The Louis Berger Group, Inc.
1513 Walnut Street, Suite 250, Cary, North Carolina 27511
Tel (919) 467-3885 Fax (919) 467-9458 www.louisberger.com

Memo

To: Ann Ayers, AICP
Town of Wake Forest

From: Jennifer Lewis, EI
The Louis Berger Group, Inc.

CC: Scott Lane, AICP
The Louis Berger Group, Inc.

Date: April 10, 2007

Re: Town of Wake Forest Bicycle Plan Working Paper No. 2

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1. Introduction

This document represents Working Paper No. 2 for the Wake Forest Bicycle Plan. In this Working Paper No. 2, we build upon the findings of Working Paper No. 1 – including the existing conditions and planned projects - to provide recommendations for future bicycle facility projects and related actions. In addition, we also provide a set of facility design guidelines and best practices which will help Wake Forest in their implementation of the Plan. Last, this Working Paper includes a set of recommendations for education, encouragement, and enforcement programs to foster a more bicycle-friendly climate in the Town.

The contents of this paper are organized as follows:

- Projects
  - Planned NCDOT Projects
  - Planned Town Projects
  - Greenway Priorities
  - New Proposed Projects
  - Recommended Phasing
  - Recommended Treatments
  - Project Prioritization
- Standards and Design Guidelines
- Programs and Ancillary Facilities Recommendations
  - Programs
  - Ancillary Facilities
- Policy Recommendations
- Funding and Recognition Sources
  - Local Funding
  - State and National Funding
  - Private Funding
  - Recognition Programs
- Summary and Next Steps

2. Projects

Bicycle facilities can be constructed through a number of avenues, thus it is important to take a comprehensive look at the planned activities of all of the parties that potentially could build bicycle facilities. In the Town of Wake Forest, bicycle facilities can be constructed in one of two ways – using public funds, or through private development. Since private development is market-based and frequently difficult to predict, the following paragraphs will focus more on project public spending for estimating the planned locations of bicycle facilities in Wake Forest.

There are a variety of options for a project to be constructed through public funds. First, they can be constructed as part of a planned project by the Town, often either through the public works and transportation departments (frequently on-road facilities are constructed this way) or through the Parks and Recreation department (more often, greenways are constructed this way). Sometimes, bicycle facilities are constructed in connections with the construction of other public facilities, such as schools, libraries, or health-related buildings.

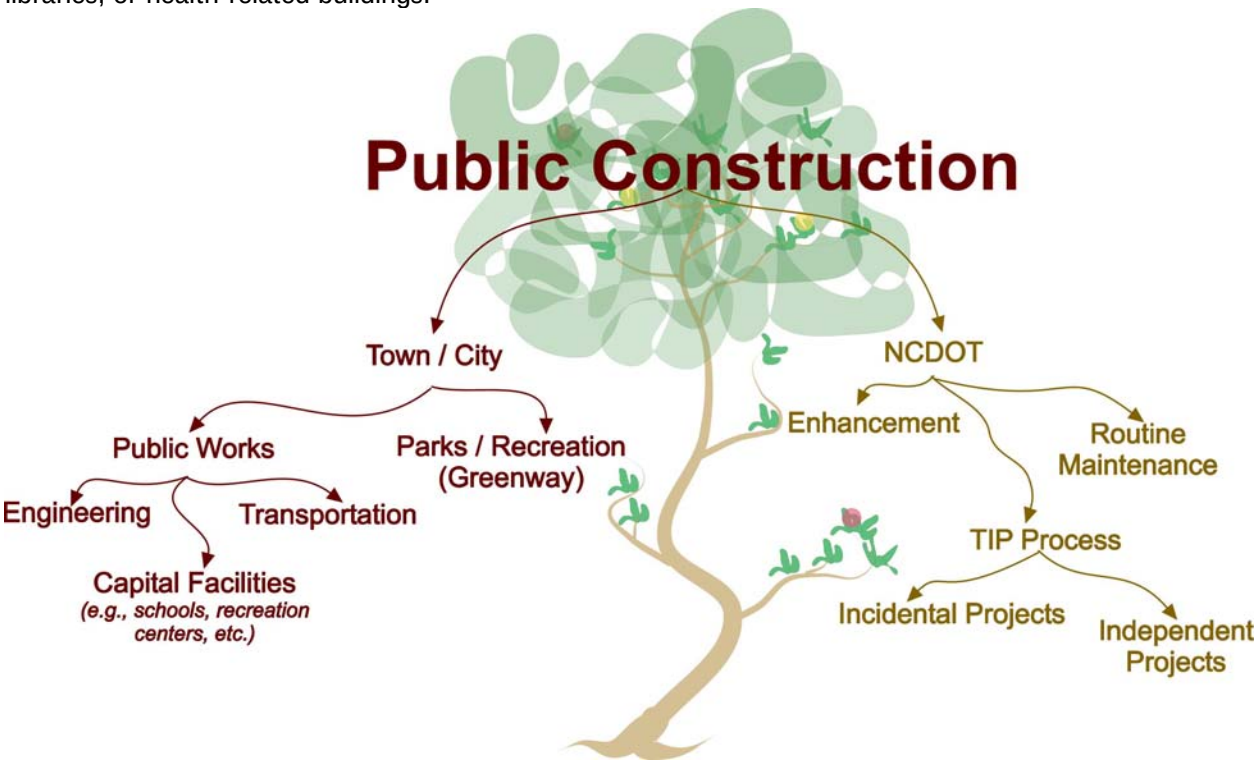


Image 1. This image illustrates the various avenues through which bicycle facilities can be constructed in Wake Forest.

The most common method that bicycle facilities are constructed, however, is through the North Carolina Department of Transportation. When NCDOT constructs bicycle facilities, they are usually constructed as one of four different types of projects. These projects are:

1. Incidental projects. Incidental projects are those bicycle facilities, either on-road or off-road, which are constructed as part of another, larger roadway project. These projects often occur when a road is widened or a new road is constructed.
2. Independent projects. Independent projects are those bicycle facilities which are constructed independent of another roadway project. In an independent project, NCDOT may construct a greenway or multi-use trail without making any improvements on related or nearby roadways excepting those improvements necessary for the greenway or multi-use trail.
3. Enhancement projects. Enhancement projects are funded by the NCDOT enhancement project fund, and are often intended to make improvements to a pre-existing roadway or area to enhance its appearance or use.
4. Re-striping associated with maintenance. Sometimes, on-road bicycle facilities can be provided when a road is restriped in association with routine maintenance. This can only happen in circumstances in which there is adequate roadway width for the bicycle lane or sharrow.

In general, both NCDOT independent and incidental projects must go through the NCDOT Transportation Improvement Project (TIP) selection process, which includes recommendations from the Capital Area Metropolitan Planning Organization (CAMPO), of which Wake Forest is a member.

Thus, in order to estimate planned bicycle facility construction in Wake Forest, it is important to look at the planned facilities of the following public agencies:

- North Carolina Department of Transportation:
    - Planned Incidental Projects
    - Independent Projects
    - Enhancement Projects
    - Maintenance Projects
- CAMPO Planned Projects
- Town of Wake Forest, including the public works, transportation, and parks and recreation departments

The following paragraphs provide a description of the planned projects for each of these agencies. Some projects are simply planned, while others are funded and expected for construction within the next couple of years.

2.1. Planned NCDOT Projects

The following projects are planned in NCDOT's listing of TIP projects. At the time of this publication, the projects are unfunded.

Table 1. Planned TIP Projects (roadway and bicycle) in Wake Forest.

TIP No.	Incidental	Bicycle Related Improvements
None Assigned	E. Juniper Ave: N. White St to Town Limits	Bicycle Safety Improvements
None Assigned	N. Allen Road	Wide Paved Shoulders
None Assigned	S. Franklin St. Ext: E. Holding Ave to Forestville Rd./Rogers Rd.	Bicycle Safety Improvements
None Assigned	NC 98 Bypass west of Thompson Mill Rd. to east of Jones Dairy Rd.	Pedestrian/Bike Path
None Assigned	US 1A: Capital Blvd to NC 98 Bypass	Widen - Include Bike Lanes
None Assigned	Stadium Dr: US 1 to CBD	Bicycle Safety Improvements
	Independent	**Bicycle Related Improvements**
E-4708	Wake Forest Bypass Greenway	scheduled for feasibility study

Table 2. CAMPO Planned Projects in Wake Forest.

CAMPO 2030 Incidental Bike Project List
Thompson Mill Road: NC 98 to Granville Co.
Averette Road: US 401 (North) to NC 98
Forestville Road: US 1A to Smithfield Road

2.2. Planned Town Projects

In addition to funded roadway improvements, the Town also has several plans for future projects which relate to bicycle facilities. First, the Town's *Transportation Plan* (2003) contains a section on bicycle facilities (see Table 3

Table 3). Next, the Town also recently completed its *Pedestrian Plan* (2006), which contains a listing of corridors that should be considered for pedestrian improvements (Table 4). The Town should consider making bicycle facility improvements in conjunction with these pedestrian improvements, when the time comes for them to be constructed.

Table 3. Planned bicycle facilities in the *Wake Forest Transportation Plan* (2003).

Corridor	End Points	
Durham Road (NC 98)	Hampton Way Drive	US 1
Durham Road (NC 98)	US 1	Tyler Run Drive
Franklin Street	Wait Avenue	Holding Avenue
Franklin Street Extension	Holding Avenue	Rogers Road
Harris Road (& ext.)/North Loop	Capital Boulevard (US 1)	East Wait Avenue (NC 98)
Heritage Lake Road (and extension)/Forestville Road	East Wait Avenue (NC 98)	Louisburg Road (US 401)
Jenkins Road	Horse Creek Greenway	Capital Boulevard (US 1)
Jones Dairy Road	NC 98 Bypass	Averette Road
Juniper Avenue	North White Street	Planned Smith Creek Greenway
Ligon Mill Road	South Main Street	Burlington Mills Road
Ligon Mill Road	Burlington Mills Road	Louisburg Road (US 401)
Ligon Mill Road Extension	Durham Road (NC 98)	South Main Street
North Main Street	Harris Road	North Avenue
North White Street	Wake/Franklin County Line	Spring Street
Purnell Road	Horse Creek Greenway	Capital Boulevard
Rogers Road	South Main Street	Forestville Road
Rogers Road	Forestville Road	Louisburg Route (US 401)
Seminary Loop		
South Main Street	South Avenue	Holding Avenue
South Main Street	Holding Avenue	Planned NC 98 Bypass
South Main Street	Planned NC 98 Bypass	Capital Boulevard
Stadium drive	Capital Boulevard (US 1)	Wingate Street
Wait Avenue/Roosevelt Avenue	White Street	Planned North Loop
Wait Avenue	Planned North Loop	Zebulon Road (NC 96)

Table 4. Priority pedestrian corridors as listed in the *Town of Wake Forest Pedestrian Plan*, January 2007.

Corridor	End Points	
North Main Street	North Avenue	Harris Road
Durham Road	Capital Blvd (US 1)	North Wingate Street
North White Street	Roosevelt Road	Flaherty Park
North Avenue	Start	End
Roosevelt Road	Front Street	Wait Avenue
Rogers Road	Forestville Road	South Main Street
South Main Street	South Avenue	Holding Avenue
E. Cedar Avenue	North Main Street	Railroad Tracks
North Franklin Street	NC 98 Bypass	Wait Avenue
Front Street	Start	End
Heritage Lake Road	Rogers Road	Heritage Heights
South Avenue	Start	End
South Wingate Street	Holding Avenue	Stadium Drive
Spring Street	North White Street	Taylor Street
Wait Avenue	Allen Road	Roosevelt Avenue
Rogers Road	W.F. Extra-Territorial Jurisdiction	Forestville Road
Stadium Drive	North Wingate Street	Capital Blvd.
North Wingate Street	Stadium Drive	Chestnut Street
Rock Spring Road	Stadium Drive	Juniper Avenue
South Main Street	Holding Avenue	Rogers Road

2.3. Greenway Priorities

The Town's Greenways Committee also maintains a listing of priority greenway segments. While the Town's greenway system is minimal at this time, these priority greenway segments are critical to making connections in the future with Raleigh's greenway system and providing links between the Town's various major park facilities. The following is a listing of the priority greenway locations as identified by the Town's Greenways Committee as of March 12, 2007.

Section	Section Priority	Segment Location	Segment Type
Smith Creek	1a	East side of reservoir, from 98 Bypass tunnel to the north end of the reservoir	T/S
	1b	West side of reservoir, from dam/east side connection (bridge over spillway), north along the west side, to the north end	DEV
	1c	North end of golf course, north to 98 bypass to pedestrian tunnel	T/S?
	1d	Soccer center bridge, up the creek/east side of golf course, to sidewalk	T/S
	1e	Rogers Rd south to park/school complex	T/S
	1f	Heritage HS Park/school south to the opposition lot	DEV?
	1g	Opposition lot	PUR
	1h	North end of the existing greenway at Burlington Mill Rd north to the opposition lot	PUR?
	1i	South end of existing Burlington Mills greenway to waste treatment plant and new tract recently purchased, meeting Neuse River trail	T/S?
Dunn Creek	2a	Soccer center to just north of 98 Bypass	T/S
	2b	Just north of 98 Bypass north just past Wait Ave	PUR
	2c	North within "Reservoir Tract"	DEV?
Downtown	3a	From Dunn Creek connection (via sidewalks, to Kiwanis Trail and downtown)	T/S
	3b	From Downtown west to Richland Creek greenway (along Stadium Dr?)	T/S
Austin Creek	4a	From Smith Creek north of golf course to Bowling Green	PUR/T/S
	4b	Within Bowling Green to Austin Creek trail	T/S
	4c	Austin Creek subdivision	DEV
Richland Creek North	5a	from Durham Rd north to Joyner Park	T/S?
	5b	Joyner Park north to existing Mill Stream southern end	T/S?
	5c	Mill stream northern end to Franklin County line	PUR?
Sanford Creek	6a	From Smith Creek connection (Heritage HS) east to Heritage South western end	PUR
	6b	Heritage South/Wildflower	DEV
	6c	Sanford east from Wildflower part way to Rolesville line	PUR/DEV?
	6d	Sanford east the rest of the way to Rolesville line	PUR/DEV?
Bishops Area	7a	From east side of reservoir through Bishop's Grant	T/S
	7b	In Bishop's Landing and The Reserve	DEV?
	7c	East of Bishop's Landing part way to Averette	DEV?
	7d	Rest of the way to Averette and beyond	DEV?

Section	Section Priority	Segment Location	Segment Type
Richland Creek South	8a	From Durham Rd south to 98 Bypass	T/S?
	8b	From 98 Bypass south to Wakefield trail connection	PUR?
	8c	From Wakefield trail south to Neuse River trail	PUR?
Holding Farm	9a	Network within new village and connections to adjacent trails	DEV?
98 Bypass	10a	Along Bypass from reservoir west to S. Main St.	DEV?
	10b	From S. Main St. west to Capital Blvd/Richland trail connection	DEV?
	10c	From Capital Blvd. West to NC 98	DEV?/T/S?
	10d	From NC 98 north to Horse Creek connection?	PUR?
Neuse River	11a	North side, west side of Capital, east to Waste Treatment Plant	T/S?
	11b	North side, from Waste Treatment Plant east to US 401	T/S?
Horse Creek	12a	From Franklin Co. line to Falls Lake	PUR?
Northwest Area	13a	From Horse Creek northwest via ? Creek, to Franklin/Granville County line	PUR?
Tom's Creek	14a	401 to Neuse River	?

Segment Type Definitions		
Town/State	T/S	owned by Town or State
To be developed	DEV	Likely to be developed in near future, likely can get corridor
Opposed	OPP	condemnation required, opposed to use as greenway
Purchase	PUR	must be purchased to include, opposition not expected

(Please note: Map to be produced for Draft Plan – awaiting Greenways Committee meeting results.)

2.4. New Proposed Projects

Based on the responses from the Wake Forest Bicycle Plan survey conducted in the earlier part of this project, as well as input from the Stakeholders and Town Staff, the following is a listing of proposed project locations. Most of the on-road locations are already described in the Town's Transportation Plan (2003), but the greenway loops are not.

Table 5. Proposed projects and descriptions

Location	Approx. Length (mi.)	Purpose/Connections
Off-road		
Inner Greenway Loop	5.79	*Greenway loop around downtown area, connecting to commercial, residential, recreational areas.*
Outer Greenway Loop	9.47	*Greenway loop extending from downtown area out to southern Wake Forest and the Raleigh greenway system.*
Greenway along NC 98	4.24	*Greenway extending along the new NC 98 bypass to connect from Jones Dairy Road intersection to Main Street intersection.*
On-Road		
Main Street: Capital to Downtown	3.8	*Connections to commercial development along Main Street from residential development leading into downtown. Also connection to Wake Forest High School.*
Rogers Road: Main Street to Forestville Road	2.98	*Connections from residential development to commercial development along Rogers Road and also to Heritage School.*
Wait/Roosevelt Avenue: Main Street to NC 98	1.25	*Connections from proposed Smith Creek Greenway to downtown, Wake Forest Public Library, and residential development.*
White Street: Elm Avenue to Town Limits	2.26	*Connections from residential development to J.B. Flaherty Park, the DuBois Center and Forest Pines School, downtown, and Wake Forest Seminary School.*
Harris Road: Capital Blvd. to Oak Street	0.82	*Connections between proposed Joyner Park, proposed greenway to Richland Creek Greenway area, downtown, and nearby residential development.*
Ligon Mill Extension: Main Street to Durham Road	2.59	*Opportunity for an off-Capital Blvd/US 1 connection between commercial development on Main Street, nearby residential development, and Wake Forest High School.*
Ligon Mill: Louisburg Road to Main Street	4.05	*Connections to residential development, proposed Smith Creek greenway, commercial development along Main Street, downtown, and Raleigh Greenways system.*
Intersection of Main Street and US 1/Capital Blvd.	n/a	*Connection from Wakefield to commercial area along Capital Blvd and Main Street, as well as into downtown Wake Forest*

2.5. Recommended Phasing

Because many of the projects in Table 5 are quite lengthy, it is recommended that they are split into phases to reduce costs and increase construction feasibility. Table 6 lists recommended phasing for some of the projects listed in Table 5 above.

Table 6. Recommended project phasing.

Location	Approx. Length (mi.)
Main Street: Capital to Downtown	
Segment A: Capital Blvd. to NC 98 Bypass intersections	1.93
Segment B: NC 98 Bypass to Holding Ave.	0.49
Segment C: Holding to Harris St.	1.38
Rogers Road: Main Street to Forrestville Road	
Segment A: Main Street to Heitage Lake	1.41
Segment B: Forestville to Marshall Farm	0.65
Segment C: Marshall Farm to Town Limits	0.92
Wait/Roosevelt Avenue: Main Street to NC 98	
Segment A: White Street to Allen Dr.	0.55
Segment B: Allen to NC 98 Bypass	0.70

2.6. Recommended Treatments

There is currently no national standard for determining the appropriate treatments for on-road bicycle facilities. There are, however, numerous guides and locality-specific standards. The 2002 guide: "Bicycle Facility Selection: A Comparison of Approaches" (King, 2002) is provides a summary of the guidelines used in selected cities and towns throughout the US and Europe for identifying the appropriate bicycle facilities for roads. The type of treatments which the guidelines recommend vary based on traffic volume and speed. This study found that in general, most places in the United States studied rely primarily on bike lanes or marked shoulders as the bicycle facility of choice and there is only limited use of separated lanes or multi-use paths. Table 7 shows a reproduction of the matrix in the Bicycle Facility Selection Guide for bicycle facility treatment guidelines used by the Federal Highway Administration. This is generally representative of the national approach to bicycle facility treatments. In contrast, European cities and nations rely more consistently on the use of separated lanes or multi-use paths. Table 8 shows the matrix in the Bicycle Facility Selection Guide for bicycle facility treatment guidelines in the Netherlands, one of the countries in Europe with the highest percentage of bicycle use.

Table 7. United States (FHWA) Matrix for Bicycle Facility Treatments.

Facility/Treatment	Posted Speed					
	15 mph	20 mph	25 mph	30 mph	35 mph	40 mph
Narrow Lane	--	--	--	--	--	--
Wide Lane	< 10,000 ADT	< 10,000 ADT	--	--	--	--
Bike Lane or Shoulder	> 10,000 ADT	> 10,000 ADT	All ADT	All ADT	All ADT	All ADT
Separated Lane or Path	--	--	--	--	--	--

Table 8. Netherlands Matrix for Bicycle Facility Treatments.

Facility/Treatment	Posted Speed					
	15 mph	20 mph	25 mph	30 mph	35 mph	40 mph
Narrow Lane	<800 ADT	--	--	--	--	--
Wide Lane	--	<9,000 ADT	<6,000 ADT	<4,000 ADT	<2,000 ADT	--
Bike Lane or Shoulder	--	9,000-10,000 ADT	6,000-9,000 ADT	4,000–6,500 ADT	2,000-2,500 ADT	--
Separated Lane or Path	--	>10,000 ADT	>9,000 ADT	>6,500 ADT	>2,500 ADT	all

Source for both tables: King, Michael. "Bicycle Facility Selection: A Comparison of Approaches." Pedestrian and Bicycle Information Center, Highway Safety Research Center, University of North Carolina at Chapel Hill. August 2002.

Following an extended discussion with stakeholders, it was determined that when possible, the primary treatment for bicycle facilities in Wake Forest should be to install multi-use paths. However, roadways, especially those that already exist, frequently have inadequate right-of-way available to construct multi-use paths. In these cases, the Town should use bicycle lanes until adequate right-of-way can be acquired to provide multi-use paths. Table 9 provides a listing of the proposed projects and their proposed treatments based on the matrices available in the Bicycle Facility Selection Guide and Stakeholder Input.

Table 9. Proposed projects and recommended treatments.

Map Reference Number	Location	Proposed Treatments
Off-road Facilities		
14	Inner Greenway Loop	*10 ft. wide multi-use trail with appropriate trail amenities.*
15	Outer Greenway Loop	*10 ft. wide multi-use trail with appropriate trail amenities.*
1	Greenway along NC 98	*10 ft. wide multi-use sidewalk with a setback of 5 ft. from NC 98.*
On-Road Facilities		
Main Street: Capital to Downtown		
2	Segment A	*Bicycle lanes, multi-use path when possible*
3	Segment B	*Bicycle lanes, multi-use path when possible*
4	Segment C	*Shared lane/sharrow*
Rogers Road: Main St. to Forestville Rd.		
5	Segment A	*Bicycle lanes, multi-use path when possible*
6	Segment B	*Bicycle lanes, multi-use path when possible*
7	Segment C	*Bicycle lanes, multi-use path when possible*
Wait/Roosevelt Avenue: Main St. to NC 98		
8	Segment A	*Bicycle lane*
9	Segment B	*Bicycle lane*
10	White Street: Elm Ave. to Town Limits	*Bicycle lanes, multi-use path when possible*
11	Harris Road: Capital Blvd. to Oak St.	*Bicycle lanes, multi-use path when possible*
12	Ligon Mill Ext.: Main St. to Durham Rd.	*Multi-use path and bicycle lane*
13	Ligon Mill: Louisburg Rd. to Main St.	*Multi-use path and bicycle lane*
14	Intersection of Main St. and US 1/Capital Blvd.	*Continue wide shoulder/bike paths along Capital Blvd. and Main St. through the intersection. Provide dashed lines to indicate bicycle travelways. Consider providing "bike boxes" to raise cyclist visibility, provide bicycle-sensitive signals, and signals with specific phases for cyclists.*

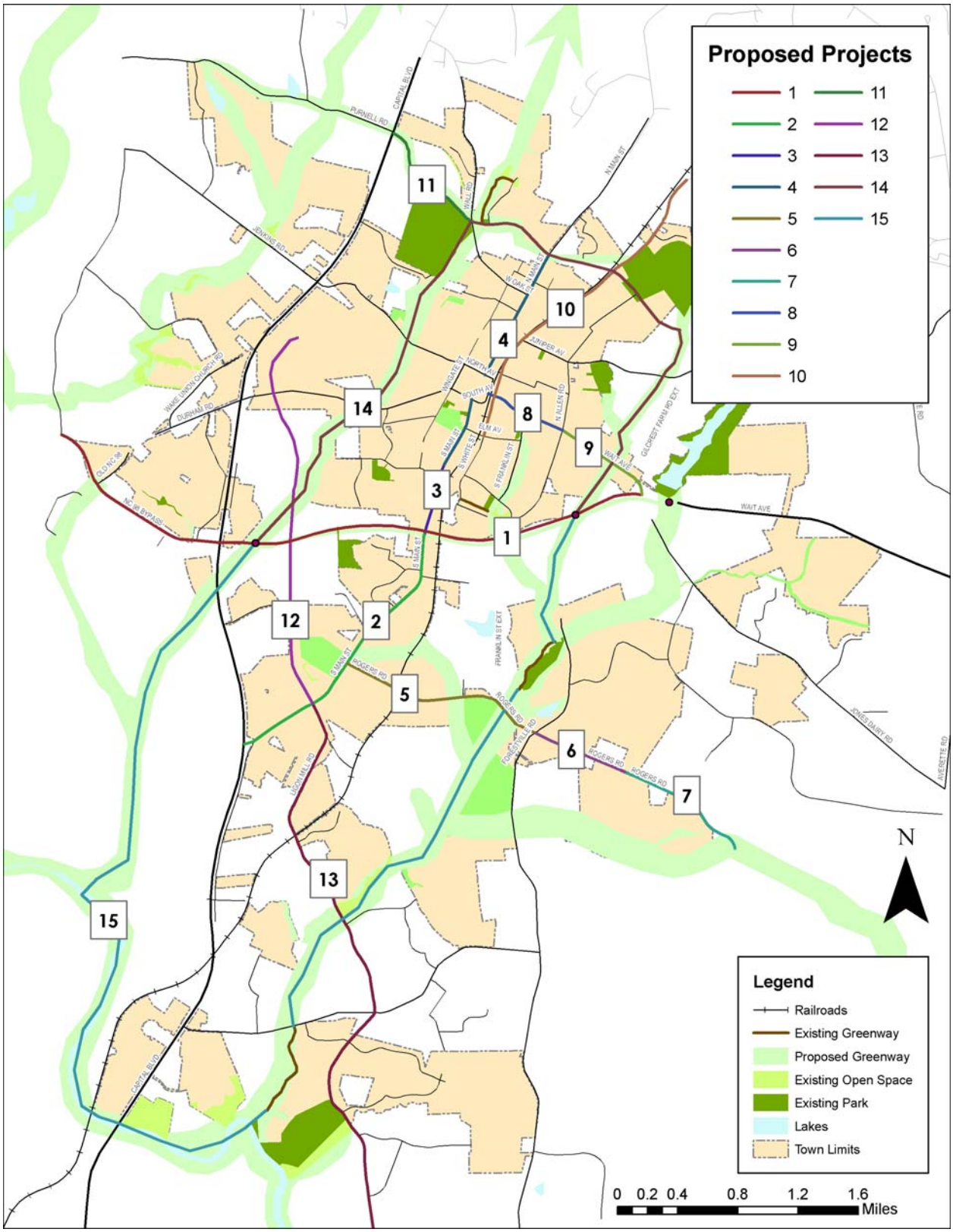


Figure 1. Map of proposed projects in the Bicycle Plan.

2.7. Project Prioritization

The Town of Wake Forest does not have unlimited funding to construct bicycle facilities, and therefore the proposed projects in this Plan should prioritized. Using Table 5, members of the Bicycle Plan's Stakeholder Committee selected which routes were their top priority projects. In the Draft Plan, a schedule and implementation guide will be presented. The following is a listing of the Stakeholder's selected top priority projects.

Top Priority Projects:
- Outer Greenway Loop
- Main Street: Capital Blvd. to NC 98 Bypass Intersection
- White Street: Elm Avenue to Town Limits
- Ligon Mill Extension: Main Street to Durham Road

Second Priority Projects:
- Outer Greenway Loop
- Main Street
- Rogers Rd

In the Draft Plan, these projects will be considered first as candidates for the top priority projects and discussed in the schedule and implementation guide.

3. Standards and Design Guidelines/Best Practices

For the purposes of this Plan, a separate section has been prepared which contains design guidelines and best practice recommendations. A draft of this section is contained in Appendix 1.

4. Programs and Ancillary Facilities Recommendations

A bicycle-friendly community is not created overnight, nor is it created simply through constructing bicycle lanes. A bicycle-friendly community also has programs and policies which support cycling and promote it to its residents. In addition, the community has "ancillary" facilities and programs, such as bicycle parking and maps, which support cycling and make it more pleasant. According to the NCDOT Bicycle and Pedestrian Plan Outline, programs should be created that target three areas: encouragement, education, and enforcement. The following is a listing of some recommendations for programs and ancillary facilities which could be established by the Town that meet these three areas.

4.1. Programs

Program Action: Establish a Safe Routes to School Program	**Target E's:** Encouragement and Education
Purpose: To encourage students, teachers, and staff to walk or bicycle to school while creating a safer climate in which to do so.	**Responsible Parties:** Wake County Schools – specifically those in Wake Forest in coordination with the Town's Planning, Parks and Recreation, and Transportation Department.
Activities: ♦ Walking or bicycling school bus. ♦ Encouragement activities at school – education about benefits, games and promotions. ♦ Conduct a bicycling audit and identify potential improvements near the school. ♦ Distribute flyers to parents about being Safe Routes to School focused. ♦ Walk (or bicycle) to School day/week/month.	

Program Action: Participate in Bike-to-Work Week	**Target E's:** Encouragement and Education
Purpose: Encourage employees and employers to bicycle to work. **Activities:** A Triangle-wide activity with incentives and contests for employers and employees who participate in bicycling to work in the Bicycle-to-Work week.	**Responsible Parties:** Wake Forest Planning Department with the Capital Area Metropolitan Planning Organization's Bicycle and Pedestrian Committee and SmartCommute

Program Action: Establish Standing Bicycle and Pedestrian Advisory Committee	**Target E's:** Encouragement, Education, and Enforcement.
Purpose: Advocate for bicycle-friendly Town policies and actions. **Activities:** The Committee would meet regularly to discuss bicycle-related issues in Wake Forest, advise the Town staff and council on bicycle-related actions. Some of the actions that the Committee could be responsible for are: - Coordinating a Town annual bicycle event - Generating Wake Forest-specific education materials - Reviewing development plans for bicycle-friendliness Lobbying Planning Commission and Planning staff to require more bicycle-friendly developments.	**Responsible Parties:** Town Council's approval will be necessary to form the Committee in order for it to be official. Town staff assistance will be necessary to coordinate committee meetings – this could be undertaken by a Bicycle and Pedestrian Coordinator.

Program Action: Create a Bike Rodeo Event.	**Target E's:** Education and Encouragement
Purpose: Educate children and parents about safe bicycling skills. **Activities:** This event could be held in conjunction with another event – either a Town event such as Downtown Arts Day or July 4th Celebration, or a Triangle-wide event such as Bike-to-Work Week. Bike Rodeos usually involve establishing an obstacle course with various typical situations which cyclists may encounter. Participants are then "coached" through the rodeo by trained rodeo "Emcees", such as a League of American Bicyclists Instructor or a trained bicycle policeperson. These individuals help participants to understand appropriate actions that should be taken in tricky situations (such as will be encountered on the obstacle course). Upon completion, the rode participant usually receives a prize, often a bike helmet or reflective gear to make cyclists more visible. Wake Forest could consider requesting bike helmets from NCDOT – they have a free bike helmet program for safety events.	**Responsible Parties:** Wake Forest Planning Department staff could hold the rodeo, potentially in coordination with the Parks and Recreation Department. Staff should also consider teaming with the Police Department to assist with safety educations. Could also team with local bike clubs who have certified instructors.

Program Action: Establish a Travel Demand Management (TDM) Program	**Target E's:** Encouragement
Purpose: A TDM program is intended to reduce demand for automobile travel by encouraging the use of alternative forms of transportation. **Activities:** TDMs can be either private efforts or public programs. In Research Triangle Park, TDM efforts are spearheaded by SmartCommute@RTP which works to encourage RTP employees to take alternative transportation. In Chapel Hill, the Town has a TDM policy which requires new development to include access for alternative transportation – sidewalk and crosswalks for pedestrians, bicycle lanes for cyclists, connections to greenways, and bus stops. Developers receive priority treatment should they chose to include optional amenities such as showers and bicycle parking. Employers also participate in Chapel Hill's TDM program. They receive incentives for committing to provide employees with information about	**Responsible Parties:** Town Staff to promote TDM resolution and TDM coordinator position. Then, TDM coordinator to follow-through and monitor the program.

alternative transportation, allowing employees flex time for bus travel, and encouraging employees to take alternative travel through reward programs. Wake Forest should consider a multi-pronged TDM approach. First, Wake Forest should consider making an over-arching town-wide commitment to TDM – either through a Town Council resolution, ordinance, or a staff policy. Next, Wake Forest should establish development requirements that encourage alternative transportation. At the same time, the Town should identify a TDM coordinator who would be responsible for promoting the Town's TDM commitment both internally within Town staff and externally to employers and employees in Wake Forest. The coordinator would develop programs to reach out to employers and educate them about the importance of TDM, its benefits, and potential TDM related activities. The coordinator would encourage employers to establish their own TDM programs. Since Wake Forest currently does not have its own transit system, the TDM coordinator should also reach out to TTA and CATS to encourage regional transit connections.	

Program Action: Create a Helmet-to-Go Program	**Target E's:** Enforcement (and Education)
Purpose: To encourage helmet use among cyclists.	**Responsible Parties:** Wake Forest Planning Staff and Police Department.
Activities: Policepeople on patrol would be armed with free helmets. Should police see child or adult cyclists riding without a helmet, police will stop cyclist, remind them about helmet laws, and provide them with a helmet should they not own one. Disciplinary action should be taken for repeat offenders. This activity could also be conducted for cyclists riding at night without reflectors or lights, or for cyclists riding in the wrong direction. For cyclists riding at night, police could be equipped with free blinkies and reflective material.	

Program Action: Develop Pamphlets for Police to Distribute	**Target E's:** Enforcement
Purpose: Educate motorists and cyclists about rights and responsibilities of the road.	**Responsible Parties:** Wake Forest Staff and Wake Forest Police Department.
Activities: Develop pamphlets which clearly explain motorists' and cyclists'' rights and responsibilities on the road. Provide these pamphlets to patrolmen for distribution to violators or people exhibiting dangerous behavior, perhaps in instead of a citation for first-time offenders. Triangle SmartCommute and CAMPO already have brochures prepared which Wake Forest could use or borrow as a template to make Wake Forest-specific brochures.	

Program Action: Conduct Officer Training	**Target E's:** Enforcement
Purpose: Educate officers on cyclists' rights and responsibilities to ensure appropriate and consistent application of the law as well as raise awareness about the need to protect cyclists from unsafe driver behavior.	**Responsible Parties:** Wake Forest staff and Police Department.
Activities: Wake Forest staff should coordinate with Police Department to set-up a workshop day. Make sure pertinent staff attend. Workshop should be taught by a trained policeman in cyclist safety. This activity could be conducted as an annual event for office training.	

Program Action: Monthly Bike Day	**Target E's:** Encouragement
Purpose: Encourage cycling in Wake Forest.	**Responsible Parties:** Wake Forest Staff and Parks and Recreation Department.
Activities: In many cities, such as Chicago (see http://www.bikethedrive.org/) one day a month a major thoroughfare is closed down to auto-traffic and cyclists are allowed to ride it. Wake Forest should consider doing this, perhaps with White Street or portions of Main Street, or a along a route which may encompass many streets. This monthly event could be advertised to neighboring communities as a draw for visitors. May have economic benefits by encouraging participants to shop at Wake Forest stores and eat at Wake Forest restaurants. If unwilling to do the event monthly, maybe could be done annually – perhaps as bike to work week. Also could consider conducting the ride, but not shutting down the streets.	

Program Action: Wake Forest Bicycle-Friendly Signs	**Target E's:** Encouragement and Education
Purpose: To raise awareness that Wake Forest is a bicycle-friendly community (or wants to be) and motorists should therefore drive safely and be courteous to cyclists. Intended to create an understanding that cyclists are accepted and welcome road users.	**Responsible Parties:** Wake Forest Planning and Public Works.
Actions: Develop signs. Install signs at all major "gateways" into Wake Forest.	

4.2. Ancillary Facilities

Program Action: Develop a Local Routes Program	
Purpose: Formalize bicycle routes inside Wake Forest to preserve as accessible routes for all skill levels.	**Responsible Parties:** Wake Forest Planning and Town Staff.
Activities: The local routes program would be a system of signed routes throughout town, especially in neighborhoods. These routes are respected by Town, NCDOT, and developers. Whenever road is upgraded, the bicycle-friendly nature of the road must be preserved. Maps of these routes could be distributed. Maps could also highlight destinations on it and locations of bicycle parking racks.	

Program Action: Bicycle Parking Installation Program	
Purpose: Provide bicycle parking at major public and private destinations in Wake Forest.	**Responsible Parties:** Wake Forest Planning and Town Staff.
Action: Install bicycle parking at major public and private destinations in Wake Forest. The Town should identify key locations for these racks. Parking racks encourage bicycle riding by providing a secure location for cyclists to leaver their bikes when riding to a destination.	

Program Action: Maps of Bicycle Parking Locations	
Purpose: Educate cyclists about bicycle rack locations through town so that cyclists know which destinations the town may have which will be ok to ride your bike to and still be able to legally and safely park your bike.	**Responsible Parties:** Wake Forest Planning and Town Staff.
Action: Prepare map of bike parking locations. Distribute maps at locations such as: town hall, planning building, police department, real estate offices, downtown shops and restaurants.	

Program Action: Downtown "Green Streets" Program	
Purpose: Create a series of "green streets" which are bicycle-friendly through downtown as an starter project for bicycle improvements in Town.	**Responsible Parties:** Wake Forest Planning and Town Staff.
Action: Construct a small network of striped bike lanes and intersection improvements within the downtown area as a 'proof of concept' project for on-street bikeways. This loop could serve as a connecting element within the proposed perimeter greenway.	

5. Policy Recommendations

Working Paper No. 1 discussed the existing bicycle-related policies in the Town of Wake Forest. This section provides recommendations which build upon those existing policies to improve them to make them more bicycle-friendly, and also recommends additional policies which should be established to make Wake Forest more supportive to cycling in Town. Policies can affect the Town's budget, the construction of public facilities, and private and public development requirements. The following policy recommendations address each one of these areas.

Development-related Policies

1. **Establish policy to require bicycle facilities and their impacts to be included in Traffic Impact Analyses for new private development.** Currently, the Town's Manual provides extensive guidelines for conducting Traffic Impact Analysis which address methods for assessing traffic generation, trip distribution, existing conditions, planned improvements, and even pedestrian facilities, but not bicycle facilities. The Town should establish a policy to require mapping of bicycle facilities, including bicycle lanes, paved multi-use paths, and greenways, to be included with each Traffic Impact Analysis. In addition, bicycle facilities should be considered as a mitigation approach for potential vehicle traffic generated by developments.
2. **Establish school zones around all schools.** Currently, there are elementary, middle, and high schools in Wake Forest which have limited to no bicycle and pedestrian access. The Town should establish an ordinance which creates school zones around existing schools. Within these school zones, roads should be made bicycle- and pedestrian-friendly through reduced speeds, the addition of warning signs for bicyclists and pedestrians, construction of sidewalk and bicycle lanes, access to greenways, pedestrian- and bicycle-responsive signals, and bicycle parking. In addition, the Town should create a policy which requires provisions for bicycle access at all new schools. These policies, in coordination with an organized Safe Routes to School effort, should make schools in Wake Forest safer for students, parents, teachers, and staff.
3. **Strengthen Greenway Ordinance Requirements.** Currently, developers pay a Parks and Recreation Fee, which funds both parks and greenway construction. Developers are also required to reserve land for greenway construction based on the planned future greenway locations indicated in the Town's *Open Space and Greenway Plan* (2002). These policies can be strengthened in a variety of ways, which are listed below. These recommendations are made in order of increasingly dramatic changes to the current policies:
    a. Current Parks and Recreation fees should be divided into a specific percentage for greenway construction and a specific percentage for parks construction. The Town should maintain an accounting approach which tracks the amount of money designated for greenways and the money designated for parks.
    b. Require developers to build greenways rather than to simply reserve land, and to make a payment-in-lieu separate from the Parks and Recreation fee when construction is not feasible.
    c. Require developers to identify existing or proposed greenways and construct connections to them, just as they would identify and construct connections to existing roads. These adjacent connections should be identified clearly on mapping submitted for site, subdivision, and zoning reviews.

4. **Develop a Greenways Maintenance and Safety Policy.** Currently, greenway facilities constructed by neighborhoods must seek permission from the Wake Forest Parks and Recreation Department in order to join with the municipal system. In addition, connecting to the municipal system does not guarantee maintenance and security responsibilities are transferred from the neighborhood to the Town. In order to encourage neighborhoods and developers to construct greenways, this policy should be changed to guarantee the transfer of maintenance and security responsibilities to the Town. At the same time, to compensate for this, the neighborhood or developer should be required to make a "connection fee". This "connection fee" could either be considered as part of the Parks and Recreation Fee, or could be a separate fee.

Design-related Policies

1. **Require striped bicycle lanes and appropriate signage where called for in the Bicycle Plan.** Currently, Wake Forest relies on wide outside lanes/shared lanes as its bicycle facilities. Wide Outside Lanes and shared lanes should be replaced by bicycle lanes. Bicycle signs should be posted along all bicycle facilities indicated in the Bicycle Plan.
2. **Require striped bicycle lanes and appropriate signage along new subdivision streets.** Currently, bicycle facilities are not required in Wake Forest's subdivision ordinances. Subdivision ordinances should be revised to require bicycle lanes on major subdivision roads, and signage to indicate the presence of cyclists to motorists. This will not only make a subdivision more bicycle-friendly, but also potentially reduce traffic impacts of the subdivision by encouraging more travel by bicycle rather than automobile.
3. **Use Bicycle Facility Selection Guide as the policy for determining bicycle facility types along streets and upgrade roads as maintenance or construction is planned.** Currently, Wake Forest has bicycle facilities selected for only certain roads. All roads in Wake Forest excepting interstates should accommodate cyclists and pedestrians. In keeping with this philosophy, the Town should use the guidelines set forth in the Bicycle Facility Selection Guide to determine the appropriate bicycle facility for every road in town. When work is scheduled for any road in town – from maintenance to new construction – the Bicycle Facility Selection guide should be consulted to determine the appropriate bicycle facilities which should be added with this work.
4. **Require intersections to have bicycle-sensitive signals as part of development requirements and public works engineering standards.** None of the signals in the Town of Wake Forest are currently sensitive to cyclists. This results in circumstances in which cyclists who obey traffic laws must remain stopped at red lights until a vehicle large enough to trigger the signal arrives. Obviously, this sort of wait can be a hindrance to bicycle travel. Wake Forest should require all new signals, and any signal upgrades, to be set so that they are sensitive to cyclists.
5. **Require all new public facilities to have bike parking and bicycle access.** Just as Wake Forest has instated requirements for new private development to have bicycle parking, so should all new public facilities. Public and private facilities should also be required to provide bicycle access through bicycle lanes and connections to greenways.

Budget-related Policies

1. **Create an annual budget for bicycle-related improvements.** Currently, bicycle-related improvements are made as ancillary construction to a larger project, such as a new development or a road widening. There are too many necessary bicycle improvements for the Town to wait for these sorts of mechanisms to construct the needed bicycle facilities. To address this, the Town should create an annual budget item to conduct bicycle-related improvements in order to speed the process of making the town more bicycle-friendly.

6. Funding and Recognition Sources

It is important that Wake Forest consider funding and recognition sources in order to support their continued efforts to make the town more bicycle-friendly. Funding sources help to mitigate the financial

burden of some bicycle-friendly improvements which will be necessary to make the town more bicycle-friendly, while also raising awareness about the Town's efforts. Although some recognition programs do not provide funding, they also serve a purpose of creating a goal for the Town to pursue in their efforts to become more bicycle-friendly, and also by establishing a mechanism to highlight the Town's efforts, both locally and nationally. Recognition makes the Town more marketable to visitors, business, and prospective residents.

6.1. Funding Sources

As discussed in Section 1 of this Working Paper, bicycle facilities are constructed – and therefore funded – through a number of avenues. Funding can be divided into four categories: local, state, national, and private funding. The following paragraphs describe some of the more prominent sources in each category. Wake Forest should tap into all of these sources, and search for others as well, in order to take advantage of the funds available.

6.1.1. Local Funding

Local funding sources can include budgets for the Town of Wake Forest's Public Works Department, Engineering Department, Planning Department, and Parks and Recreation Department. Currently, the Town does not have an annual budget line item specifically for bicycle facilities, however, in the past bicycle facilities have been constructed as an ancillary to another project – such as the bicycle parking racks at the Library. Various departments in the Town should consider teaming more frequently to ensure that more funding is available for bicycle facilities. For example, if there is a roadway project which is being constructed by the Public Works/Engineering Department that may also be adjacent to a proposed greenway which is eventually to be constructed by the Parks and Recreation Department, the two departments should team together to build the greenway as part of the roadway project. This would reduce construction costs while also providing a cost-sharing opportunity for the two departments.

Other entities that Wake Forest should consider teaming with locally include Wake County and the Capital Area Metropolitan Planning Organization. Wake Forest is in Wake County, which has its own Open Space Plan. In situations where the town may be making improvements which relate to this plan, specifically for greenways which can be used by cyclists, the Town should consider cost-sharing with Wake County. Wake Forest is also a member government of the Capital Area Metropolitan Planning Organization (CAMPO), which comprises municipalities in Wake County and parts of Granville, Franklin, Johnston and Harnett. CAMPO is responsible for responsible for carrying out an annual work program approved by the CAMPO standing committees, part of which must address updating the Metropolitan Transportation Improvement Program (a seven-year project programming schedule) and a long-range transportation plan (a minimum twenty-year forecast of projects and programs). CAMPO funnels money from the federal government for use locally, and the Town of Wake Forest is eligible for funds as a member municipality. Since CAMPO is federally funded, a more detailed description of its funding opportunities for Wake Forest is provided in the next sub-section.

6.1.2. State and National Funding

State and national funding are a combined category because many of the state entities administer national funds. The North Carolina Department of Transportation (NCDOT) is the single largest source of funding available to Wake Forest for bicycle facilities, with the following potential funding sources:

- State Transportation Improvement Program
    - Incidental Projects
    - Independent Projects
- Transportation Enhancement Program
- Spot Improvement Program
- Small Urban Funds
- Hazard Elimination Program
- Governor's Highway Safety Program

- Statewide Discretionary Funds

NCDOT also administers the Safe Routes to School Program, which is federally funded. In addition to NCDOT, CAMPO administers funding from the Federal Highway Administration for the Congestion Mitigation and Air Quality Improvement Program (CMAQ). The following paragraphs provide a more thorough description of each of the various funding sources.

- **State Transportation Improvement Program (STIP)** – This program is the overall funding source for study, design, and construction of major transportation projects, including bicycle facilities, in the state. Frequently, projects funded by the STIP are also partly funded by other sources, including matching funds from local municipalities. Bicycle facilities are eligible for funding from this program as independent projects separate from a roadway construction, widening, or some other sort of roadway work, but one of the most cost-effective and efficient ways to gain funding for bicycle facility construction is to incorporate them as incidental to a larger project. Overall, most bicycle accommodations within the state are made as incidental improvements. For more information on the TIP process, see:
  http://www.ncdot.org/transit/bicycle/funding/funding_TIP.html.
  For NCDOT's Pedestrian Policy Guidelines, please see:
  http://www.ncdot.org/transit/bicycle/laws/laws_pedpolicy.html.
  For NCDOT's Greenway Policy, please see the following link at the Division of Bicycle and Pedestrian Transportation's website:
  http://www.ncdot.org/transit/bicycle/laws/laws_greenways_admin.html.

- **Transportation Enhancement Program** - Transportation enhancements are transportation-related activities that are designed to strengthen the cultural, aesthetic, and environmental aspects of transportation systems. The transportation enhancements program provides for the implementation of non-roadway capacity improvement projects, including bicycle and pedestrian facilities; landscaping; and aesthetic improvements. Various forms of bicycle facilities such as multi-use paths, underpasses, bridges, and crossing improvements are eligible for funding.

- **Spot Improvement Program** - The NCDOT Bicycle and Pedestrian Transportation Division budgets $500,000/year for "spot" safety improvements throughout the State. These improvements include items such as signing, grate replacement, bike rack installations, hazard remediation at skewed railroad crossings, and other small-scale improvements. The Spot Improvement Program is used only for bicycle and pedestrian projects; however, it should not be viewed as a priority source for funding identified projects. It is typically used for small-scale and special-situation projects that are not of a significantly large enough scale to merit being a TIP project. Taking these requirements into consideration, proposals for projects should be submitted directly to the Bicycle & Pedestrian Transportation Division.

- **Small Urban Funds** – Small Urban Funds are available for small improvement projects in urban areas. Each NCDOT Highway Division has $2 million of small urban funds available annually. Although not commonly used for bicycle facilities, local requests for small bicycle projects can be directed to the NCDOT Highway Division office for funding through this source. A written request should be submitted to the Division Engineer providing technical information such as location, improvements being requested, timing, etc. for thorough review.

- **Hazard Elimination Program** – This program focuses on projects intended for locations that should have a documented history of previous crashes. Bicycle projects are eligible for this program, although the funds are not usually used for this purpose. This program is administered through the NCDOT Division of Highways. Similar to the Small Urban Funds, it is a significantly limited funding source.

- **Governor's Highway Safety Program (GHSP)** – This program provides funding for projects which show that will make substantial progress in reducing crashes, injuries and fatalities at a specific location. All funding is considered to be "seed money" to get programs started – the grantee is expected to provide a portion of the project costs and to continue the program after GHSP funding ends. Projects are only approved for one full or partial federal fiscal year at a time; however, projects may be funded for up to three consecutive years. Amounts of GHSP funds vary from year to year, according to the specific amounts requested.

- **Statewide Discretionary Funding** - The Statewide Discretionary Fund consists of $10 million and is administered by the Secretary of the Department of Transportation. This fund can be used on any project at any location within the state. Primary, urban, secondary, industrial access, and spot safety projects are eligible for this funding. To request funding, an agency must submit a written request to the NCDOT Highway Division office with a clear description of project and project justification.

- **Safe Routes to School Program** – The federal Safe Routes to School Program is intended to create and promote safe walking and cycling in order to improve safety near schools, promote active lifestyles, and reduce pollution and congestion caused by school traffic. In North Carolina, NCDOT, in conjunction with the Federal Highway Administration, has established the North Carolina Safe Routes to School program. The North Carolina Safe Routes to School program provides opportunities for schools to apply for funding for both programs and capital improvements projects to encourage walking and cycling to school. For more information about the Safe Routes to School Program, please see the North Carolina Safe Routes to School's webpage at : http://www.ncdot.org/programs/saferoutes.

- **Coordination with CAMPO for CMAQ Funds** – As part of the Capital Area Metropolitan Planning Organization, Wake Forest is eligible for assistance in receiving funding through the FHWA's Congestion Mitigation and Air Quality (CMAQ) Improvement Program. Through this program, projects which may help to reduce traffic congestion and improve air pollution, such as bicycle-related improvements, are eligible for funding.

6.1.3. Private Funding

In addition to fee-in-lieu money from developers, Wake Forest can consider a variety of private funding sources. Contrary to NCDOT and federal funding, most private funding sources offer limited grants which are aimed at establishing programs and conducting projects on a smaller scale to encourage more cycling. Many of the funding sources, such as the Blue Cross Blue Shield Fit Together Grants and the Robert Wood Johnson Foundation Active Living By Design Awards, relate more to encouraging healthy lifestyles, which can be fostered through a more bicycle-friendly town. The following paragraphs provide descriptions of the some of the private funding sources that Wake Forest can consider.

- **Blue Cross Blue Shield Fit Together Grants** – The FitCommunity Program is one of the programs established by the Fit Together partnership of Blue Cross Blue Shield and the NC Health and Wellness Trust Fund. The Fit Together partnership was created to promote physical activity and healthy eating in an effort to combat the recent dramatic increase of obesity in North Carolina. The FitCommunity Program is a designation and grant program to recognize and reward municipality and county efforts to promote physical activity, healthy eating and tobacco-free programs, policies, environments and lifestyles. A municipality or county is eligible for grant money once it has received a FitCommunity designation. Cary's strong bicycle program, greenway system, and parks facilities, make it a likely candidate for the FitCommunity designation. Potential grant money could be used for starting a Safe Routes to School program, Walk-to-Work week, or another community event to promote walking.

- **Bikes Belong Grants** – The Bikes Belong Coalition is a national organization whose missions is to put people on bicycles more often. The Grants Program, founded in 1999, was the first major,

ongoing initiative undertaken by the Bikes Belong Coalition. The Grants Program strives to put more people on bicycles more often by funding important and influential projects that leverage federal funding and build momentum for bicycling. These projects include bike paths, lanes, and routes, as well as mountain bike trails, BMX facilities, and large-scale bicycle advocacy initiatives. The Bikes Belong Grants Program funds projects in two categories: (1) Facilities and (2) Advocacy. For the facility category, Bikes Belong will accept applications from non-profit organizations; and from public agencies and departments at the national, state, regional, and local levels. For the advocacy category, Bikes Belong will only fund organizations whose mission is expressly related to bicycle advocacy. Bikes Belong accepts requests for funding of up to $10,000 for either facility or advocacy projects. For more information, see http://bikesbelong.org.

6.2. Recognition Programs

The following are two examples of some of the recognition programs that are available to Wake Forest. Similar to funding sources, recognition programs can be both publicly and privately entities. Although recognition programs may not include funding, through highlighting award recipients they provide free marketing which will make the town more attractive to visitors, businesses, and future residents.

- **Robert Wood Johnson Foundation Active Living By Design Awards** - Active Living by Design is a national program of the Robert Wood Johnson Foundation and is administered by the UNC School of Public Health. The program establishes innovative approaches to increase physical activity through community design, public policies and communications strategies. Active Living by Design is funding 25 community partnerships across the country to demonstrate how changing community design will impact physical activity. Although funding is currently not available for additional communities, the Town of Wake Forest should continue to monitor Active Living by Design as a potential funding source should the Town chose to make a commitment to healthy living. For more information, please see: http://www.activelivingbydesign.org/.
- **League of American Bicyclists (LAB) Bicycle-Friendly Community Program** – The LAB, founded in 1880 originally as the League of American Wheelmen, is one of the oldest national advocacy organizations for bicycles in the United States. The LAB's Bicycle-Friendly Community Program is an awards program that recognizes municipalities that actively support bicycling. Currently, communities are designated bicycle-friendly on a scaled award which runs from platinum (most bicycle-friendly community), gold, silver, and bronze. For more information, please see: http://bicyclefriendlycommunity.org.

7. Next Steps

This Working Paper (Working Paper No. 2) has built upon the existing conditions information provided in Working Paper No. 1 to provide recommendations for project, program, and policy actions which the Town of Wake Forest can take to make itself a more bicycle-friendly community. The next steps in this Bicycle Plan preparation process are to take the recommendations from Working Paper No. 2 and create an Action Plan (sometimes called an Implementation Plan) which organizes the recommendations in Working Paper 2 into logical steps for the Town. This Action Plan will take into account funding needs, staffing restrictions, and potential political constraints to the recommendations to create a schedule and approach for each recommendation in the Plan that will help the town move forward.

The final step of this Bicycle Plan preparation process prior to final approval is to create and review a Draft Plan. The Draft Plan will be prepared by combing Working Paper No. 1, Working Paper No. 2, and the Action Plan into a single, cohesive document. This Draft Plan will be presented to Wake Forest staff and the Steering Committee for their review, following which the Draft Plan will be next presented to NCDOT and the community for review. Once revisions based on these reviews are made, the Plan will be prepared for presentation to Town Council for their review and approval. This should be expected sometime in July or August.

Appendix 1. Standards and Design Guidelines/Best Practice

This section of the Plan is provides an overview of bicycle facility design treatments, and identifies solutions for trails, on street facilities and bicycle parking.

Section 5. Facility Design Guidelines

5.1. 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 key principles for these guidelines:

1. 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.

2. 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 generally are not permitted to ride on sidewalks, except for young children. 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.

3. 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.

4. 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 appropriate types of bicyclists will be accommodated.

5. 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 1. Bicycle Facility Types

Facility Type	Category	Width	Surface	Treatment	Function
Bike Lane	On-Street	5'-6'	Asphalt	On-street lane striped and signed to NCDOT standards	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
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.	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	For skilled bicyclists who are capable of sharing the road with motor vehicles
Shared Use Path	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, wheelchairs. Minimizes potential trail crossing conflicts with autos.
Single Track Trail	Off-Street	3'-8'	Natural Surface	Designed to meet IMBA guidelines	Designed for mountain bicyclists; can include a variety of off-road bicycling trail types

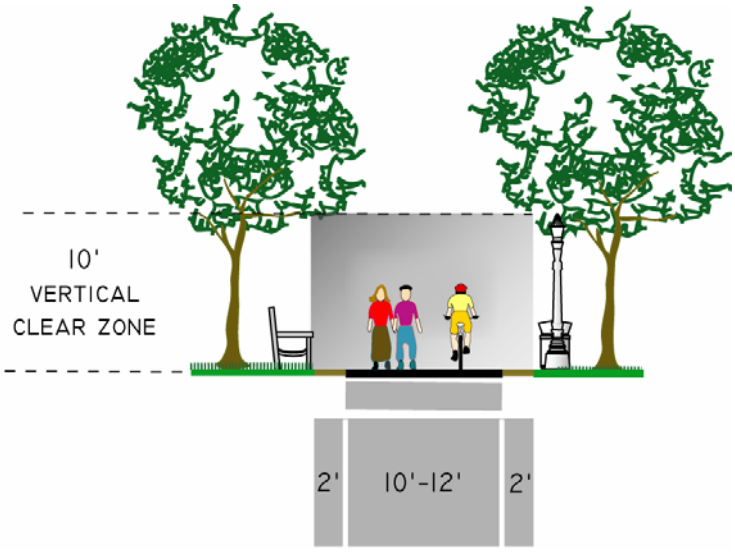
5.2. Design Guidelines

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.

5.2.1. 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 bikeway systems are integrated to provide a seamless system of bicycle facilities Wake Forest.

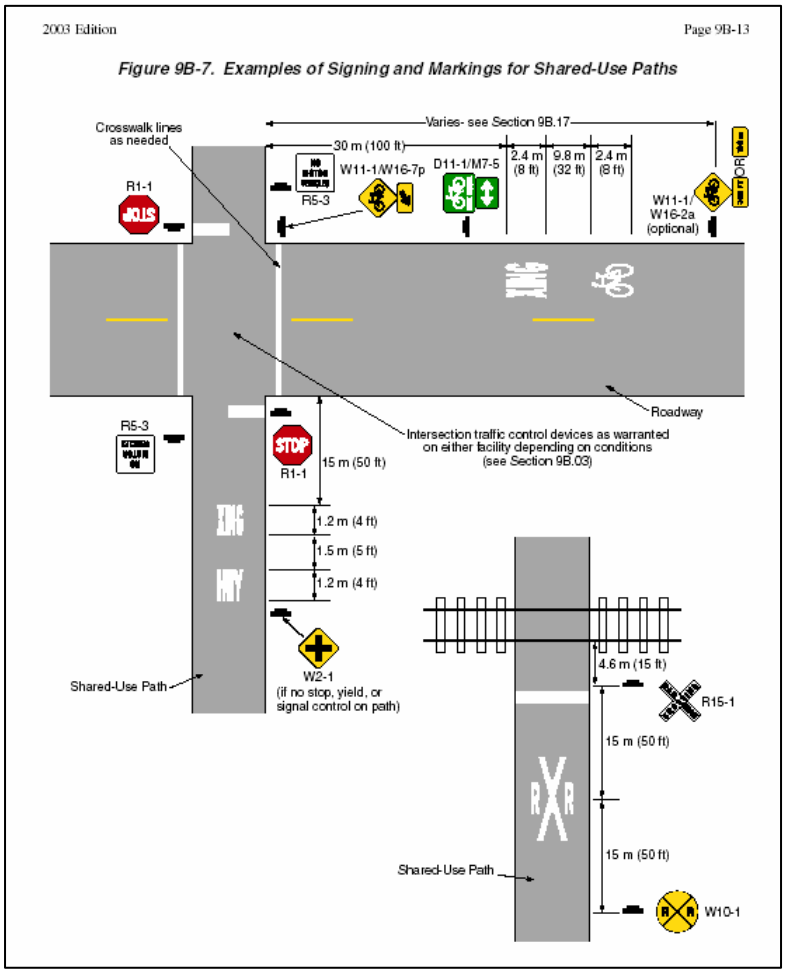
The graphic below illustrates a typical shared use path section, which is the most common design for Wake Forest's trail and greenway network. The cross section provides for two-way bicycle and pedestrian traffic, typically has its own right-of-way, and can accommodate maintenance and emergency vehicles.



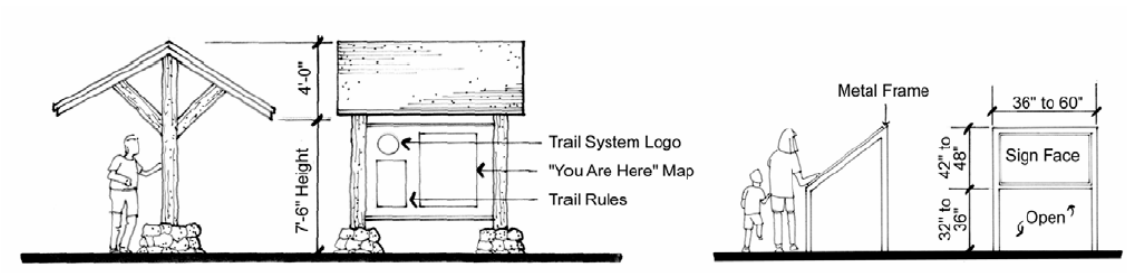
Typical Shared Use Path Design Graphic: Alta Planning + Design

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). 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.

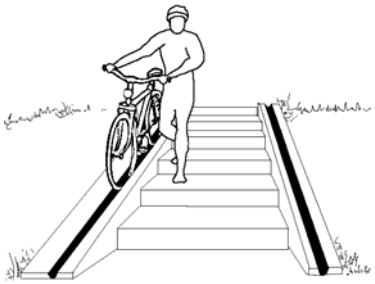


Trailhead information installations provide gateways between on-street facilities and greenway systems.

Graphic: Alta Planning + Design

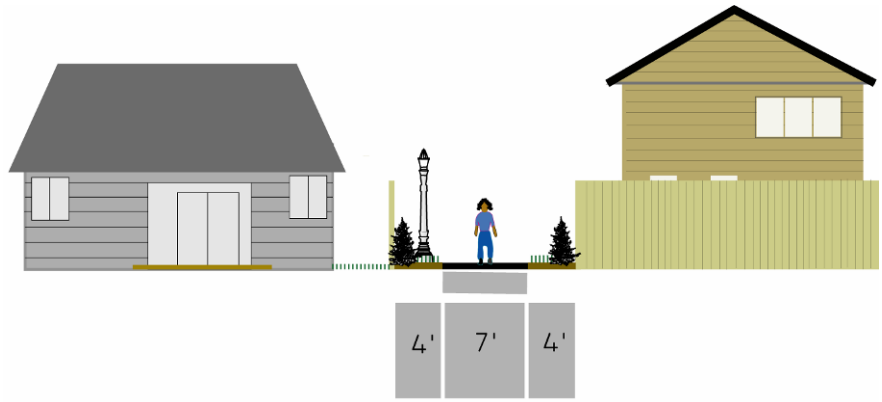
Neighborhood Trails and Access Ways

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.



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.

Graphic: Alta Planning + Design



Neighborhood Bicycle and Pedestrian Access Way

Graphic: Alta Planning + Design

5.2.2 On-Street Bikeways: Complete Streets

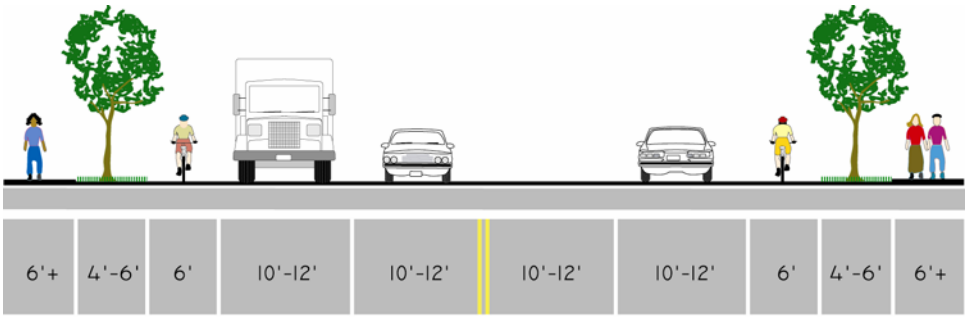
The 2003 Wake Forest Transportation Plan calls for bicyclists to either 'share the road' with motor vehicles on roadways, or to ride on separated shared use paths. This approach will provide for experienced cyclists who are capable of riding in traffic, and for recreational bicyclists who will use the trails for health and fitness. This approach will limit the potential of bicycling to provide a real transportation alternative throughout the 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 functional classification of the facility, the average daily traffic (ADT) and 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.

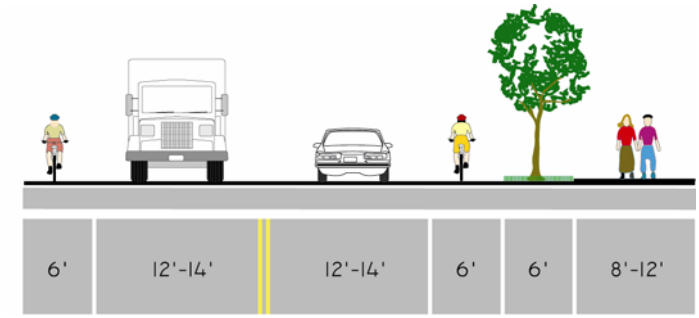
High Volume Roadways

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. 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.



High-Volume, High-Speed Roadway Graphic: Alta Planning + Design

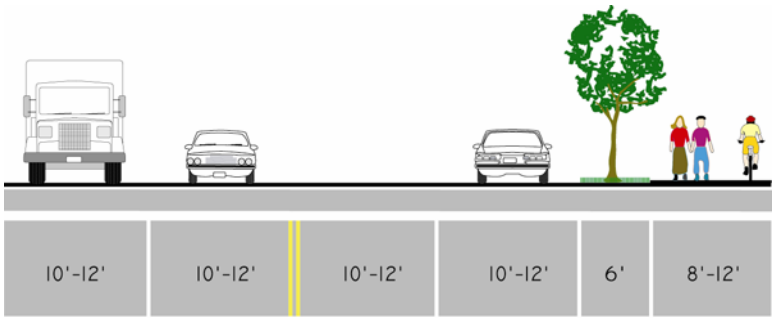
The previous figure illustrates a typical bicycle accommodation in urbanized areas. The minimum bike facility width is 4 ft on open shoulders and 5 ft from the face of a curb, guardrail, or parked cars, with 6 ft the preferred width in urban and suburban areas.



Side Path with Bike Lanes on a High-Volume, High-Speed Roadway

Graphic: Alta Planning + Design

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. 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.



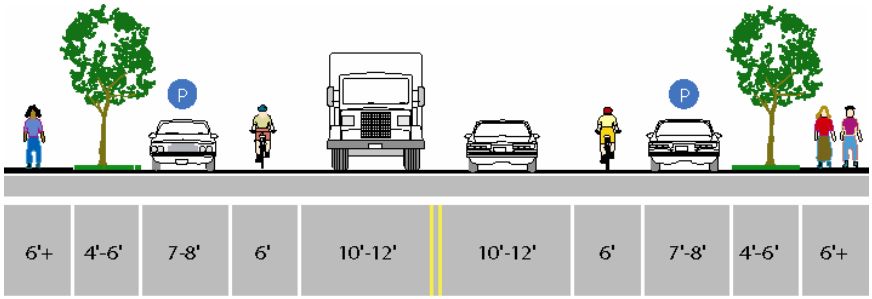
Shared Use Path on a High-Volume, High Speed Roadway

Graphic: Alta Planning + Design

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.

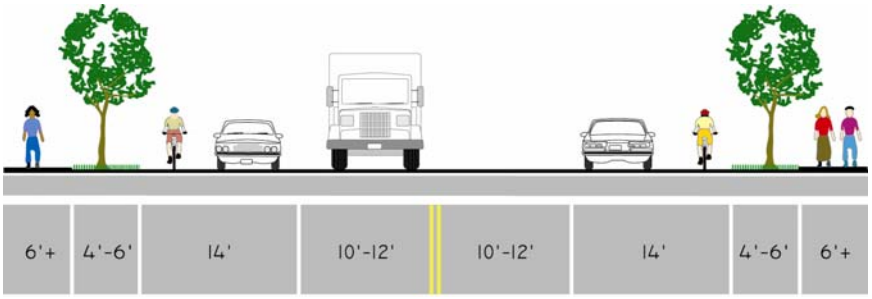
Moderate Volume Roadways

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.



Bike Lane with On-Street Parking Graphic: Alta Planning + Design

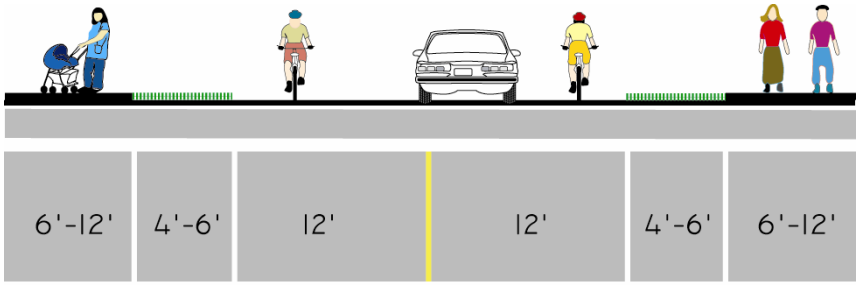
Another option is to provide a 14' wide curb lane to so that experienced bicyclists and motor vehicles can share the roadway. In rural and suburban sections, a paved shoulder can be provided where right-of-way is limited and there is not enough room to provide both sidewalks and the wide outside lanes.



Wide Outside Curb Lane Graphic: 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.



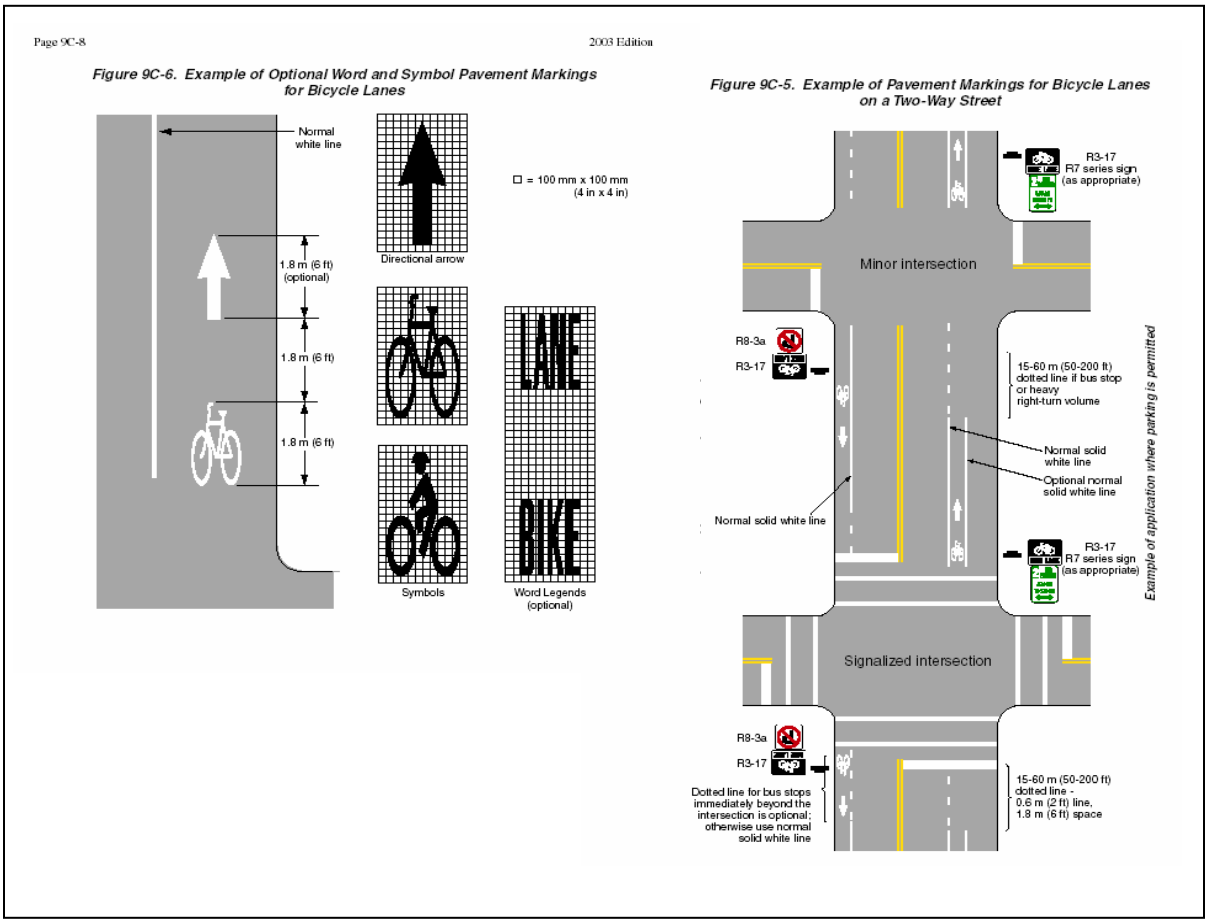
Neighborhood Street Graphic: Alta Planning + Design

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. A good reference on this topic is the report entitled "***Bicycle Facility Selection: A Comparison of Approaches***" published by the Pedestrian and Bicycle Information Center and Highway Safety Research Center, University of North Carolina – Chapel Hill in August 2002.

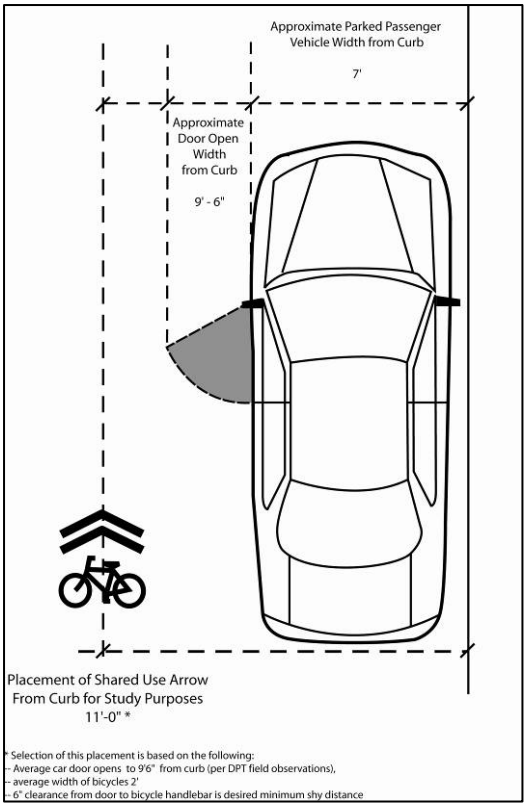
5.2.3 Pavement Markings and Signage

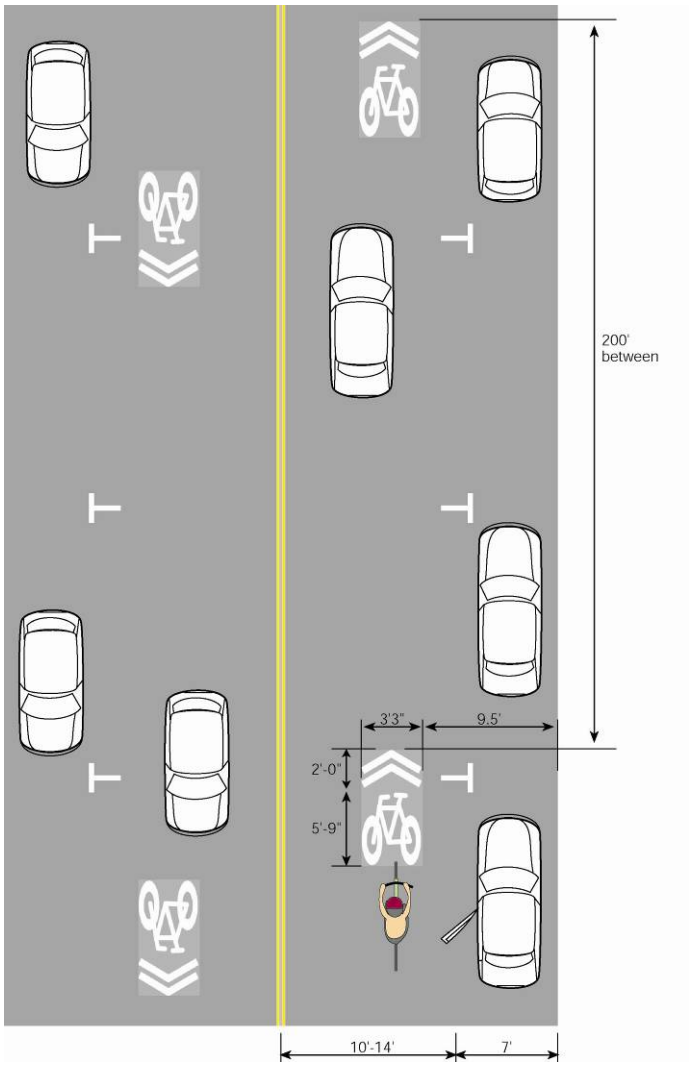
The Manual on Uniform Traffic Control Devices (MUTCD) provides guidance for lane delineation, intersection treatments, and general application of pavement markings and symbols for on-road bicycle facilities and off-road paths. In addition to those presented in the MUTCD, experimental pavement markings 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 as an 'experimental' treatment 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.

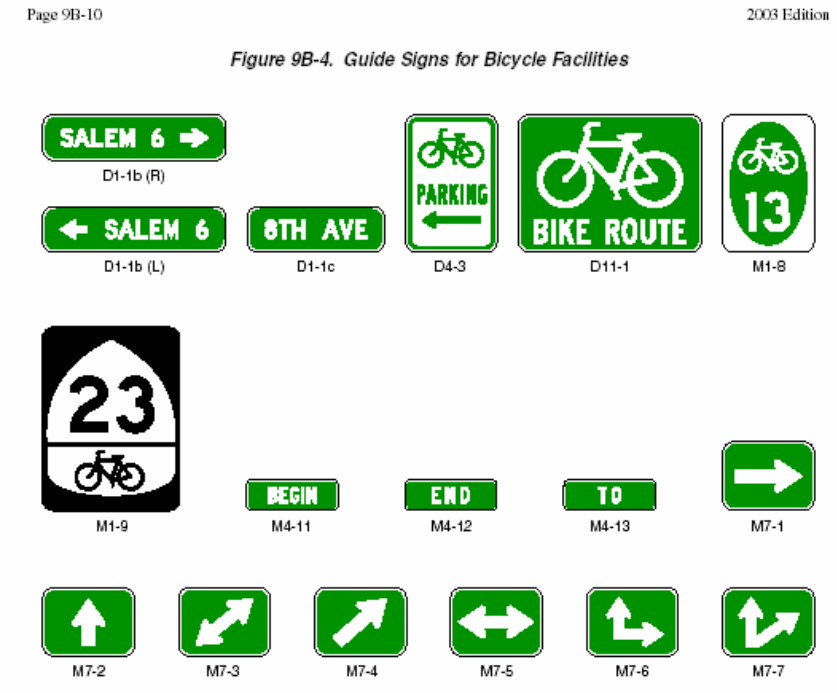
A selected list of bikeway signs from the MUTCD is shown below.

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



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

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.

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.

The "Share the Road" sign, is designed to advise motorists that bicyclists need to share roadways with motor vehicles along certain sections of designated bicycle routes.

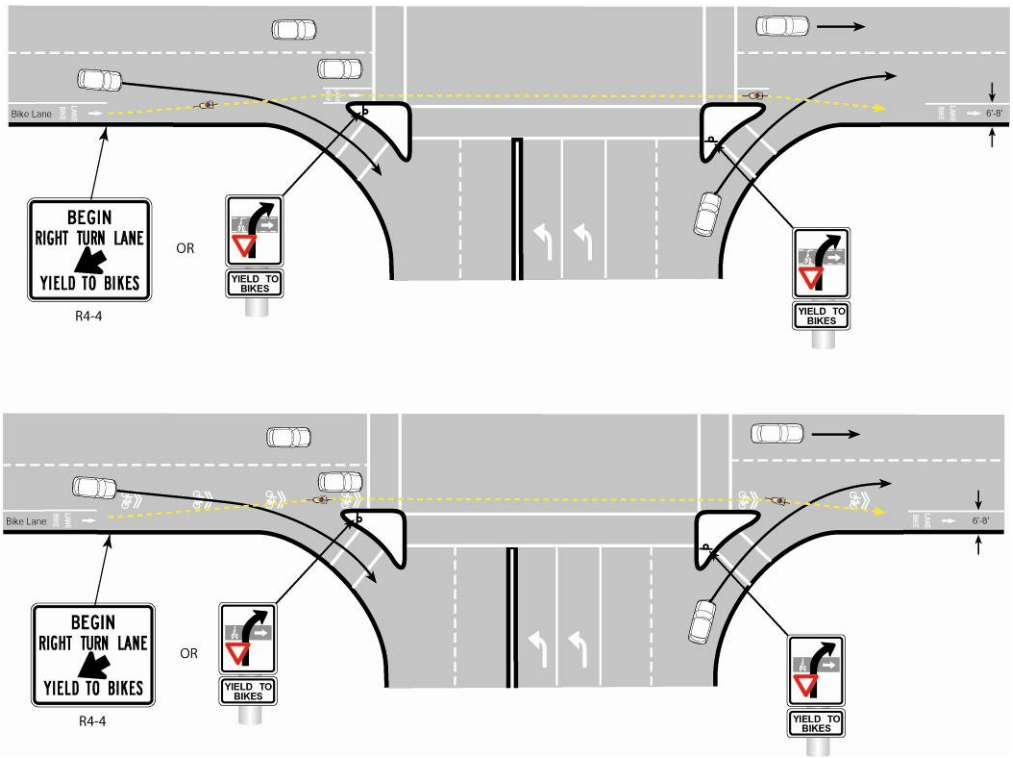
Share the Road signs remind motorists that bicyclists have the right to ride on the roadway.

5.2.4 Bicycle-friendly Intersections

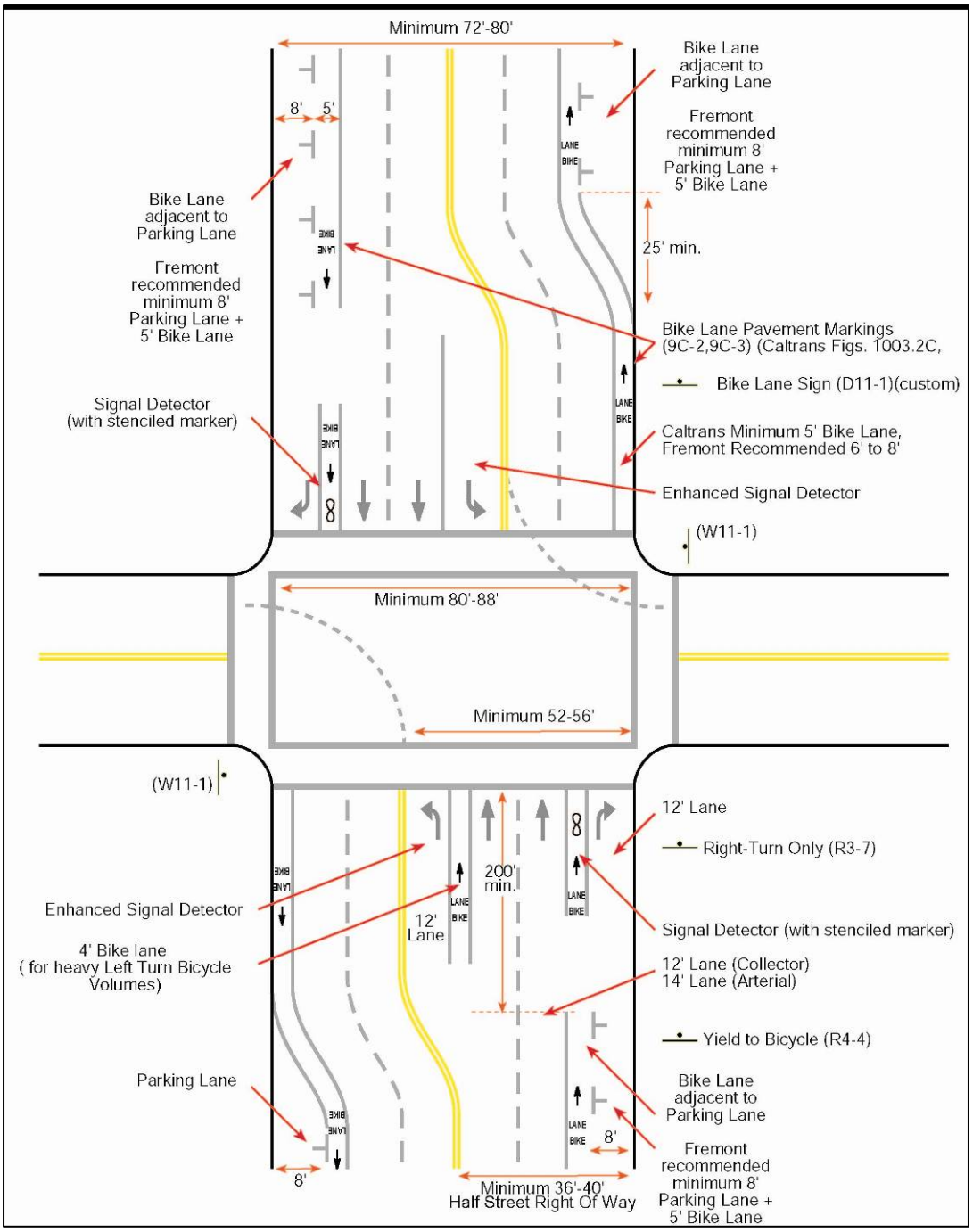
Through bike lanes at intersection approaches protect bicyclists from right turning motorists.
Photo: Alta Planning + Design

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, 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.



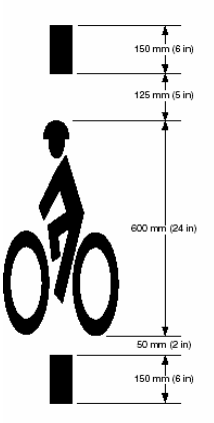
Bike lane through intersection with free right-turn lanes.
Graphics: Alta Planning + Design



Bicycle lane configurations at intersections. Graphic: 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 on the roadway to activate the signals.



"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.

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

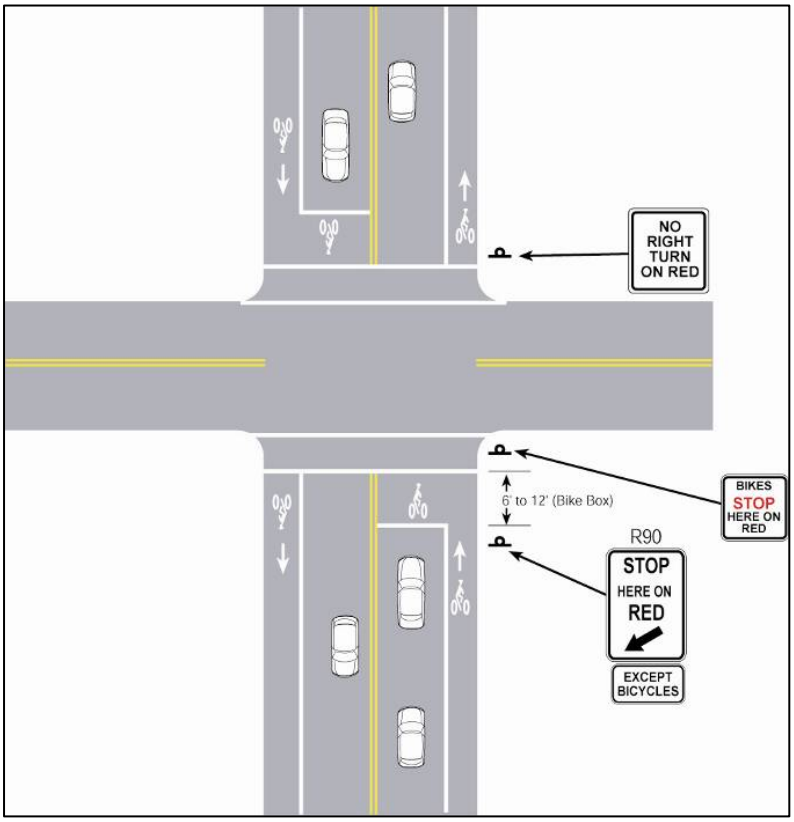
Bike box in Eugene, OR.

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



Plan View of the Bicycle Box
Graphic: Alta Planning + Design

5.2.5 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.

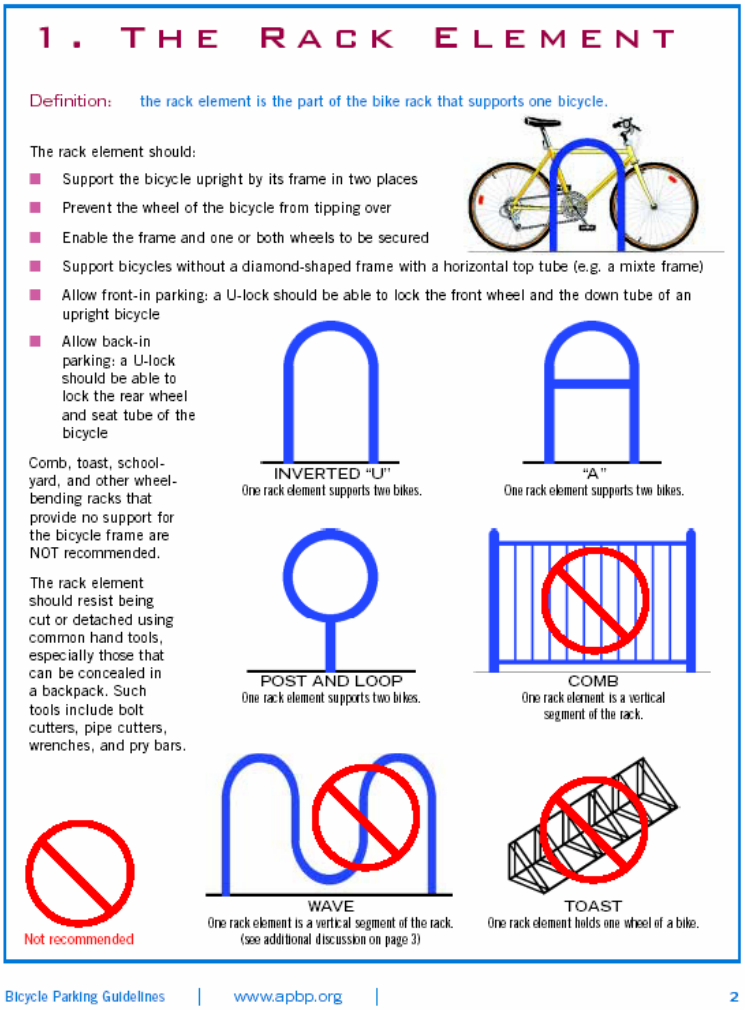
- Empty racks should not pose a tripping hazard for visually impaired pedestrians. Position racks out of the walkway's clear zone.

- 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.

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 Guidelines for Bicycle Parking Locations and Quantities



APBP's Recommended practice for bicycle parking facilities

5.3 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, 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:

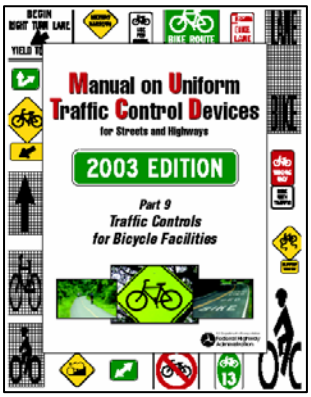
The following is a list of references and sources utilized to develop design guidelines for Wake Forest's Bicycle Master Plan. Many of these documents are available online and are a wealth of information and resources available to the public.

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
http://www.ncdot.org/transit/bicycle/projects/resources/projects_facilitydesign.html

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
http://www.bicyclinginfo.org/pdf/bikeguide.pdf

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