CHAPTER 4 OUTLINE:

CHAPTER 4: BICYCLE FACILITY NETWORK

OVERVIEW

The City of Raleigh's Bicycle Facility Network represents a comprehensive set of existing and proposed bicycle transportation facilities. The network includes shared roads, paved shoulders, bicycle lanes, side paths and greenways. In total, there are approximately 435 miles of recommended bicycle facilities, all of which are shown on pages 4-15 to 4-19.

The following sections of this chapter include 1) how the network was designed; 2) brief descriptions of the types of facilities that make up the network; and, 3) network maps.

METHODOLOGY FOR NETWORK DESIGN

The bicycle facility network was designed by first assembling all existing bicycle-related recommendations and information from current plans and studies (as outlined in Chapters 2 and 3, and in Appendices E, F, and G). The assembled information was then presented to the public, City staff, the Steering Committee, and various project stakeholders. Together, the input from these groups helped to inform the overall network design; through writing and drawing on input maps, filling-out comment forms, direct dialogue, and e-mailed comments. These and other key inputs are shown in the diagram below:

This diagram illustrates the many inputs and levels of analysis used to design the Bicycle Facility Network.

Key Factors for Network Design

• *Online Survey/Comment Forms* - Locations most in need of improvements for bicyclists (intersections and high speed/high volume roadways) were identified by over 700 people through the online survey and were discussed during public meetings (see Chapter 2 and Appendix A: Public Input Summary for more information).

• *Existing Facilities and Current Recommendations* - Locations of existing and planned facilities were verified both in the field and by City of Raleigh Transportation staff and Steering Committee members. Current recommendations were also taken into consideration, such as matching recommendations for Raleigh's Green Streets (see the Comprehensive Plan Update) and the future plans Hillsborough Street.

• *Connectivity/Gap Analysis* - Gaps in existing facilities or deficiencies in facilities were highlighted by participants in public workshops and analyzed by project consultants.

• *Trip Attractors/Destinations* - Places which are likely to attract bicyclists were identified and ranked through the online survey and during meetings with the public and project committees (see Map 2.4 Trip Attractors). The draft network was analyzed to ensure that it served local and regional trip attractors.

• *Staff and Committee Work-Sessions* - City staff met with the Steering Committee and consultants several times throughout the planning process to discuss progress on the development of the plan, the overall bicycle facility network, and to offer critical input to its design.

• *Public Workshops / Input Maps*- Participants at two public open-house Bicycle Plan workshops (with over 200 people in attendance), a Southeast Raleigh Assembly meeting, a Downtown Raleigh Alliance meeting, and a meeting for Raleigh Bike Plan Volunteers, provided suggestions, comments, and concerns about Raleigh's current conditions for bicyclists and potential improvements. Most input from these meetings was recorded through public input maps (see Appendix A Public Input Summary for more information)

• *Analysis of Current Conditions* - Field analysis by project consultants and project volunteers was also used to assess bicycling conditions on roads and intersections throughout Raleigh. Further analysis of current conditions was conducted through research and data collection from secondary sources (see Chapter 2 for more information).

RECOMMENDED FACILITY TYPES

A variety of bicycle facilities are recommended due to 1) the range of skill and comfort levels involved in bicycling, and 2) the range of conditions for bicycling on different roadway environments. These recommendations are at a planning level only and will require further analysis before implementation.

Raleigh's bicycle route network is made up seven core types of bicycle facilities. Descriptions and standards for each type are described in *Chapter 4: Bicycle Facility Standards*. The images and descriptions below are provided for a quick reference when viewing the *Bicycle Facility Network Maps* (pages 4-15 through 4-19).

Note: Bicycle lanes are the preferred type of on-road bicycle facility as determined by the Bicycle Plan Steering Committee and supported by the public input into this process. It was judged that bicycle lanes create clearly designated separated spaces that would encourage more bicycling among all user groups.

Bicycle Lane

See pages 7-12 to 7-16 for details.

A bicycle lane is a portion of the roadway that has been designated by striping, signing, and pavement markings for the preferential and exclusive use of bicyclists. Bicycle lanes are always located on both sides of the road (except one way streets), and carry bicyclists in the same direction as adjacent motor vehicle traffic. The minimum width for a bicycle lane is four feet; five- and six-foot bike lanes are typical for collector and arterial roads.

Shared Lane Marking ("Sharrow")

See page 7-11 for details.

It is recommended that bicycle shared lane markings (or 'sharrows') be approached incrementally as a new facility treatment. Shared lane markings are used on roadways where dedicated bicycle lanes are desirable but are not possible due to physical or other constraints. Placed in a linear pattern along a corridor (typically every 100-250 feet), shared lane markings make motorists more aware of the potential presence of cyclists; direct cyclists to ride in the proper direction; and remind cyclists to ride further from parked cars to avoid 'dooring' collisions.

Wide Outside Lanes

See page 7-8 and 7-10 for details.

A wide outside lane refers to the through lane closest to the curb and gutter of a roadway. The American Association of State Highway and Transportation Officials (AASHTO) standard lane width to accommodate both motorists and bicyclists is 14'. This facility type allows motorists to more safely pass slower moving bicyclists without changing lanes. Wide outside lanes are intended for bicyclists with traffic-handling skills.

Paved Shoulders

See page 7-17 for details.

Paved shoulders are the part of a roadway which is contiguous and on the same level as the regularly traveled portion of the roadway. There is no minimum width for paved shoulders, however a width of at least four feet is preferred. Ideally, paved shoulders should be include in the construction of new roadways and/or the upgrade of existing roadways, especially where there is a need to more safely accommodate bicycles.

Signed Bicycle Routes

See pages 4-11 and 7-10 for details.

This designation refers to the City of Raleigh's original signed bicycle routes. Rather than a specific a bicycle facility type, these routes contain combinations of facilities, if any. This Plan recommends discarding the current system (the reasoning behind this recommendation is outlined on page 4-11). In the future, signed bicycle routes may emerge from the newly developed bicycle facility network for the City that have greater function, utility, and safety.

Multi-Use Paths/Greenways

See pages 7-32 to 7-34 for details.

Multi-use paths are completely separated from motorized vehicular traffic and are constructed in their own corridor, often within an open-space area. Multi-use paths include bicycle paths, rail-trails or other facilities built for bicycle and pedestrian traffic. The term 'greenway' is used only for those multi-use paths and sidepaths that are indicated on the Capital Area Greenway map and included in the City's Comprehensive Plan.

Sidepaths

See page 7-18 for details.

Multi-use paths located within the roadway corridor right-of-way, or adjacent to roads, are called 'Sidepaths'. Sidepaths are most appropriate in corridors with few driveways and intersections. Bicycle routes where side paths are recommended should also have adequate on-road bicycle facilities (such as paved shoulders or bicycle lanes) wherever possible.

Network Map Sub-Category Definitions

As indicated in the legend of the Bicycle Facility Network Map, some facilities are broken down into sub-categories for method of development. Those for bicycle lanes are explained below:

Bicycle Lane - Road Diet: Road diets typically involve reducing the number of travel lanes (from a four-lane road to a two-lane road with center turn lane, for example) allowing adequate space for bicycle lanes. Road diets also have traffic calming benefits.

Bicycle Lane - Stripe: Refers to projects that require only the striping of a bicycle lane, with no other changes needed to the roadway or existing roadway striping.

Bicycle Lane - Restripe: Refers to projects that require restriping travel lanes (often to a more narrow width) allowing adequate space for bicycle lanes. Narrowing the widths of travel lanes has been demonstrated to have no affect on overall roadway capacity (for more on this topic, refer to the following page, 4-6).

Bicycle Lane - New Construction: Refers to projects that require adding additional pavement width to the roadway to allow adequate space for bicycle lanes. These were determined based on future roadway reconstruction schedules and/or lack of opportunity with the current roadway environment.

Other facilities also have sub categories shown on the maps, indicating whether they are existing, planned, or proposed. These are defined as follows:

Proposed: Bicycle facilities labeled as 'proposed' are recommendations that came out of the Bicycle Plan planning process.

Planned: Bicycle facilities labeled as 'planned' already appear in previously adopted City of Raleigh plans.

Existing: Bicycle facilities labeled as 'existing' are already constructed and in use.

Table 4.1 Mileage of Recommended Bicycle Facilities

Recommended Facility	Method	Mileage
Bicycle Lane	Stripe	37
Bicycle Lane	Restripe	101
Bicycle Lane	New Construction	164
Bicycle Lane	Road Diet	30
Shared Lane Markings	Stripe	30
Paved Shoulder	New Construction	7
Wide Outside Lane	New Construction	78
Total		447

Recommended Off-Road Facilities	Method	Mileage
Greenways	New Construction	65
Sidepath	New Construction	9
Total		94

Signed Bicycle Routes		N/A

Grand Total		*541 miles*

Bicycle Lane Development Through Travel Lane Narrowing

One means of developing bicycle lanes is through restriping or travel lane narrowing. In laying out the bicycle network facility recommendations and methods, it was determined that 10' travel lanes were acceptable in order to fit bicycle lanes into the existing roadway environment. For example, an existing five lane cross section with 12' lanes (Total roadway width of 60') could be altered to 10' lanes with 5' bicycle lanes (Total roadway width of 60'). This methodology used in developing recommendations is supported by research in both automobile traffic safety and bicycle level of service improvements.

Current AASHTO literature, research, and precedent examples support the notion of reducing 12' travel lanes to 10' lanes. The 2004 AASHTO Green Book states that travel lanes between 10 and 12 feet are adequate for urban collectors and urban arterials. (1) "On interrupted- flow operating conditions at low speeds (45 mph or less), narrow lane widths are normally adequate and have some advantages." At the 2007 TRB Annual Meeting, a research paper using advanced statistical analysis, supported the AASHTO Green Book in providing flexibility for use of lane widths narrower than

1) American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, Washington, DC 2004.

Decision Tree for Recommending Bicycle Facilities

In order to determine what type of facility to recommend for individual roadways, a methodology was developed for the City of Raleigh. Utilizing such information as future roadway reconstruction schedules, existing roadway widths, existing roadway speed limits, and existing traffic volumes, the decisions were made through a decision-tree, as presented below.

12 feet on urban and suburban arterials. The paper indicates there is no difference in safety on streets with lanes ranging from 10 to 12 feet. "The research found no general indication that the use of lanes narrower than 12 feet on urban and suburban arterials increases crash frequencies. This finding suggests that geometric design policies should provide substantial flexibility for use of lane widths narrower than 12 feet." The research paper goes on to say "There are situations in which use of narrower lanes may provide benefits in traffic operations, pedestrian safety, and/or reduced interference with surrounding development, and may provide space for geometric features that enhance safety such as medians or turn lanes. The analysis results indicate narrow lanes can generally be used to obtain these benefits without compromising safety." and "Use of narrower lanes in appropriate locations can provide other benefits to users and the surrounding community including shorter pedestrian crossing distances and space for additional through lanes, auxiliary and turning lanes, bicycle lanes, buffer areas between travel lanes and sidewalks, and placement of roadside hardware." (2)

2) Relationship of Lane Width to Safety for Urban and Suburban Arterials, Ingrid B. Potts, Harwood, D., Richard, K, TRB 2007 Annual Meeting

Precedent examples also show the large number of communities around the United States that have narrowed travel lanes to enable the development of bicycle lanes. The Missoula Institute for Sustainable Transportation accumulated a list of these communities by asking members of the Association of Pedestrian and Bicycle Professionals. The webpage titled "Accommodating Bike Lanes in Constrained Rights-of-Way (http://www.strans.org/travellanessurvey.htm) lists the community, their methods, and contact information. Cities such as Arlington, VA, Cincinnati, OH, Charlotte, NC, Houston, TX, and Portland, OR have regularly narrowed travel lanes to 10' or even commonly use them in new roadway development. Arlington, VA has been installing bicycle lanes on streets when they are repaved and have a number of streets with 10' lanes and bicycle lanes that have been functioning well without operational issues and complaints. Cincinnati, OH uses a policy that 10 foot lanes on collections and arterials are always permitted. New installations of 10 foot lanes with bicycle lanes require a speed limit of 35mph or under. By restriping 12 foot lanes to 10 feet, the City of Houston, TX has converted 30 miles of arterial streets.

Lane narrowing and the addition of bicycle lanes will require further analysis beyond this planning effort. Changing the roadway design may also require a reduction in speed limit and consideration of traffic calming designs such as median islands. For roadways with higher speed limits and traffic volumes, wider bicycle lanes may be warranted. Further analysis of bicycle lane restriping projects is warranted to determine appropriateness of lane narrowing, bicycle lane widths, and speed limits that impact both motorists and bicyclists.

BICYCLE STATIONS AND PARKING

Bicycle parking is an essential component of the bicycle network by providing increased convenience and accessibility. During this planning process, City of Raleigh staff, Downtown Raleigh Alliance members, and the Consultant determined sites for bicycle stations and bicycle racks. An analysis of bicycle conditions at major destinations was also conducted and shown in Appendix G, leading to recommendations found in this chapter.

Bicycle stations are recommended at future transit hubs sited throughout the Raleigh area and are displayed in the network maps. Integrating bicycle facilities with transit modes allows bicyclists to expand their range of travel through "trip chaining." Bicycle racks are recommended at strategic locations in the downtown area such as parking garages. These locations are listed below and displayed in the Downtown Network map (Map 4.6).

Bicycle Stations (Future Transit Hubs)

- City Bus Terminal - Moore Square Station (Downtown)
- Cameron Village
- Crabtree Valley Mall
- Triangle Town Center
- WakeMed
- Avent Ferry Rd./Gorman St.
- NC State - Varsity Dr.
- Western/Jones Franklin
- Pecan Rd./S. Saunders St.

Right: An example bicycle station (by Paul Zykofsky, 2004). The first facility of its kind in the U.S., Bikestation Long Beach is strategically located on a nexus for light rail, buses, pedestrians, and a local shuttle that services neighborhoods and key attractions. This example station offers attended indoor bicycle parking (free during regular business hours), professional repair services, and a bike shop.

Bicycle Parking

- Downtown Sites
  - Moore Square area
  - Caswell Square
  - Convention Center
  - Lane St. (Dawson to Salisbury)
  - N.C. Museums - State Capitol area
  - Morgan/McDowell Parking Deck
  - Market Plaza - Fayetteville Street
- Local colleges and universities
- Ridgeway Shopping Center

It is recommended that further analysis be conducted to place bicycle racks at key destinations such as bus stops, shopping centers, and office complexes across the city. Bicycle parking should also be made available with new development. Further information about bicycle parking and stations can be found in Chapter 7: Design Guidelines.

Below are photos of where some people in Raleigh are currently locking their bicycles, demonstrating a need for proper bicycle parking.

RALEIGH'S SIGNED BICYCLE ROUTES

Raleigh's signed bicycle route system was discussed at public workshops and was field-evaluated by a volunteer group of local bicyclists. The results of these informal evaluations, in concert with consultant consideration, led to the recommendation that the current route system be discarded. The reasoning behind this recommendation is outlined in the following points:

- First and foremost, the Plan now defines a Bicycle Level of Service for the entire City. Since bicycles are considered vehicles, they are entitled to use the roadways as constructed.

- Second, there are many bicyclists that are not going to feel comfortable using the City's roadways as currently constructed. The Plan recommends a number of improvements that over time will make the entire community more bicycle friendly, and this includes substantial physical improvements to the roadway environment.

- Third, the current bicycle route system does not have substantial function nor utility. Bicyclists at public workshops, including commuter bicyclists, rarely used the existing signed and marked route system.

- Fourth, as the existing system evaluation revealed, many of the routes are missing essential signage and contain many awkward turns, street crossings, and directional issues that cause bicyclists not to follow the intended routes. This system of route designation is an outdated method of accommodating bicyclists.

- Fifth, a route system may imply falsely where bicyclists can bicycle in the City. It is a goal of this plan to encourage more people to bicycle and that should be done through facility development.

- Sixth, the City would be better served to direct its resources into the production of an updated Bicycle Map that provides current, updated information for bicyclists.

- Seventh, in the future, bicycle commuting routes may emerge from the newly developed bicycle facility network for the City that have greater function, utility, and safety. In upcoming years, the City can explore once again the use and utility of a signed route for commuters.

REGIONAL CONNECTIONS

The City of Raleigh should look beyond its city limits and link bicycle facilities to neighboring and regional destinations. It is recommended that the City of Raleigh coordinate efforts with surrounding communities such as Wake Forest, Cary, Durham, Wake County, Johnston County, and others to create long distance connections for alternative transportation and recreation. Recently, Wake Forest, Cary, and Durham completed Bicycle Plans. It will be critical to ensure compatibility and connectivity with these planning efforts and actual bicycle facilities that meet at municipality borders.

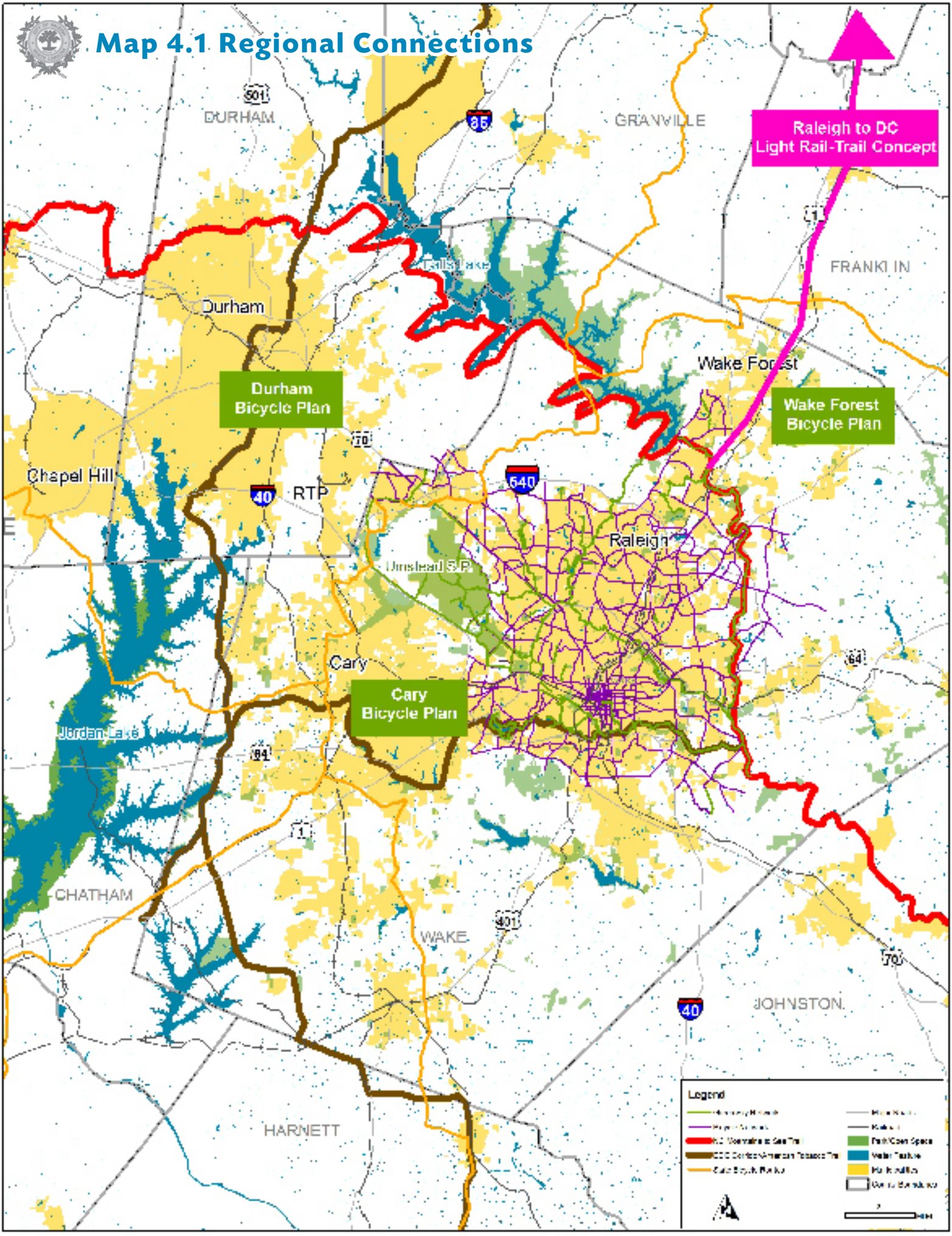
Regional greenway corridors such as the Mountains-to-Sea Trail, East Coast Greenway, and American Tobacco Trail will encourage and draw users from all over the Triangle into the area and to other locations, boosting tourism and interest in trail expansion (see regional connections in Map 4.1). Long-range efforts should be made to connect Raleigh to this regional network. For instance, the Neuse River Greenway will be a segment of the Mountains-to-Sea Trail. Also, the City of Raleigh should be positioned to cooperate and assist with future light-rail/trail corridors such as the potential corridor to Washington DC.

Additionally, NCDOT State Bike Routes #1 and #2 (http://www.ncdot.org/transit/bicycle/maps/ maps_highways .html) already traverse the Raleigh and Triangle area. Connections to these state routes will help bring bicyclists into and out of the Raleigh area.

BICYCLE FACILITY NETWORK MAPS

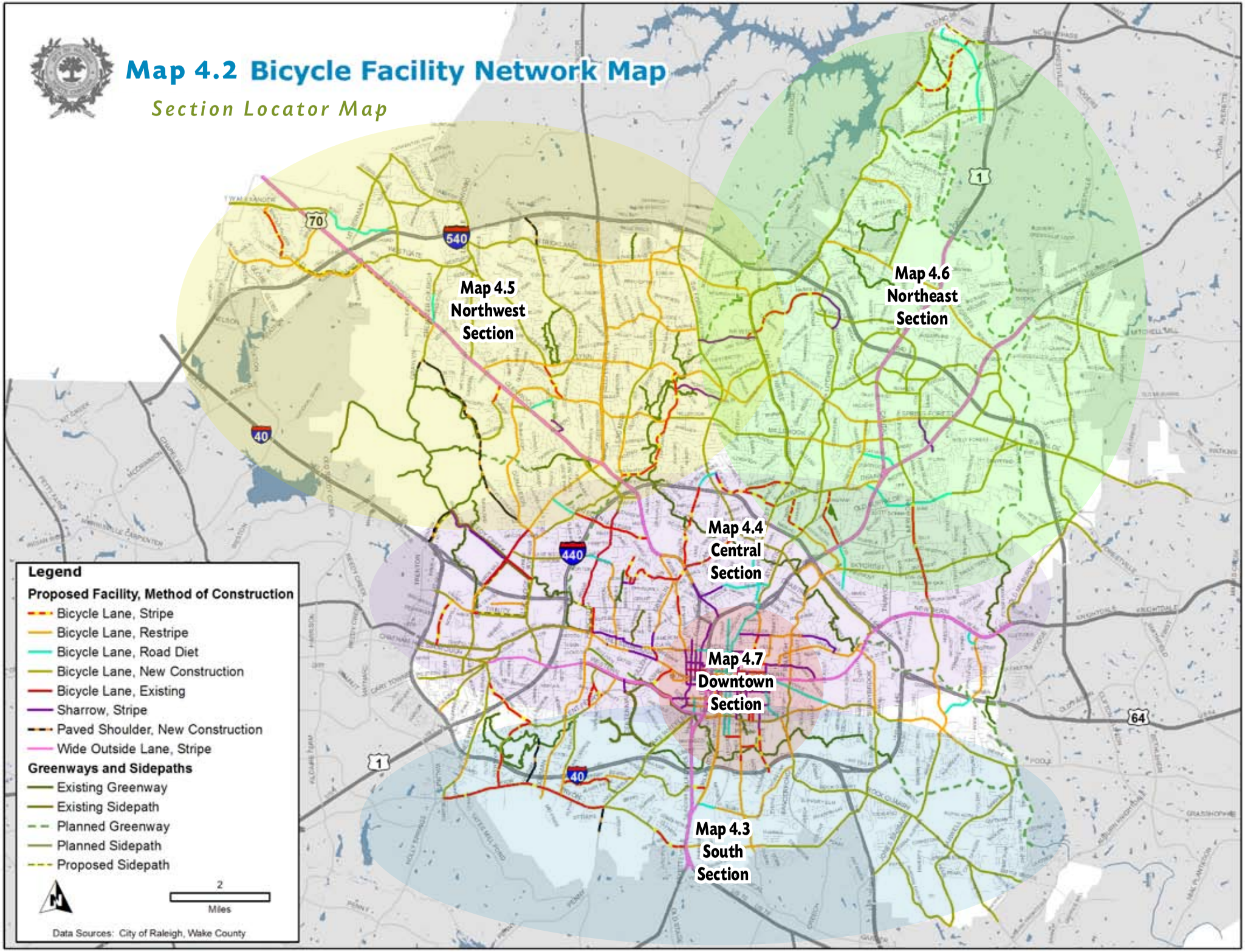
The *Bicycle Facility Network Map* is too large to be legible on a single page for this document and is therefore provided in sections. Map 4.2 (on page 4-14) shows the general areas in Raleigh covered by the three sectional maps on pages 4-15 to 4-19.

Map 4.1 Regional Connections



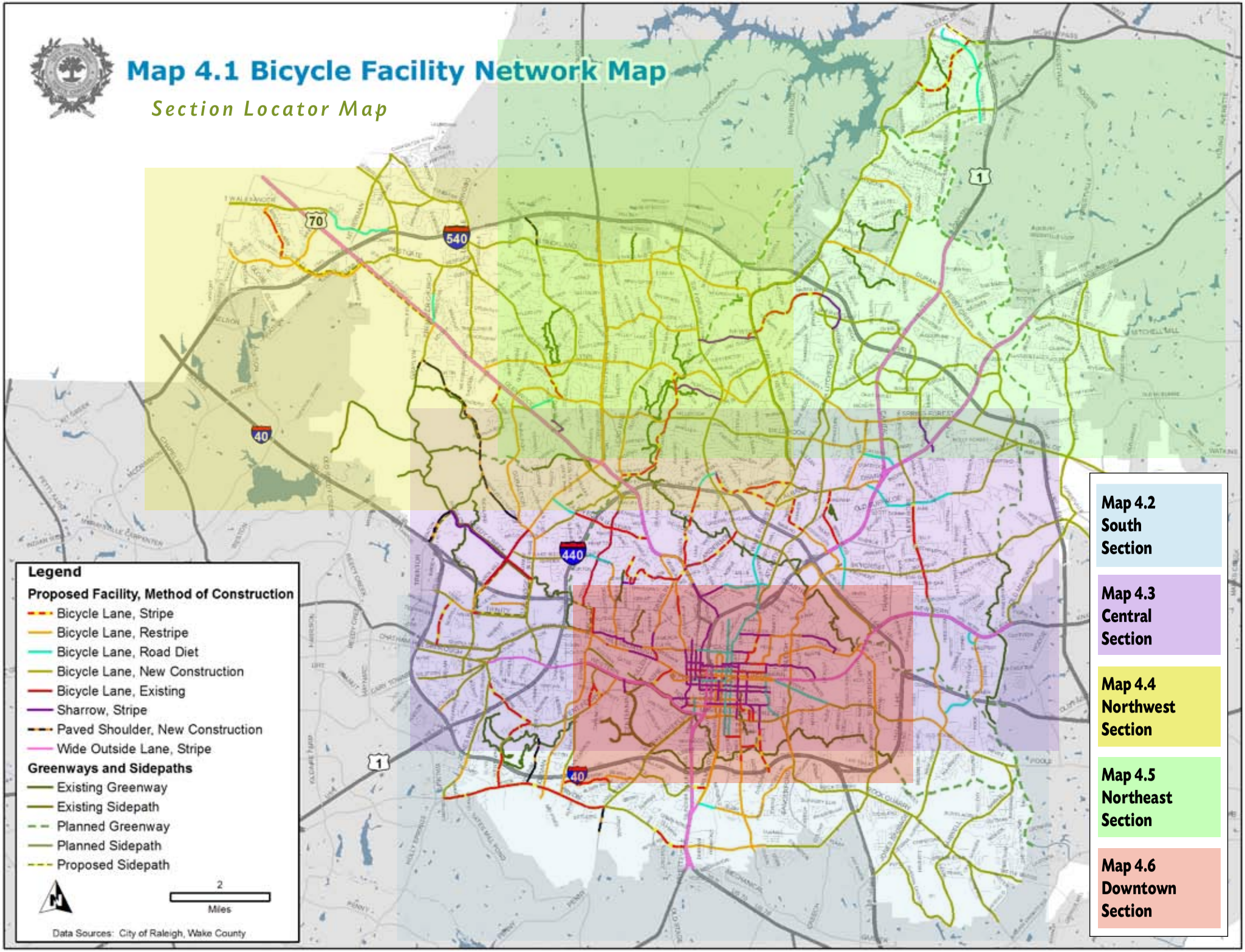
Map 4.2 Bicycle Facility Network Map

Section Locator Map

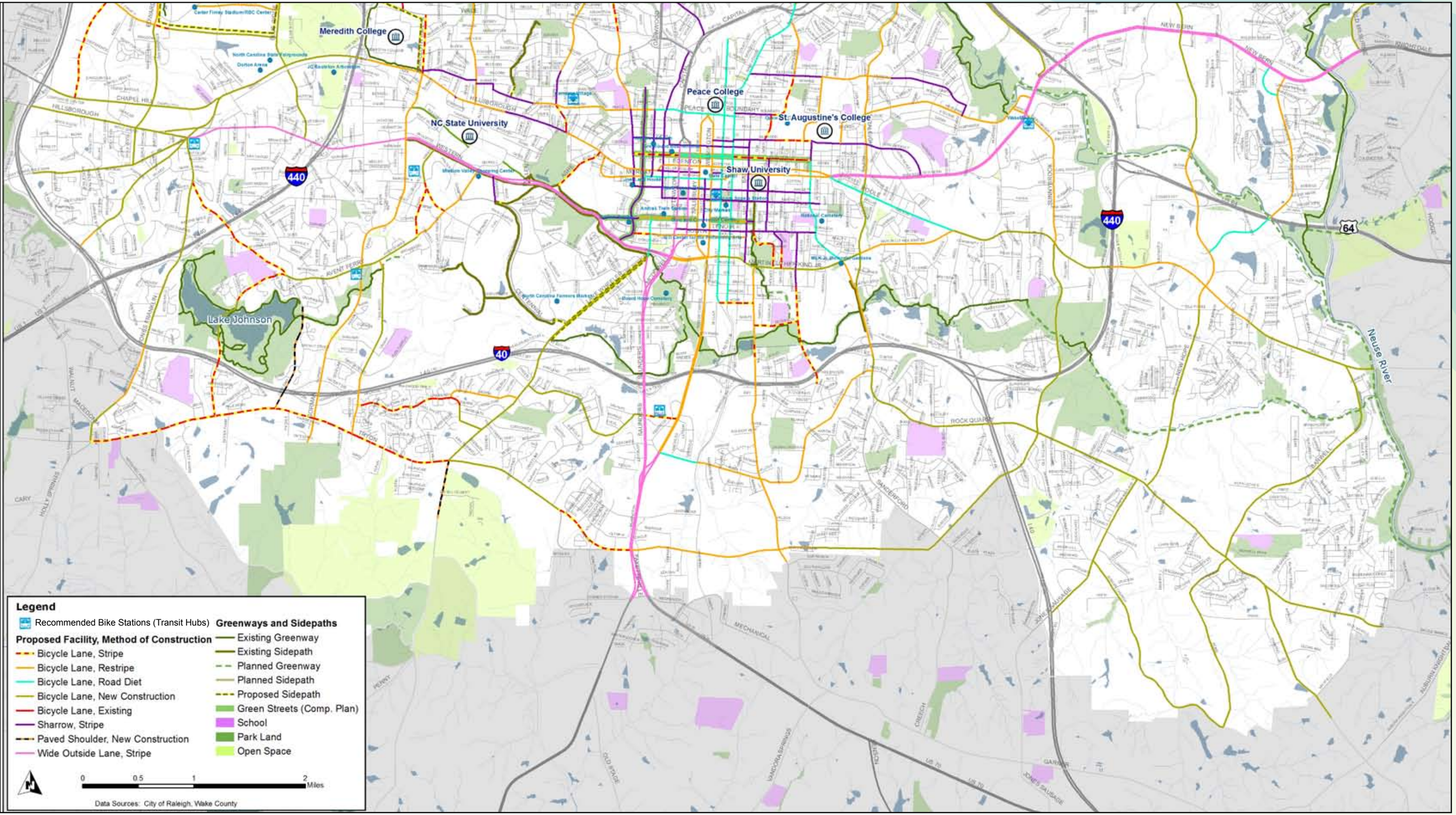


Map 4.1 Bicycle Facility Network Map

Section Locator Map



MAP 4.3 RECOMMENDED BICYCLE FACILITIES - South Section



Locator Map Color

MAP 4.4 RECOMMENDED BICYCLE FACILITIES - Central Section

Shelley Lake
Umstead Park
Meredith College
NC State University
Peace College
St. Augustine's College
Shaw University
Neuse River

Legend

Recommended Bike Stations (Transit Hubs)

Proposed Facility, Method of Construction
- Bicycle Lane, Stripe
- Bicycle Lane, Restripe
- Bicycle Lane, Road Diet
- Bicycle Lane, New Construction
- Bicycle Lane, Existing
- Sharrow, Stripe
- Paved Shoulder, New Construction
- Wide Outside Lane, Stripe

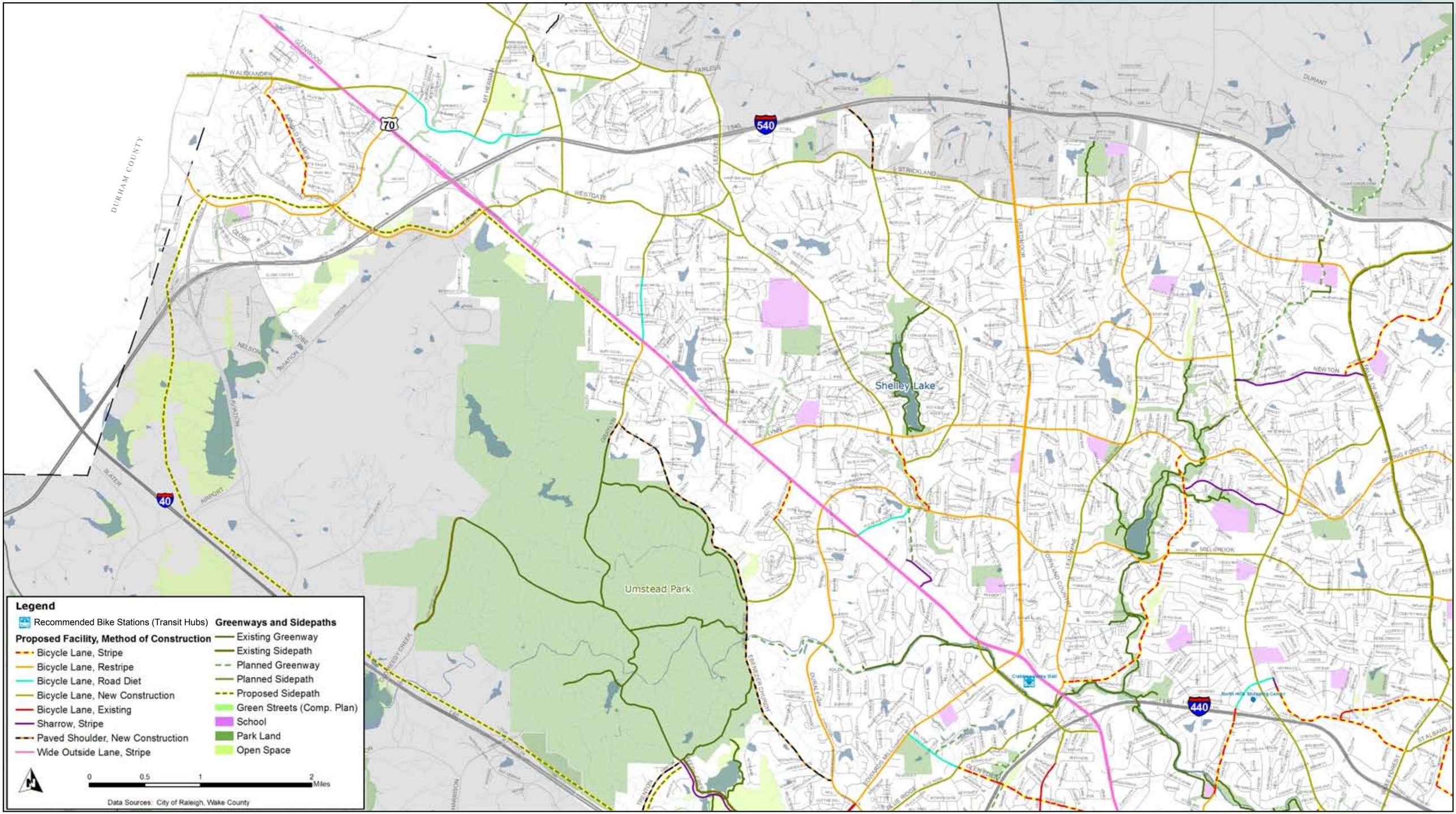
Greenways and Sidepaths
- Existing Greenway
- Existing Sidepath
- Planned Greenway
- Planned Sidepath
- Proposed Sidepath
- Green Streets (Comp. Plan)
- School
- Park Land
- Open Space

0 0.5 1 2 Miles

Data Sources: City of Raleigh, Wake County

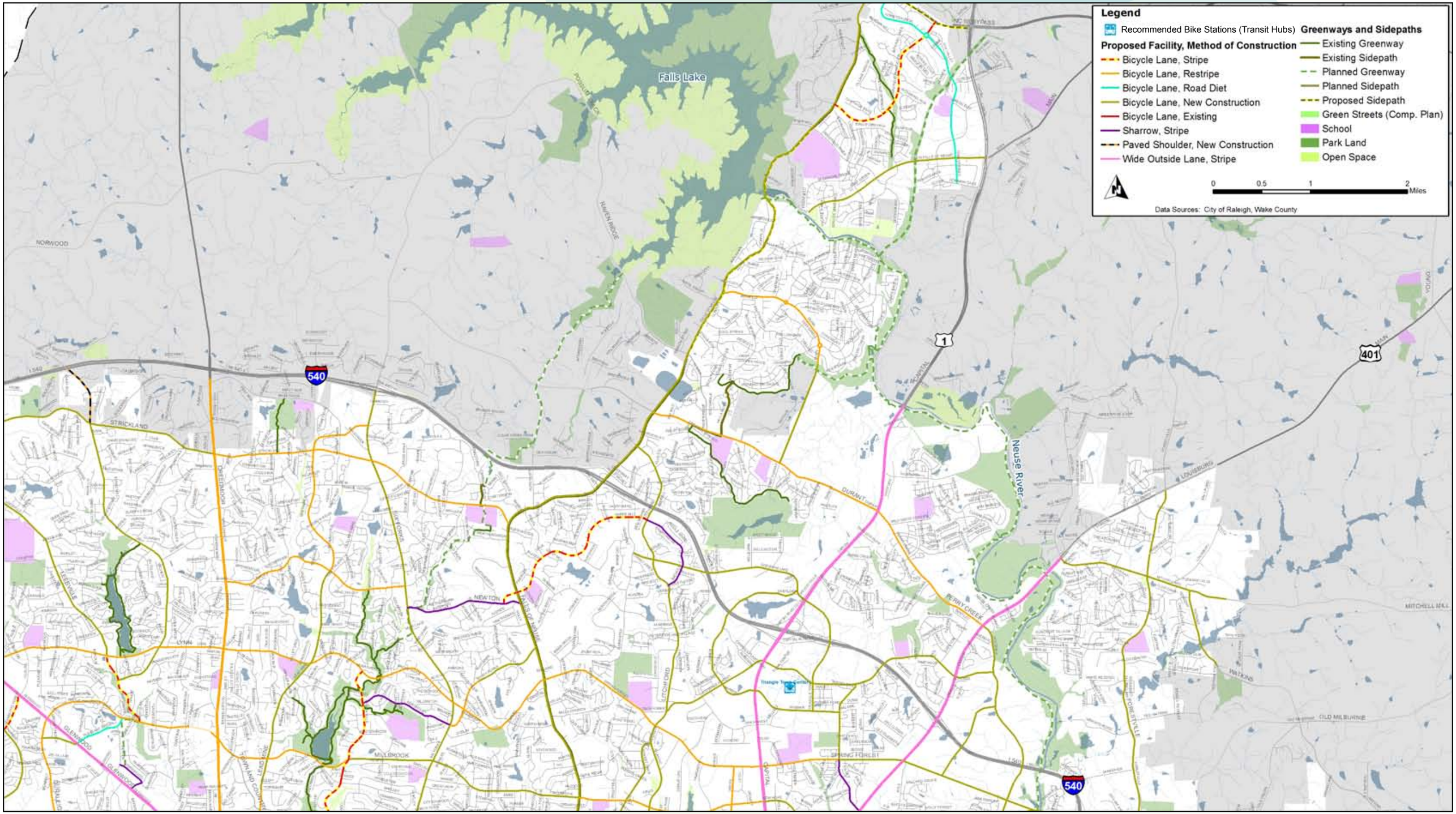
Locator Map Color

MAP 4.5 RECOMMENDED BICYCLE FACILITIES - *Northwest Section*



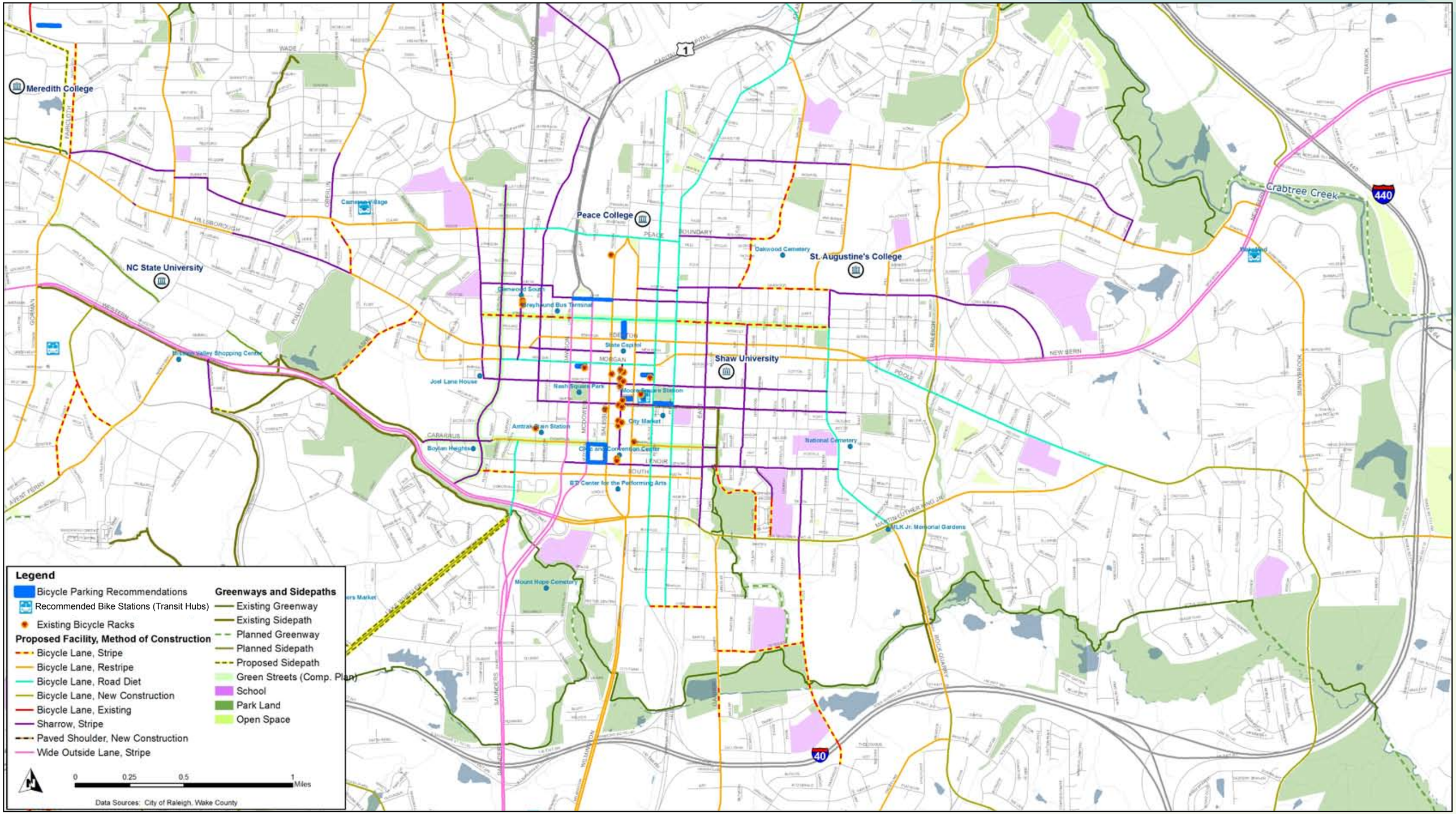
Locator Map Color

MAP 4.6 RECOMMENDED BICYCLE FACILITIES - Northeast Section



Locator Map Color

MAP 4.7 RECOMMENDED BICYCLE FACILITIES - Downtown Section



Locator Map Color