporary correction involves welding steel cross straps or bars perpendicular to the parallel bars to provide a maximum safe opening between straps. Identifying a hazardous grate with pavement marking is inadequate; a cyclist could miss the pavement marking in the dark or be forced over such a grate inlet by other traffic.

When a new roadway is designed, all drainage grate inlets and utility covers should be kept out of the cyclists' expected path. When an existing roadway is reconstructed, all drainage grate inlets and utility covers should be replaced wherever possible with bicycle-friendly castings to ensure the safety of cyclists.



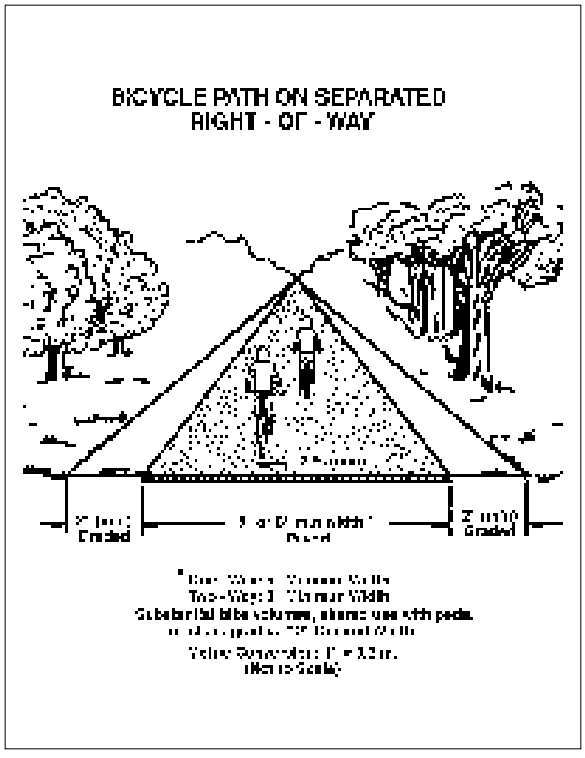
*Bicycle-safe drainage grate*

## Multi - Use Paths

### Width

*One-directional path*: AASHTO establishes **5 feet** as the minimum width of a one-directional bicycle path, but cautions that such a path will be used as a two-way facility unless measures are taken to assure one-way operation. The International In-Line Skating Association recommends **8 fee**t for one-way skating paths; **10 feet**, **6 inches** for combined bicycle / in-line skate, one-way paths.

*Two-directional path*: AASHTO establishes **8 feet** as a minimum and **10 feet** as a recommended width for a two-directional "bicycle path". If substantial bicycle volume and shared use with joggers and other pedestrians is anticipated, AASHTO recommends a width of **12 feet**. The Rails-to-Trails Conservancy recommends a width of **16 feet** for paths for "non-motorized" use in urban settings.




*Widths recommended by AASHTO for multi-use paths.*

*New York City*: Multi-use paths are generally shared by cyclists, pedestrians, joggers and, increasingly, in-line skaters. Pavement markings and signage or, where space and funds permit, physical dividers are used to separate a "wheels only" path (bicycles and in-line skates) from "feet only" path (runners and pedestrians). Typical widths of multi-use paths in New York City are shown below.

#### Existing Paths

| | | |
|---|---|---|
| Shore Parkway Bicycle Path | | |
| (69th Street to 4th Avenue): | 11'-6" to 14' | (wheels only) |
| (4th Avenue to Bay Parkway): | 11' to 14' | (shared ) |
| Ocean Parkway: | 10' | (wheels only) |
| North Bronx Greenway: | 8' | (shared) |

#### New or Reconstructed Paths

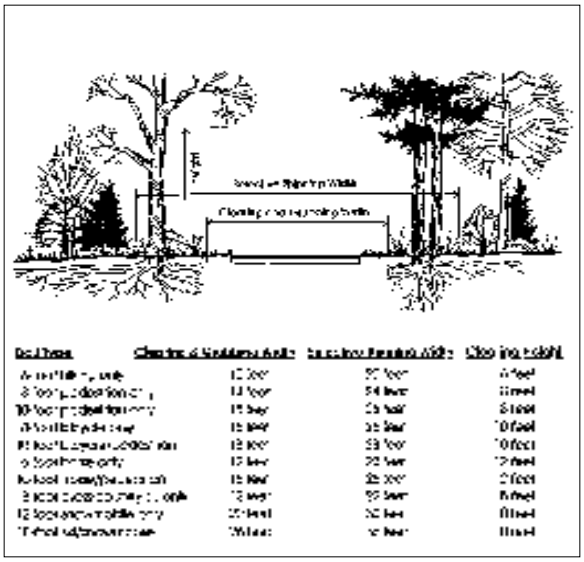
| | | |
|---|---|---|
| Shore Parkway Bicycle Path | | |
| (Knapp St to Penn. Ave): | 12' | (shared) |
| Route 9A: | 16' | (wheels only) |
| East River Esplanade: | 10' | (wheels only) |

#### Buffer

AASHTO establishes a minimum **2 foot**, recommended **3 foot**, wide graded area located adjacent to both the sides of the path to provide clearance from trees, poles, walls, fences, guardrails. AASHTO further recommends a wide separation between a bicycle path and adjacent highway to instruct both the cyclist and the motorist that the path functions as an independent highway for non-motorized vehicles. When the distance between the edge of the roadway and the bicycle path is less than **5 feet**, construction of a physical divider is recommended. Such a divider should have a minimum height of **4.5 feet** to prevent the cyclist from toppling over the divider.

## Vertical Clearance

AASHTO establishes a minimum vertical clearance of **8 feet**, although a greater clearance may be needed to permit passage of maintenance vehicles. A clearance of 10 feet is desirable in underpasses and tunnels. The Rails-to-Trails Conservancy provides specific vegetative clearance requirements.



*Vegetative clearance chart, Rails-to-Trails Conservancy*

## Alignment

The minimum radius of curvature negotiable by a bicycle is a function of the superelevation rate of the bicycle path surface, the coefficient of friction between the bicycle tires and the bicycle path surface, and the speed of the bicycle. The chart below shows the additional, width required, based on curve radii.

| Radius (ft.) | Additional Pavement Width (ft.) |
|---|---|
| 0-25 | 4 |
| 25-50 | 3 |
| 50-75 | 2 |
| 75-100 | 1 |
| 100+ | 0 |

## Grades

AASHTO recommends a maximum **5 percent** grade; higher grades are difficult to climb and, on the downhill, may cause some cyclists to exceed the speeds at which they are competent; grades over 5 percent and less than 500 feet long are acceptable when a higher design speed is used and additional width is provided; grades steeper than 3 percent may not be practical for bicycle paths with crushed stone surfaces.

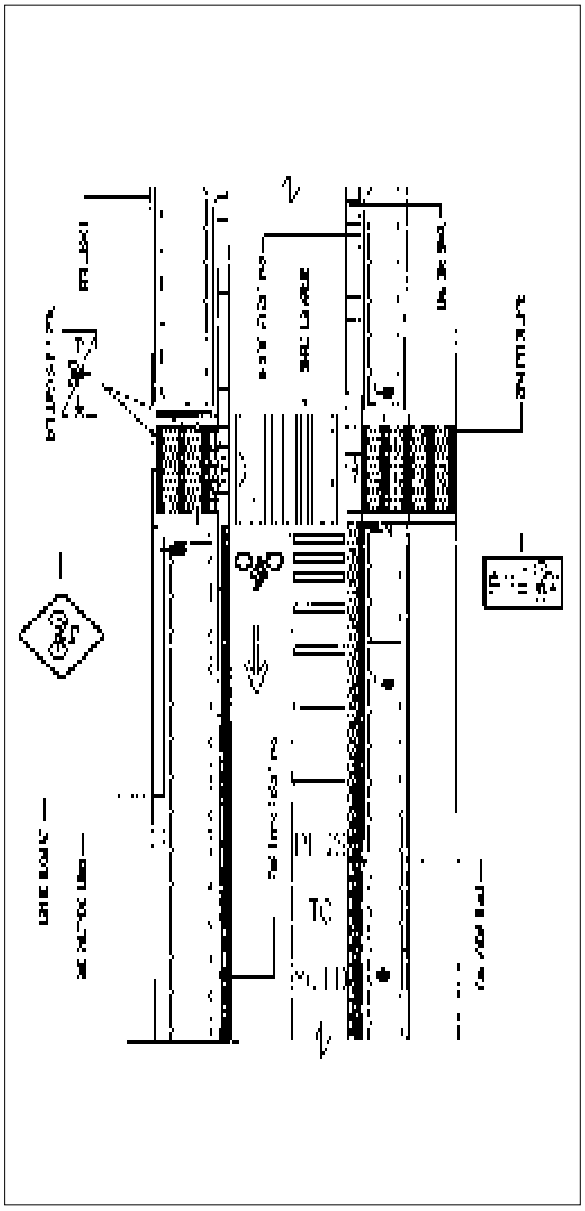
## Signing and Pavement Marking

The regulatory, warning and informational types of MUTCD signing can be applied, where appropriate, to multi-use paths. AASHTO also recommends a **4"** wide yellow centerline stripe to separate opposite directions of travel. Warning stripes on fixed objects (i.e., bollards or elevated roadway columns) are also used to delineate lanes.

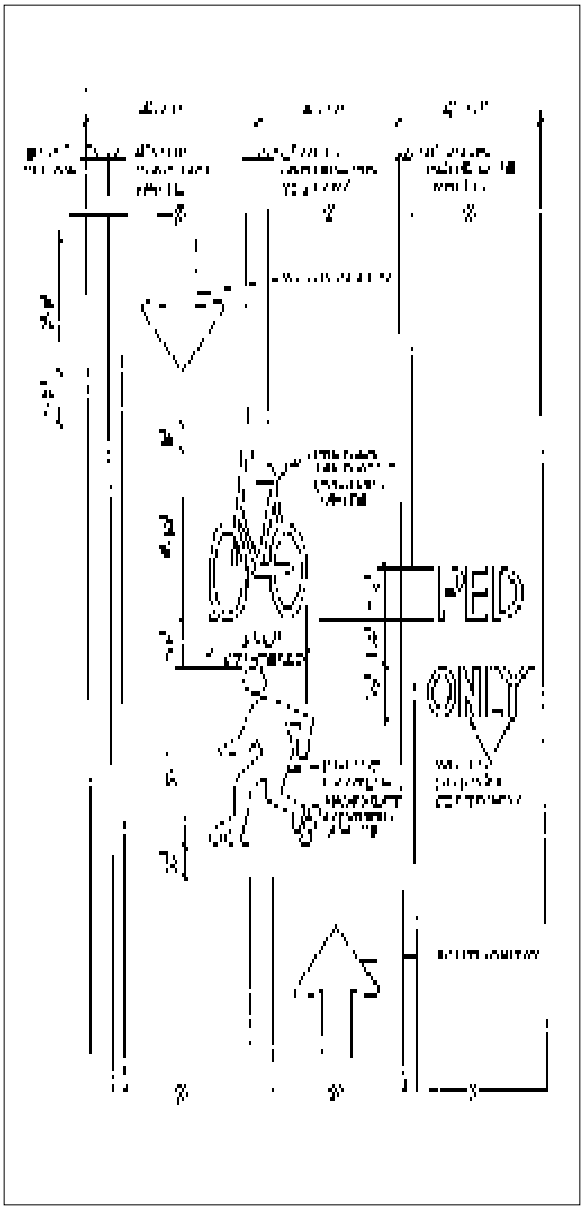
Travel Path Restriction Signs are used exclusively where there is a shared use with pedestrians and cyclists, an especially common occurance in New York City.


*Travel Path Restriction Sign.*

*New York City:* Unlike on-street lanes, off-street paths, generally under the joint jurisdiction of NYC DPR and DOT, are not subject to conformance with the State statute on traffic control devices. This permits greater flexibility in addressing the unique needs of cyclists and pedestrians.



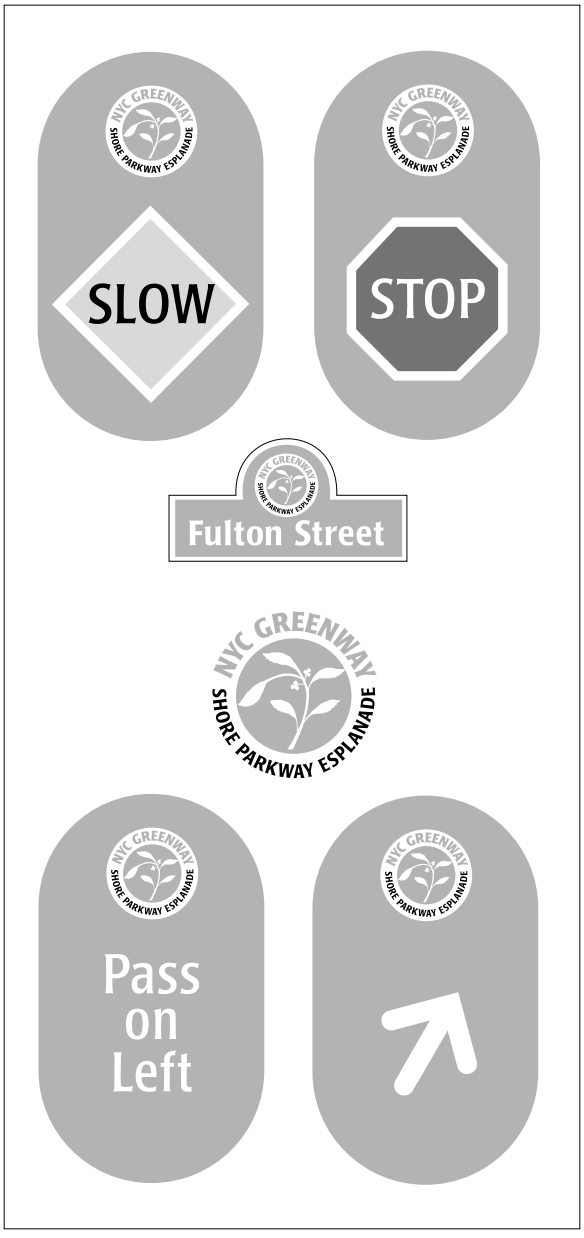
*Proposed pavement marking and signage design for Route 9A Path. Source: NYS DOT*




*Proposed pavement marking and signage design for the Reconstruction of the Shore Parkway Bicycle Path. Source: DPR*

The NYC DCP has recently proposed signage for the City's Greenway System in an effort to provide recognizable identity for a greenway while guiding users safely along the route. The signage uses a green color and vertical lozenge shape for easy recognition and installation on narrow paths, and a distinctive logo with the greenway's name. The signage will be consistent with MUTCD standards in the on-street segments of the Greenway system.


*Proposed standard greenway signage. Source: DCP*




*Proposed standard greenway signage. Source: DCP*

## Intersections

AASHTO recommends the following for intersections of path users and motor vehicles:

Locate traffic controls (signal, stop sign, etc.) so that motorists and cyclists are not confused by which controls apply to them.

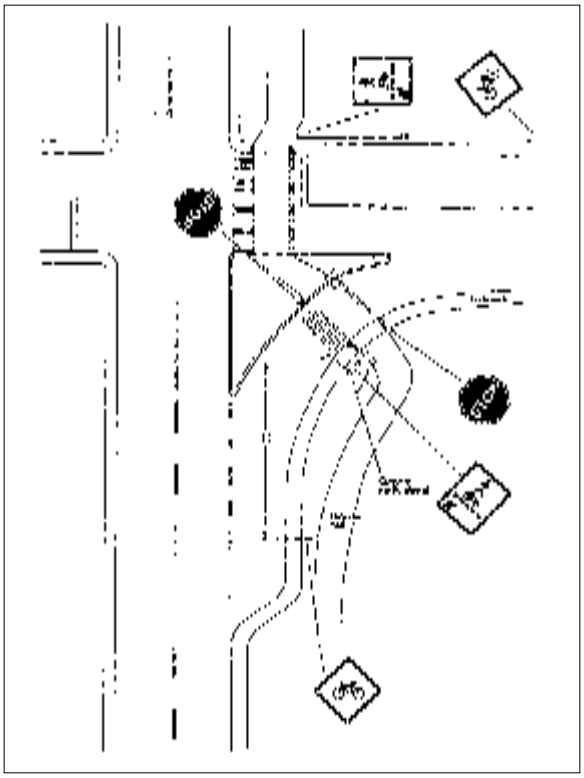
Site path-highway crossing away from intersections with other highways. Where physical constraints prohibit such independent intersections, the crossing may be at or adjacent to the pedestrian crossing.

Consider a refuge island for path users at crossings of high volume, multi-lane arterial highways.

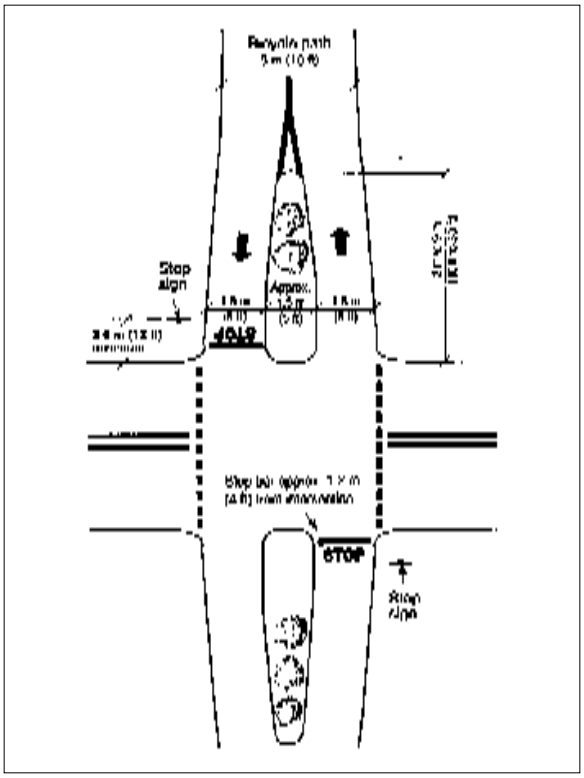
When a path terminates at an existing road, the path should be safely integrated into the existing system of roadways.

Path intersections and approaches should be on relatively flat grades; stopping sight distances at intersections should be checked with adequate warning provided.

Ramps for curb cuts at intersections should be the same width as paths, providing a smooth transition between the path and the roadway.



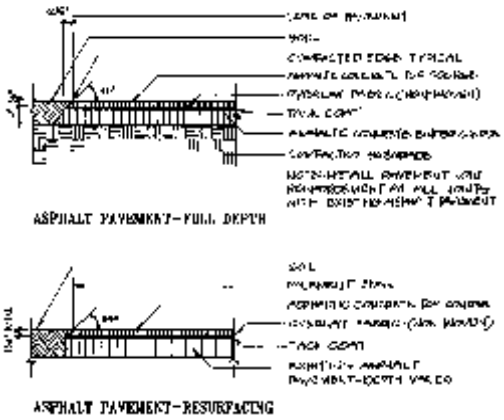
*Intersection design of multi-use path crossing an arterial roadway. Bicycles and pedestrians use crosswalk and refuge island. Source: Velo Quebec*



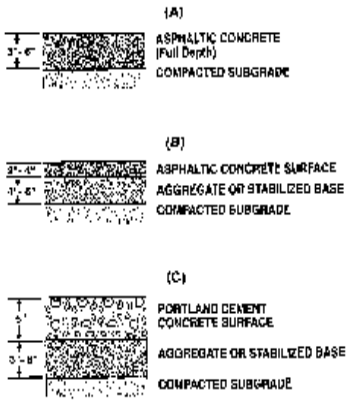

*Intersection design for multi-use path crossing a local street. Source: North Carolina DOT*

## Pavement Materials

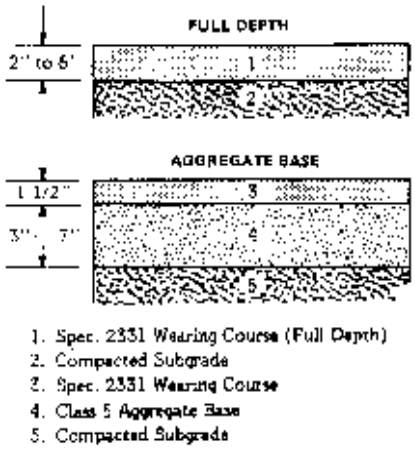
According to AASHTO, designing and selecting pavement sections for bicycle paths is in many ways similar to designing and selecting highway pavement sections. Asphalt has traditionally been the most common material, although subgrade stability and cost are the major factors affecting the material choice. In addition to asphalt, materials used in New York City paths include asphalt hex block unit pavers (Eastern Parkway path) and concrete (Ocean Parkway path). Hexblock has proven less desirable as a paving material because of its natural tendency to form a convex surface with aging, creating a rough riding surface.



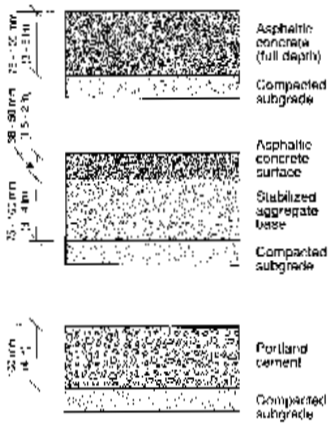

*Reconstruction of the Shore Parkway Bicycle Path, NYC DPR*




*Bicycle Master Plan, Oregon DOT.*




*Bikeway Design Manual, Minnesota DOT*




*Bicycle Facilities Planning & Design Guidelines, N. Carolina DOT*

*Miscellaneous paving details for multi-use paths .*

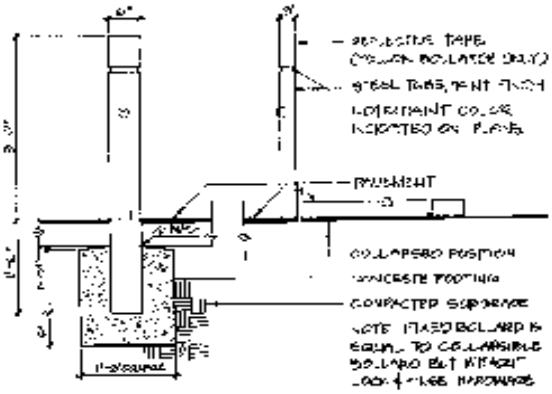
## Vehicle Access Controls

Bicycle paths often need some form of physical barrier at roadway intersections to prevent unauthorized motor vehicles from entering. Barriers are especially warranted when paths are located near sensitive natural habitats. However, access for maintenance and emergency vehicles must be provided. Listed below are some possible examples of physical barriers:

*Gates / Bollards:* Lockable gates or collapsible bollards permit entrance by authorized vehicles. AASHTO recommends that, when more than one post is used, a 5 foot spacing is desirable; wider spacing can allow motor vehicle entry, while narrower spacing might prevent safe entry by bicycles. NYC DPR has developed several guard rail and bollard details for various locations throughout the city.

Additional methods for restricting access include curbing, fence and barrier rails or changes in elevation, such as graded berms.

*Vegetation:* A path can be divided into two narrow entryways and separated by low landscaping to prevent unauthorized access. Emergency vehicles could enter by straddling the landscaping. All terrain vehicles (ATVs) can usually drive over most plantings, rendering this alternative less effective.



*Detail for a collapsible steel bollard.*
*Source: Reconstruction of the Shore Parkway Bicycle Path, DPR*

*Steel barrier rail installed along the perimeter of Marine Park, Brooklyn.*

*Vegatated berm along Flatbush Avenue and Floyd Bennett Field, Brooklyn.*

*Vehicular access controls.*

## Bridge Structures

Bicycle access to bridges is essential in New York, a city of islands, rivers and water crossings. AASHTO provides the following guidelines:

*New structures*: The minimum width should be the same as the approach path, plus an additional 2 foot wide clear area to provide a minimum horizontal distance from the railing or barrier and to provide maneuvering space if pedestrians or other cyclists are stopped on the bridge. In addition, access by emergency, patrol and maintenance vehicles should be considered in establishing both the vertical and horizontal design clearances.

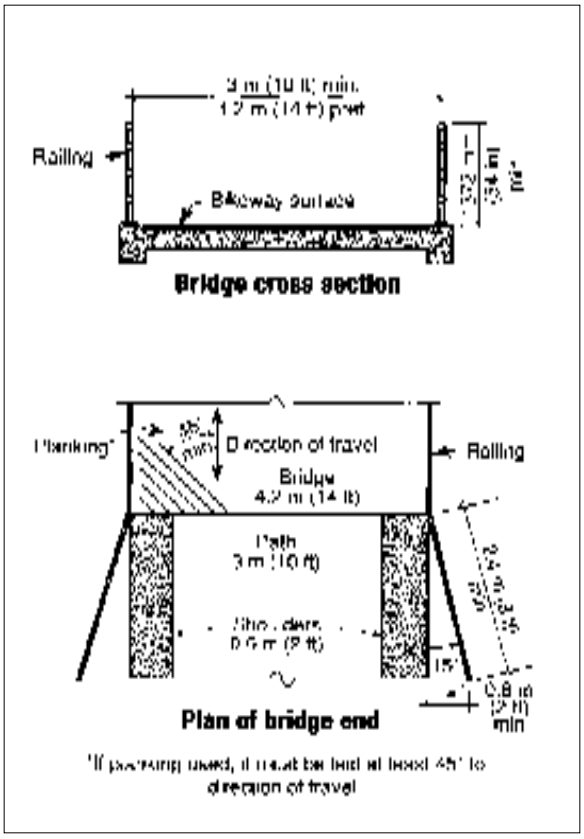
Railings, fences, or barriers on both sides of a bicycle path structure should be a minimum of 4.5 feet high. Smooth rub rails should be attached to the barriers at handlebar height of 3.5 feet.

*Existing structures:* AASHTO offers 3 options:

1. A path should be constructed across the bridge where (A) the facility will connect with a path on both ends; (B) sufficient width exists on that side of the bridge or can be obtained by widening or restriping lanes; and (C) bicycle traffic can be physically separated from motor vehicle traffic.

2. Wide curb lanes or on-street lanes should be provided where (A) the path transitions into lane or signed route at one end of the bridge and (B) sufficient width exists or can be obtained by widening or restriping.

3. Existing sidewalks should be used as one-way or two-way facilities where (A) conflicts between cyclists and pedestrians will not exceed tolerable limits and (B) the existing sidewalks are adequately wide. Under certain circumstances, the cyclist may be required to dismount and cross the structure as a pedestrian.




*Details for multi-use brdiges. Source: North Carolina DOT*

All of the examples described above are found on New York City bridges. Bicycle and pedestrians bridges are located along some of the City's Greenway routes, such as the bridges over the FDR Drive to East River Park. Multi-use paths are found on some of the city's major bridges, such as the Brooklyn, Williamsburg, Queensboro and George Washington Bridges. On-street lanes have recently been implemented on the Cross Bay Boulevard Bridge. In addition, although not officially designated as bicycle facilities, many bridge sidewalks, such as the sidewalks along the Harlem River bridges, serve as informal bicycle routes.

Width of NYC Bridge paths:

| | |
|---|---|
| Brooklyn Bridge: | 16 ' (center span) |
| | 10 ' (Brooklyn approach) |
| Manhattan Bridge: | 10' 6" (under construction) |
| Queensboro Bridge: | 11' 10" (proposed) |
| Williamsburg Bridge: | 12' (under construction) |
| George Washington Bridge: | 7' 4" (between ropes) |
| | 5' 8" (Manhattan approach) |

When a structural solution cannot be achieved for a major bridge crossing, a "bike-on-bus" service is an option. The three methods of carrying bicycles on buses are (A) rear-mounted racks; (B) front-mounted racks and (C) by allowing bicycles inside the bus. The "bike-on-bus" has been implemented on the QBX1 bus line over the Whitestone Bridge, and is being explored as one alternative for bicycle access by DCP over the Verrazano-Narrows Bridge.

As stated by AASHTO, the appropriate width of a retrofitted bicycle facility on an existing bridge is best determined by the designer, on a case-by-case basis, due to the large number of variables.

## Maintenance and Protection of Traffic


*Temporary stair crossing over work zone during replacement of wood decking on the Brooklyn Bridge Promenade.*

Federal law requires that construction projects which force the temporary closing of a bicycle facility provide a reasonable alternate route. These design guidelines recommend that the temporary facility be designed to ensure the safety of all modes, minimize any necessary detour distance and avoid forcing cyclists to dismount.

## Innovative Infrastructure

European countries have historically exhibited more innovation in the development of bicycle facilities, due at least in part to the Europeans' greater acceptance of the bicycle as a viable mode of transportation. Increasingly, U.S. cities have looked to Europe to develop demonstration projects of innovative bicycle facilities. Described below are some of the more successful examples.

### Pigmented Bicycle Lanes

Pigmented bicycle lanes are found in Dutch and German cities, and pigmented motor vehicle lanes are found in London and in Dutch cities to create a roadway hierarchy. The selection of a pavement color for bicycle lanes which differs from the motor vehicle lane has the following benefits: bicycles are given preferential status; vehicle speeds are reduced by creating the impression of a more narrow roadway for motor vehicles; and motor vehicle parking is discouraged. Oregon has proposed pigmented lanes for traffic calming purposes in its recent state transportation plan.

### Center median bicycle lanes

A center median bicycle lane can sometimes reduce the number of conflicts between bicycles and motor vehicles as bicycles are not forced to cross the path of right turning vehicles. Seattle has successfully implemented a center median lane.

### Shared bus-bike lane

Shared bus-bike lanes have proven successful in Madison, WI, Toronto, Ontario, London, UK and in the Lyon region in France. An exclusive bus lane can reduce the number of single occupancy vehicles and provide cyclists, under certain conditions, with a preferred lane.

Key ingredients for success include:

- Wide curb lanes of 14 to 16 feet.
- Peak bus headways of 1.5 - 2 minutes.
- Prominent sign & pavement markings.
- Limited right-turn movements.
- Consistent enforcement.

Recent technological improvements, such as compressed natural gas and improvements in emission controls, can render this an attractive option.

*Shared bus-bike lane in Freiburg, Germany.*

### Contra-flow bicycle lanes

A contra-flow bicycle lane is a two-way bicycle lane located adjacent to a one-way motor vehicle lane. Although this alternative encourages cyclists to ride against motor vehicle traffic, and is therefore contrary to the rules of the road, the following special circumstance can justify its implementation:

- Direct access to destinations.
- A substantial number of cyclists are already using the roadway in a contra-flow direction.
- There are few intersections on the route and cyclists can merge into typical traffic flow.

Successful examples of contra-flow lanes are found in German, Dutch and English cities, Montreal and Eugene, OR.

### Signals

Signal innovations include the following:

*"Bicycle-exclusive" signal phase*: Popular in the London and the Netherlands, the signal phase is activated by pushbuttons or metal detection loops embedded in the pavement. Adjustments to the timing of motor vehicle signals allow adequate time for bicycles to cross two or more lanes of traffic. A bicycle-exclusive signal is located at Herald Square in Manhattan. A remnant of the Sixth Avenue separated bicycle lane, this signal is not activated by cyclists.

*Advanced stop lines:* This alternative gives cyclists a head start at difficult left-turn movements.

### Raised or separated bicycle lanes

This alternative can act as an effective hybrid of multi-use paths and on-street lanes, and has proven successful in Montreal, and cities in Oregon, Copenhagen, Denmark and Germany. Separation from motor vehicle traffic is achieved by either installing unit paver safety strips or constructing a slightly raised path on a mountable curb. These paths allow cyclists to enter or exit a lane for turning and passing slow moving cyclists. The separation also deters motorists from moving into the bicycle lane. The major disincentive to this alternative is higher implementation costs, complicated replacement after street repairs and an additional space requirement of approximately one meter.

The failure of the curb separated bicycle lane on Sixth Avenue in Manhattan, installed and removed in 1980 was an important lesson on the importance of designing a site specific facility. Located on one of the city's major corridors, with heavy motor vehicle and pedestrian use, the lane became a refuge for pedestrians and street vendors, forcing its removal within months.

*Bicycle lane in Frankfurt, Germany separated from motor vehicle traffic by a series of rubberized curbs, anchor bolted into the street pavement.*

## Traffic Calming

Originating in European cities, but increasingly common in U.S. cities, traffic calming initiatives attempt to reduce the amount and speed of motor vehicle traffic and improve bicycle and pedestrian safety. Perhaps the most popular initiative to derive from Europe is the woonerf, or living yard. The woonerf, which is located exclusively on residential streets, involves the installation of traffic calming devices to prohibit motor vehicles from traveling faster than the speed of walking. This creates an environment where cyclists and pedestrians have a higher priority. Described below are the more popular traffic calming devices:

*Speed table:* This modified speed bump has proven effective in reducing motor vehicle speed and diverting volume to adjacent streets, although localities have been reluctant to install them as they are not found in the MUTCD. Speed tables should be located no more than 500 feet apart (to better control vehicle speed) and should not be located on emergency access routes. DOT is evaluating the effectiveness of speed tables installed at 8 locations in 1996.

*Speed table used to slow vehicular traffic on a residential street in York, England.*

*Traffic circles (mini-roundabouts):* Seattle has taken the lead in the installation of traffic circles. Constructed in the middle of a residential street, the Seattle traffic circles are custom fitted to an intersection's geometrics. Every circle is designed to allow a single unit truck to maneuver around the circle without running over it, although a two-foot concrete apron is built around the outside edge of the circle to accommodate larger trucks. The interior section of the circle is usually landscaped. A study of the impact of traffic circles at 14 intersections in Seattle revealed that the total number of collisions dropped from 51.6 to 2.2 after installation. Accidents within a one block radius also decreased, from 101 to 33.

*Traffic circle used to reduce through vehicular traffic while allowing local access in a residential neighborhood of Seattle.*

*Chicanes:* Chicanes are barriers placed in the street that require drivers to slow down and drive around them. Seattle, WA has found chicanes to be effective in the reduction of speed and traffic volumes at specific locations. However, the speeds between the chicanes has not significantly changed.

*Bicycle Boulevard:* The purpose of a bicycle boulevard is to provide a throughway where cyclists have precedence over automobiles, an indirect route that reduces travel time for cyclists, and a safe travel route that reduces conflicts between cyclists and motor vehicles. Palo Alto, CA constructed a bicycle boulevard along a 2 mile stretch of a residential street which runs parallel to a busy collector arterial. Barriers were constructed to prevent the through movement of motor vehicles but allow the through movement of cyclists. The boulevard continues to function as a local street, providing access to residences, on-street parking, and unrestricted local travel. An evaluation after 6 months showed a reduction in the amount of motor vehicle traffic, a nearly two-fold increase in bicycle traffic, and a slight reduction in bicycle traffic on nearby streets. Boulevard barriers include the installation of stop signs, curb extensions, one-way “chokers”, speed humps and traffic circles.

Benefits of the bicycle boulevard include the reduced cost of altering an existing street versus constructing a new path; increasing mobility and safety for cyclists and pedestrians and reducing motor vehicle speed and volume. Potential problems include increased motor vehicle traffic on adjacent streets; high risk of danger to cyclists and pedestrians at arterial roadway crossings; and high cost if there is a significant reliance on traffic signals.

*Slow streets:* The slow street is much like the Dutch woonerf. Examples of the slow street are found in Seattle and Berkeley, CA. The Seattle example, located in a new large-scale housing development, involved the installation of curb extensions (neck downs), the placement of the street and sidewalk at the same level, the clear delineation of motor vehicles parking areas and the placement of signs identifying the street as a slow speed, or woonerf, area.

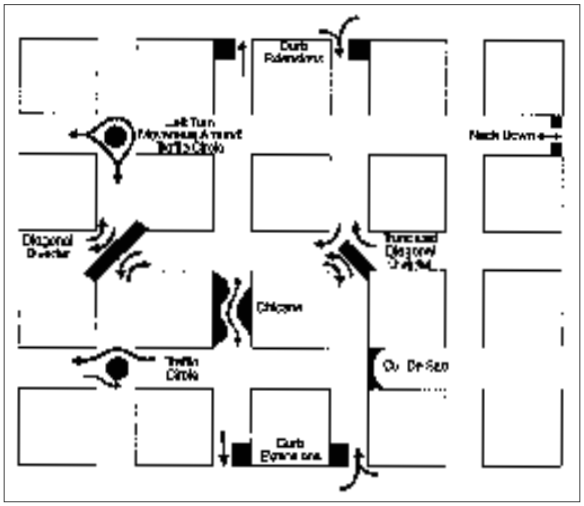



*Diagram of typical traffic claming measures.*