Section 7. Facility Design Guidelines

This section of the Plan provides an overview of bicycle facility design treatments and identifies solutions for trails, on-street facilities and bicycle parking. Most safe bicycling is done in the street, and proper design of on- and off-road facilities is paramount.

7.1. Introduction

This section of the Wake Forest Bicycle Plan is based on current state and national guidelines including the *North Carolina Bicycle Facilities Planning and Design Guidelines* (NCDOT Office of Bicycle and Pedestrian Transportation, January 1994) and the *AASHTO Guidelines for the Development of Bicycle Facilities* (AASHTO, 1999). The Wake Forest guidelines use these documents as a baseline for minimum conditions, and are intended to provide design solutions for a wide range of bicycle facility types. It is recognized that on facilities maintained by NCDOT, the State's design guidelines will apply, and that Wake Forest has the potential to exceed these minimum guidelines where conditions warrant on facilities within their jurisdiction.

The following are five key principles that underlie these guidelines.

Greenways and On-Street Bikeways *Wake Forest will have both a complete network of greenways and trails, and a complementary network of on-street bicycling facilities. These two systems will be interconnected to make it possible for all destinations in Wake Forest to be accessible by bicyclists.*

Bicycling is "Street Legal" *All roads in Wake Forest are legal for the use of bicyclists, except those roads designated as limited access arterials or freeway facilities which prohibit bicyclists. In addition, bicyclists are not permitted to ride on sidewalks in Wake Forest. This means that most streets are bicycle facilities and will be planned, designed and maintained accordingly. A "Complete Streets" policy approach will guide infrastructure development by ensuring that bicycle facilities are integrated in the community's infrastructure.*

Design for All Bicyclists *Bicyclists have a range of skill levels, from "Type B/C" inexperienced / recreational bicyclists (especially children and seniors) to "Type A" experienced cyclists (adults who are capable of sharing the road with motor vehicles). These groups are not always exclusive – some elite level athletes still like to ride on shared-use paths with their families and some recreational bicyclists will sometimes use their bicycles for utilitarian travel.*

Baseline Accommodations *At a minimum, facilities will be designed for the use of Type "A" cyclists with a goal of providing for Type "B" cyclists to the greatest extent possible. In areas where specific needs have been identified (for example, near schools), the needs of different types of bicyclists will be accommodated.*

Flexibility *These guidelines are intended to be flexible and can be applied with professional judgment by project designers. Specific national and state guidelines are identified in this document, as well as design treatments that may exceed these guidelines.*

Table 7-1. Bicycle Facility Types

Facility Type	Category	Width	Surface	Treatment	Function
Bike Lane	On-Street	4'-6'	Asphalt	On-street lane striped and signed to NCDOT standards; design should ensure a limited number of commercial driveways and turning movements	For bicyclists on roadways
Signed Shared Roadways	On-Street	varies	Asphalt	May either be a low volume roadway with traffic calming and signage to create a safe shared use environment, OR a higher volume roadway with wide (14') outside lanes	Used for designated bicycle routes; can include signage and pavement markings, including "sharrows"
Bicycle Boulevard	On-Street	varies	Asphalt	Multiple traffic calming treatments combined with bike lanes and or signed shared roadways to create priority streets for bicyclists	Provides a continuous facility on streets with varying widths, volumes and speeds
Shared Curb Lane	On-Street	9'-12'	Asphalt	Common facility type in low-speed and low-volume street types; can include signage and treatment markings, including sharrows	Utilitarian cycling on streets which are not otherwise designated as elements of the bicycle network
Wide Curb Lane	On-Street	12'-14'	Asphalt	Smooth pavement, bicycle compatible storm grates; can include signage and treatment markings, including sharrows	For skilled bicyclists who are capable of sharing the road with motor vehicles
Paved Shoulders/Wide Striped Shoulders	On-Street	varies (min. 2')	Asphalt	The outside lane (in each direction of travel) is widened behind the white edge delineator stripe	For utilitarian bicyclists depending on condition, width, speed of adjacent traffic, and frequency of driveways
Shared Use/Multi-Purpose Path / Multi-Use Trail	Off-Street	10'-14'	Asphalt, concrete or other smooth firm surface	Designed to NCDOT standards. Separated from roadway by planting strip or vertical curbing	Typical application for regional trail and some community pathways and bikeways. Accommodates bicycles, pedestrians, and wheelchairs. Minimizes potential trail crossing conflicts with autos
Single Track Trail	Off-Street	3'-8'	Natural Surface	Designed to meet International Mountain Biking Assn (IMBA) guidelines	Designed for mountain bicyclists; can include a variety of off-road bicycling trail types

7.2. Design Guidelines

Bicycle facilities are grouped into three categories: 1) Shared Use Paths, Greenways and Trails, 2) On Street Bikeways, and 3) Bicycle Parking and Support facilities. The following sections are based on definitions established by AASHTO, NCDOT, the MUTCD and innovative design concepts from other communities in the U.S.

7.2.1. Shared Use Paths, Greenways and Trails

Shared use paths, greenways and trails are among the terms used to describe facilities for pedestrians, bicyclists and non-motorized travel that are separated from roadways. These facilities are presented in the 2002 Wake Forest Greenways Plan. This document provides supplemental information to ensure that greenways and on-street bikeways are integrated to provide a seamless system of bicycle facilities in Wake Forest.

The graphic in Figure 7-1 illustrates a typical, shared use trail cross-section, which is the most common design for Wake Forest's trail

and greenway network. The cross-section provides for two-way bicycle and pedestrian traffic, typically has its own right-of-way, and can accommodate maintenance and emergency vehicles.

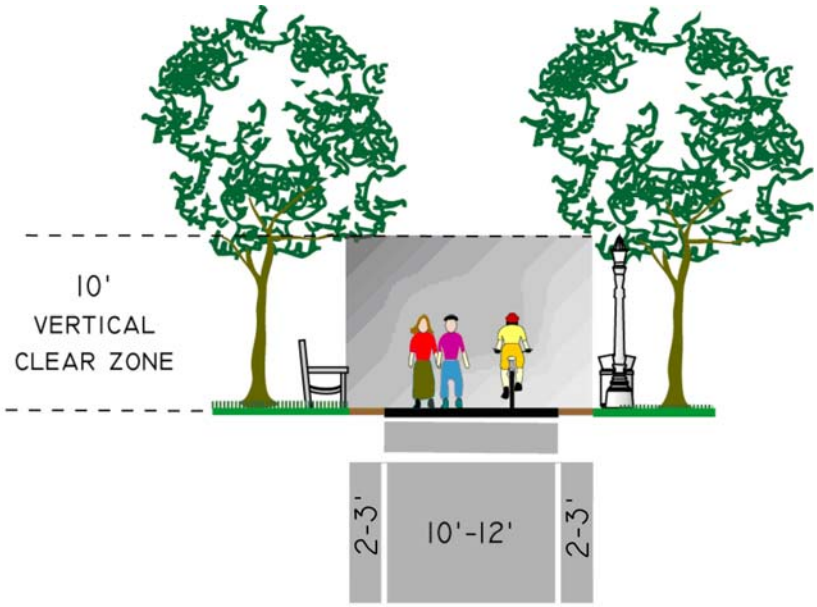
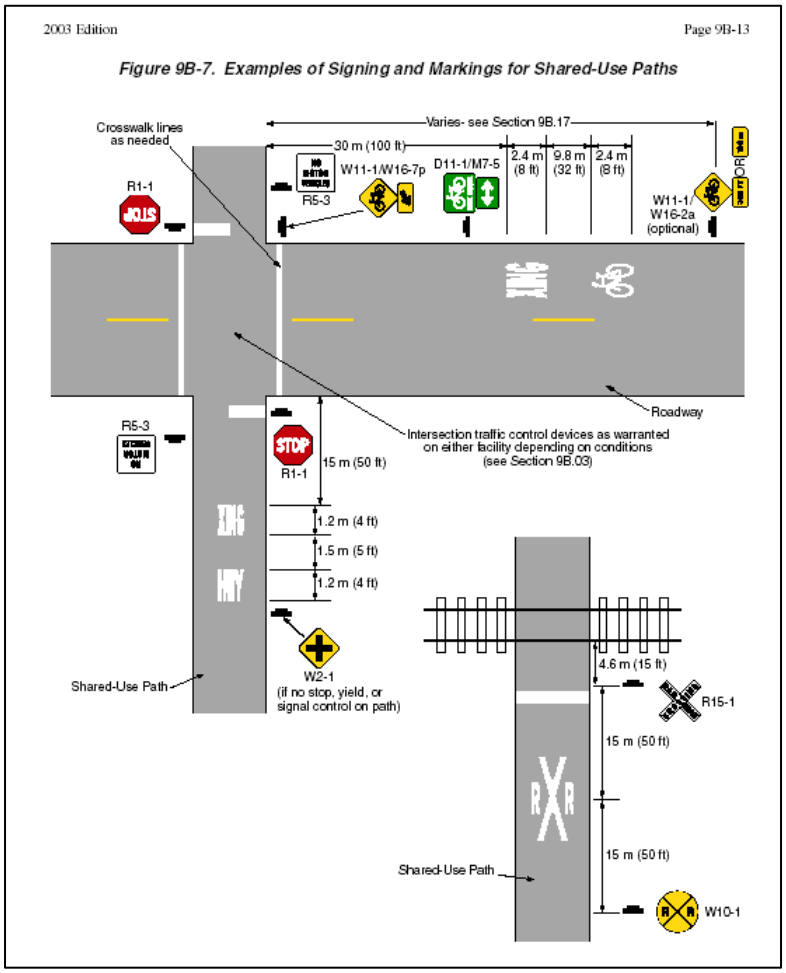


Figure 7-1. Typical Shared Use Trail Design *Alta Planning + Design*

Shared Use Path Crossing of local street in Durham, NC. *Photo: J. Olson*

In addition to dimensional standards, there are other design considerations unique to bicyclists on shared use paths. One of the key elements is to safely integrate connections between these off-street facilities and on-street bikeways. This includes crossings and access features for roadways, with design features both for vehicles and trail users. Signage types, locations, and other criteria are identified in the *Manual for Uniform Traffic Control Devices* (MUTCD; available on-line at: http://mutcd.fhwa.dot.gov/kno-2003r1.htm). Warning signage and other notices, such as wayfinding signage, should be installed when a trail crosses a road or crosses another trail. Adequate warning distance is based on vehicle speeds and line of sight. Signage should be highly visible to alert motorists that trail users are present. Supplemental devices such as signals, flashing beacons, ramps, refuge islands, enhanced roadway striping or changes in pavement texture may also be required. Signing for trail users also includes standard stop or yield signs and pavement markings, interpretive trailheads and wayfinding signage, combined with bollards or other access controls.



⇦MUTCD examples of signage and pavement markings for shared use paths.

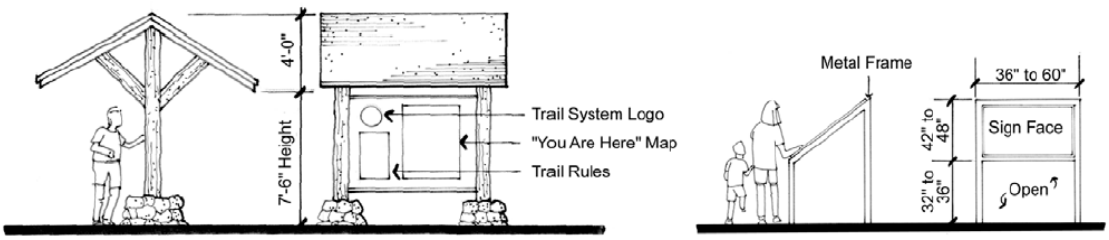


Figure 7-2. Trailhead information installations provide gateways between on-street facilities and greenway systems. *Alta Planning + Design*

Neighborhood Trails and Access Ways

Neighborhood trails provide access to shared use paths and between destinations within a community. These smaller-scale facilities typically have their own rights-of-way and serve only non-motorized users. These trails should be at least 8' wide if shared pedestrian and bicycle use is anticipated, although smaller cross-sections are acceptable for access ways within neighborhoods.

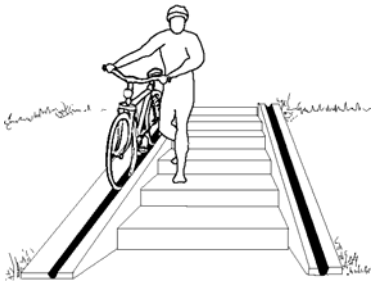


Figure 7-3. Innovative local access ways include the Dutch Staircase (left) which provides bicycle wheel gutters to allow bicycles to be walked on stairways; and a small boardwalk bridge (right) that provides access across a creek between two neighborhoods.
Alta Planning + Design

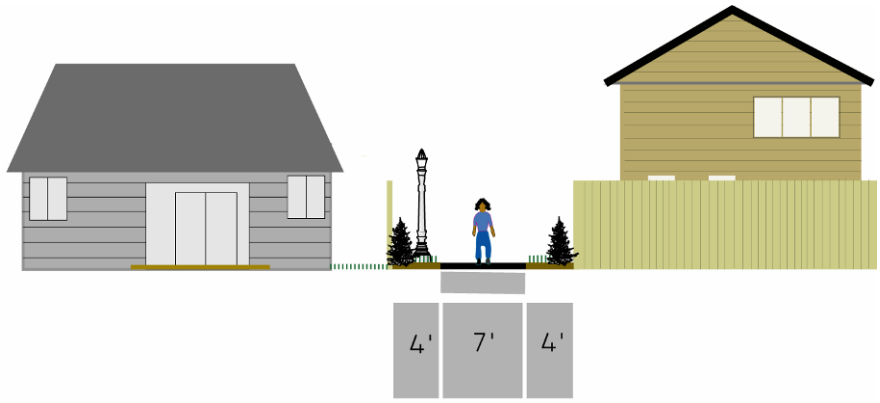


Figure 7-4. Neighborhood Bicycle and Pedestrian Access Way

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7.2.2. On-Street Bikeways: Complete Streets

The 2003 Wake Forest Transportation Plan calls for bicyclists to either 'share the road' with motor vehicles on roadways, or to ride on separated shared use paths. This approach will provide for experienced cyclists who are capable of riding in traffic, and for recreational bicyclists who will use the trails for recreation, health and fitness. This approach, however, will limit the potential of bicycling as a real transportation alternative for the Wake Forest community. An alternative approach calls for using a range of on-street bikeways to ensure that people of all skill levels can choose to ride their bicycles for transportation and recreation.

This complete street in Amsterdam includes wide sidewalks with landscaping and bicycle parking, bicycle lanes, transit lanes and vehicle lanes.
Photo: J.Olson

The concept of "Complete Streets" is based on the principle that all streets should be safe and accessible for the use of all modes of transportation, not just motor vehicles. In order for Wake Forest to accommodate motor vehicles, bicyclists and pedestrians in the community's roadway network, an expanded palette of design techniques including bike lanes, bicycle-actuated signals and other innovative solutions will need to be developed. The on-street bikeway design treatments in Wake Forest will vary according to the width and number of lanes of the facility; frequency of driveways; the average daily traffic (ADT); and travel speeds on the adjacent roadways. The following are configurations that can be applied to local roadways during new construction, re-design and maintenance projects. Flexibility in design and context sensitive solutions will need to be applied in sections with constrained rights-of-way in order to achieve solutions that work for all modes of travel.

High Volume Roadways

On roadways with 3,000 or more vehicles per day and speeds greater than 40 mph, bicycle lanes or paved shoulders can be used to improve bicyclist safety and comfort over that typically provided by wide outside lanes. A buffer or curb must separate the sidewalk from the roadway for pedestrian safety. The width of the bicycle lane, buffer, and sidewalk (or side path) should appropriately reflect the volume and speed of the vehicles using the roadway.

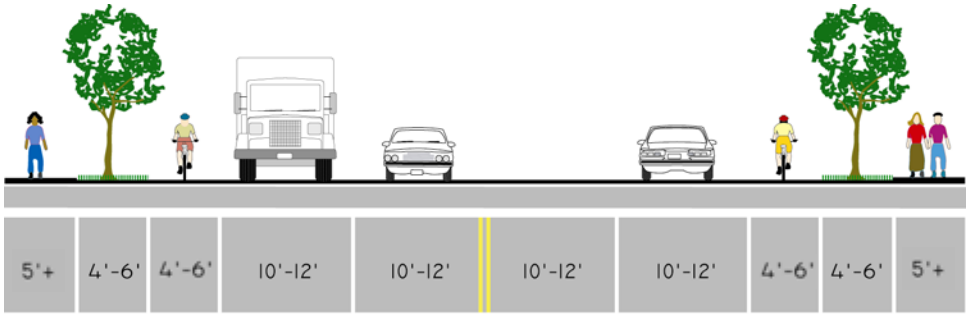

Figure 7-5. High-Volume, High-Speed Roadway Alta Planning + Design

SIDE PATHS AND ROADWAYS

Bike Paths Adjacent to Roadways must be designed carefully, recognizing the following:

Discourage wrong-way travel on streets to reach the path

Recognize that motorists may not pay attention to cyclists using an intersection from an adjacent path

Right-of-Way limitations may impose carefully designed reductions of roadway and path width

Motorists may harass on-road bicyclists if they feel that all cyclists should be using the path

Barriers between the adjacent path and roadways, while often viewed as critical safety features, may complicate maneuvering on and maintenance of the path and/or roadway.

Source: AASHTO Guide for the Development of Bicycle Facilities (1999)

The previous figure illustrates a typical bicycle accommodation in urbanized areas. The minimum bike facility width is four feet on open shoulders and six feet from the face of a vertical curb, guardrail, or parked cars. The width of the gutterpan (the flat part of the curb-and-gutter) should not be counted as part of the width of the bicycle lane, since safety issues arise with differentials in height of the street and the gutterpan due to repaving, presence of drainage grates, and conflicts with the vertical curb and bicycle pedals.

Some arterials and major collectors can accommodate a shared use path on one side of the roadway and on-street bicycle lanes, shoulders or wide curb lanes on both sides of the road. The shared use path provides a comfortable walking space for pedestrians and enables children and recreational bicyclists to ride without the discomfort of riding in a busy street (Figure 7-6). This configuration works best along roadways with limited driveway crossings and with services primarily located on one side of the roadway, such as along a waterfront or other natural feature.

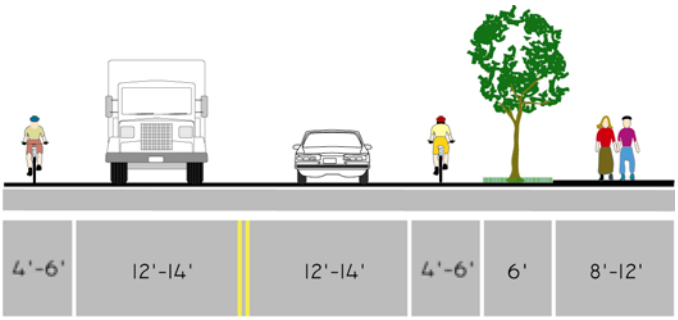

Figure 7-6. Side Path with Bike Lanes on a High-Volume, High-Speed Roadway

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Sometimes a shared use path can provide accommodation on high-volume, high-speed roadways. This type of facility works best in corridors where there are limited driveway/intersection crossings and more desirable destinations along one side of the roadway, or where no roadway space is available to provide both bike lanes and sidewalks, yet the road travels past a number of desirable locations. The path should be at least 10' wide (preferable 12') with a 6' or greater vegetated buffer where possible (Figure 7-7).

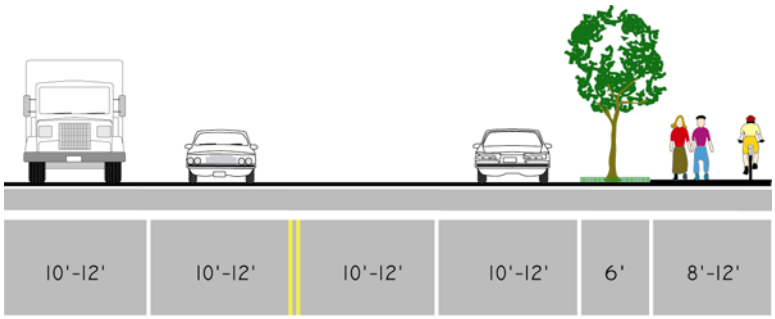

Figure 7-7. Shared Use Path on a High-Volume, High Speed Road

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Moderate Volume Roadways

On moderate volume roadways, such as minor collectors, on-street parking is often permitted. Where on-street parking is permitted and a bike lane is provided, the bike lane should be between parking and the travel lane.

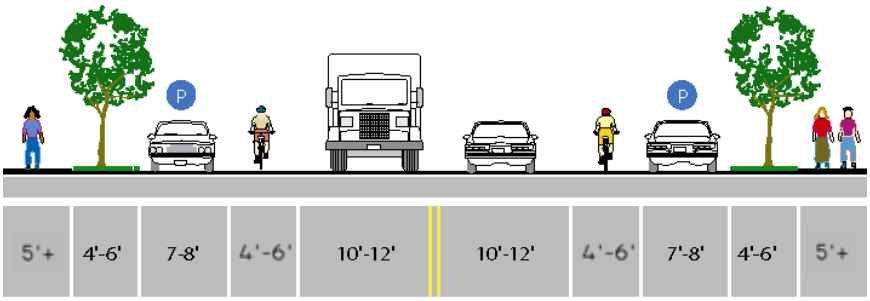

Figure 7-8. Bike Lane with On-Street Parking

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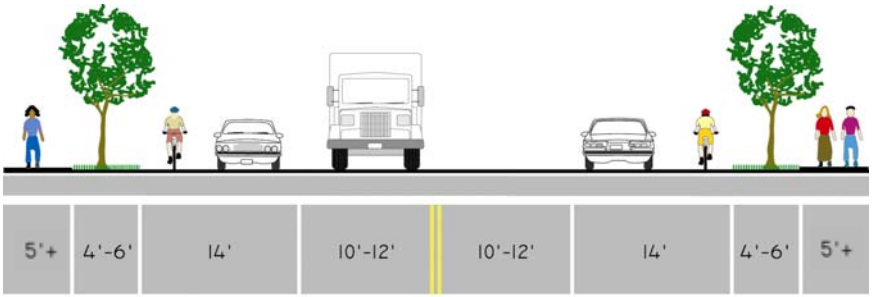
Another option is to provide a 14'-wide curb lane so that experienced bicyclists and motor vehicles can share the roadway.

In rural and suburban sections, a paved shoulder can be provided where right-of-way is limited and there is not enough room to provide both sidewalks and the wide outside lanes.



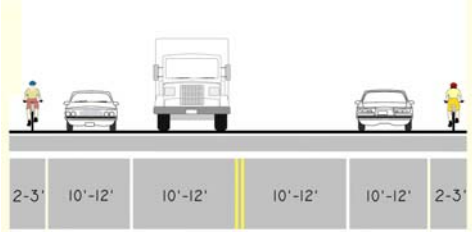


Figure 7-9. Wide Outside Curb Lane (left) and Paved Shoulder (above)
Alta Planning + Design

Low Volume Roadways

On low volume, low speed roadways (i.e., neighborhood streets); bicyclists can share the road with vehicles. Pedestrians should be separated from the roadway with a buffer or a curb, and traffic calming can be used to control motor vehicle speeds.

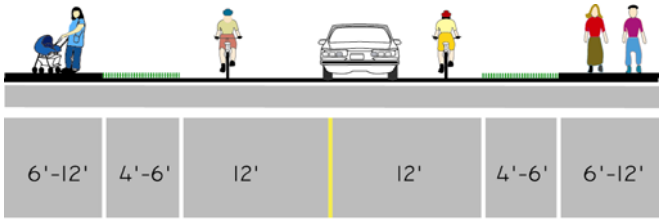


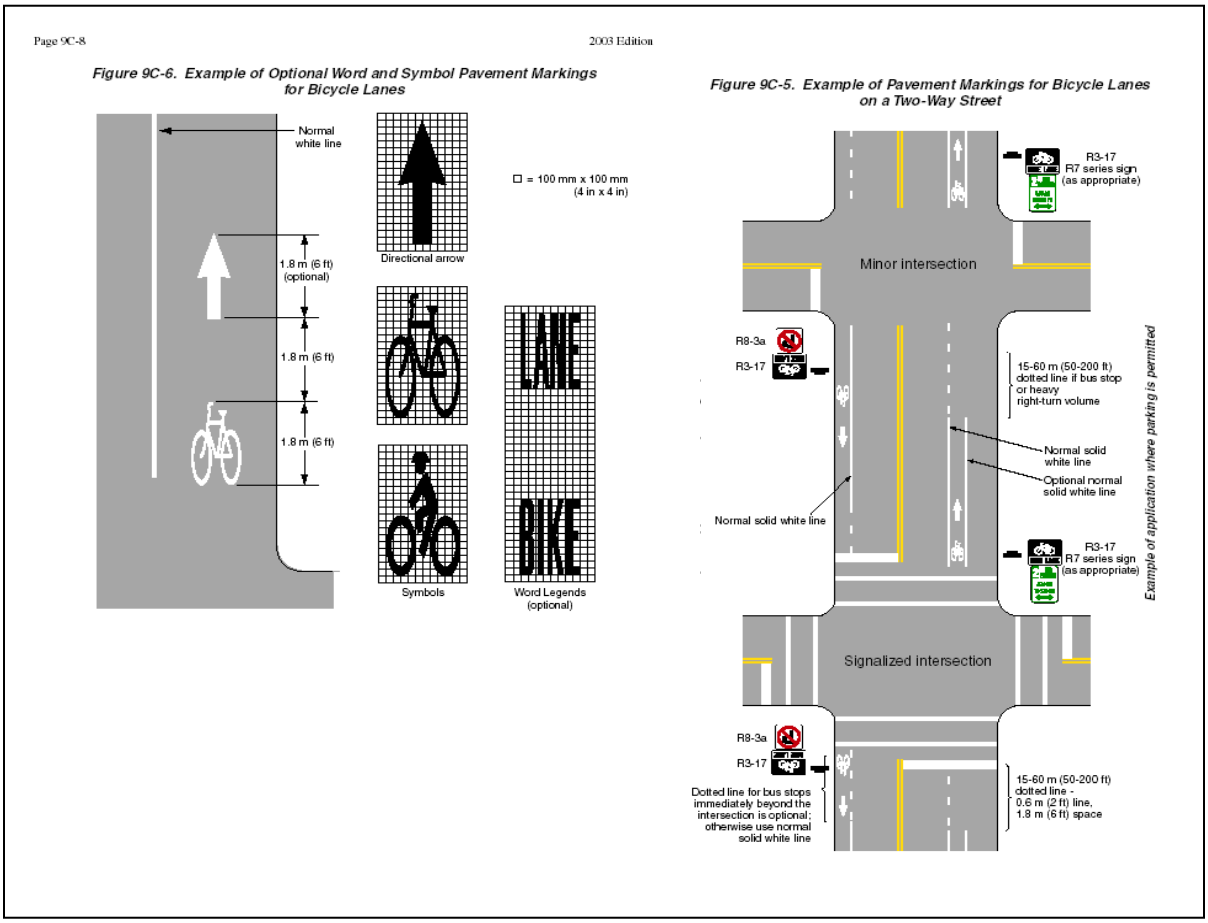
Figure 7-10. Neighborhood Street
Alta Planning + Design

On-Road Bicycle Facility Selection Criteria

The appropriate bicycle facility for a particular roadway can be identified by a variety of level of service factors, including vehicle volumes, lane widths and the speed of the roadway. The AASHTO ***"Guide for the Development of Bicycle Facilities"*** (1999) is recommended for additional reading and guidance.

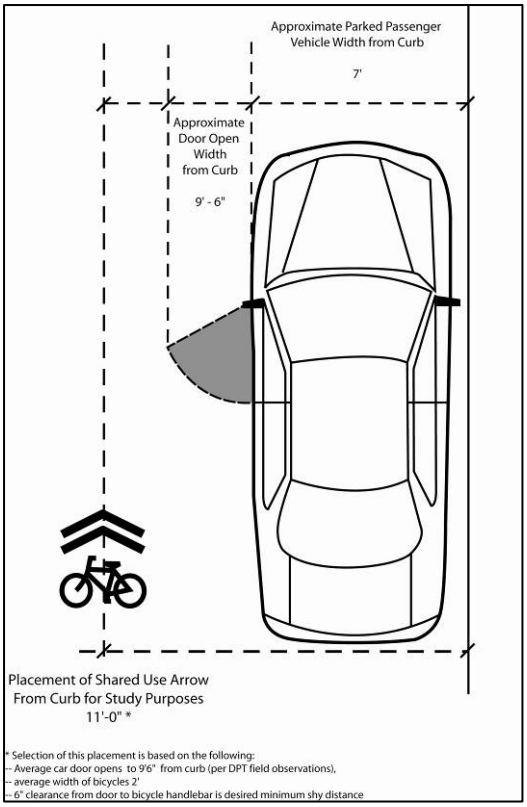
7.2.3. Pavement Markings and Signage

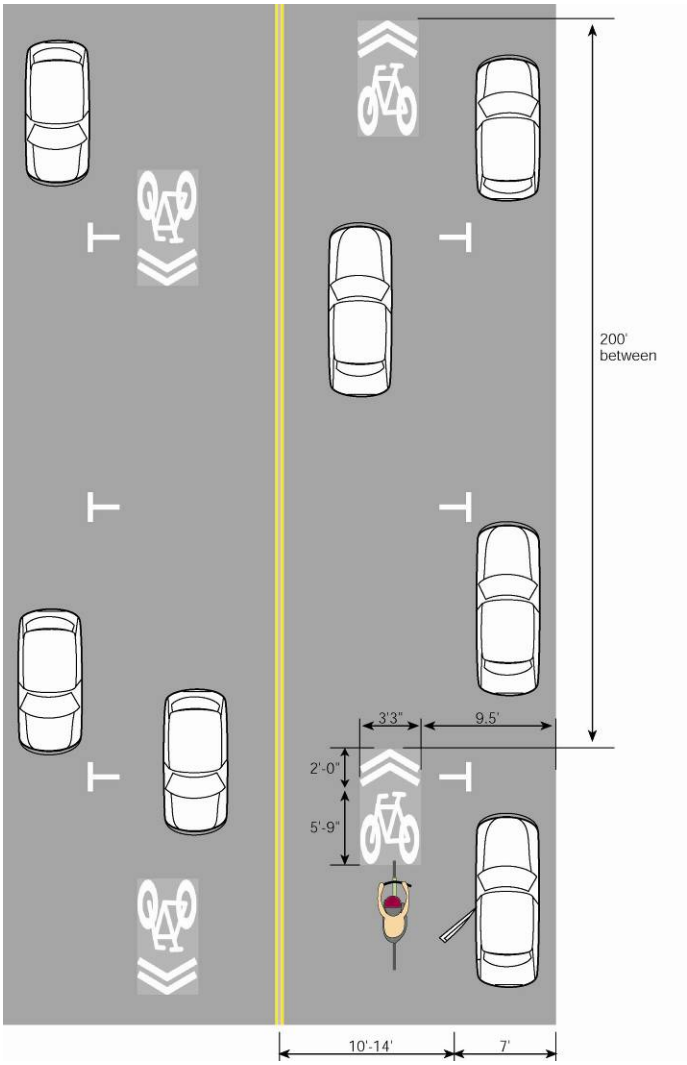
The Manual on Uniform Traffic Control Devices (MUTCD) provides guidance for lane delineation, intersection treatments, and general application of pavement markings and symbols for on-road bicycle facilities and off-road paths. In addition to those presented in the MUTCD, experimental pavement markings may also be considered in consultation with NCDOT.



MUTCD examples of optional word and symbol pavement markings for bicycle lanes.

A new bicycle shared lane arrow (or "sharrow") stencil has been developed for use on on-road bikeways where the right-of-way is too narrow for designated bike lanes. The sharrow stencil can serve a number of purposes, such as making motorists aware of bicyclists in their lane, showing bicyclists the direction of travel and, with proper placement, reminding bicyclists to bike farther from parked cars to prevent "dooring" collisions. Denver, San Francisco, Portland and other cities have effectively used these markings for several years, and this treatment is currently being considered for inclusion in the MUTCD. Sharrows can be used on municipal roadways, and possibly as an 'experimental' treatment on state-maintained roads, with approval from the NCDOT.





"Sharrow" installed on Market Street, San Francisco, and design details for the pavement markings.

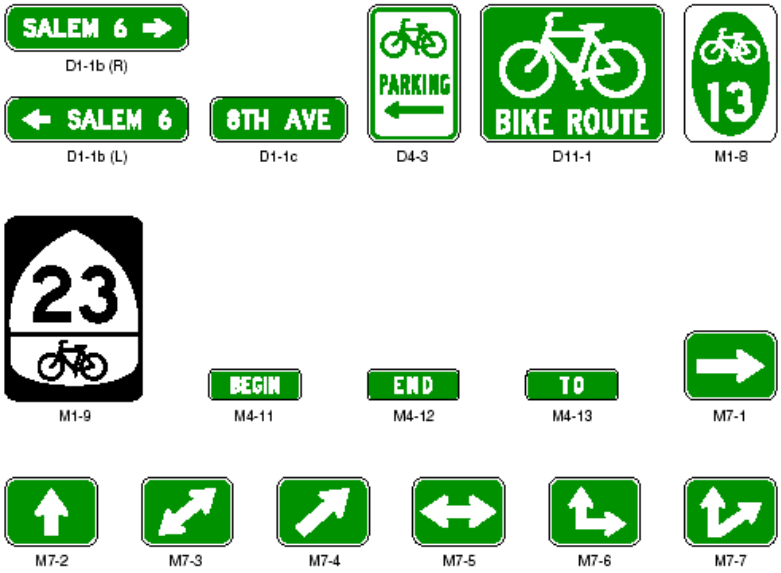
Signed bikeway systems can include bike lanes, signed bike routes, and shared use paths. Implementing a well-planned and attractive system of signage can greatly enhance bikeway facilities by defining their presence and location to both motorists and existing and potential bicycle users. By leading people to community destinations, these improvements provide benefits to local residents and visitors. Bike lanes and bike routes should be provided with distance-to-destination and wayfinding messages where appropriate.

A selected list of bikeway signs from the MUTCD is shown below.

Item	Location	Color	MUTCD Designation
No Motor Vehicles	Entrances to trail	B on W	R5-3
Use Ped Signal / Yield to Peds	At crosswalks; where sidewalks are being used	B on W	R9-5, R9-6
Bike Lane Ahead: Right Lane Bikes Only	At beginning of bike lanes	B on W	R3-16, R3-17
STOP, YIELD	At trail intersections with roads	W on R	R1-1, R1-2
Bicycle Crossing	For motorists at trail crossings	B on Y	W11-1
Bike Lane	At the far side of all arterial intersections	B on W	D11-1
Hazardous Condition	Slippery or rough pavement	B on Y	W8-10
Turns and Curves	At turns and curves which exceed 20- mph design specifications	B on Y	W1-1, W1-2, W1-4, W1-5, W1-6
Trail Intersections	At trail intersections where no STOP or YIELD required, or sight lines limited	B on Y	W2-1, W2-2, W2-3, W2-4, W2-5
STOP Ahead	Where STOP sign is obscured	B, R on Y	W3-1
Signal Ahead	Where signal is obscured	B, R, G	W3-3
Bikeway Narrows	Where bikeway width narrows or is below 8'	B on Y	W5-4
Downgrade	Where sustained bikeway gradient is above 5%	B on Y	W7-5
Pedestrian Crossing	Where pedestrian walkway crosses trail	B on Y	W11A-2
Restricted Vertical Clearance	Where vertical clearance is less than 8'6"	B on Y	W11A-2
Railroad Crossing	Where trail crosses railway tracks at grade	B on Y	W10-1
Directional Signs	At intersections where access to major destinations is available	W on G	D1-1b(r/l), D1-1-c
Right Lane Must Turn Right; Begin Right Turn Here; Yield to Bikes	Where bike lanes end before intersection	B on W	R3-7, R4-4
Trail Regulations	All trail entrances	B on W	N/A
Multi-purpose Trail: Bikes Yield to Pedestrians	All trail entrances	N/A	N/A
Bikes Reduce Speed & Call Out Before Passing	Every 2,000 feet	B on W	N/A
Please Stay on Trail	In environmentally-sensitive areas	N/A	N/A
Caution: Storm Damaged Trail	Storm damaged locations	B on Y	N/A
Trail Closed: No Entry Until Made Accessible & Safe for Public Use	Where trail or access points closed due to hazardous conditions	N/A	N/A
Speed Limit Signs	Near trail entrances; where speed limits should be reduced from 20 mph	B on W	N/A
Trail Curfew 10PM – 5 AM	Based on local ordinance	R on W	N/A

Recommended Bicycle Facilities Signage

In general, the sizes of signs used on shared-use paths are smaller than those used on roadways. The MUTCD lists minimum sign sizes for both types of bicycle facilities.

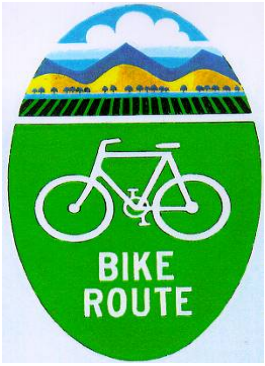


MUTCD Standard Bikeway Signage (Figure 9B-4)

Share the Road signs remind motorists that bicyclists have the right to ride on the roadway.

Innovative signing is often developed to increase bicycle awareness and improve visibility. Signs to be installed on public roadways in North Carolina must be approved by NCDOT's Traffic Control Devices Committee. New designs can be utilized on an experimental basis with NCDOT approval, but are unlikely to be allowed at this time unless placed on a non-state maintained roadway in town.

In California and Oregon, San Francisco and Portland have used approved customized bike route logo signs. Jurisdictions may choose a graphic of their choice for the upper third portion of the sign and a numbering system, similar to the highway numbering system, can be used in the lower third.



Several California cities use customized logo signs to define bike routes.

Another signage option is the "Share the Road" sign, designed to advise motorists that, as vehicles, bicyclists need to share roadways with motor vehicles along certain sections of roadway, especially designated bicycle routes. Also refer to the North Carolina "Share the Road" initiative, which is described in detail at: www.ncdot.org/transit/bicycle/safety/programs_initiatives/share.html.

Through bike lanes at intersection approaches protect bicyclists from right turning motorists.
Photo: Alta Planning + Design

7.2.4. Bicycle-friendly Intersections

Intersections represent one of the primary safety issues for bicyclists. Generally, the bigger the intersection, the more difficult it is for bicyclists to navigate. On-coming vehicles from multiple directions and increased turning movements make it difficult for motorists to see non-motorized travelers. Intersections must provide a designated place for bicyclists to operate as vehicles. Bike lanes and pavement markings should be continued through intersections, to provide safe conditions for all road users. Signal detection devices, including loop, infrared and video detectors should be designed to be activated by bicyclists.

Bicyclists wanting to make left turns must either choose to behave as vehicles by crossing travel lanes and using the left-turning travel lane, or they can act as pedestrians and dismount their bikes, push the pedestrian walk button located on the sidewalk (if available), and then cross the street in the crosswalk. Where right-turn lanes are present, bicyclists traveling straight through an intersection need to maneuver from the right curb lane to a through lane of travel. The design of intersections should clearly communicate to motorists and bicyclists the movements for both to expect.

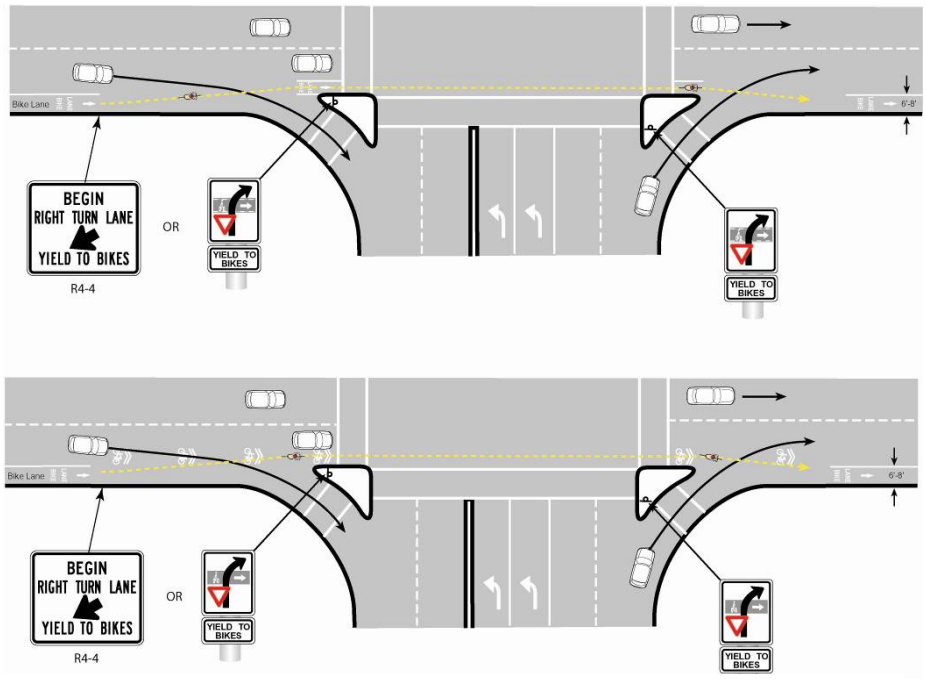


Figure 7-11. Bike lane through intersection with free right-turn lanes.
Alta Planning + Design

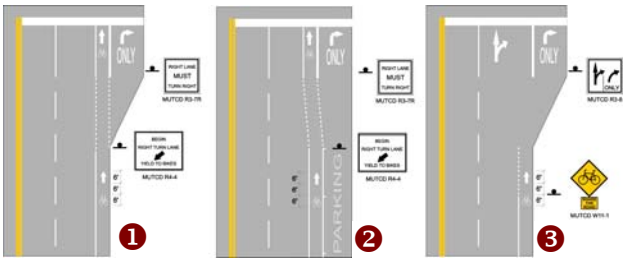
The Translation of Bicycle Lanes at Intersections requires considerations of the cross-section of the street, presence of on-street parking, and if turning lanes are present.

❶ *Right-Turn Only Lane.* Use mini-skips (dotted lines) to denote the "weave" movement between bicycles going straight and cars crossing into a right-turn-only lane.

❷ *On-Street Parking.* Again, the use of mini-skips helps mark the bike lane for drivers wishing to turn right.

❸ *Through-Right with Right-Turn Only Lane.* Here, the bicycle lane disappears as the cyclist must negotiate a route to the center of the through-right lane.

Source: AASHTO Guide for the Development of Bicycle Facilities (1999)



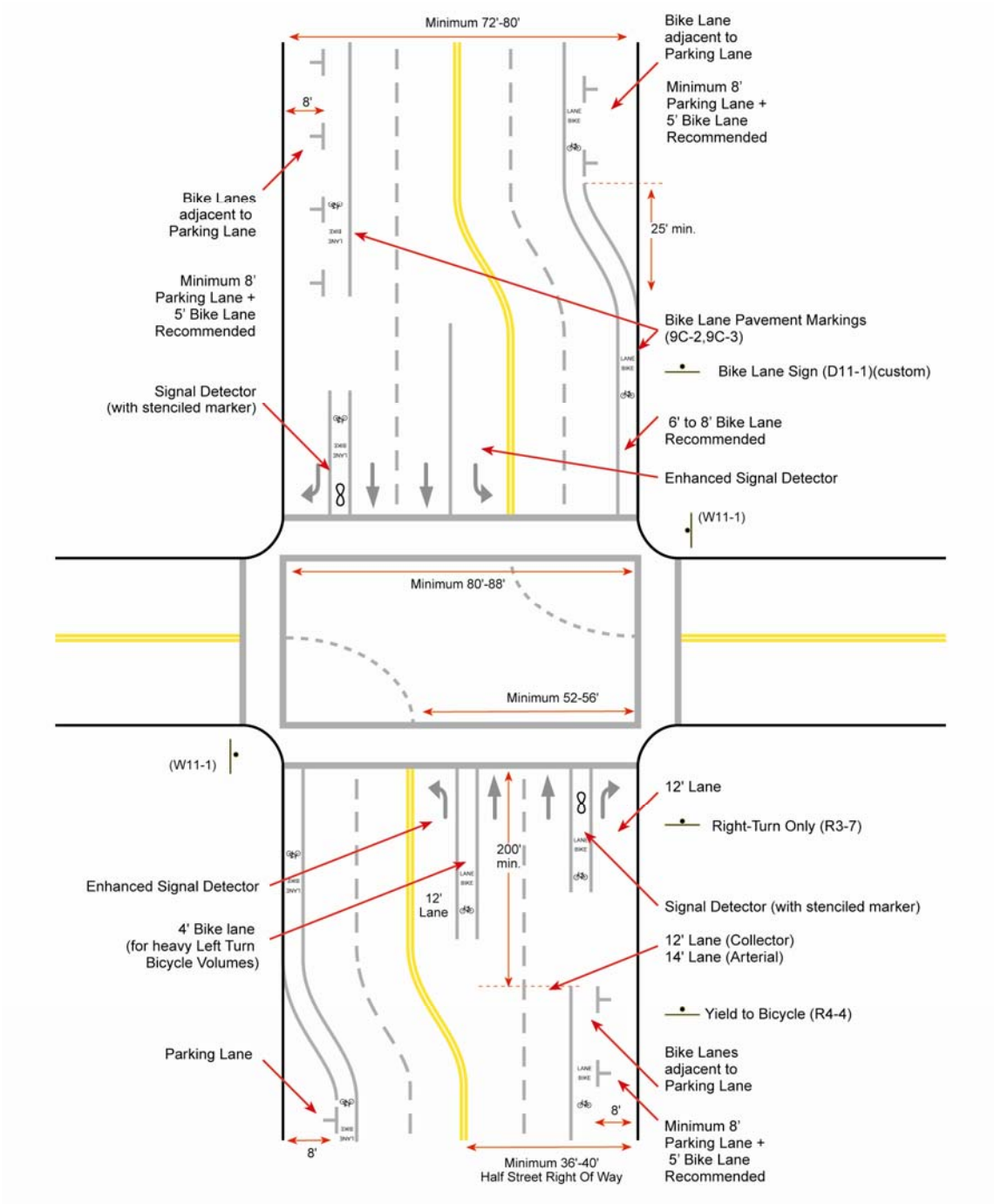
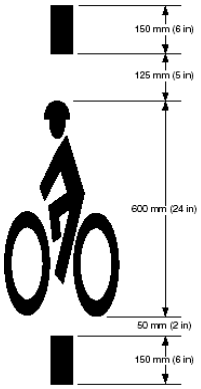


Figure 7-12. Bicycle lane configurations at intersections. *Alta Planning + Design*

Bicyclist Activated Signals

Changing how intersections operate can help make them more "friendly" to bicyclists. Improved signal timings for bicyclists and bicycle-activated loop, video or infrared detectors make it easier and safer for cyclists to cross intersections. Bicycle-activated loop detectors are installed within the roadway to allow the bicyclist to trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel and avoid maneuvering to the side of the road to trigger a push button. The purpose of bicycle activated signals is to give cyclists extra green time before the light turns yellow to make it through the light. Current and future detection devices should have pavement markings to indicate where cyclists should be positioned on the roadway to activate the signals.



Bicycle signal actuation pavement markings.
Photo: J.Olson MUTCD

"Bike Box" / Advance stop line

A 'bike box' is a relatively simple innovation to improve turning movements for bicyclists without requiring cyclists to merge into traffic to reach the turn lane or use crosswalks as a pedestrian. The bike box is formed by locating the stop line for motor vehicles back from the intersection and adding a stop line for bicyclists immediately behind the crosswalk. When a traffic signal is red, bicyclists can move into this "box" ahead of the cars to make themselves more visible, or to move into a more comfortable position to make a turn. Bike boxes have been used in Cambridge, MA, Eugene, OR, and in many European cities but they are not standard practice as yet in North Carolina.

Bike Box in Eugene, OR.

Photo: Evaluation of an Innovative Application of the Bike Box, FHWA, 2000.

Potential Applications of the Bike Box:

- At intersections with a high volume of bicyclists and motor vehicles
- Where there are frequent turning conflicts and/or intersections with a high percentage of turning movements by both bicyclists and motorists
- To help enforce "No right turn on red" conditions
- Can be combined with a separate bicycle signal (optional)

Bicycle Box in Oxford, England⇨ filled in with color to emphasize allocation of space to bicycle traffic. *Photo: J.Olson*

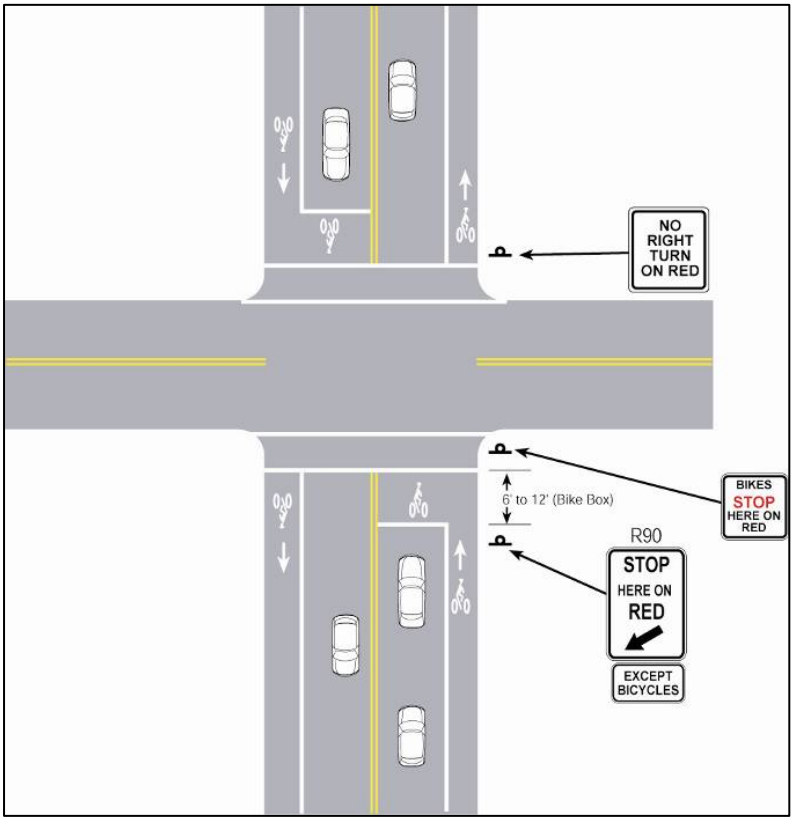


Figure 7-13. Plan View of the Bicycle Box
Alta Planning + Design

7.2.5 Bicycle Parking

As bicycle usage grows, the need for bike parking also increases. Long-term bicycle parking at transit stations and work sites, as well as short-term parking at destinations throughout the community, can support bicycling. Bicyclists need secure parking because bicycles are exposed to weather and theft.

When choosing bike racks, there are a number of factors to keep in mind:

- The rack element (part of the rack that supports the bike) should keep the bike upright by supporting the frame in two places allowing both the frame and wheels to be secured.
- Install racks so there is enough room between adjacent parked bicycles. If it becomes too difficult for a bicyclist to easily lock their bicycle, they will park it elsewhere and the bicycle capacity is lowered. A row of inverted "U" racks should be installed with 15" minimum between racks.
- Empty racks should not pose a tripping hazard for visually impaired pedestrians. Position racks out of the walkway's clear zone.
- When possible, racks should be in a covered area protected from the elements, and within sight of building entrances for security. Long-term parking should always be protected and placed in visible locations.

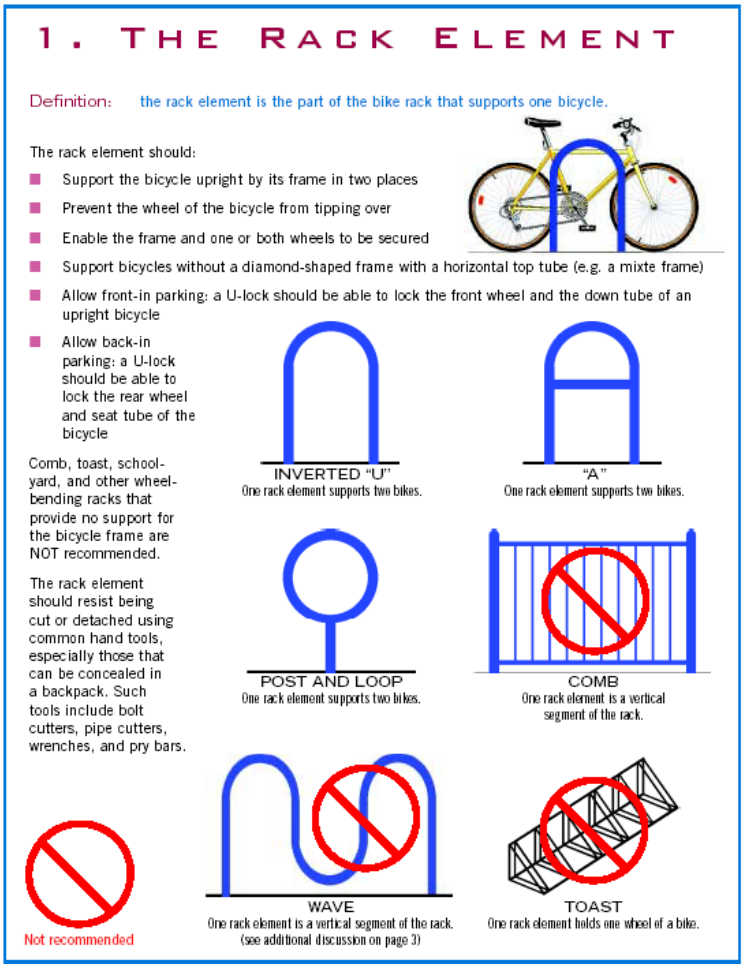
Some revisions to the Town's Bicycle Parking ordinance which the Town should consider include:

- Define the number of spaces in a "rack" or identify the number of expected bicycle parking spaces. The number of bicycle parking spaces in a rack can vary from two all the way to as many as six or eight. As currently written, the ordinance specifies the number of racks, but not the number of spaces.
- Base bicycle parking requirements on characteristics such as land use or numbers of seats/attendees/expected amount of the community to be served rather than number of parking spaces. The needed number of parking spaces may decrease as bicycle use increases. In addition, parking spaces often indicate a level of inaccessibility by bicycling. Sometimes the smaller, more community-oriented places will have fewer parking spaces but are more likely to be attractions for bicyclists. This is especially true for libraries, schools, parks, recreation centers, and art centers.

The table on the following page provides basic guidelines on ideal locations for parking at key activity centers as well as optimum quantities of parking spaces.

Land Use or Location	Physical Location	Bicycle Capacity
City Park	Adjacent to restrooms, picnic areas, fields, and other attractions	8 bicycles per acre
City Schools	Near office entrance with good visibility	8 bicycles per 40 students
Public Facilities (city hall, libraries, community centers)	Near main entrance with good visibility	8 bicycles per location
Commercial, retail and industrial developments over 10,000 gross square feet	Near main entrance with good visibility	1 bicycle per 15 employees or 8 bicycles per 10,000 gross square feet
Shopping Centers over 10,000 gross square feet	Near main entrance with good visibility	8 bicycles per 10,000 gross square feet
Commercial Districts	Near main entrance with good visibility; not to obstruct auto or pedestrian movement	2 bicycles every 200 feet
Transit Stations	Near platform or security guard	1 bicycle per 30 parking spaces

Recommended Locations and Capacities of Bicycle Parking



APBP's Recommendations for bicycle parking facilities

7.3. Summary of Recommendations

These design guidelines provide Wake Forest with a flexible range of alternatives for creating an integrated network of bicycle facilities, including greenways, on-street bikeways and support facilities. These guidelines can supplement the typical sections developed in the 2002 Greenways Plan and the 2003 Transportation Plan. With a 'complete streets' approach to integrating bicycling and walking throughout the community, Wake Forest can apply these cost effective solutions to improve community mobility, recreation, health and safety. Implementing these concepts will require design judgment and careful applications of context-sensitive solutions. These design guidelines can be applied both through 'stand alone' projects and as integrated elements in ongoing projects. Bicyclists, pedestrians and motorists will benefit from these improvements to the community's infrastructure.

Improved facilities for bicycling in Wake Forest will be enjoyed by residents and visitors of all ages and abilities. *Photo: J.Olson*

Resources:

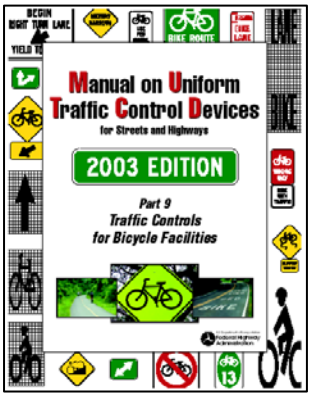
The following is a list of references and sources utilized to develop design guidelines for Wake Forest's Bicycle Master Plan. Many of these documents are available online and are a wealth of information and resources available to the public.

AASHTO Guide
Guide for the Development of Bicycle Facilities, 1999.
American Association of State Highway and Transportation Officials, Washington, DC.
www.transportation.org

AASHTO Green Book
Policy on Geometric Design of Streets and Highways, 2001.
American Association of State Highway and Transportation Officials, Washington, DC.
www.transportation.org

NCDOT
The North Carolina Bicycle Facilities Planning and Design Guidelines, 1994
NCDOT Division of Bicycle and Pedestrian Transportation
www.ncdot.org/transit/bicycle/projects/resources/projects_facilitydesign.html *(note: not available on-line but can be ordered from this location)*

MUTCD
Manual on Uniform Traffic Control Devices, 2003.
Federal Highway Administration, Washington, DC.
http://mutcd.fhwa.dot.gov

PBIC / APBP
Bicycle Facility Selection: A Comparison of Approaches
Michael King, for the Pedestrian and Bicycle Information Center
Highway Safety Research Center, University of North Carolina – Chapel Hill, August 2002
www.bicyclinginfo.org/pdf/bikeguide.pdf

Association of Pedestrian and Bicycle Professionals
Bicycle Parking Design Guidelines
www.bicyclinginfo.org/pdf/bikepark.pdf