



City of Raleigh *Parks, Recreation and
Cultural Resources Department*

Capital Area Greenway Planning & Design Guide

Final Draft November 2014



City of Raleigh Parks, Recreation and Cultural Resources Department

Published January, 2015

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Baileywick Trail

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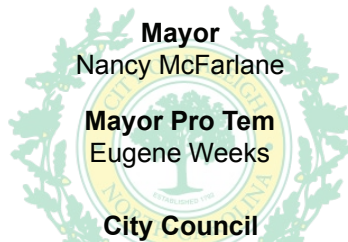
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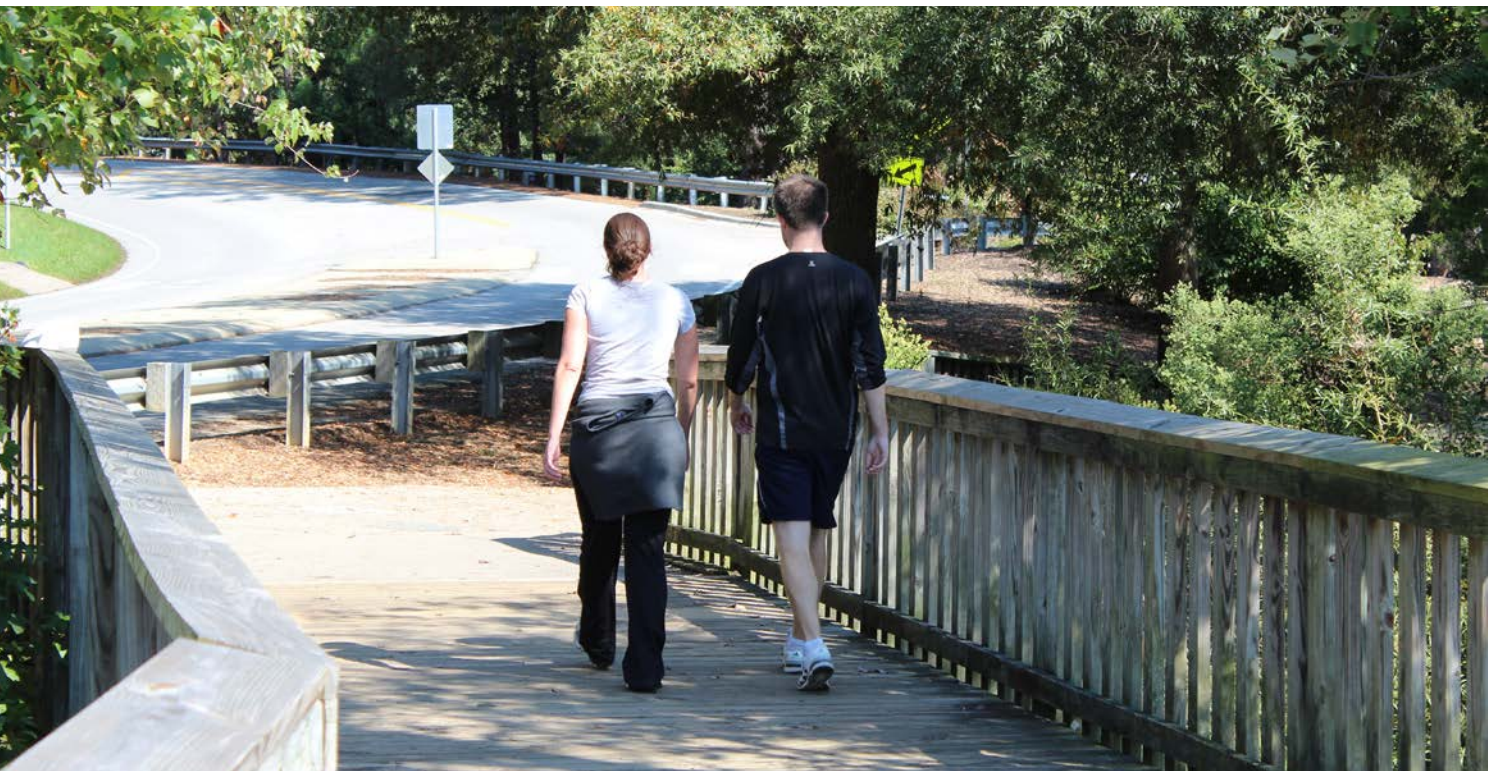
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Lake Lynn Trail

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Thank you to all who participated
in this process.

Executive Summary

Goal of the 2014 Update

The 2014 Update is a guide for the future of the City and how the greenway system interacts with other infrastructure, economic drivers, and quality of life standards for citizens and visitors. Providing a greenway guide for responding to changes in culture and function is the goal of this document.

Purpose of the City of Raleigh Capital Area Greenway Planning and Design Guide

The City of Raleigh Capital Area Greenway (CAG) Planning and Design Guide intends to assist the City of Raleigh in the planning, design, and engineering of greenway trail facilities. This document will serve as a guide to help city staff and consultants select appropriate facilities or treatments given the project context of existing and proposed greenway trails. The Guide supplements the City of Raleigh Parks, Recreation and Cultural Resources System Plan and is intended to be used simultaneously when planning and designing greenways and greenway trails in the CAG System. Prior to undertaking any greenway trail development project, the following documents should be referenced:

- The City of Raleigh Unified Development Ordinance (UDO)
- The City of Raleigh Parks, Recreation and Cultural Resources System Plan
- The City of Raleigh Bicycle Transportation Plan
- The City of Raleigh 2030 Comprehensive Plan
- Guidelines for Outdoor Developed Areas

The CAG System serves as a highly functional bicycle and pedestrian network for recreation, environmental protection, conservation, and transportation. It is critical to plan and design modern bicycle and pedestrian facilities outside the greenway trail network that connect to the CAG System. This document uses the bicycle, pedestrian, and greenway trail information and resources that are available nationally and applies them to the local context of the greenway trail network.

The System Plan

The System Plan establishes seven (7) Guiding Principles that are a part of the framework for the Vision and Implementation of the Department's plan. These principles shape the goals and objectives of the parks, recreation and cultural facilities and services throughout the City, including greenways:

Connectivity & Accessibility
Equitable Distribution
Continuous Reinvestment
Collaboration & Coordination
Balanced Experience
Innovation
Communication & Engagement

Elements of the Greenway System

Greenways within the CAG System are defined as linear, natural areas which may be suitable for trail development. Greenways are generally open space corridors, providing valuable vegetative buffers, environmental preserves, or wildlife corridors.

Greenway trails are constructed public access facilities within greenways or public utility rights-of-way. Individual greenway trails make up a larger network that connects neighborhoods, schools, parks, downtown, and commercial areas.

History of the Capital Area Greenway System

The CAG System began as a 1970s planning effort to effectively manage floodways. Preserving land adjacent to all major waterways and tributaries protects aquatic and edge habitats, prevents development of ecologically sensitive lands, and prevents potential flood damage. These primary waterways and tributaries define the corridors of the system. In addition to flood management and environmental benefits, the system also provides a series of linear parks throughout the city that create recreational opportunities for residents and visitors.

The formative vision of flood protection also influences how the city defines elements within the system. Greenways are located along the watercourses within Raleigh and protect the floodways along these corridors. The greenway is a corridor typically 50 to 150 feet in width, extending from the top of the stream bank. This corridor may or may not be developed to provide access. If access is provided, the greenway trail may be natural surface, boardwalk, or a hardened surface such as concrete or asphalt.

Updates to the plan in 1986 and 1989 emphasize recreation and inclusion of the greenway system in the parks and recreation offerings of the city. These updates also discuss the addition of adjacent land outside waterways to include land that protects natural and historic features.

The purpose of greenway corridors as defined in the *1989 Update* include:

- Preserving unique natural features
- Providing open space
- Buffering non-compatible land uses and areas
- Controlling runoff and aiding in floodplain management
- Providing wildlife habitat
- Providing hiking and bicycle paths

The *1989 Update* created a system hierarchy which identified corridors, connectors, nodes, and loops. Corridors remain the primary backbone of the system running along waterways; connectors include sidewalks and on-road bicycle facilities and utility corridors; nodes are parks, schools, and employment centers; and loops are trails around Shelley Lake, Lake Johnson, and Lake Lynn.



Reedy Creek Trail

The *2030 Comprehensive Plan*, a long range policy document, provides policy guidance for growth and development and contains action items directed at the City to implement the vision of future development. The plan further defines the goals of the greenway system. Transportation, connectivity, and green infrastructure are highlighted as main components as the city begins to incorporate greenways into the larger picture of planning, economic development, and livability. Goals of the Greenway System in the *2030 Comprehensive Plan* are defined as:

- Preserve natural characteristics of the land;
- Preserve wildlife corridors;
- Preserve riparian buffers as a means of protecting water quality;
- Preserve stream corridors to manage stormwater runoff;
- Provide buffers for multiple land uses;
- Provide opportunities for passive recreation;
- Provide shared-use trails for recreation and safe transportation routes.

Policies and action steps of the *2030 Comprehensive Plan* provide a foundation for the future of a comprehensive bicycle and pedestrian network. Minimum tread widths of 10 feet; park land acquisition; links to employment centers, schools, shopping areas, and transit facilities; regional connectivity; and standards for acquiring 100 foot wide vegetative buffers or the entire 100 year floodplain (whichever is greater) with corridor acquisition folded into the vision for a greenway system that supports recreation, preservation, and transportation.

Current Conditions

Raleigh boasts one of the most extensive greenway systems in the United States. As of 2014, the City's current greenway open space holdings total over 3,802.92 acres. A complete list of existing greenway trails are provided in the following table. 114 miles of greenway trails have been built to date and an additional 120 miles are proposed. Currently, there is no dedicated funding or schedule for the construction of these proposed trails. The proposed trails will achieve the goals of interconnectivity to

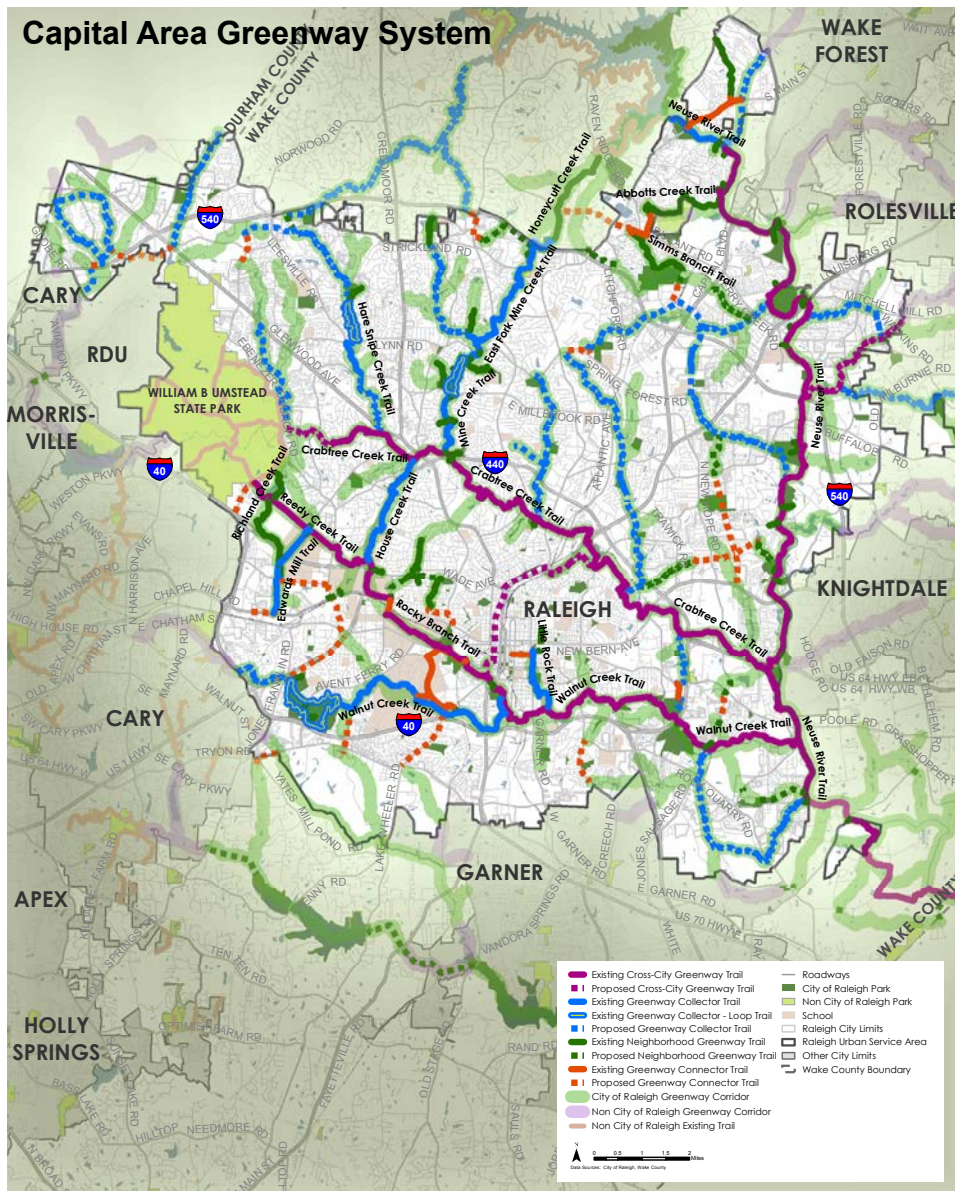
Existing Greenway Trails

TRAIL NAME	MILEAGE
Abbotts Creek	2.9
Baileywick	0.6
Beaver Dam	0.8
Birch Ridge Connector	0.3
Centennial Bikeway Connector	2.3
Crabtree Creek	14.6
East Fork Mine Creek	2.5
Edwards Mill Connector	1.3
Gardner Street	0.7
Hare Snipe Creek	2.3
Honeycutt Creek	3.8
House Creek	2.8
Lake Johnson East Loop	2.8
Lake Johnson West Loop	2.1
Lake Lynn Loop	1.9
Little Rock	1.6
Marsh Creek	0.3
Martin Street Connector	0.4
Mine Creek	4.1
Neuse River	27.5
Reedy Creek	5.0
Richland Creek	3.1
Rocky Branch	3.8
Shelley Lake Loop	2.1
Simms Branch	1.7
Snelling Branch	0.8
Spring Forest	0.4
Wakefield	1.4
Walnut Creek	15.6
TOTAL	114

existing trails; regional trail systems; proximity to parks, schools, and commercial and employment centers; and existing and proposed bicycle and pedestrian network connections. In the future, there is potential to revise these proposed trails in response to demographic and development shifts.

Summary of Recommendations

New greenway trail connections, design standards, amenities, and a wayfinding system will further



advance the CAG System as an integral component of environmental protection, recreational opportunities, and transportation infrastructure. This guide outlines the needs of different user types, as well as how they interact while using the trail system. A hierarchy of proposed greenway trail classifications serve to guide the design based on user needs. Safety, efficiency, comfort, and recreation and transportation interests will guide the new standards and implementation strategies.

This document reflects national standards, best practices, innovations in greenway design, and the needs of Raleigh residents and visitors. It complies with local standards and ordinances such

as the City of Raleigh's Unified Development Ordinance (UDO) and 2030 Comprehensive Plan. As the system continues to grow, time passes, and cultural shifts are observed, these guidelines should also grow to reflect the needs of a dynamic city.

Looking Forward

Greenway lands were originally preserved for floodway protection, with trails built for recreation and social interaction. While these and other benefits are still provided to their users, significant federal transportation policy changes and programs created a number of provisions to improve conditions for bicycling and walking as viable modes of alternative transportation. Federal transportation funds established for capital improvements created an emphasis on reducing auto trips and providing multi-modal connections through implementation of greenway trails as a transportation network that will connect schools, shopping centers, parks, and employment centers. In the future, funding resources will perpetually shift and change while Raleigh citizens will continue to desire greenway

trails that connect them to places they live, work, learn, and play. As data becomes more widely known about the quantitative and qualitative benefits greenway trails bring to communities, the demand for interconnected greenway corridors and trail networks will grow throughout Raleigh and adjacent communities.



Crabtree Creek Trail near Lockwood Park

Chapter 1 Introduction

Section 1.1 | The Value of Greenway Planning

Significant population increases and growth are projected over the next several decades in the Raleigh area and surrounding communities. Development pressure will continue to influence the character of the landscape, inevitably shaping the form and quality of the City's open space. The CAG System will serve to protect the City's streams and watercourses and make many of Raleigh's natural resources accessible.

Communities across the U.S. and throughout the world are investing in greenway corridors and trail systems as a factor of overall livability. A well-integrated CAG System within the Raleigh community can:

- Influence urban growth patterns by conserving open space.
- Create value, generate economic activity, and spur economic growth.
- Increase property values.
- Offer transportation cost savings.
- Provide a network that will connect neighborhoods, schools, shopping areas, parks, and employment centers.
- Improve health through active living.
- Support clean air, clean rivers, and wildlife.
- Mitigate flooding, soil erosion, and stream siltation by preserving buffers between developed areas and streams.
- Enhance cultural awareness and community identity.
- Contribute to the aesthetic and visual character of the City.
- Offer a natural space for public art displays, with benefits to both citizens and local artists.

Capital Area Greenway Vision

Over the past ten years, Raleigh has continued to grow and prosper, even through the recent economic recession, and has received numerous accolades for its high quality of life, business climate, and diversity of culture. The City has also established a new vision through the adoption of the 2030 *Comprehensive Plan* and Unified Development Ordinance (UDO). The City recognizes the important relationship between quality of life and its greenways, parks, recreation and cultural facilities and programs. By weaving together the social history with the economic and environmental goals of the community, the City of Raleigh continues to be a special place to live, work, play, and start a business.

The City's greenway system, is one of the most valued assets and is a primary contributor to the high quality of life enjoyed throughout Raleigh. Residents consistently rank the enhancement and expansion of the greenway system as one of their top priorities. The CAG system balances the protection of thousands of acres of natural areas with the provision of access to an interconnected network of greenway trails. The system is and will continue to become a better foundation for environmental protection, recreation opportunities, and transportation infrastructure within the City's Parks, Recreation, and Cultural Resources (PRCR) System.

Section 1.2 | Guiding Principles

Guiding Principles

The System Plan establishes seven Guiding Principles that are a part of the framework for the Vision and Implementation of the Department's plan. These principles shape the goals and objectives of the parks, recreation and cultural facilities and services throughout the City, including greenways:

Connectivity & Accessibility

Continue to design, build and improve parks, recreation, and cultural facilities to be accessible and hazard free for residents and visitors of all abilities. The system should promote health and wellness and economic development through connectivity between resources, as well as connectivity between neighborhoods, commercial areas, and employment centers to provide a strong sense of community across the region.

Equitable Distribution

Provide residents opportunities to enhance their quality of life and well-being through equitable distribution of outstanding parks, recreation, and cultural facilities and services. As Raleigh continues to grow and diversify, the park system will be proactive to accommodate the trends and needs of all user demographics. Where equitable distribution is not possible with existing facilities, innovative alternatives will be considered.

Continuous Reinvestment

The PRCR system continues to be an important part of the City's infrastructure and community fabric. The City and its partners should continue to regularly maintain and upgrade this system to respond to the growing population, changing demographics, and trends in order to sustain a high quality of life for residents.

Collaboration & Coordination

A variety of agencies, public, private and non-profit, provide parks, recreation and cultural facilities and program opportunities throughout the City of Raleigh. The City and its partners should regularly coordinate and collaborate to avoid unnecessary duplication of services, leverage resources, and provide the best possible recreation and cultural experiences.

Balanced Experience

The City should be a national model for improving the quality of life in the community by providing diverse and healthy experiences throughout the City of Raleigh. The City should regularly evaluate changing trends and the community's evolving interests and priorities in order to meet the needs of the public for recreation, education, and healthy living opportunities.

Innovation

Raleigh's demographics, development patterns and lifestyles continue to evolve as the city grows and urbanizes. The parks, recreation, and cultural system should continually respond to these changes with innovative facility design; programs and services through the development of new delivery models; and outcome-based standards and criteria. The City should continue to seek opportunities within the system to foster creative solutions and recognize where current practices are sufficient.

Communication & Engagement

Raleigh residents are passionate about their parks, recreation, and cultural resources system and desire an active role in decision-making. Communication should be used to enable a stronger community by promoting public participation opportunities. The City should continue to provide opportunities for residents to remain involved through active marketing and promotion of park, recreation, and cultural opportunities.

The City has established a vision for the overall system that strives to integrate the PRCR System into the

City's infrastructure, while also addressing evolving trends and changing needs of the community, as summarized in the following vision statement:

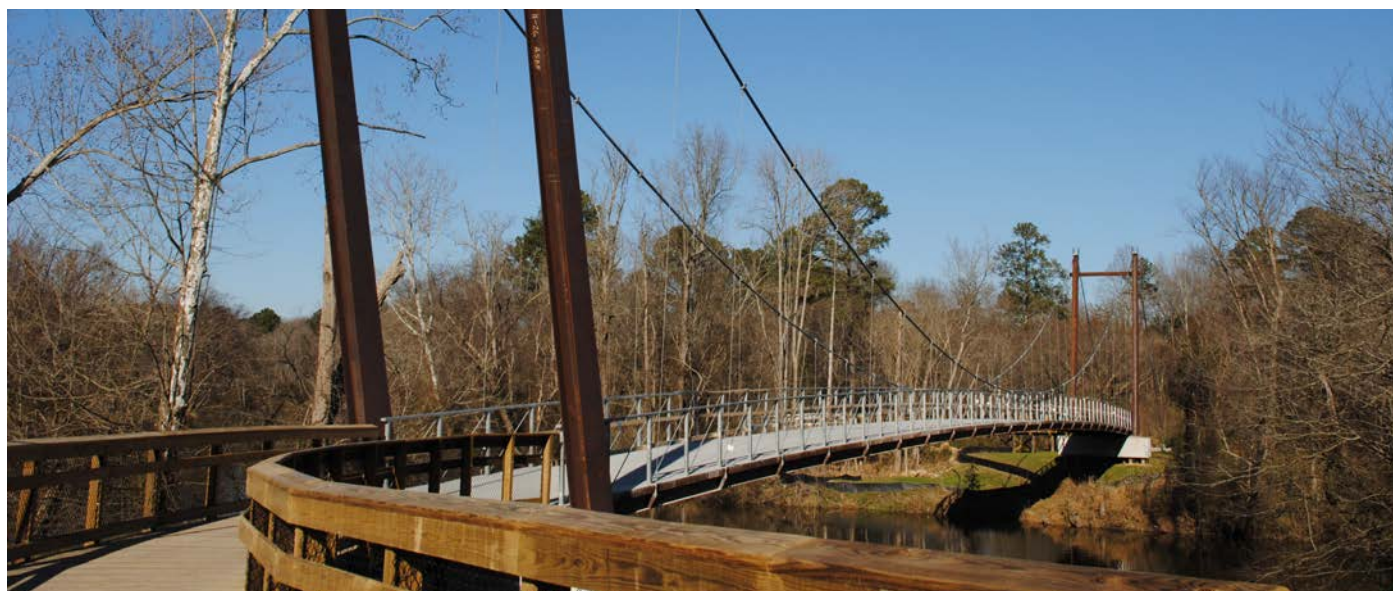
The City's vision for its parks, recreation, and cultural resources system is 'bringing people to parks and parks to people.' It is a system that addresses the needs of all and fosters a community of creativity, engagement, healthy lifestyles, and welcoming neighborhoods. In addition to providing traditional, high quality parks, recreation, and cultural facilities and programs, the City uses innovative initiatives to reach all residents, workers, and visitors.

The greenway system is one of eight sub-systems that are a part of the System Plan framework. The Greenway Sub-system outlines a series of goals, objectives and action items found in the System Plan. Identified goals include:

Goal 1: The City of Raleigh will protect and enhance linear natural resource areas.

Goal 2: The City of Raleigh will improve connectivity and accessibility to greenway corridors and greenway trails throughout the city.

Goal 3: The City of Raleigh will enhance existing greenway trails to provide a high quality system consistent with recreation needs and priorities.



Neuse River Trail Bridge, City of Raleigh.

Section 1.3 | Public Participation

The development of this design guide was coordinated with the public participation strategy for the City of Raleigh's PRCR System Plan. A multi-faceted approach to public participation was developed for the Plan that was consistent with the City's adopted Public Participation Guidelines for Park Planning (2012). A primary goal of the public participation process was to provide opportunities for geographical, topic specific, and policy related input from citizens.

The coordinated public participation included a series of community meetings, visioning sessions, online engagement, stakeholder interviews, and online and mailed surveys. The following are key themes from the public participation process:

- Need for a hierarchy of greenway trails based on level of use and type, i.e commuting, recreation, etc.
- Continue to expand and connect the greenway trails system to strengthen its ability to serve as transportation infrastructure as well as a recreation amenity.
- Provide greenway wayfinding to highlight destinations, time and distances, health information, and educational interpretative elements using innovative techniques that inform the public of the greenway system.
- Utilize sidewalks and greenway trails to provide better pedestrian and bicycle connections to

small, neighborhood parks

- Provide connections to adjacent businesses and neighborhoods
- Expand the greenway trail system and continue to make key connections of existing trails and parks in locations such as northeast Raleigh and Capital Boulevard, Downtown to Midtown and the connection to Umstead State Park
- Request for key greenway trail intersections and trailheads to provide user amenities such as rest rooms, drinking fountains, and parking
- Provide benches and rest areas along existing trails.
- Create world-class experiences in parks and greenways.
- Identify natural lands for future preservation and conservation.

These themes were also echoed in the online survey where over 46 percent of respondents do not feel there is sufficient access to greenway trails from their residence. Respondents also chose 'Develop new greenways and connect existing trails' as the second most selected action you would be most willing to fund with your City tax dollars after 'Maintain existing parks, recreation facilities and fields'.

In the mailed and telephoned survey, thirty percent (30%) of households indicated that the highest priority should be placed on the development of greenway trails/connections closer to home. Other areas that were given highest priority were: more emphasis on the development of smaller "walk to" parks (27%), and equal emphasis on the development of small and large parks (22%).

More details on the public participation process can be found in the Parks, Recreation and Cultural Resources System Plan.



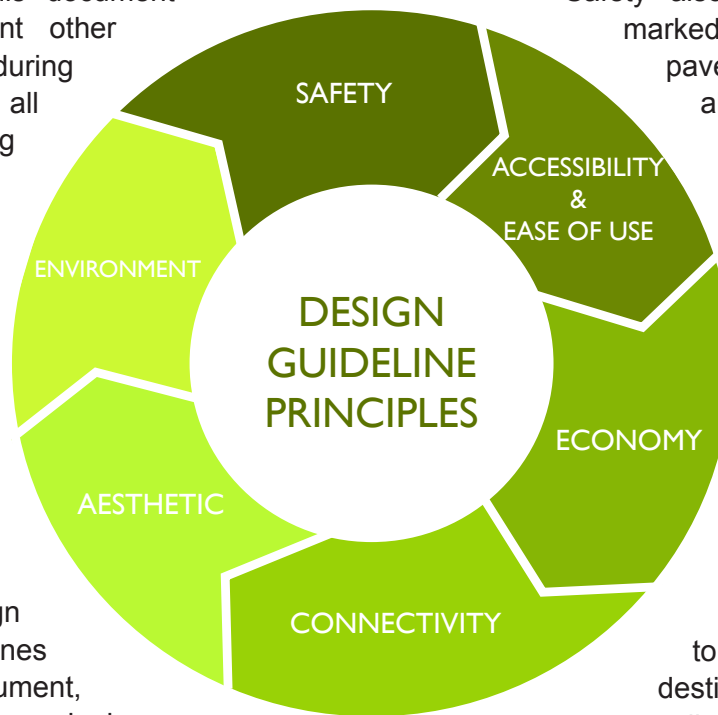
Community Meeting at Lake Lynn Community Center, January, 2013.

Section 1.4 | Principles of Greenway Trail Design

Introduction

The design guidelines in this document are flexible and should be applied using professional judgment. A number of design treatments included in the Guide are not specifically covered under current guidelines. Statutory and regulatory guidance may change. For this reason, the guidance and recommendations in this document function to complement other resources considered during a design process, and in all cases best engineering practices should be used. Pedestrian, bicycle, and greenway trail design is rapidly evolving, and design manuals should be regularly updated to reflect the latest proven designs and treatments.

Within the Design Standards and Guidelines section of this document, treatments are covered by a single sheet tabular format relaying important design information, example photos, schematics (if applicable), and existing summary guidance from current or upcoming draft standards. Existing standards are referenced throughout and should be the first source of information when seeking to implement any of the treatments featured in this document.



Safety

In addition to the physical and perceived safety of the greenway trail system, the pedestrian and bicycling environment connecting to the network should also be safe. Safety means minimal conflicts with external factors, such as user types, user volumes, vehicular traffic, and protruding architectural elements.

Safety also means routes are well marked with appropriate non-slip pavement markings, wayfinding alternatives, and directional signage.

Accessibility and Ease of Use

The greenway trail network should be accessible and easy to use. Sidewalks, greenway trails, and crosswalks should permit the mobility of residents of all ages and abilities and allow all people to easily find a direct route to a destination with minimal delays, regardless of mobility, sensory, or cognitive disability impairments. The greenway trail network should employ principles of universal design, Americans with Disabilities Act requirements, and the Access Board's Architectural Barriers Act Guidelines for Outdoor Developed Areas. Trail users have a range of skill levels, and greenway trail and crossing facilities should be designed to accommodate all users to the greatest extent possible. All roads are legal for the use of pedestrians and bicyclists (except freeways, from

which each is prohibited unless a separate facility on that right-of-way is provided). This means that bicycle and pedestrian facilities connecting to the greenway trail system should be designed, marked, and maintained accordingly. For information on bicycle facility design, reference the *The Capital Area MPO Bicycle Facility Planning and Engineering Guidelines* (2006).

Economy

The greenway trail network improvements should be economical. Pedestrian and bicycle improvements should achieve the maximum benefit for their cost (including initial cost and maintenance cost) as well as a reduced reliance on more expensive modes of transportation. Where possible, improvements in the right-of-way should stimulate, reinforce, and connect with adjacent private improvements. The North Carolina Department of Transportation's (NCDOT) Complete Streets policy and the City of Raleigh's Unified Development Ordinance (UDO) and 2030 Comprehensive Plan should be referenced whenever designing greenway trails or intersections within the roadway right-of-way.

Connectivity

The City's greenway trails, sidewalks, and bicycle network should connect to places people want to go. The network should provide continuous routes and convenient connections between destinations such as homes and neighborhoods, schools, retail areas, public services, employment centers, and transit. The routes should be as direct as feasible given environmental factors and constraints. Efforts to connect users to recreation opportunities and facilities, such as parks and civic areas, should be a priority. Greenway trails should connect to natural areas and open space in Raleigh, providing opportunities for socializing and quiet reflection. Existing and proposed greenway trails should connect with the network of pedestrian and on-street bicycling facilities to complete recreational and commuter routes.

Aesthetic

The greenway trail corridor and support facilities should be attractive and enhance community livability. Good design should integrate with and support the development of complementary uses and should encourage preservation and construction of art, landscaping, and other items that add value to communities. These components might include open spaces such as plazas, courtyards, and squares, and amenities like street furniture, banners, art, plantings, and special paving. These items, along with historical elements and cultural references, should promote a sense of place and not detract from the greenway experience or natural setting. Public activities should be encouraged and the municipal code should permit commercial activities such as dining and vending when they do not interfere with safety and accessibility.

Environment

Greenway trails are the most important facility for linking conservation, recreation, and transportation. As such, they must be developed and maintained in ways that avoid negative impacts to the ecological resources of the area. The following best management practices are recommended for developing and maintaining greenway trail systems:

1. Sustainability of natural systems should be prioritized in design and construction of greenway trails.
2. Ecologically sensitive areas should be preserved or protected whenever possible.
3. Develop greenway trails in areas already influenced by human activity, including existing infrastructure rights-of-way.
4. Design should avoid or minimize erosion associated both with greenway trail treads and stormwater runoff.
5. Use natural infiltration and best management practices for stormwater management.
6. Responsible planning and management of greenways and greenway trails is an ongoing responsibility/activity.

Section 1.5 | Design Standards, Publications, and Guidelines

The guidelines recommended in this document are intended to assist City of Raleigh CAG staff and consultants in the selection and design of greenway trails and their ancillary facilities. The standards draw together best practices by facility type from public agencies and municipalities nationwide. The following guides have been used to formulate standards and best practices for implementing the CAG System.

National Guidelines

The Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices* (MUTCD) defines the standards used by road engineers nationwide to install and maintain traffic control devices on all public streets, highways, greenway trails, and private roads open to public traffic. The MUTCD is the primary source for guidance on lane striping requirements, signal warrants, and recommended signage and pavement markings.

To further clarify the MUTCD, the FHWA created a table of contemporary bicycle facilities that lists various bicycle-related signs, markings, signals, and other treatments and identifies their official status (e.g., can be implemented, currently experimental). See *Bicycle Facilities and the Manual on Uniform Traffic Control Devices*.

Greenway trail design treatments not explicitly covered by the MUTCD are often subject to experiments, interpretations, and official rulings by the FHWA. The *MUTCD Official Rulings* is a resource that allows website visitors to obtain information about these supplementary materials. Copies of various documents (such as incoming request letters, response letters from the FHWA, progress reports, and final reports) are available on this website: <http://mutcd.fhwa.dot.gov/orsearch.asp>.



American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities*, updated in June 2012 provides guidance on dimensions, use, and layout of specific bicycle facilities. The standards and guidelines presented by AASHTO provide basic information, such as minimum sidewalk widths, bicycle lane dimensions, detailed striping requirements, and recommended signage and pavement markings.

The National Association of City Transportation Officials' (NACTO) *Urban Bikeway Design Guide* is a modern publication of nationally recognized greenway trail design standards, and offers guidance on the current state of the practice designs. The NACTO *Urban Bikeway Design Guide* is based on current practices in the best cycling cities in the world. The intent of the guide is to offer substantive guidance for cities seeking to improve bicycle transportation in places where competing demands for the use of the right of way present unique challenges. All of the NACTO *Urban Bikeway Design Guide* treatments are in use internationally and in many cities around the US.

Offering similar guidance for pedestrian design, the 2004 AASHTO *Guide for the Planning, Design and Operation of Pedestrian Facilities* provides comprehensive guidance on planning and designing for people on foot.

Meeting the requirements of the Americans with Disabilities Act (ADA) is an important part of any bicycle and pedestrian facility project. The United States Access Board's proposed *Public Rights-of-Way Accessibility Guidelines* (PROWAG), the ICC/ANSI A117.1 *Accessible and Usable Buildings and Facilities*, the 2010 ADA *Standards for Accessible Design* (2010 Standards) and the ABA *Accessibility Guidelines for Outdoor Developed Areas* contain standards and guidance for the construction of accessible facilities. This includes requirements for sidewalk curb ramps, slope requirements, and pedestrian railings along stairs.

Some of these treatments are not directly referenced in the current versions of the AASHTO Guide or the MUTCD, although many of the elements of these treatments are found within these documents. In all cases, engineering judgment is recommended to ensure that the application makes sense for the context of each treatment, given the many complexities of urban streets.

Crime Prevention Through Environmental Design (CPTED) is defined as a multi-disciplinary approach to deterring criminal behavior through environmental design. CPTED strategies rely upon the ability to influence offender decisions that precede criminal acts by affecting the built, social, and administrative environment. These principals should be applied to all greenway trails within the CAG System when feasible.

State Guidelines

North Carolina Department of Transportation *Complete Streets Planning and Design Guidelines* (2012). The North Carolina Department of Transportation (NCDOT) adopted a Complete Streets policy in July 2009. The policy directs

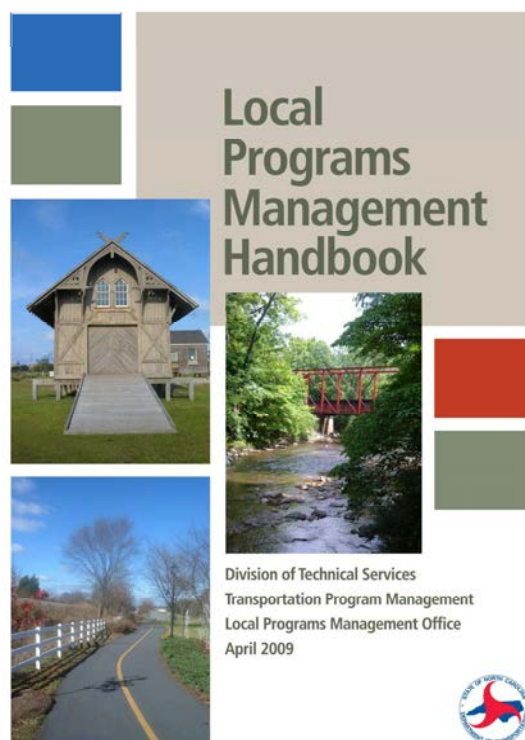


North Carolina Complete Streets Planning and Design guidelines, published in 2012

communities to consider and incorporate several modes of transportation when building new projects

or making improvements to existing infrastructure. This document provides guidance on how that policy will be implemented in order for NCDOT to collaborate with cities, towns, and communities during the planning and design phases of projects. Together, they will decide how to provide the transportation options needed to serve the community and complement the context of the area.

NCDOT Local Programs Management Handbook, (2009). Federally funded greenway trail projects where funding is for construction will usually require coordination through NCDOT. NCDOT will



NCDOT Local Programs Management Handbook, published April 2009

administer the construction funding with a State Project number while the design funding is provided elsewhere. NCDOT will require the greenway trail design to meet all State guidelines and various NCDOT standards. NCDOT has published the *Local Programs Management Handbook*, to guide municipalities through the process for these types of projects.

The major components of greenway trail development plans are as follows:

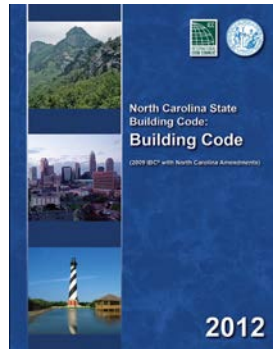
- Design plans must generally meet all NCDOT plan preparation standards and applicable checklists.
- Any structures (boardwalks, bridges, walls, etc.) will require a geotechnical report and borings that meet NCDOT standards.
- All permits must be approved before NCDOT will release the construction funding.
- All ROW and easements, both permanent and temporary, need to be acquired before NCDOT will release the construction funding.
- Construction cost estimates, specifications, and bid documents must meet NCDOT standards.
- Construction administration must be provided by the municipality meeting State and Federal standards. It should be noted that the prime consultant is ineligible for selection for construction administration per NCDOT standards.

North Carolina Bicycle Facilities Planning and Design Guidelines (1994). These guidelines were developed by the Division of Bicycle and Pedestrian Transportation (DBPT) in coordination with pertinent branches of the North Carolina Division of Highways. Adopted by the North Carolina Board of Transportation, they are a significant contribution to the design and construction of safe bicycle facilities, including greenway trails. Since 1994, the field of bike facility design has evolved and modern treatments can be found in the *2011 NCDOT Complete Streets Design Guidelines*, *2013 WalkBikeNC Plan*, *2012 AASHTO Guide for the Development of Bicycle Facilities*, and the *2013 NACTO Bikeway Design Guide*.

NCDENR Neuse River Basin Buffer Rules. The purpose of the Neuse River Basin buffer regulations are to “protect and preserve existing riparian buffers in the Neuse River Basin to maintain their nutrient removal functions.” The rules apply to 50-foot wide riparian buffers directly adjacent to surface waters in the Neuse River Basin (intermittent streams,

perennial streams, lakes, ponds, and estuaries), excluding wetlands. Greenway trails are considered an allowable use and may exist within the riparian buffer provided that there are no practical alternatives. Written authorization and approval is required from the Division of Water Resources. Best management practices shall be used if necessary to minimize disturbance, preserve aquatic life and habitat, and protect water quality.

2012 *North Carolina Building Code*, published by the International Code Council. North Carolina state building codes are founded on the principles intended to establish provisions consistent with the scope of a building code that adequately protects public health, safety, and welfare; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products, or methods of construction. When designing any structure along greenway trails within the CAG System, including, but not limited to benches, railings, fencing, bridges, and restroom buildings, consult with the current NC building code during design.



Local Guidelines

The *Capital Area MPO Bicycle Facility Planning and Engineering Guidelines* (2006). These guidelines are meant to support and clarify State-level design guidelines to provide more consistency in bicycle facility use across the Capital Area MPO region. These guidelines do not include all facility types under discussion in the CAG Design Guidelines.

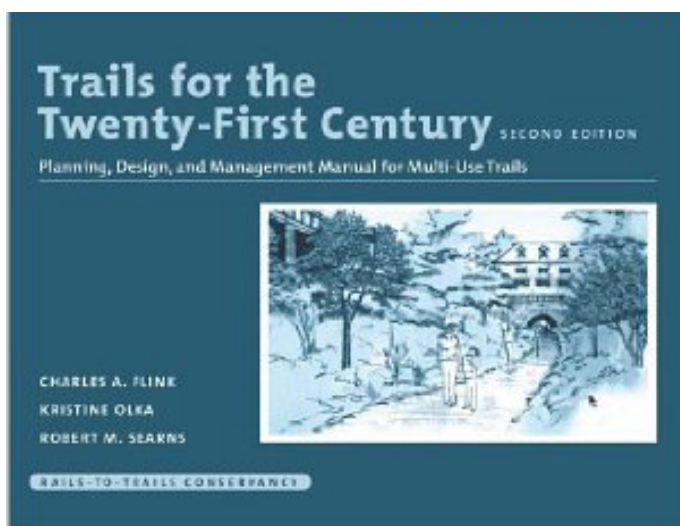
Raleigh Unified Development Ordinance (UDO) Minimal Impact Development Standards (updated 2013). The new UDO promotes a walkable, bikeable, transit-friendly city with high density, mixed-use districts. The 300-page document has guidelines governing open space and greenway trail spatial requirements as it relates to development.

The City of Raleigh 2030 Comprehensive Plan. This comprehensive planning document (amended November 19, 2013) establishes policies that respond to the requirements and aspirations of the City's residents, and accordingly influence social, economic, and physical development. The plan includes guidance and references for Land Use, Transportation, Environmental Protection and Parks, Recreation and Open Space.

While all references listed in this section are valuable to planning and designing CAG trails, special attention should be given to AASHTO, MUTCD, and ADA guidelines when designing greenway trails.

Other Publications

Trails for the Twenty-First Century (2001). This book provides a comprehensive overview of greenway trail planning, design, construction, and operations/maintenance. It summarizes steps necessary to complete a successful greenway project using a systematic approach. Construction method best practices make recommendations for proper sub-grade preparation, sub-base material, and tread



surface. Also included in the book are specific design guidelines regarding proper greenway trail ancillary facilities and environmental considerations, land acquisition, management, and operations and maintenance of greenway trails.

Designing Greenways (2006). This publication focuses on the holistic approach of greenways as ecological corridors. The book explains how greenways function ecologically and illustrates how to solve natural and social fragmentation. It is a practical guide for how planners, designers, and conservationists can implement solutions with consideration of land use and infrastructure issues.



Neuse River Trail at Falls Lake

Chapter 2 Greenway Classifications + User Types

Introduction

Greenway trails within the CAG System can range in function and character based on their alignment, surrounding land uses, environmental condition, distance, and connections to destinations. A variety of greenway trails in the network should be designed based on the user types and their needs. The following chapter provides a background and framework for classifying greenway trails for development, and an understanding of the population that uses these facilities.

Greenway trail classifications can help elected officials, advisory board members, and staff make decisions involving the expenditure of public funds and the enhancement of public safety. Decisions related to acres of land or easements to be purchased, the types of greenway trails to construct, and the location of greenway trails can be facilitated by incorporating standards and guidelines in the greenways planning and decision-making process.

New construction may allow opportunities for additional ROW acquisition, to allow for greenway trails of recommended width. Where repairs are needed on existing sections of greenway trail, certain restrictions may exist that prevent upgrades consistent with classifications. Adjacent land use, easement widths, and environmental conditions

should be identified across the existing network when repairing greenway trails. Consideration of overall feasibility and practicality of improvements should be exercised when repairing greenway trails under these conditions.

The amenities most appropriate for each trail classification are identified. However, because any trail classification may have a unique situation in which due to land use, user type, or other circumstance, any of the noted amenities may fit. Therefore, the amenities identified for each classification are prioritized as opposed to strictly only for that classification.

Section 2.1 | Definition of Greenways and Greenway Trails

Greenways Defined

For the purposes of the CAG System, **greenways** are defined as linear, natural areas which may be suitable for access. Some greenways in Raleigh may not be suitable for greenway trail development and benefit the community by remaining as undeveloped open space, providing valuable buffers, environmental preserves, or wildlife corridors.

Greenways help link fragmented tracts of open space and protect sensitive natural features, natural processes, and ecological integrity as well as other benefits listed on page 11. Greenways also contribute to cleaner air by preserving trees and other vegetation that create oxygen and filter air pollutants such as ozone, sulfur dioxide, carbon monoxide, and airborne particles of heavy metal. The natural buffer zones that occur along greenways protect streams, rivers, and lakes, preventing soil erosion and filtering pollution caused by agricultural, built environment, and roadway runoff.

Historically, the City of Raleigh acquired greenway easements within corridors rather than fee or title to a strip of land where greenways were desired. The greenway easements are in perpetuity and attached to a deed, therefore it transfers when properties are sold to the next owner. This policy is successful in that it conserves public space for potential greenway trails and enhances environmental benefits while allowing developers to transfer development rights for the unencumbered portions of the property. The city currently owns fee simple parcels along some designated greenway corridors within the CAG System.



An undeveloped greenway corridor

Section 2.2 | Greenway Corridor Types

Greenway Trails

Greenway trails are constructed public access facilities within greenways or public utility rights-of-way (where an easement is present). Combined together, individual greenway trails make up a larger network that connects neighborhoods, schools, parks, downtown, and commercial areas. Greenway trail construction should provide access and connectivity without damaging the qualities of the natural environment that are most valued and appreciated. Trail surfacing should be selected to support projected intensities of use, ADA accessibility, and to enable multiple user types if appropriate. Surface selection should also consider site topography, surface drainage, frequency of flooding, construction cost, and maintenance concerns.

Riparian Corridors

The CAG System provides a connective amenity for the community, supplying recreational value and ecological resilience for continuity to some of its most important natural areas.

The system is best viewed as a network or web of open space with greenway trails that provide many benefits, including an opportunity for people and wildlife to safely travel through the urban environment. Greenway trails within the City of Raleigh are constructed within natural corridors, man-made corridors, or along tracts of open space or other public lands.

Riparian corridors are the primary component of the CAG System, and include land directly adjacent to the City's rivers and perennial streams, including both flood plains and high ground. Riparian corridors may exist as developed greenway trails with classifications, while others may be proposed for future development. Some riparian corridors, however, do not currently include greenway trails and function simply as wildlife corridors, buffers, and green infrastructure. These greenway corridors are preserved tracts of open space where no greenway trail or defined public access currently exists, or where no proposal has been made for future development. As demographic and development patterns expand or shift, there is potential for these previously "unassigned" corridors to become locations for proposed trails.

All greenway land within the City of Raleigh's jurisdiction falls within the drainage basins, or



The Neuse River Greenway is constructed in a riparian corridor.

watersheds, of the Neuse River and its major tributaries, Crabtree Creek, Walnut Creek, Richland Creek, and Harris Creek. Minor tributaries include Leadmine, Marsh, House, Honeycutt, Turkey, Mine, Sycamore, Hare Snipe, Rocky Branch, Big Branch, and East Fork Mine creeks.

Existing riparian corridors within Raleigh have typical corridor widths of 50, 75, 100 or 150 feet, extending from the top of the stream bank. Designated greenway corridors in Raleigh vary in width from 50 to 150 feet based upon the adjoining stream classification. The inherent characteristics of the land immediately surrounding streams such as poorly-drained soils, high water table, and steep slopes often limit development.

Consistent with the System Plan Action Items, the City should develop criteria to evaluate a strategy, methodology, benefits, and impacts of widening greenway corridors to the full width of the floodplain whenever possible. This will maximize and achieve the ecological benefits rendered by greenway corridors.

Man-Made Corridors

Man-made corridors are potential greenway trail corridors that follow man-made linear elements of the roadway or utility infrastructure, or they may follow corridors created by patterns of land development. Man-made corridors can make important connections throughout the system by capitalizing on abandoned rail corridors, roadway rights-of-way, or utility rights-of-way. For all man-made corridors, a greenway trail easement must be acquired from the current fee simple title owner of the land.

City of Raleigh Public Utilities

Many CAG trails are constructed within City of Raleigh sewer easements. Most of these easements are also located within riparian corridors. Parks, Recreation, and Cultural Resources staff has worked closely with City of Raleigh Public Utilities to design greenway trails in a way that minimizes greenway trail and sewer line conflicts. No structures are permitted within sewer easements unless no other alternative exists.

Roadway Rights-of-Way

Some state-owned roadways within City limits include right-of-way widths sufficient for accommodating greenway trails separated from on-road traffic. NCDOT routinely grants encroachment agreements for greenway trails. All encroachment agreements require design approval and adherence to NCDOT stormwater design and traffic control standards.

Railroad Rights-of-Way

Federal legislation allows public interim use of inactive, abandoned railroads as trails. This method of right-of-way preservation is known as railbanking, and the trails that are built within railroad corridors are referred to as “rail-trails.” For railbanking to be successful, both the interested trail agency and the railroad must agree upon the interim use and negotiate a purchase price for the corridor. Once an agreement is made, the railroad is released of all liability and management responsibilities. The responsible trail agency assumes any mitigation measures, permitting requirements, safety improvements, and liability associated with trail development for public use.

Rail-with-trail development provides public access in active railroad corridors. Rail-with-trail projects are often developed with fencing between the trail and the railway. Many trail agencies purchase the trail right-of-way, but in some cases a use easement or license can be purchased from the railroad. FHWA has published design guidelines for rail-with-trail corridors which can be viewed online.

Public Service of North Carolina Gas Transmission Rights-of-Way

It is now possible to build greenway trails within gas transmission easements owned by Public Service of North Carolina (PSNC) Inc. PSNC cannot directly grant greenway trail easements to the City since PSNC is not the fee-simple owner of the underlying properties. Once easements have been acquired from underlying property owners, most franchise agreements between the City and PSNC would allow the City to construct greenway trails along gas rights-of-way subject to meeting design/siting/construction standards as may be required by PSNC. These

easements should be explored for trail development, especially as important connector trails.

Power Transmission Rights-of-Way

Duke Energy, which owns the majority of power lines within Raleigh, generally will allow its rights-of-way to be used for trail development with the acquisition of an easement from the current fee simple title owner of the land. In recent years Duke Energy has developed electric transmission right-of-way requirements for shared-use trails. Any use of these easements requires permission and design approval from the utility. City of Raleigh staff should explore the feasibility of utilizing these transmission corridors to augment its planned greenways to the greatest extent allowed by Duke Energy.

Connected On-road Facilities

On-road bicycle facilities and sidewalks outside greenway trail corridors can connect users from residential, civic, social, and employment areas to the greenway trail network. These connections are generally located on or along the conventional transportation system of streets and are segregated by use (bicycle/pedestrian). They include bicycle lanes, signed bicycle routes, sharrows, bicycle boulevards, sidewalks, paved shoulders, and cycle tracks. On-road facilities that connect directly to greenway trails complement the network and are not intended as an alternative to greenway trail development. In order to provide improved bicycle/pedestrian connectivity, transportation analysis should meld both on-road and greenway systems in order to provide ultimate solutions.

Section 2.3 | Capital Area
Greenway Classifications

Classification Purpose

The CAG System provides a variety of greenway trail types and user experiences, from unimproved linear tracts of open space, to very tightly specified and engineered greenway trails. Some greenway trails include paved tread while others have natural surfacing or raised tread material such as boardwalk. The system’s valued role as a functional and recreational part of the City’s environment may be further understood by classifying different types of greenway infrastructure: *Cross City Greenway Trails*, *Greenway Collector Trails*, *Neighborhood Greenway Trails*, and *Greenway Connectors*. A summary table can be found on the following page.

Designated greenway corridors in Raleigh vary in width from 50 to 150 feet based upon the adjoining stream classification. The corridor width may then vary depending upon the topography of the area, the amount of existing development, the existence of significant biological areas, and patterns of property ownership. The following classifications are intended

to balance the needs to preserve greenway corridors, provide adequate land for trails where appropriate, and to provide privacy for adjacent land uses. The City of Raleigh should make reasonable attempts to protect the various greenway corridors by restricting development, requiring greenway dedications, and purchasing land or easements.

Information on user types and design needs can be found in Section 2.4. The amenities most appropriate for each trail classification are identified. However, because any trail classification may have a unique situation in which, due to land use, user type, funding, or other circumstances, any of the noted amenities may fit in that particular location. Therefore, the amenities identified for each classification are termed “preferred” as opposed to strictly limited to the identified classification. Specific design treatments within each classification for greenway trail amenities and ancillary facilities can be found in Chapter 3.

CITY OF RALEIGH CAPITAL AREA GREENWAY TRAIL CLASSIFICATIONS					
Greenway Trail Classifications/ Design Standards & Guidelines	CROSS CITY GREENWAY TRAILS	GREENWAY COLLECTOR TRAILS	Greenway Collector Trail Loop Trail (Subcategory)	NEIGHBORHOOD GREENWAY TRAILS	GREENWAY CONNECTORS
Trail Description	Main routes crossing the city	Connect to larger residential, employment and retail centers	Located around lakes and other destinations	High levels of access	Links trails between corridors
	Connections to adjacent jurisdictions	Higher number of access points while maintaining mobility	Destination oriented trail	Connector into neighborhoods, parks, retail centers, employment centers	Referred to as "side-path"
	Located along streams, utility easements, roadways	Located along streams, utility easements, roadways		In-between lot connectivity typical	Transportation oriented, providing connection
					May utilize sidewalks, utility, transportation corridors
User Type	Balance of commuter and recreational use	Balance of commuter and recreational use with moderate to high volumes	Moderate to high volumes at specific times of day and year	Significant recreational use with moderate to high volume by local residents	Balance of commuter and recreational use
	Pedestrians, bicyclists, dog walkers, runners, strollers, wheelchair users	Pedestrians, bicyclists, dog walkers, runners, strollers, wheelchair users	Pedestrians, bicyclists, dog walkers, runners, strollers, wheelchair users	Pedestrians, bicyclists, dog walkers, runners, strollers, wheelchair users	Pedestrians, bicyclists, dog walkers, runners, strollers, wheelchair users
			Balance of commuter use on some sections of loop possible		
Potential Conflicts	High volumes	Trail intersection conflicts	High volumes	Trail intersection conflicts	Roadway, intersection/crossing conflicts
	Wide range of multiple user types	High volumes especially on weekends	Wide range of multiple user types	High volumes especially on weekends	Driveway access management (with roadway rights-of-way)
	Lack of adequate widths on existing trails	Multiple user types	Lack of adequate widths on existing trails		Motorist and bicyclist conflicts
			High volumes especially on weekends		Restricted ROW Width
			Balance of through users with loop users		
Guidance	Width - 12 feet preferred. 10 feet minimum 14 feet maximum	Width - 10 feet preferred, 12 feet maximum	Width - 12 feet preferred. 10 feet minimum, 14 feet maximum	Width - 8 - 10 feet preferred; 12 feet maximum	Width - 10 feet preferred
	Surface Tread - Asphalt or concrete	Surface Tread - Asphalt or concrete	Surface Tread - Asphalt, concrete, granite fines, bare earth	Surface Tread - Concrete, asphalt, granite fines, bare earth	Surface Tread - Asphalt or concrete
	Preferred Amenities: restrooms, water fountains, trash, seating, art, lighting	Preferred Amenities: water fountains, trash, seating, art, lighting	Preferred Amenities: Restrooms, water fountains, trash, seating, art, lighting	Preferred amenities: trash, art, lighting	Amenities provided in unique settings
	Wayfinding: Destination, Etiquette, Interpretive, Kiosk, Pavement Markings	Wayfinding: Destination, Etiquette, Interpretive, Kiosk, Pavement Markings	Wayfinding: Destination, Etiquette, Interpretive, Kiosk, Pavement Markings	Wayfinding: Etiquette, Pavement Markings	Wayfinding: Pavement Markings
	Separate trail option as resources allow		Separate trail option as resources allow	Create sufficient buffers between adjacent properties as resources allow	

Cross City Greenway Trails

Cross City Greenway Trails represent the highest level of greenway trail development. This classification will support non-motorized transportation and recreation uses. Cross City Greenway Trails will serve as main routes crossing the city and connecting to adjacent jurisdictions. Lighting may be installed as necessitated by trail use and location; however placement will be limited to minimize impacts to adjacent property owners and natural systems. This greenway trail classification can be located along streams, utility easements, or major roadways.

User Types

- Balance of commuter and recreational use with high volumes.
- Pedestrians, bicyclists, dog walkers, runners, strollers, skaters, wheelchair and Segway users

Potential Conflicts

- High volumes and use
- Wide range of multiple user types
- High speed traffic
- Lack of adequate widths on existing Cross City Greenway Trails



Typical Cross City Greenway Trail.

10-14 ft

Cross City Greenway Trails

Guidance

- Standard width: 12 feet minimum (up to 14 feet in areas with projected high use volumes to minimize user conflict).
- Lighting may be installed as necessitated by use and location (see *Lighting* and *CPTED* guidelines, p. 62 and 91).
- Wayfinding, regulatory, and etiquette signage is critical to minimize the impacts of high user volumes, bicycle speeds, inappropriate uses, and multiple uses (see *Signage and User Regulation* guidelines, p. 92).
- Prioritized amenities include restrooms, water fountains, waste receptacles, seating, art, and lighting (see *Amenities* section, p. 82).
- Surface tread material: Concrete or asphalt.
- Document and log any problems and identify trends or problem spots for mitigating user conflict.



Example of an existing Cross City Greenway Trail near the North Carolina Museum of Art.

Greenway Collector Trails

Greenway Collector Trails also support non-motorized transportation and recreation uses. These greenway trails provide a higher number of access points to adjacent land uses while maintaining mobility. Greenway Collector Trails connect to larger neighborhoods and development areas such as retail, employment, and civic uses. These corridors typically connect with Cross City Greenway Trails and collect users from Neighborhood Greenway Trails, Greenway Connectors, and on-road bicycle and pedestrian facilities.

User Types

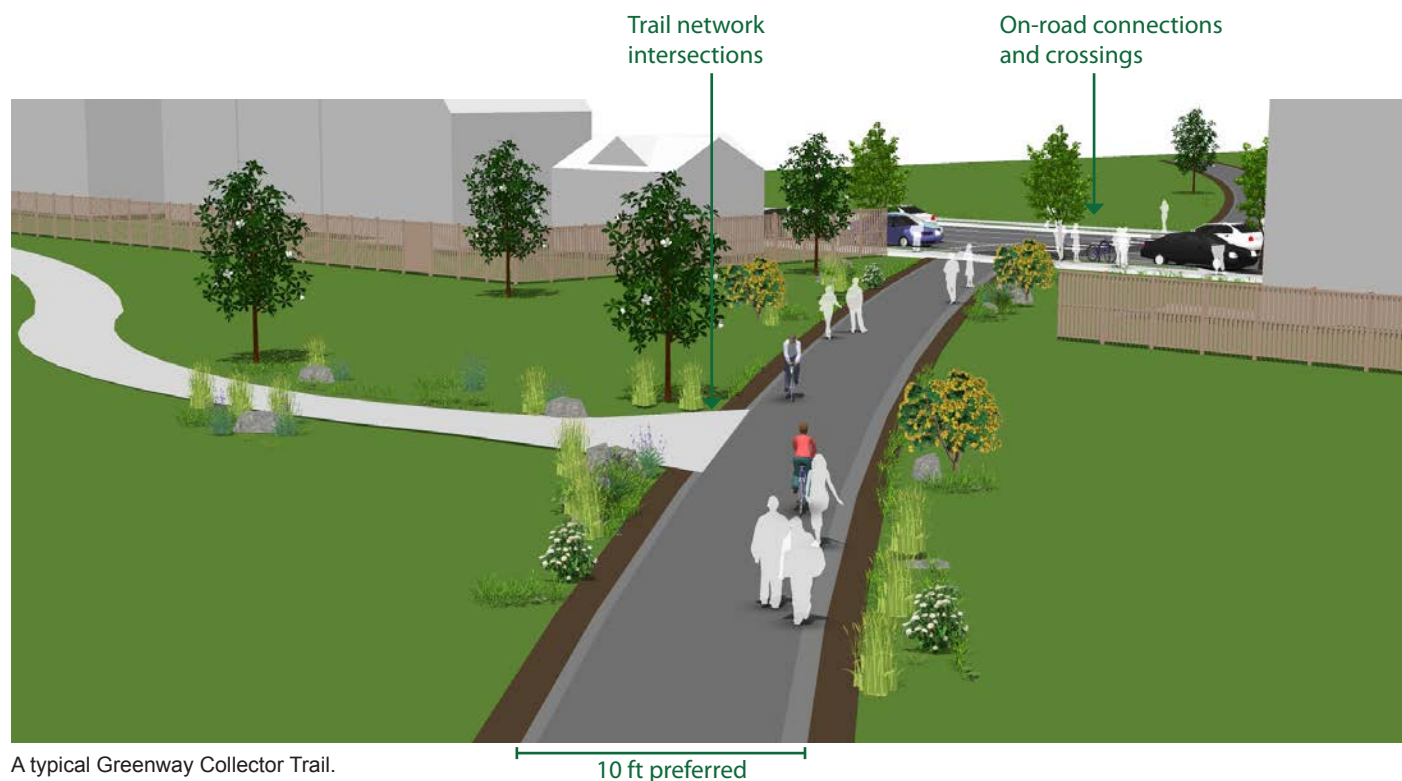
- Balance of commuter and recreational use with moderate to high volumes.
- Pedestrians, bicyclists, dog walkers, runners, strollers, skaters, and wheelchair and Segway users.

Potential Conflicts

- Trail intersection conflicts
- High volumes, especially on weekends
- Multiple user types

Guidance

- Greenway Collector Trails are located on or adjacent to connecting public lands. They can also be located within utility easements or roadway rights-of-way.
- Standard width: 10 feet (up to 12 feet in areas with projected high use volumes to minimize user conflict).
- Lighting may be installed at intersections with Cross City Greenway Trails as necessitated by use and location (see *Lighting* and *CPTED* guidelines, p. 62 and 91).
- Wayfinding, regulatory, and etiquette signage is recommended to control multiple uses and encourage trip planning (see *Signage and User Regulation* guidelines, p. 92).
- Prioritized amenities include: water fountains, waste receptacles, seating, and art at periodic locations where collectors extend long distances (recommended at over one mile).
- Surface tread material: May be concrete or asphalt depending on existing conditions and location in floodplain.



A typical Greenway Collector Trail.

Greenway Collector Trails-Loop Trails

Collector Loop trails, which provide a circuit around destinations and lakes, primarily support recreation use and are more oriented to destinations. *Collector Loop trails* are a subclassification of Greenway Collector Trails. Users often drive to these trails as recreation destinations, although commuters may use portions of Collector Loop trails.

User Types

- Moderate to high volumes at specific times of day and year.
- Pedestrians, bicyclists, dog walkers, runners, strollers, wheelchair users.
- Balance of commuter use on some sections of loop possible.

- High volumes, especially on weekends
- Wide range of multiple user types
- Lack of adequate widths on existing trails
- Balance of through users with loop users

Guidance

- Standard width: 12 feet preferred. 10 feet minimum, 14 feet maximum.
- Surface tread material: Asphalt, concrete, granite fines, bare earth.
- Preferred Amenities: Restrooms, water fountains, trash, seating, art, lighting
- Wayfinding, regulatory, and etiquette signage is recommended to control multiple uses and encourage trip planning (see *Signage and User Regulation* guidelines, p. 92).
- Separated trail option may be considered as resources allow.



Lake Johnson

Neighborhood Greenway Trails

This classification of trail acts as a connector that extends from Greenway Collector Trails into neighborhoods. Their primary purpose is to enhance connectivity and recreation by connecting targeted destinations, such as residential areas, parks, retail centers, and social centers to Greenway Collector Trails. These trails provide a high level of access to neighborhoods.

User Types

- Significant recreational use with moderate to high volumes by local residents
- Pedestrians, bicyclists, dog walkers, runners, strollers, wheelchair users

Potential Conflicts

- Trail intersection conflicts
- High volumes, especially on weekends

Guidance

- Corridor widths should allow for sufficient buffering (vegetative or fencing) between adjacent properties (see *Greenway Trail Management Facilities* section, p. 68).
- Provide connections to adjacent land uses, existing or planned sidewalks, and bicycle facilities.



A typical Neighborhood Greenway Trail.

8-10 ft preferred

- Connections are sometimes made between lots in subdivisions where appropriate and where easements allow.
- Width: 10 feet preferred, 8 feet minimum, 12 feet in highly specific locations where space, environmental conditions, and PRCR Department judgment allows.
- Surface tread material: May be concrete, asphalt, granite fines, or bare earth depending on existing conditions, projected volume of use, and location in floodplain.
- Prioritized amenities include: waste receptacles and public art.



Example of an existing Neighborhood Greenway Trail: Little Rock Trail near the Walnut Creek Wetland Center.

Greenway Connectors

Greenway Connectors link trails across topographic ridges, connecting trails between greenway corridors. Greenway Connectors can be located adjacent to streets and utilize sidewalks, utility, or other transportation corridors. When located within roadway rights-of-way, they are sometimes referred to as sidepaths. Greenway Connectors are more transportation-oriented in character and function to connect to the larger greenway trail system, with few recreational amenities provided.

User Types

- Pedestrians, bicyclists, runners, wheelchair users.

Potential Conflicts

- Roadway intersection/crossing conflicts
- Driveway access management (within roadway rights-of-way)
- Motorist and bicyclist conflicts
- Restricted right-of-way widths

Transportation focused
use; few amenities



A typical Greenway Connector Trail.

Guidance

- Where sidepaths are proposed, factor in the distance between destinations, adjacent land use, and population density along roadways.
- Provide connections to adjacent land uses, existing or planned sidewalks, and bicycle facilities.
- Standard width: 10 feet, where possible
- Surface tread material: May be asphalt or concrete depending on existing conditions, projected volume of use, and location in floodplain.
- Few recreational amenities are provided, in the case of unique settings/situations.
- Wayfinding, regulatory, and etiquette signage is recommended to encourage trip planning and reduce motorist and greenway trail user conflicts (see the *Signage and User Regulation* section, p. 92).
- See “Section 3.4: Intersections” within this document and the *Raleigh Comprehensive Bicycle Transportation Plan* for guidance on sidepaths and intersection treatments.



Example of an existing Greenway Connector near Western Blvd.

Section 2.4 | The Capital Area
Greenway System

Existing Capital Area Greenway System

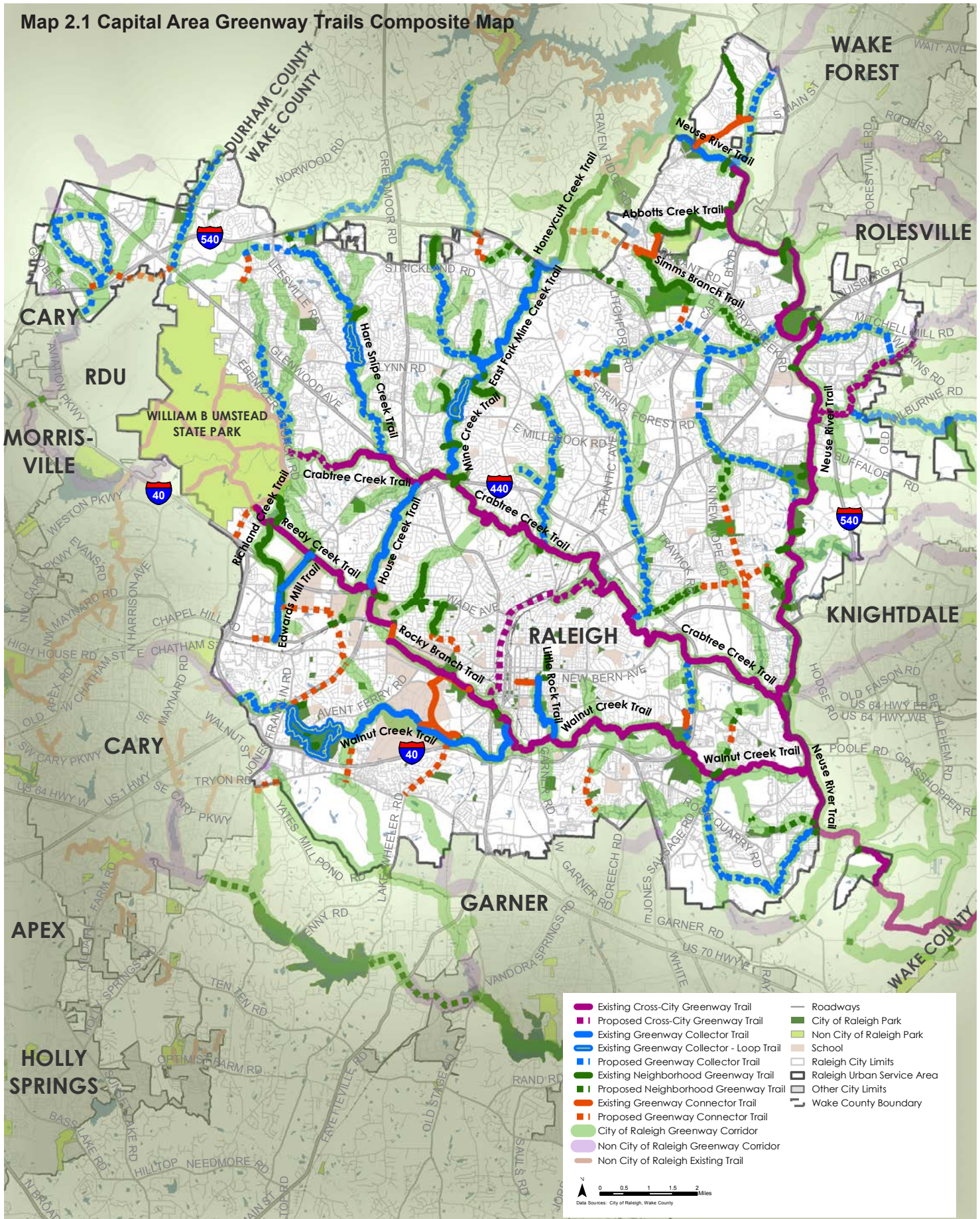
The existing CAG System encompasses 114 miles of existing greenway trails, with 120 miles proposed. Interconnectivity is a primary goal of the CAG system. This network will provide an effective recreation system linking parks and open space as well as an efficient transportation option for residents and visitors to Raleigh.

Map 2.1 summarizes the current conditions of the CAG System’s existing, planned, and proposed greenway trails. Maps on the following pages summarize greenway trails by classification type. The table on this page indicates a summary of all CAG trails by classification.

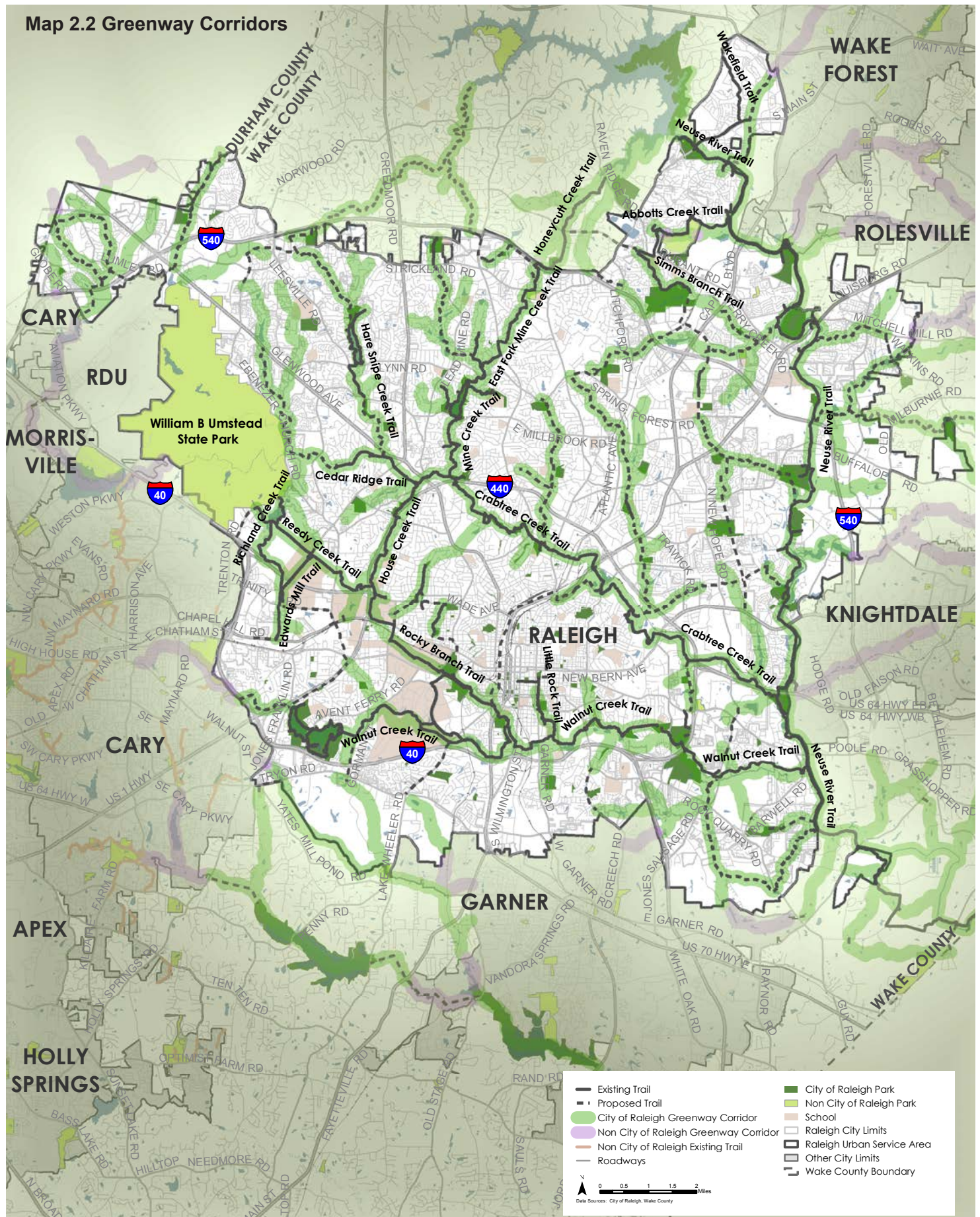
Capital Area Greenway Trails by Classification

TYPE	CLASSIFICATION	TOTAL
Existing Greenway Trails		114 miles
	Cross City Greenway Trails	62.1 miles
	Greenway Collector Trails	23.6 miles
	Collector Loop	
	Neighborhood Greenway Trails	21.7 miles
	Greenway Connectors	6.6 miles
Proposed Greenway Trails		120 miles
Unassigned Greenway Corridors		80 miles
GRAND TOTAL		314 miles

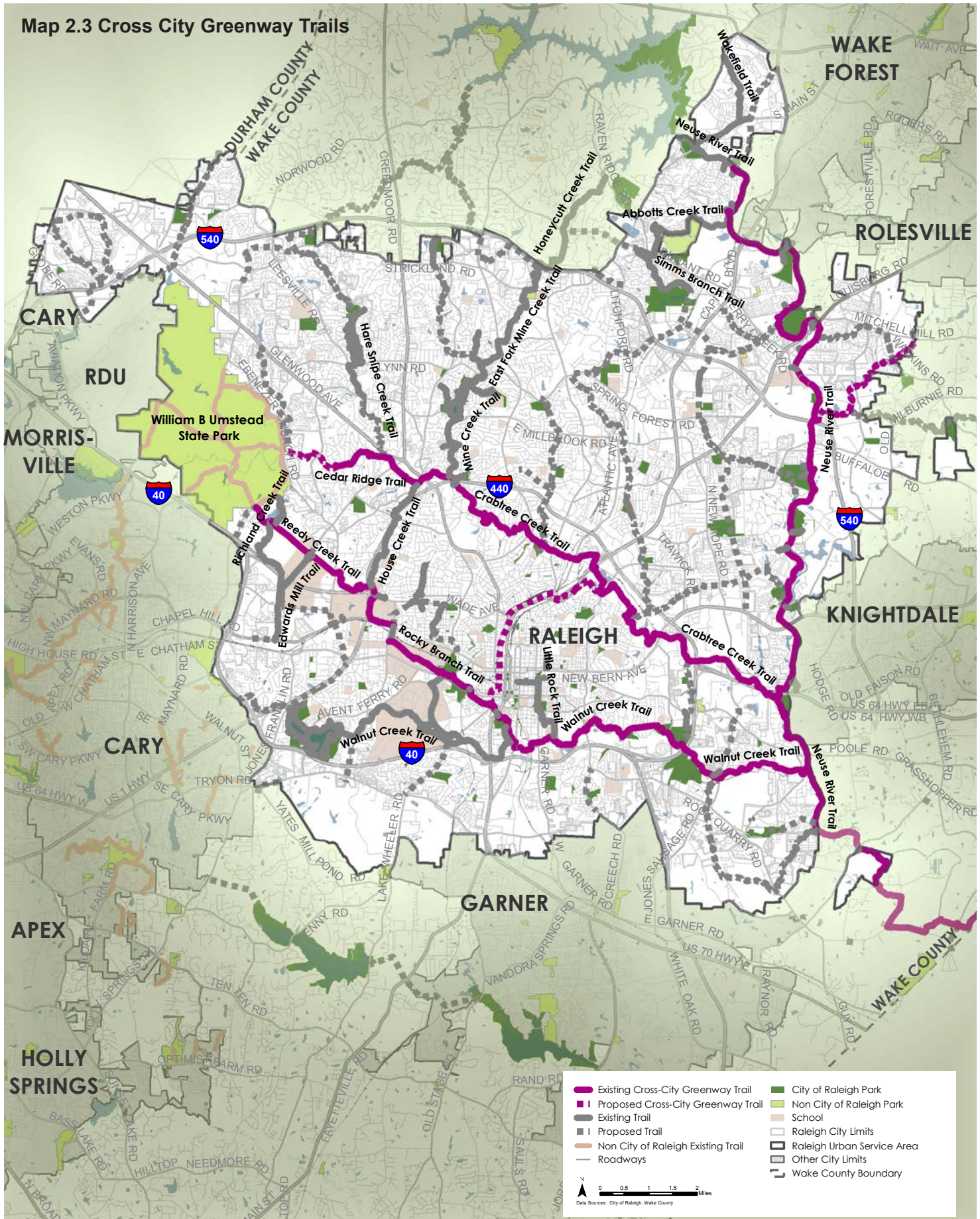
Map 2.1 Capital Area Greenway Trails Composite Map



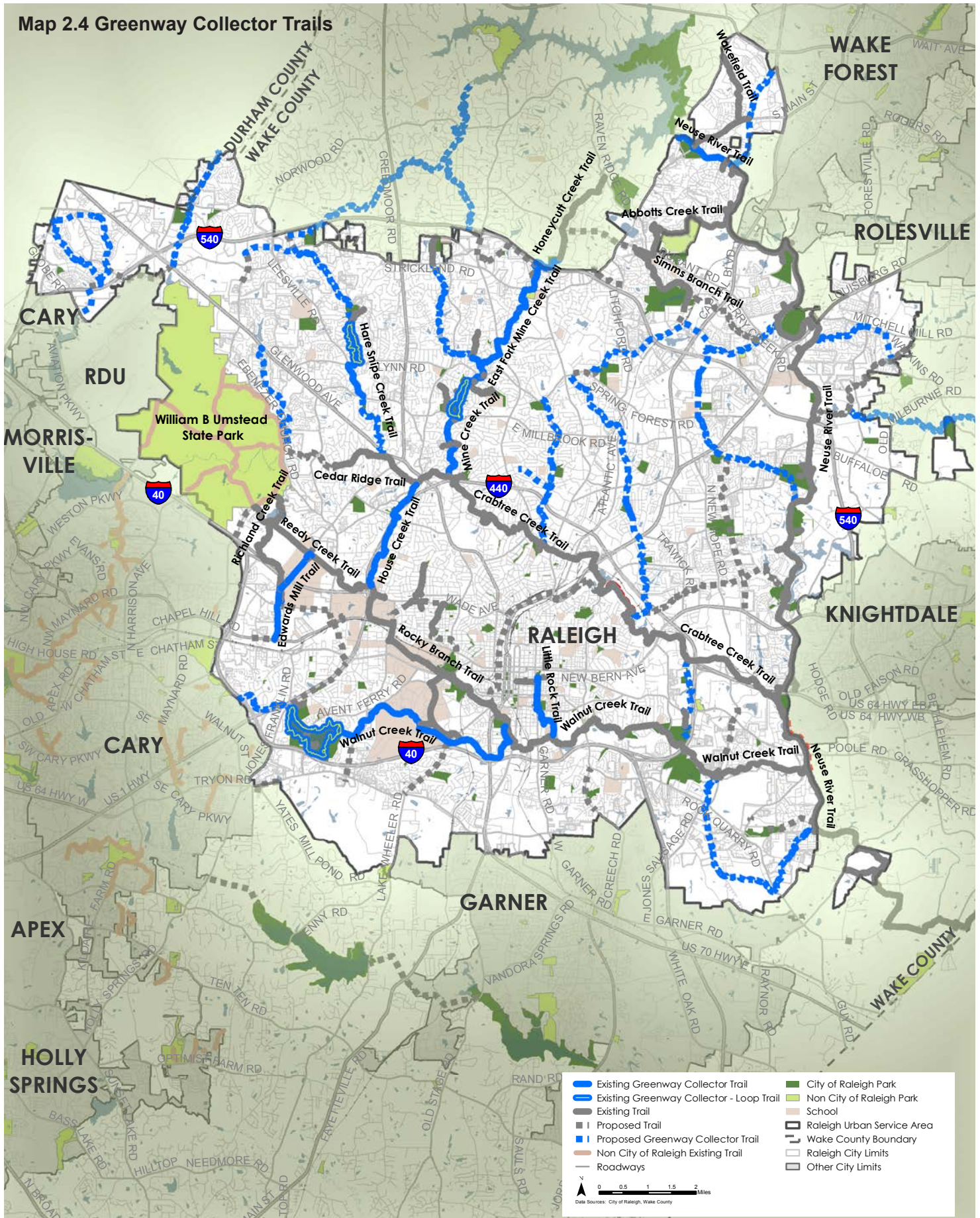
Map 2.2 Greenway Corridors



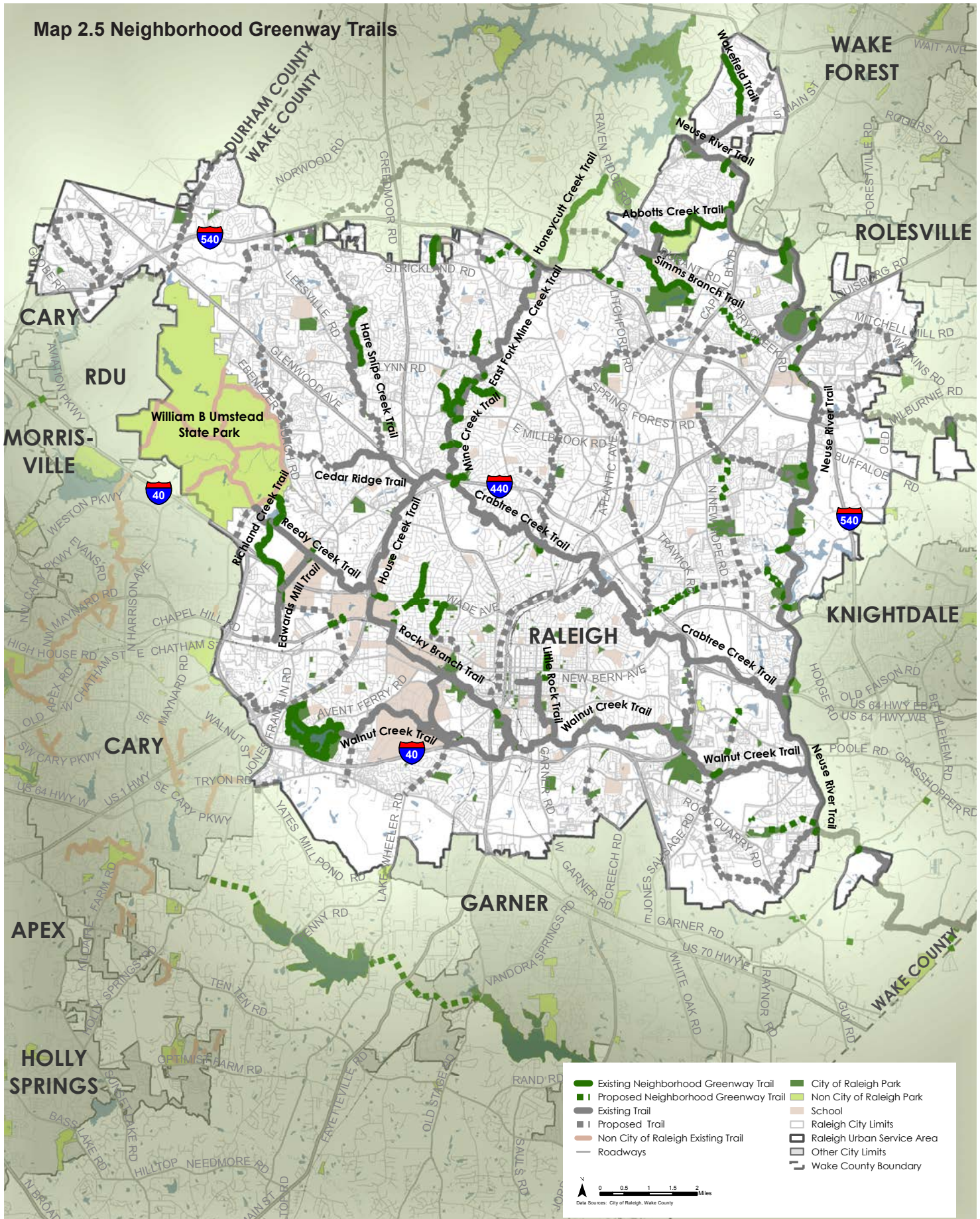
Map 2.3 Cross City Greenway Trails



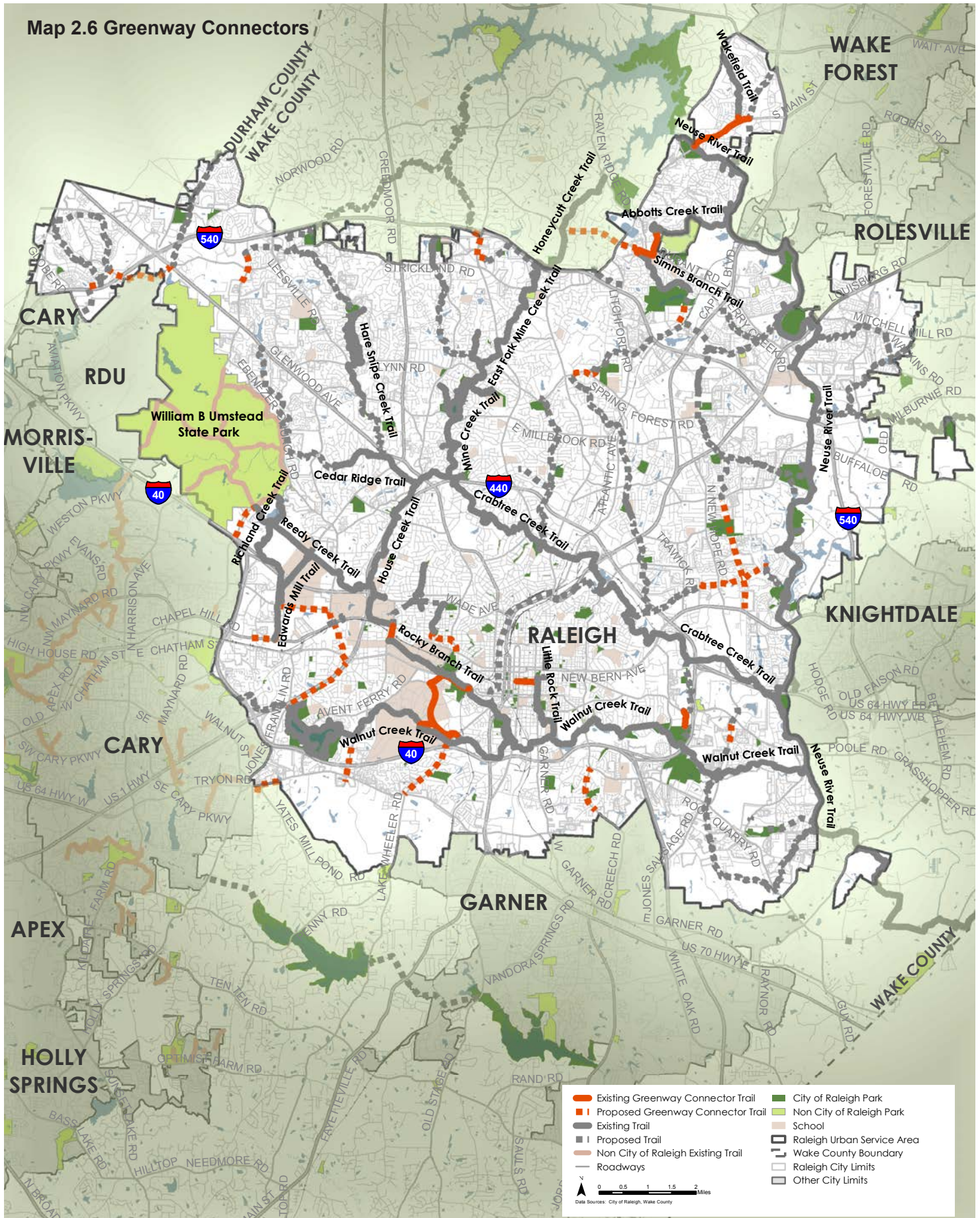
Map 2.4 Greenway Collector Trails



Map 2.5 Neighborhood Greenway Trails



Map 2.6 Greenway Connectors



Section 2.5 | User Group Definitions and Design Needs

Overview

Greenway trails attract a variety of users with different needs and expectations. Important design characteristics for different users are width, surface material, sight distances, clearances, and trail amenities. The following sections provide the framework for incorporating standards and guidelines for greenway trail design and planning.

Users of the CAG System include:

- Pedestrians - joggers, hikers, walkers, baby strollers, pet walkers, nature watchers
- Bicyclists - commuting, recreational, touring; different types of bicycles
- In-line skaters and skateboarders
- Wheelchair users and users of other mobility devices
- Electric Personal Mobility Device (EPMD)

User Conflict

One of the safety issues in greenway trail planning, design, and development is multi-user conflict. Typically these conflicts are caused by multiple user types traveling at different speeds. The combination of overuse of a trail and insufficient widths may result in user conflicts. Other factors that can lead to user conflicts are poorly designed and engineered trail alignments, inappropriate user behavior, or inadequate facility capacity. Potential conflicts that exist between greenway trail users are unique to the users themselves and indicated in Table 2.1.

The most effective trail use management plan is a well-conceived safety program that provides the individual user with a Code of Conduct for the trail, sometimes called a Trail Ordinance. Several communities across the U.S. have adopted progressive trail ordinances for public use, including King County, Washington, and the East Bay

Table 2.1 Potential Greenway Trail User Conflicts

USER TYPE	POTENTIAL CONFLICTS WITH OTHER USERS
PEDESTRIANS (includes any users on foot)	<ul style="list-style-type: none"> • Multiple pedestrians may walk more than two abreast making it difficult for other users to pass • Children may veer into oncoming users on bicycles • Pet owners may not exercise on-leash etiquette
BICYCLISTS	<ul style="list-style-type: none"> • Have tendency to startle other users • May not obey posted speed limits • May frighten wildlife • May not exercise appropriate audible etiquette when passing
SKATERS	<ul style="list-style-type: none"> • Have tendency to startle other users • May not exercise appropriate audible etiquette when passing
WHEELCHAIR USERS	<ul style="list-style-type: none"> • May not keep right making it difficult for other users to pass

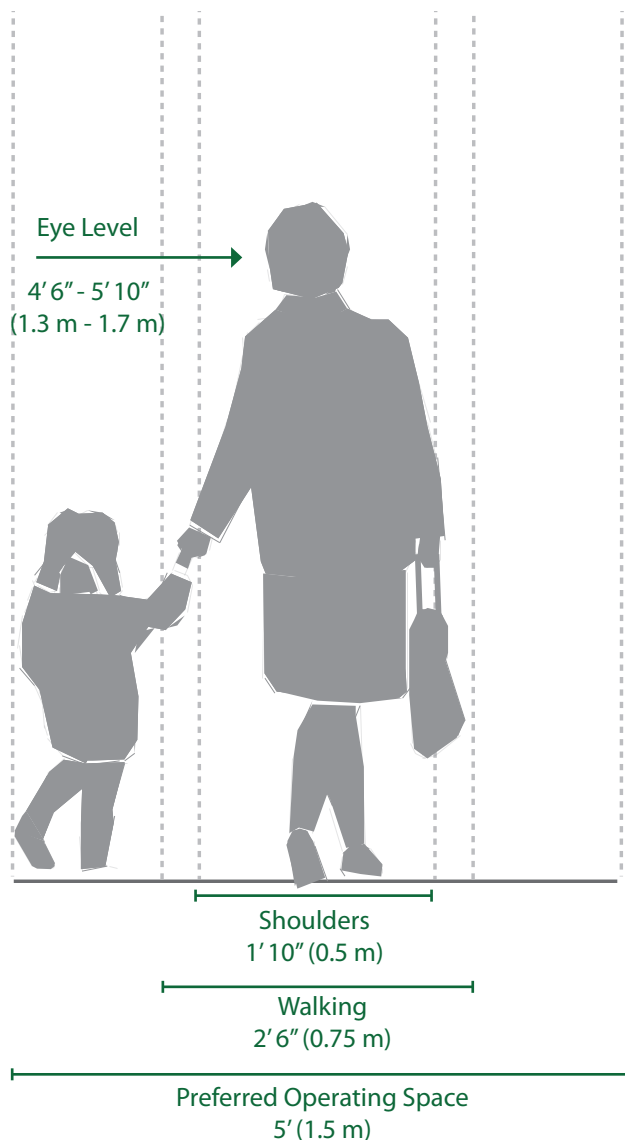
Regional Park District in Alameda and Contra Costa counties, California. The City of Raleigh currently posts greenway trail Rules and Regulations at trailheads and along greenway trails. The rules and regulations are also included on greenway maps as well as on the City’s website. The following are existing CAG Trail Rules and Regulations. The System Plan document has an action item related to this: *3. B. 3. Develop and implement a trail user safety and etiquette education program, which will include those items mentioned.*

EXISTING CAPITAL AREA GREENWAY RULES AND REGULATIONS

- Obey posted rules and regulations
- Trail hours are from dawn to dusk
- Speed limit on trails is 10 mph
- Consumption of alcoholic beverages is prohibited
- Motorized vehicles are prohibited on greenway trails
- Fires are prohibited
- It is prohibited to remove, destroy, or damage any plant life or property
- Pets must be on a leash
- Owners must remove pet waste
- It is prohibited to kill, trap, or harm wildlife
- Swimming in City lakes is prohibited
- Horses are prohibited on greenway trails
- All trail users under the age of 16 are required to wear a safety helmet when using a bike, skates, scooters or any other non-motorized vehicle
- Smoking is prohibited in City parks and greenway trails
- Weapons prohibited except those permitted in NCGS 14-415.23 (RCC Sec. 9-2021)
- Camping is prohibited in City parks and greenways without a permit

Design Needs of Pedestrians

Pedestrians have a variety of characteristics and the CAG System should accommodate a variety of needs, abilities, and possible impairments. Age is one major factor that affects pedestrians' physical characteristics, walking speed, and environmental perception. Children have low eye height and walk at slower speeds than adults. They also perceive the environment differently at various stages of their cognitive development. Older adults walk more slowly and may require assisted devices for walking stability, sight, and hearing. The table below summarizes common pedestrian characteristics for various age groups.



As a rule of thumb, the MUTCD recommends a normal walking speed of three and one half feet per second when calculating the pedestrian clearance interval at traffic signals. The walking speed can drop to three feet per second for areas with older populations and persons with mobility impairments. While the type and degree of mobility impairment varies greatly across the population, the greenway trail system should accommodate these users to the greatest reasonable extent at greenway trail intersections, sharp turns, overpasses, and underpasses.

Pedestrian Characteristics by Age

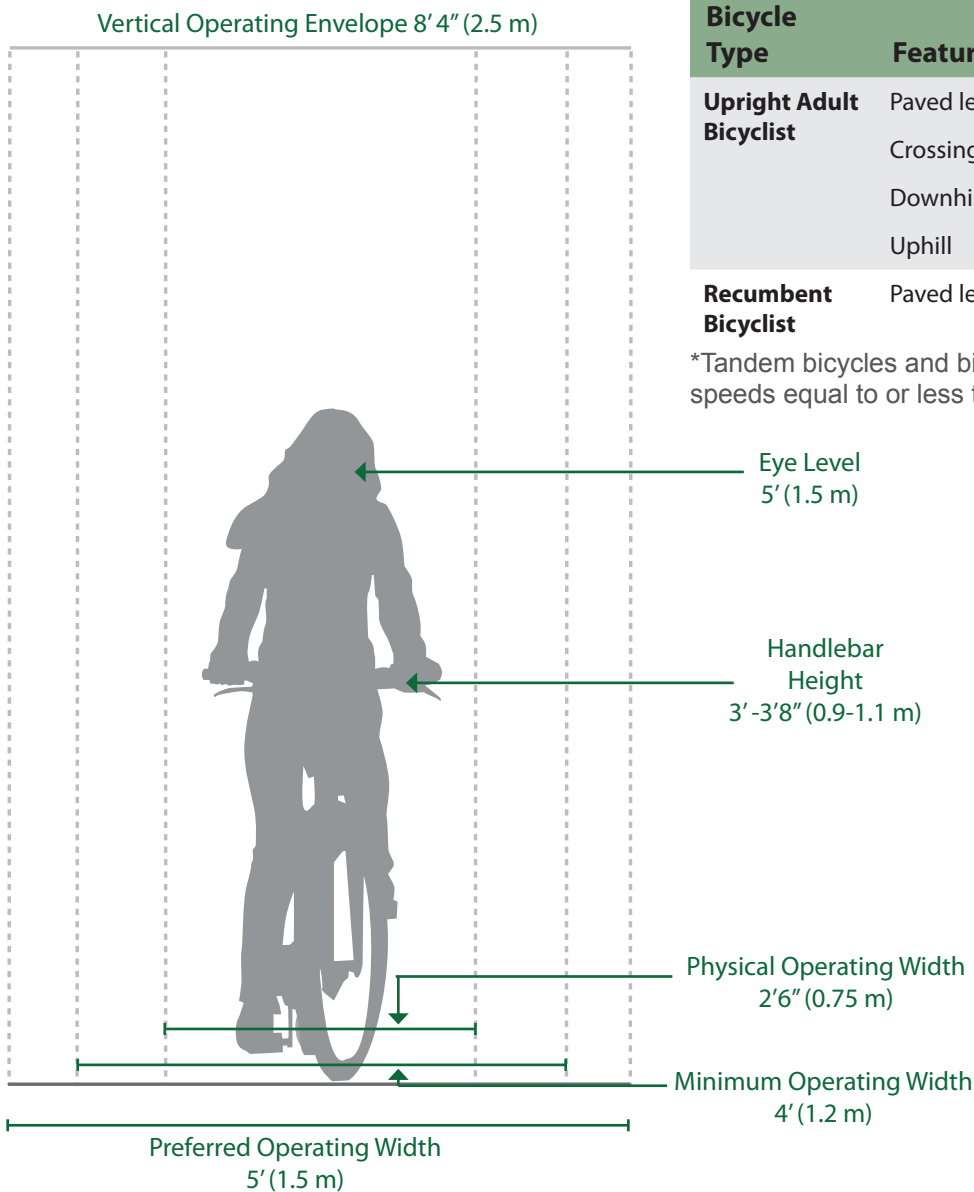
Age	Characteristics
0-4	Learning to walk Requires constant adult supervision Developing peripheral vision and depth perception
5-8	Increasing independence, but still requires supervision Poor depth perception
9-13	Susceptible to "dart out" intersection dash Poor judgment Sense of invulnerability
14-18	Improved awareness of traffic environment Poor judgment
19-40	Active, fully aware of traffic environment
41-65	Slowing of reflexes
65+	Difficulty crossing street Vision loss Difficulty hearing vehicles approaching from behind

Source: AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities. 2004. Exhibit 2-1.

Design Needs of Bicyclists

Similar to motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the bicyclist). The design of a greenway trail should consider expected bicycle types on the facility and utilize the appropriate dimensions.

Standard Bicycle Rider Dimensions



The figure below illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear, open space with no visual obstructions to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five feet or more operating width, although four feet may be minimally acceptable.

Speed Expectations

Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level surfacing	8-15 mph
	Crossing Intersections	10 mph
	Downhill	20-30 mph
	Uphill	5 -12 mph
Recumbent Bicyclist	Paved level surfacing	11-18 mph

*Tandem bicycles and bicyclists with trailers have typical speeds equal to or less than upright adult bicyclists.

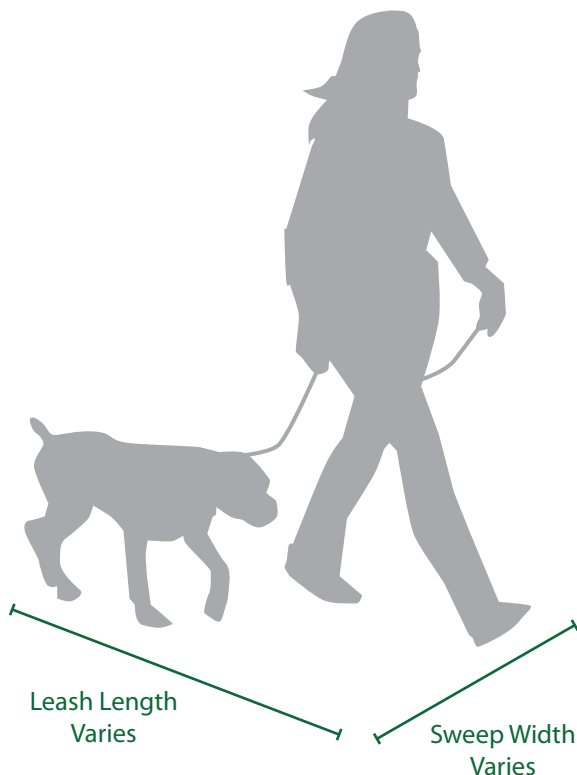
Source: AASHTO Guide for the Development of Bicycle Facilities, 3rd Edition, 2012.

Design Needs of Dog Walkers

Dog walking is a common and anticipated use on greenway trails. Dog sizes vary largely, as does leash length and walking style, leading to wide variation in possible design dimensions.

Greenway trails designed to accommodate wheelchair users are likely to provide the necessary dimensions for the average dog walker. See page 51, Design Needs of Wheelchair Users. Amenities such as dog waste stations at trailheads enhance conditions for dog walkers.

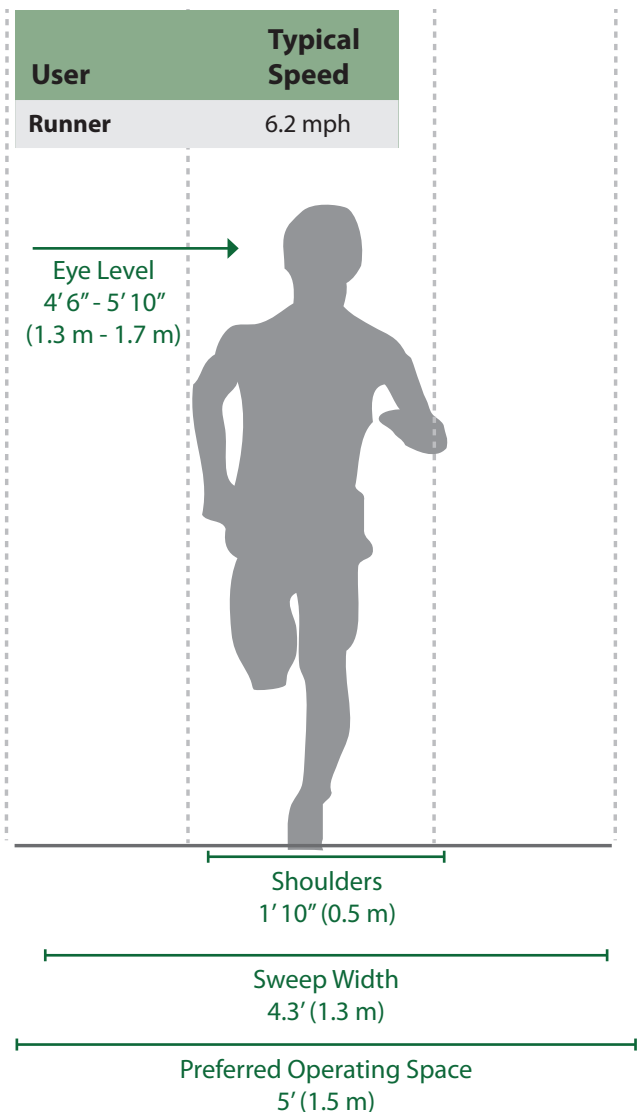
Dog walker vertical and horizontal dimensions are same as runner dimensions, pictured at right



Design Needs of Runners

Running is an important recreation and fitness activity commonly performed on greenway trails. Many runners prefer softer surfaces (such as rubber, bare earth or crushed rock) to reduce impact. Among the hardened surfaces, asphalt is preferred over concrete because it is more forgiving on joints. Runners can change their speed and direction frequently.

Typical Speed



Source: FHWA. Characteristics of Emerging Road and Trail Users and Their Safety. (2004).

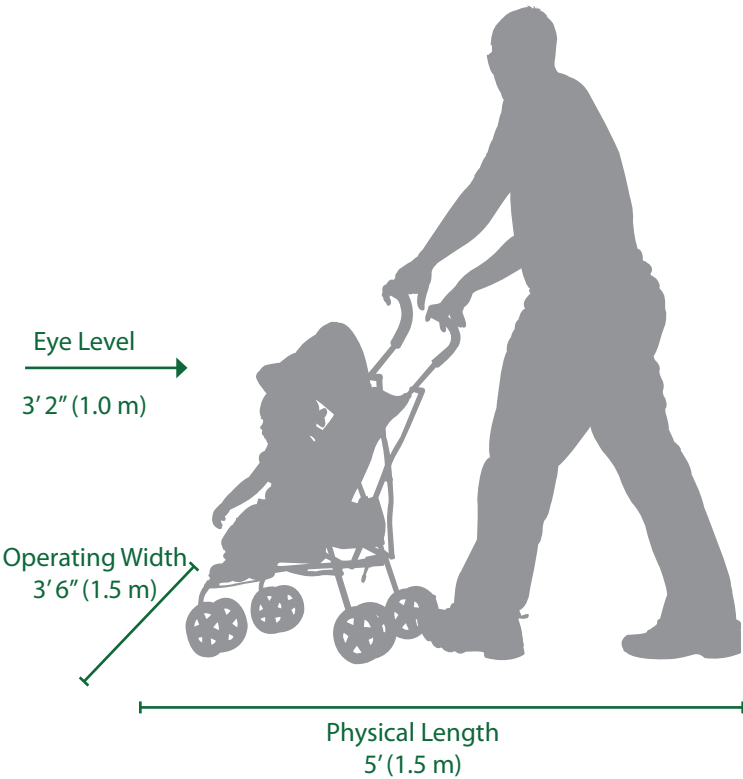
Design Needs of Strollers

Strollers are wheeled devices pushed by pedestrians to transport babies or small children. Stroller models vary greatly in their design and capacity. Some strollers are designed to accommodate a single child, others can carry three or more. Design needs of strollers depend on the wheel size, geometry and ability of the adult who is pushing the stroller.

Strollers commonly have small pivoting front wheels for easy maneuverability, but these wheels may limit their use on unpaved surfaces or rough pavement. Curb ramps are valuable to these users. Lateral overturning is one main safety concern for stroller users.

Typical Speed

User	Typical Speed
Stroller	3.7 mph



Source: FHWA. (2004).

Design Needs of Mobility Assistance Device Users

As the American population ages, the number of people using mobility assistive devices (such as manual wheelchairs or powered wheelchairs) increases.

Manual wheelchairs are self-propelled devices. Users propel themselves using push rims attached to the rear wheels. Braking is done through resisting wheel movement with the hands or arm. Alternatively, a second individual can control the wheelchair using handles attached to the back of the chair.

Power wheelchairs use battery power to move the wheelchair. The size and weight of power wheelchairs limit their ability to negotiate obstacles without a ramp. Various control units are available that enable users to control the wheelchair movement, based on user ability (e.g., joystick control, breath controlled, etc).

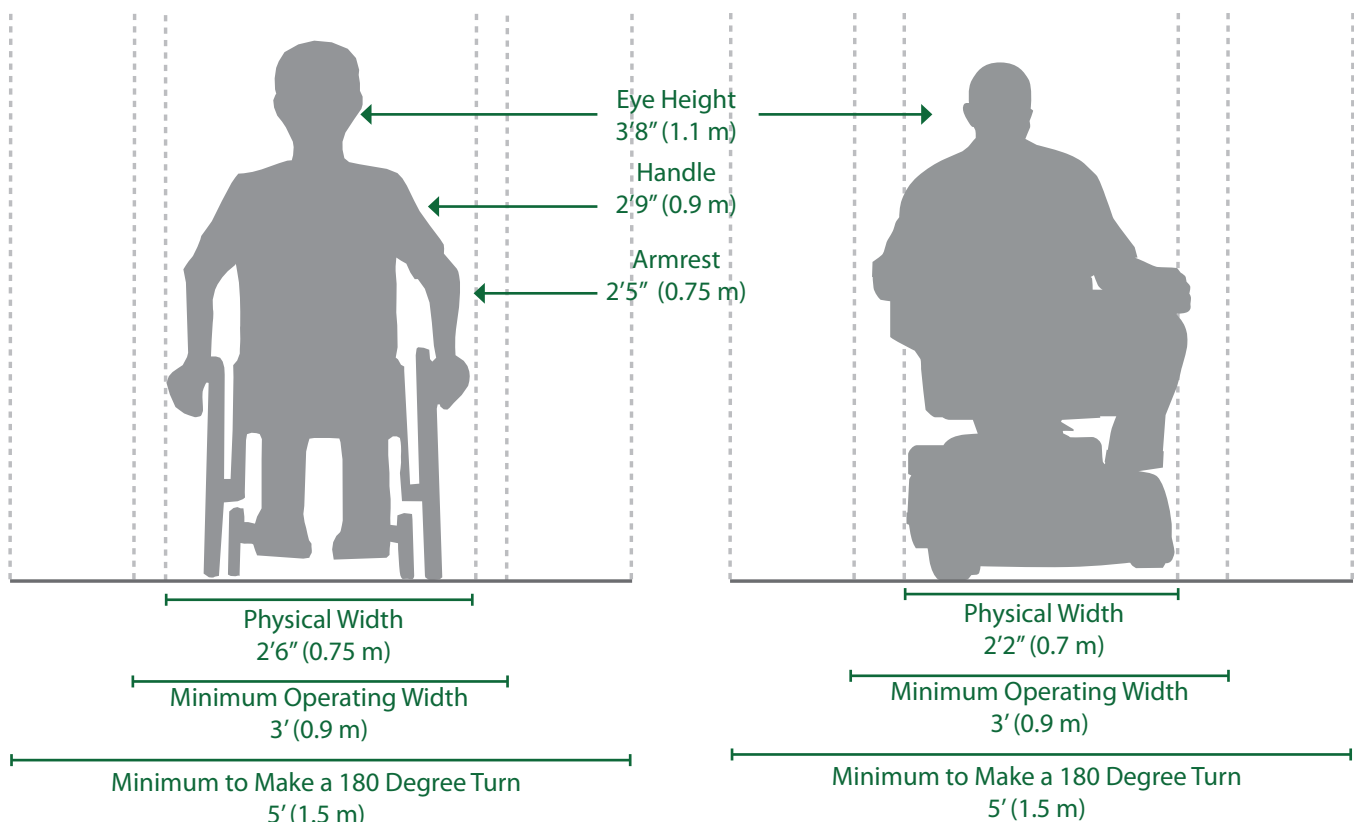
Maneuvering around a turn requires additional space for wheelchair devices. Providing adequate space for 180 degree turns at appropriate locations is an important element for accessible design. For more information on ADAAG Standards for Accessible Design and greenway trails, see Chapter 3.

Wheelchair User Typical Speed

User	Typical Speed
Manual Wheelchair	3.6 mph
Power Wheelchair	6.8 mph

Wheelchair User Design Considerations

Effect on Mobility	Design Solution
Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
Cross-slopes cause wheelchairs to veer downhill.	Cross-slopes of less than two percent.
Require wider path of travel.	Sufficient width and maneuvering space.



Source: FHWA. Characteristics of Emerging Road and Trail Users and Their Safety. (2004).
 USDOJ. 2010 ADA Standards for Accessible Design. (2010).

Design Needs of Skaters

Inline skates are commonly used for recreational and transportation purposes. They typically have three to five wheels of 3 to 4 inches diameter, aligned in a straight line. Inline skate design allows for more efficient and high speed travel than quad wheel skates.

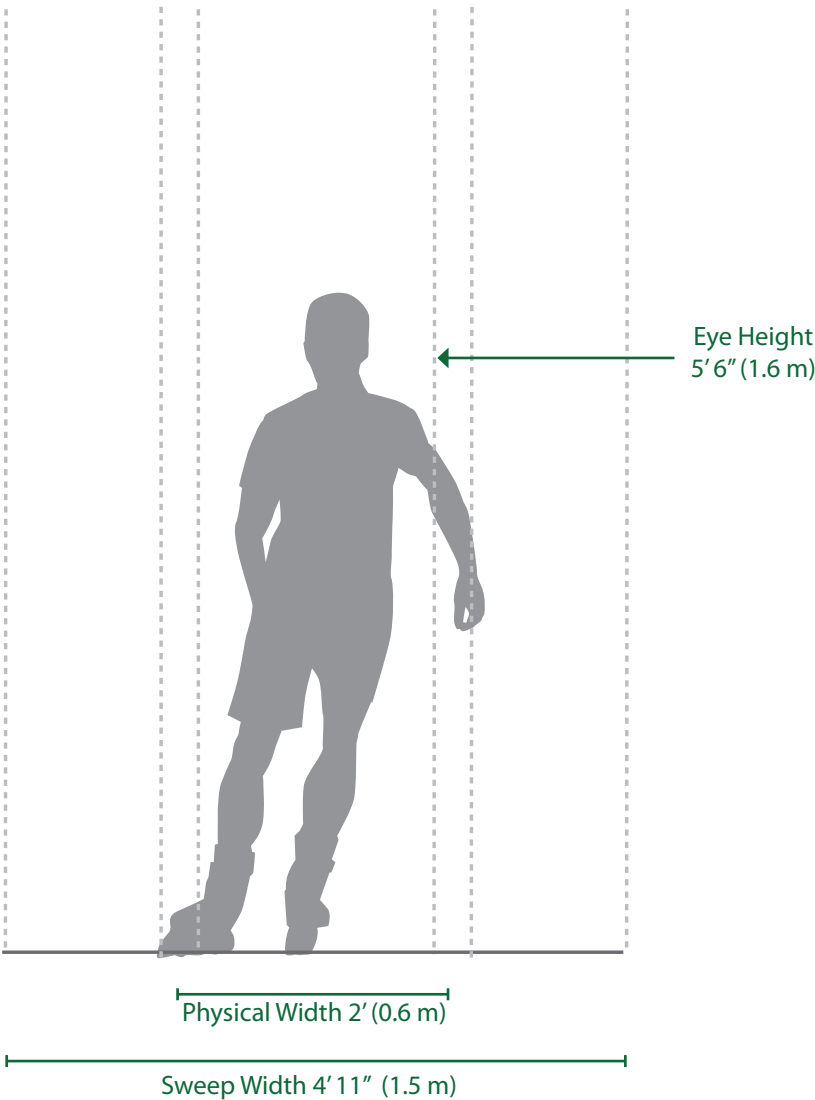
Operational characteristics vary by skill level of the operator. Novice skaters travel more slowly and have

a narrower sweep width from advanced skaters. Novice users may also have trouble making sharp turns and stopping quickly, particularly on speed grades.

Inline skates are nearly impossible to use on unpaved surfaces and can be uncomfortable and difficult to operate on rough pavements such as asphalt with large aggregate.

Typical Speed

User	Typical Speed
Inline Skates	9.9 mph



Source: FHWA. Characteristics of Emerging Road and Trail Users and Their Safety. (2004).

Design Needs of Electric Personal Mobility Devices (e.g., the Segway)

Electric personal mobility devices (EPMDs) such as the Segway, are appearing on paths and roadways around the country. North Carolina legislation has classified EPMDs as pedestrians, offering them all of the same rights and responsibilities. A person operating an electric personal assistive mobility device on a greenway trail shall yield the right-of-way to pedestrians and other human-powered devices.

The Segway is a self-balancing, electric-powered transportation device. Its footprint is not much larger than the human body and has two wheels side by side next to the user's feet. The Segway uses gyroscopes and tilt sensors to monitor the body's

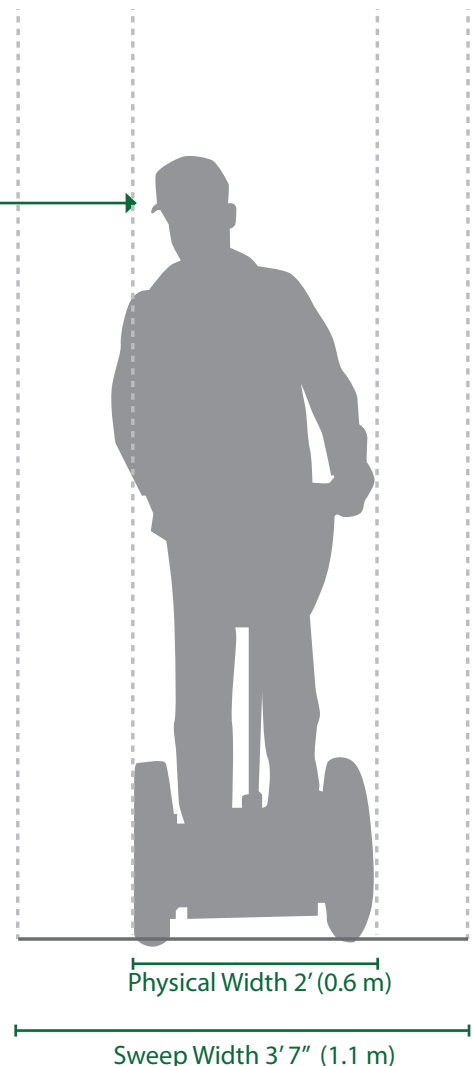
movements and balance the device on the single axle. When a person leans forward, the Segway moves forward; leaning backward causes it to move back. The Segway has no brakes; to stop the device, users simply straighten up from their leaning position. Turning is accomplished with a twisting motion on the handlebar. Because both wheels are on one axle, it can turn in place with no turning radius.

At this time, the City of Raleigh does not have any additional regulations on the time, place, or manner of operation of segways. For additional information on the NCGS, see **Part 11C. Electric Personal Assistive Mobility Devices, Section 20-175.6. Electric personal assistive mobility devices.**

Typical Speed

User	Typical Speed
Segway	10.5 mph

Eye Height
5' 10" (1.8 m)



Source: FHWA. Characteristics of Emerging Road and Trail Users and Their Safety. (2004).



Worthdale Boardwalk

Chapter 3 Design Standards + Guidelines

Section 3.1 | Design Considerations

Overview

The CAG Design Standards and Guidelines provides parameters for implementing a consistent physical character for the greenway trail system.

The guidelines address the following design issues:

- Design considerations for different applications and site conditions
- Design regulations
- Greenway trail management features
- Amenities
- Signage and user regulation

Design Considerations for Environmental Stewardship

Greenway trails within the CAG System are an important tool for linking recreation, conservation, and transportation. As such, they must be developed and maintained in ways that avoid negative impacts to the natural resources of the area. The following guidance is recommended for developing and maintaining greenway trails within the CAG System.

Protect Sensitive Ecological Areas

Construction of greenway trails can have unintended negative consequences on the environment. When prioritizing greenway trails in the CAG System, balance costs, accessibility, aesthetics, and available land against environmental impacts. Prevent greenway trail development from impacting the following areas when possible:

- Wetlands, lakes, rivers, and streams
- Rare and endangered species habitat
- Public water supplies

- Sensitive forest areas
- Steep slopes and soils that are identified as restricted for trail or road development
- Unique or important geologic features or formations

Provide Buffers to Protect Natural Systems

Maintaining buffers between greenway trails and adjacent sensitive natural areas is essential to ensuring their long-term ecological quality, diversity, and habitat value. Irrespective of how well greenway trails are designed and constructed, they have an impact on the environments they traverse. These impacts include habitat fragmentation, soil compaction, increased runoff and erosion, and introduction of nonnative plant species. For these reasons, the use of vegetative buffers is an essential part of greenway trail planning and design. Recommended buffer widths, however, will vary in response to a number of conditions, including:

- Sensitivity of the ecological systems being impacted
- Extent of the natural open space or greenway corridor being traversed
- Type of greenway trail being proposed and its potential for creating ecological impacts
- Grade and soil types
- Desired trail experience

Recommended buffer widths may range from 50-200 feet depending on conditions and associated regulatory requirements. When planning and designing greenway trails in natural and cultural resource areas, consult with the state's Natural Heritage Program, the State Historic Preservation

Office, Neuse River Buffer Rules, and local floodplain administrators to determine appropriate buffer widths.

Use Best Practices for Stormwater Management

The most critical component of greenway trail design and management is to prevent standing water on the greenway trail. On highly developed greenway trails, (Cross City Greenway Trails) the use of natural, dispersed infiltration systems such as vegetated swales and bioswales will bring ecological and hydrologic advantages over engineered stormwater control structures such as storm drains and catch basins.

Use Low Impact Design and Construction Methods

Greenway trail development and maintenance across, along, and within ecologically sensitive areas is often desirable and justifiable. In the CAG System, the vast majority of greenway trails occur along riparian areas. Low impact greenway trail planning, design, and maintenance will lessen impacts to existing vegetation, wildlife, water resources, and soils, resulting in a durable greenway trail system that will serve the public needs and provide a quality recreational experience. For more information on these methods, review the *Boardwalk* and *Bridges* guideline in Section 3.4.

Permitting

The construction of any greenway trail in the CAG System will require permits for construction. Depending on the corridor location and structures, some greenway trails will require coordination with various agencies at the state and federal level.

Potential permits which may be required for greenway trail construction include:

- *Wake County/City of Raleigh Stormwater Management (National Pollutant Discharge Elimination System General Permit)*
- *Wake County Floodplain Development Permit*
- *City of Raleigh Land Disturbance Permit and NC Division of Land Quality*

- *Wake County/City of Raleigh Building Permit (for structures)*
- *North Carolina Department of Transportation Encroachment Permit (other agency encroachment agreement permit may be required)*
- *FEMA Conditional Letter of Map Revision (CLOMR)/FEMA Letter of Map Revision (LOMR)*
- *U.S. Army Corps of Engineers Section 401/404 Permit, Pre-Construction Notification (PCN) Permit*

Prior to undertaking design or construction, determine current local requirements with Raleigh Stormwater Management and Planning and Development departments.

Section 3.2 | Greenway Trail Facilities

General Design Practices for Paved Greenway Trails

The intent of greenway trail construction is to make open space available without damaging the qualities of the natural environment that are most valued and appreciated. Surfacing should be selected to support projected intensities of use and to enable multiple uses. Surfacing should also account for site topography, surface drainage, frequency of flooding, construction cost, and maintenance concerns.

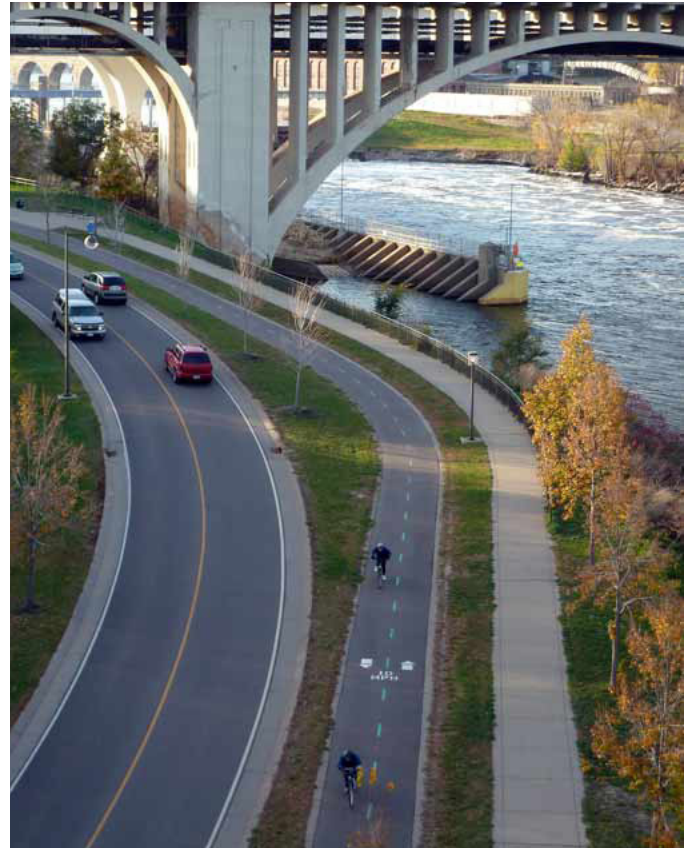
Key features of CAG trails include:

- Frequent access points from the local on-street transportation network.
- Directional signs to direct users within the greenway trail network.
- A limited number of at-grade crossings with streets or driveways.
- Providing easily accessible connections to destinations.
- Designing facilities that safely accommodate multiple user types.

Greenway Trail Surfacing Types

American Disabilities Act Accessibility Guidelines compliant greenway trails require paved surfaces, in most instances for access and ease of use. In limited cases, packed gravel fines can be used, where there is little to no topography. However, packed surfaces require much more maintenance effort and cost over time, and may not be desirable in the long term.

Asphalt tread surfaces have traditionally been used for CAG trails. Asphalt greenway trails offer substantial durability for the cost of installation and maintenance. Asphalt is popular with users for its smooth, continuous surface and has the benefit of lower cost, but requires more upkeep than concrete. As a flexible pavement, asphalt can also be considered for installing a paved greenway trail on grades steeper than 3 percent. If constructed properly on suitable sub-grade, asphalt has a life span of about half that of concrete, or 10-15 years.

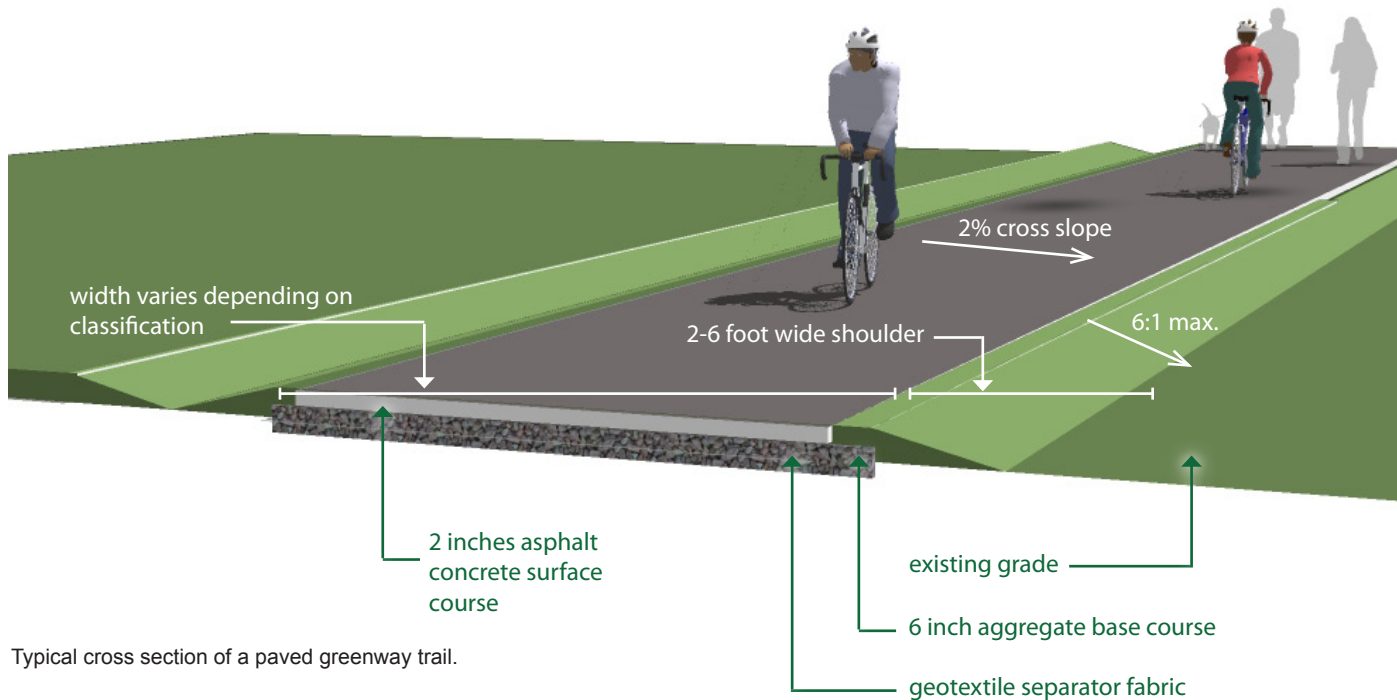


Example of a separated track for pedestrians; along West River Parkway, Minneapolis; photo by Stuart Macdonald, 29 Oct 2010; courtesy of American Trails

When properly constructed and maintained on a regular basis, concrete can last 25 years or more. The high cost of concrete is often the most limiting factor since it is one of the most expensive surfaces to install. It is recommended that concrete be used for its superior durability and lower maintenance requirements in areas prone to frequent flooding, and for intensive urban applications.

Permeable paving is twice the cost of asphalt to install and is only recommended in very special greenway trail applications under the following considerations:

- A maintenance schedule must be established for vacuuming debris after storm events (required to retain permeability)
- Only use permeable paving areas with proper drainage (not suitable in floodplain or areas with ponding or sedimentation)



When determining surface type for CAG trails, consider topography, landscape position, underlying soils, and Classifications indicated in Chapter 2. All surfaces have advantages and disadvantages, and each must be analyzed to determine which surface is appropriate in any given location.

Guidance

Width

- Eight feet is the absolute minimum width allowed for a shared use greenway trail and is only recommended for low volume *Neighborhood Trails*. AASHTO requirements for trails receiving federal funding is 10' minimum.
- Ten feet is recommended in most situations and is adequate for moderate to heavy use on *Greenway Collector Trails*, *Greenway Connectors*, and *Neighborhood Greenway Trails*.
- Twelve feet (and in very heavy greenway trail use, 14 feet) is recommended for situations with high concentrations of multiple users. A separate track (5 feet minimum) can be provided for pedestrian use where right-of-way permits. Separated tracks are recommended for consideration on *Cross City Greenway Trails* only.

Lateral Clearance

- A 2 foot minimum shoulder on both sides of the greenway trail should be provided for all greenway trail classifications. An additional 4 feet of lateral clearance (total of 6 feet) is a City of Raleigh standard for the installation of signage or other furnishings.
- Use 6 feet of shoulder in fill sections and 3 feet of shoulder in cut sections.
- If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night and spaced adequately (see *Bollards* guideline, p. 73 for more information).

Overhead Clearance

- Clearance to overhead obstructions should be 8 feet minimum, with 10 feet recommended.
- Convex mirrors should be provided at blind corners and at the approaches to underpasses with poor sight lines.

Striping

- Striping should be used on greenway trails with anticipated heavy use or with high concentrations of multiple users, such as *Cross City Greenway Trails* and *Greenway Collector Trails*.

- See the *Pavement Markings* guideline, p. 97, for more information.

Surface Grade

- Greenway trails should be designed to comply with ADAAG standards when possible (see *Accessible Greenway Trail Design* guideline section for more information).
- Provide a 2 percent cross slope from crown of trail in both directions to provide positive drainage off the trail as conditions allow.
- Provide a 48 inch safety rail for the following circumstances within 6 feet of the edge of pavement:
 - Slope is greater than or equal to 3:1 and drop of 6 feet
 - Slope is greater than or equal to 2:1 and drop of 4 feet
 - Slope is greater than or equal to 1:1 and drop of 1 foot

Materials

- Asphalt is the most common surface for greenway trails within the CAG System, offering substantial durability for the cost of installation and maintenance.
- It is recommended that concrete be used for its superior durability and lower maintenance requirements, specifically in areas prone to frequent flooding, since the hardness and jarring of this surface is not preferred by runners or cyclists. Saw cut concrete joints rather than troweled improve user experience.
- Proper trail foundation will increase the longevity of the trail. Two inches of surfacing material over six inches of base course gravel over geotextile fabric is recommended.



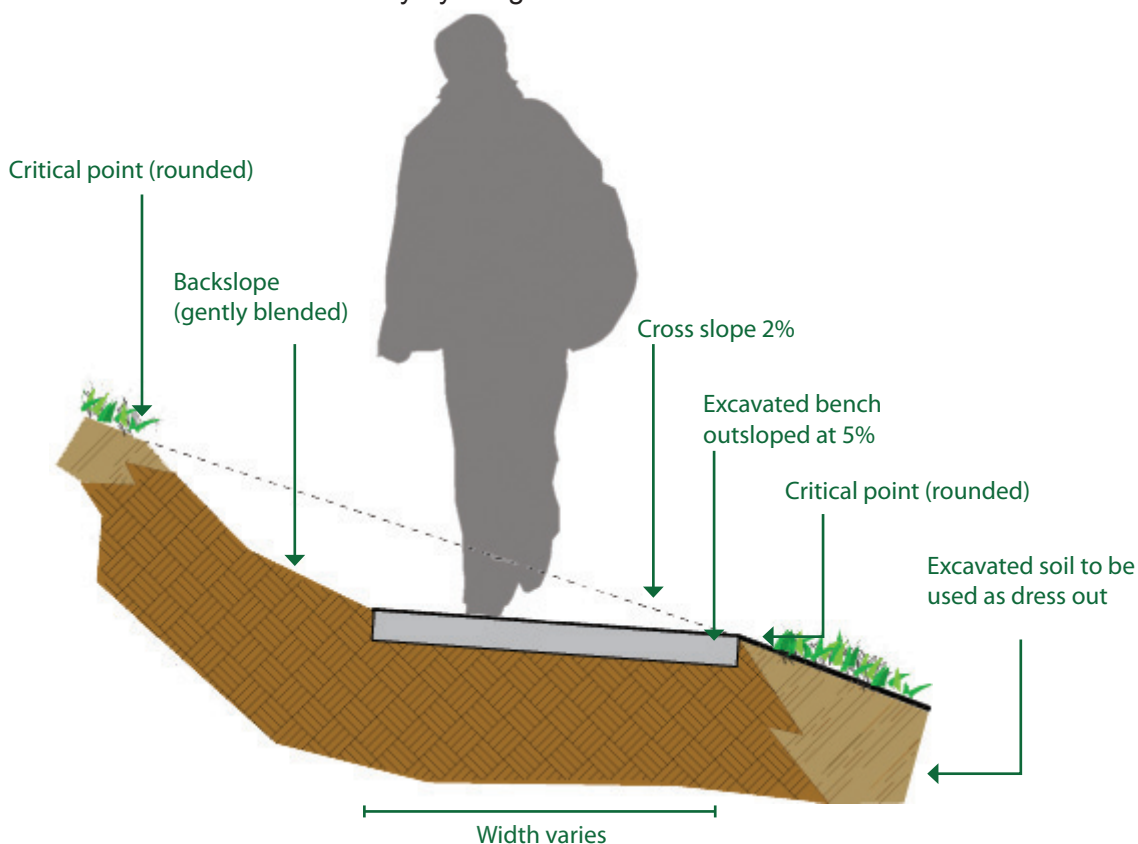
Walnut Creek Trail

General Design Practices for Natural Surface Greenway Trails

Sometimes referred to as nature trails or hiking trails, the natural surface greenway trail is used along corridors that may be environmentally-sensitive but can support bare earth, wood chip, or boardwalk trails. Natural surface greenway trails are a low-impact solution and found in areas with limited development or where a more primitive experience is desired.

Guidance

- Natural surface greenway trails can vary in width from 18 inches to 10 feet and are used for Neighborhood Trails classification only; vertical clearance should be maintained at 8-10 feet above grade.
- Refer to the beginning of this chapter for guidance on planning, designing, and constructing greenway trails in environmentally sensitive areas.
- Base preparation varies from machine-worked surfaces to those worn only by usage.
- Tread can be bare earth, rock, forest litter, or other native materials. Some greenway trails use crushed stone or screenings that contain about 4 percent fines by weight, and compact with use. Stone materials should not be used in flood-prone areas, environmentally sensitive areas, or areas with steep terrain.
- Provide positive drainage in all cases. Bench cut tread without extensive removal of existing vegetation. Build grade reversals and outsloped tread to encourage sheet flow across the trail (See *Drainage and Erosion Control* guideline, p. 70, for more information).
- Localize stormwater features at small scales along the network to minimize erosion and keep the greenway trail available for use year-round.
- Provide a longitudinal maximum slope of 5 percent and a cross slope of 2 percent.
- For additional guidance on natural surface greenway trails design and construction: <https://www.imba.com/resources/trail-building>



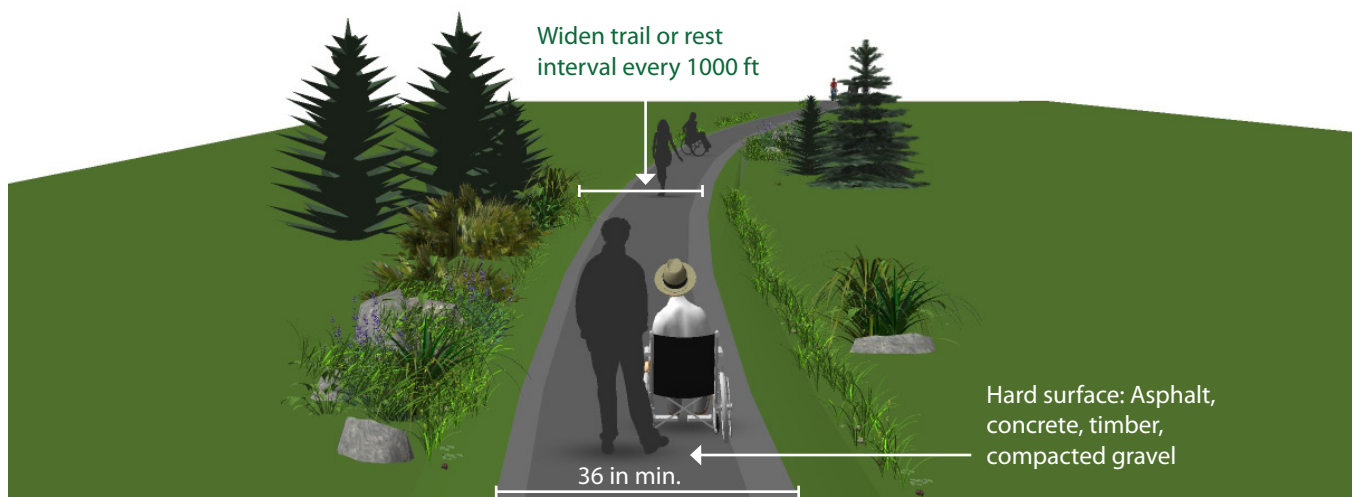
Typical cross section of a natural surface greenway trail.

Accessible Greenway Trail Design

The United States Access Board has approved American with Disabilities Act Accessibility Guidelines (ADAAG) for greenway trails and outdoor recreational access routes. Constructing greenway trails may have limitations that make meeting ADAAG and AASHTO guidelines difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources; a significant change in the intended purpose of the greenway trail; requirements of construction methods that are against federal, state, or local regulations; or terrain characteristics that prevent compliance.

Guidance

- Surface: Hardened surface such as asphalt, concrete, timber, compacted gravel
 - Clear tread width: 36 inches minimum
 - Tread Obstacles: 2 inches high maximum (up to 3 inches high where running and cross slopes are 5 percent or less)
 - Cross Slope: 5 percent maximum
 - Longitudinal slope must meet one or more of the following:
 - Five percent or less for any distance
 - Up to 8.33 percent for 200 feet max with resting intervals no less than 5 feet long and equal to the width of the trail at both ends.
 - Up to 10 percent for 30 feet max with resting intervals no less than 5 feet long and equal to the width of the trail at both ends.
 - Up to 12.5 percent for 10 feet max with resting intervals no less than five feet long and equal to the width of the trail at both ends.
- NOTE: If resting intervals are not located within the trail tread, adjacent resting interval clear widths must be 3 feet minimum.*
- No more than 30 percent of the total greenway trail length may exceed a running slope of 8.33 percent.
 - Passing Space: provided at least every 1,000 feet where greenway trail width is less than 60 inches.
 - Signs: shall be provided indicating the length of the accessible greenway trail segment.
 - Detectable pavement changes at curb ramp approaches should be placed at the top of ramps before entering roadways.
 - Trailhead signage should provide accessibility information, such as trail gradient/profile, distances, tread conditions, location of drinking fountains, and rest stops.
 - Provide one accessible parking space per every 25 vehicle spaces at trailheads.
 - Greenway trail amenities, drinking fountains, and pedestrian-actuated push buttons should be placed no higher than 4 feet off the ground.



Crime Prevention Through Environmental Design (CPTED) Principles for Greenway Trails

Personal safety, both real and perceived, heavily influences a greenway trail user's decision to use a facility and a community's decision to embrace the greenway trail system. Proper design must address both the perceived safety issues (i.e., feeling safe or fear of crime) and actual safety threats (i.e., infrastructure failure and criminal acts). CPTED is a proactive approach to deterring undesired behavior in neighborhoods and communities. When all spaces have a defined use and the use is clearly legible in the landscape, it is easier to identify undesired behavior.

Principle #1: Natural Surveillance

Principle #2: Natural Access Control

Principle #3: Territorial Reinforcement

Principle #4: Maintenance

The following elements include CPTED principles as they apply to the CAG System. Apply CPTED guidelines to greenway trail facilities, management features, and amenities when appropriate.

Guidance

- Where feasible, fencing installed along greenway trails should not obstruct the view of trail users.
- Where the greenway trail is fenced for long stretches, intermittent openings should be located to allow users to enter and exit the greenway trail. Access points to the greenway trail should be at locations with good visibility from the surrounding neighbors.
- Greenway trail signage should include the contact number to report graffiti, suspicious behavior, and maintenance issues (e.g., "Immediately report any observed graffiti to 911").
- All groundcover and shrubs along greenway trails should be trimmed to a maximum height of 36 inches above ground level.
- Trees should be limbed-up to provide a minimum of 8 feet of vertical clearance over the trail within the trail corridor.
- Tree canopies should not obstruct pathway illumination.
- Hostile native landscaping material (e.g.



vegetation with thorns) can be used in strategic areas to discourage unauthorized use and eliminate entrapment areas.

- Add anti-graffiti application to retaining walls, where appropriate.
- Where lighting is installed on greenway trails the illumination should:
 - Be adequate to identify a face up to 20 yards away.
 - Have full cut-off fixtures to reduce light pollution.
 - Provide uniform coverage, eliminating dark pockets.
- Provide good color rendition.
- Not be obstructed by tree canopies.
- The use of metal halide or light emitting diode (LED) lamps are recommended, as they provide excellent color rendition. Color rendition is especially important when describing identifying features such as hair, clothing, and vehicle color. Light quality is as important as the quantity. Poor lighting, whether too bright or not bright enough, can diminish safety.
- Lighting should respond to the conditions of the site and meet the minimum standards set forth by the Illuminating Engineering Society of North America (IESNA).

Design Considerations for Riparian Greenway Trails

As discussed in Chapter 2, riparian corridors are the primary greenway trail development corridor across the existing CAG System. Depending on the width of the floodplain area, riparian corridors often offer substantial recreational and open space preservation opportunities. These corridors include rivers and streams, drainage facilities, and wetlands (where environmentally feasible). All greenway trails constructed within riparian corridors should be studied for stormwater impacts, wildlife habitat impacts, and floodplain development impacts.

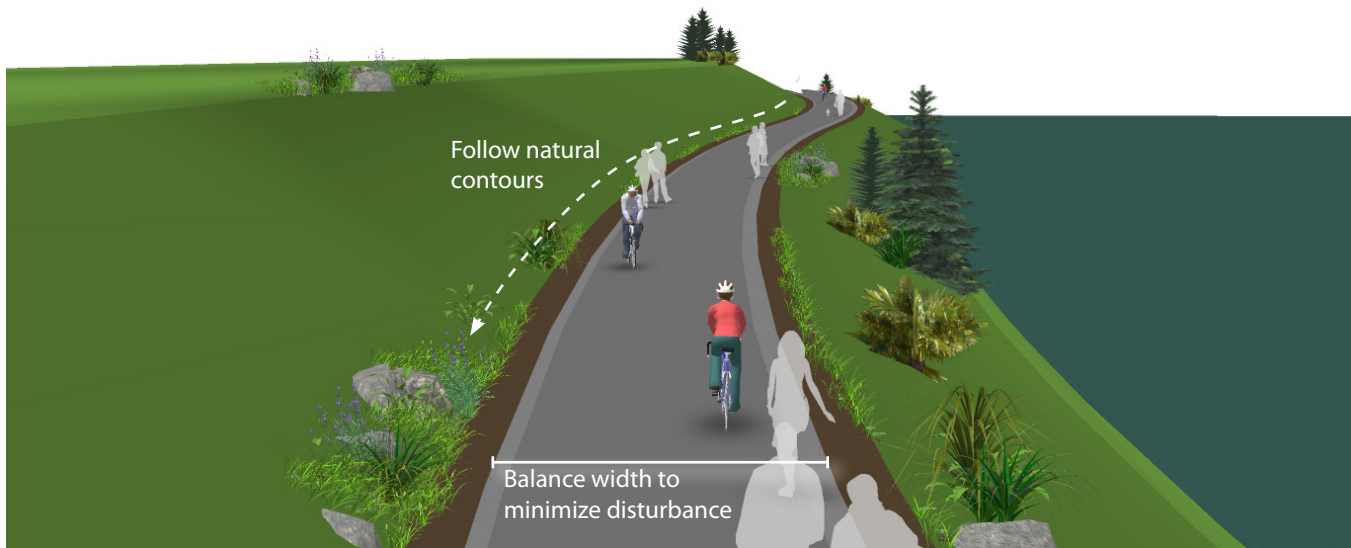
Guidance

- Greenway trails in riparian corridors should meet or exceed General Design Practices indicated previously due to their sensitive nature and generally poorly-drained and wet periods of the year. Use the *Greenway Trail Classifications* section, starting on p. 28, to determine widths and other use guidelines.
- Confirm local and current Neuse River Basin buffer rules to determine acceptable uses and buffer widths.
- All greenway trails within floodplain areas will require adequate environmental permits from local floodplain administrators. Confirm current requirements with stormwater staff when designing riparian greenway trails.

- To minimize vegetation disturbance and breaching of the forest canopy, construct the tread only wide enough as indicated by the greenway trail classification for the intended use.

Routing and Alignment

- Where possible, greenway trails should follow the contours.
- Avoid constructing greenway trails along fall lines, which are prone to erosion and generally cannot be maintained over time.
- Greenway trails through wetlands should be avoided if possible. If wetlands must be crossed, choose the narrowest point.
- Construction of greenway trails immediately adjacent to or abutting streambanks should be avoided to the greatest degree possible. Construct all trails at the maximum distance from streams as is practical.
- Include consideration of stream restoration potential where feasible. Stream restoration projects commonly involve considerable reshaping of the floodplain to reduce bank angles and heights to allow the stream to access its floodplain.



Typical cross section of a paved greenway trail along a riparian corridor.

Access Points

- Any access point to the greenway trail should be well-defined with appropriate signage designating the corridor as a shared-use greenway trail and prohibiting motor vehicles.
- Design logical points of interest to avoid informal “social” trails that follow poorly executed routes and trample floodplain vegetation or sensitive areas.

Materials and Management

- Concrete is the recommended surface treatment for greenway trails prone to flooding due to its superior durability and lower maintenance requirements.
- Permeable paving is not recommended in floodplain areas or areas without proper

drainage. Sheet flow and sediment transport clogs pores and requires vacuuming after all storm events.

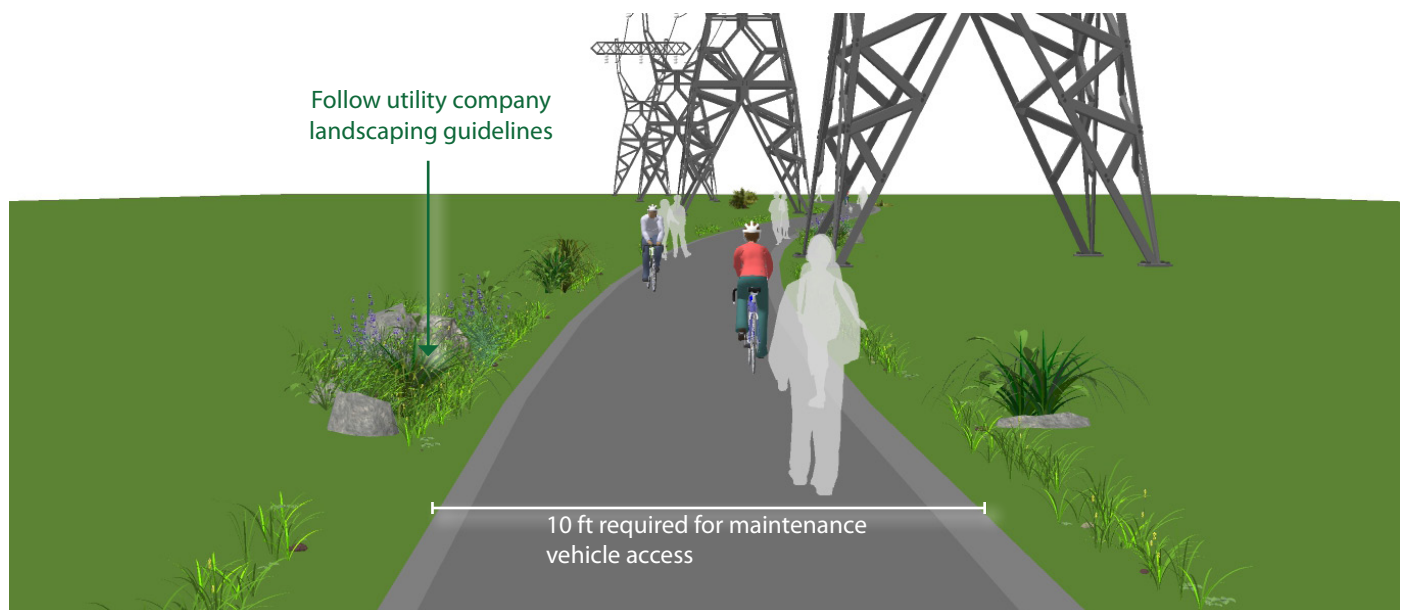
- Where wetlands are present, use elevated tread materials (such as timber boardwalk) to preserve these fragile ecosystems. For more information on raised greenway trails, see the specific design guideline in this section.
- Do not use gravel or crushed stone fines in riparian areas prone to flooding. These materials have very low cohesiveness and erode easily. They can also contribute to sediment in streams.
- Use natural dispersed infiltration systems such as vegetated swales to manage stormwater.

Design Considerations for Greenway Trails in Utility Corridors

Existing man-made corridors may be able to simultaneously serve the needs of greenway trail users. Underground utilities such as water, sewer, natural gas, or buried electric or optic lines can accommodate greenway trails as well as above-ground utilities such as telephone, cable, or overhead electric. Utility companies benefit from this arrangement by having uninterrupted, easily accessible route to their utility service.

Guidance

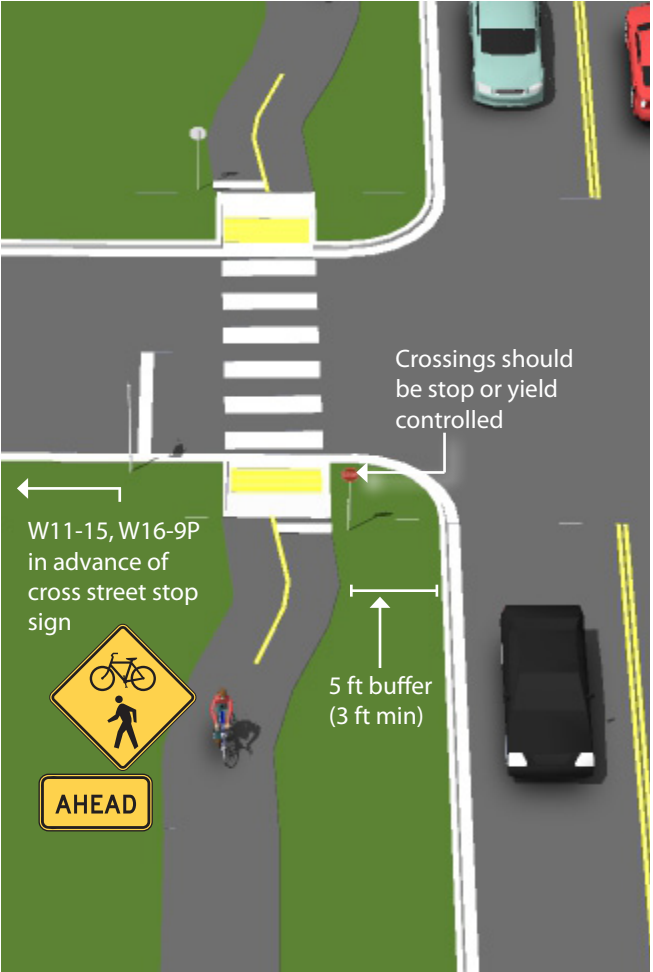
- Utility companies require specific design guidelines, routing and alignment, and landscaping limitations.
- Ten feet width is required if motor vehicles will be accessing the trail for maintenance purposes.
- In sewer easements, the edge of greenway trail should be at least 10 feet from manhole rims, where possible.
- All greenway trails require acquisition of an easement from the current fee simple title owner of the land.
- Some utilities have greenway trail width limitations within their rights-of-way. When designing trails in utility corridors, confirm current guidelines widths with each utility.
- In many cases, bollards are required at access points to deter motor vehicles. Bollards must be installed per the utility's specifications.
- For electrical utility corridors, a minimum separation of 25 feet is required between the greenway trail and any associated electrical equipment (such as guy wires, power poles, and towers; *based on Duke Energy ROW requirements for greenway trails*).
- Culverts and vegetation must be installed per the utility's specifications.
- Structures are typically restricted within utility easements. Structures include signage, lighting, and benches.
- Review each utility's policy and construction specifications for repair, maintenance, access, and corridor maintenance requirements.
- User expectations will be similar to other CAG trails, however greenway trails in utility corridors may be restricted to the conditions listed above and closed at certain times when utility repairs are necessary.



Design Considerations for Greenway Trails in Roadway Corridors

Greenway trails located within the roadway right-of-way (ROW) are typically classified as Greenway Connectors within the CAG System. Sometimes referred to as 'sidepaths,' they provide more comfortable widths than sidewalks and can accommodate multiple users when designed adequately. When designing Greenway Connectors within roadway ROW, confirm widths and other treatments by referencing the classification guideline in Chapter 2.

Guidance

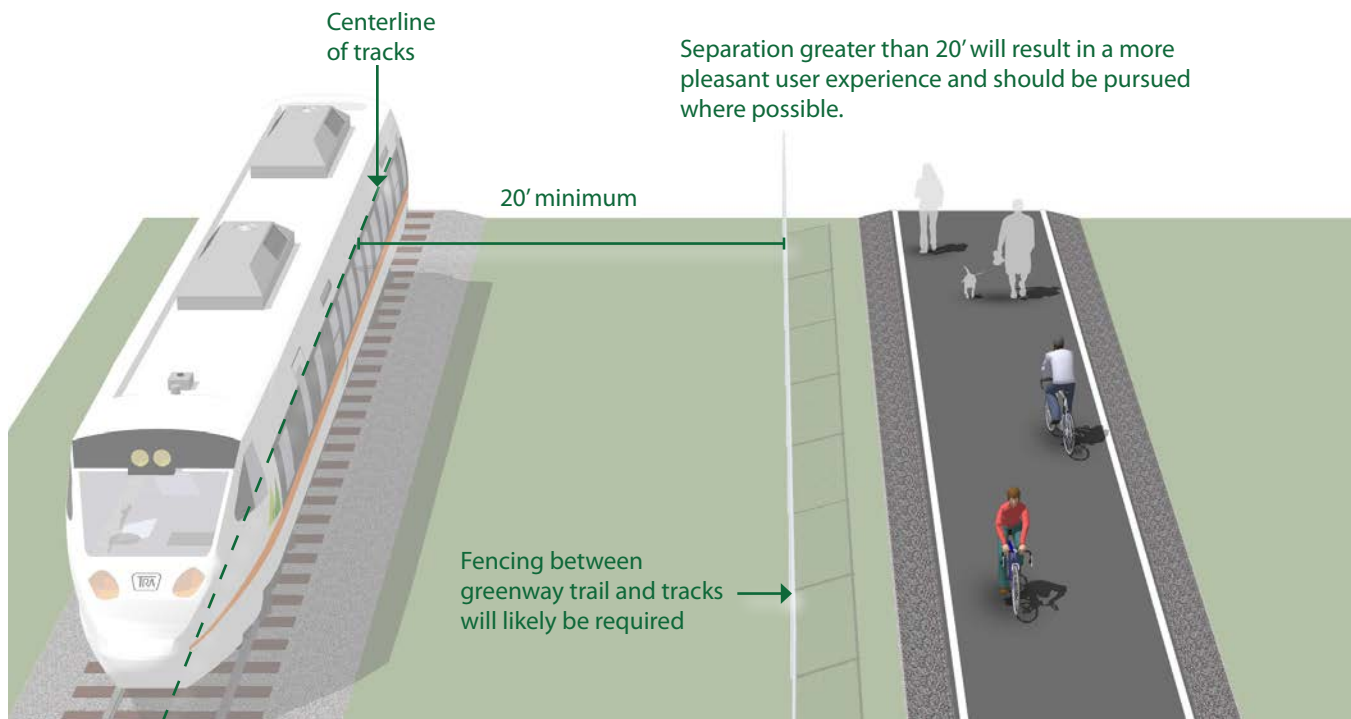
- This configuration works best along roadways with limited driveway crossings and with services primarily located on one side of the roadway, or along a riverfront or other natural feature. Not recommended in areas with frequent driveways or cross streets.
 - A minimum of 10 feet wide is necessary for bicyclists to pass other users safely on sidepaths.
 - A 5 foot or greater vegetated buffer between the sidepath and the roadway should be provided. NCDOT will allow a 3 foot buffer under certain conditions where ROW is constrained.
 - At driveway entrances and other roadway crossings, appropriate regulatory and wayfinding signage and crossing treatments should be provided (see Section 3.3).
 - In some cases, Greenway Connectors will transition from sidepaths to sidewalks or designated bicycle lanes. In the event that sidepaths merge onto streets, provide appropriate signage and pavement markings to help safe merging. See the *Raleigh Bicycle Transportation Plan* for more information on connecting with bicycle facilities.
 - All greenway trails constructed within roadway ROW require an encroachment permit from NCDOT.
- 
- Structures, such as retaining walls and bridges are not permitted in NCDOT ROW and may only be used in special conditions.
 - Depending on Average Daily Traffic (ADT) and design speeds, NCDOT requires a clear recovery zone of 9 to 14 feet from the edge of travel lane to edge of greenway trail in their roadway ROW.
 - Stormwater treatment and vegetation must be installed per NCDOT's specifications.

Greenways in Active Rail Corridors

Rails-with-Trails projects typically consist of greenway trails adjacent to active railroads. While there are no current opportunities for rails-with-trails projects within the CAG System, it is possible future corridors could become available for consideration. It should be noted that some constraints could impact the feasibility of rail-with-trail projects. In some cases, horizontal space needs to be preserved for future planned freight, transit or commuter rail service. In other cases, limited right-of-way width, inadequate setbacks, concerns about safety/trespassing, and numerous mid-block crossings may affect a project's feasibility.

Guidance

- Greenway trails in railway corridors should meet or exceed General Design Practices indicated in the section above. If additional width allows, wider tread and landscaping are desirable.
- In most cases fencing will be required to separate use. If required, fencing should be a minimum of 5 feet in height with higher fencing than usual next to sensitive areas such as switching yards. Setbacks from the active rail line will vary depending on the speed and frequency of trains, and available right-of-way.



Section 3.3 | Greenway Trail

Management Features

There are certain greenway trail management needs that may be considered for each CAG Classification for various reasons. Some greenway trails require management features to enhance user experience, provide privacy and security to adjacent property owners, or to sustain the life span of the greenway trail.

ACCESS MANAGEMENT

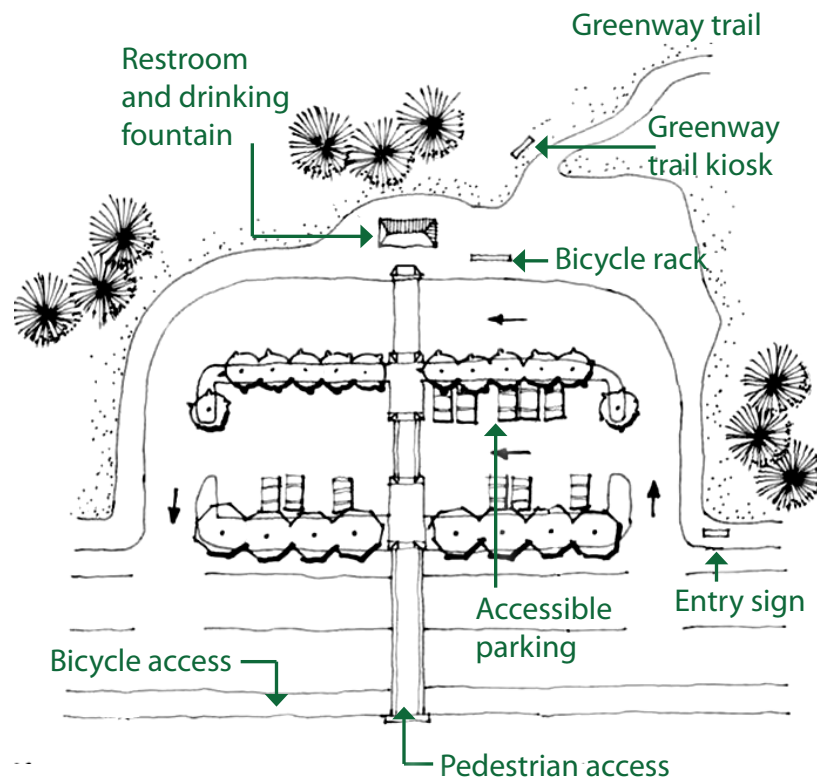
Trailheads

CAG trailheads provide essential access to the greenway trail system and can include many amenities in one location: automobile parking, bicycle parking, restrooms, drinking fountains, trash and recycle receptacles, dog waste stations, bicycle repair stations, and greenway trail wayfinding and informational signage.

There is no prescription for the frequency of trailheads. Conduct user counts, vehicle counts, and surveys across the greenway trail network at peak hours of use to determine parking demand. Consider locating trailheads with consideration to other available public facilities or through partnerships with owners of existing parking areas. When locating trailheads in or adjacent to neighborhoods streets, work with property owners to install no parking signs if desired, and to minimize impacts during construction and daily use.

Major Trailheads

Major trailheads should be established near large residential developments, commercial developments, and transportation nodes, making them highly accessible to the surrounding community and to the greenway trail system. A major trailhead could include all of the items mentioned previously plus additional facilities, such as shelters, picnic areas, and more extensive parking.



Major Trailhead

Guidance

- Major trailheads can provide parking for 10-40 vehicles, depending on availability of land and anticipated level of use of the greenway trail.
- Consider 300 to 350 square feet for each parking space.
- Major trailheads will typically have a large paved parking lot that accommodate passenger vehicles and large vehicles year round. Consider locating larger lots in existing disturbed areas to minimize environmental impacts.
- Major trailheads should provide emergency and maintenance vehicle access and turnaround.
- Place ADA accessible parking spaces near the site's accessible route, at a rate of one accessible space per 25 standard spaces. Parking spaces and access aisles should not exceed 2 percent slope in any direction.
- Parking lot surfaces should never exceed 5 percent slope in any direction.

- Where major trailheads are located near neighborhoods, provide user access from local streets crossing the greenway trail. Where greenway trails cross neighborhood streets, “No Parking” signs may be desirable to minimize impact on the neighborhood.
- Reduce the visual intrusion of large parking areas by using vegetative screening.
- Consider one-way vehicle circulation within parking areas to minimize road width.
- Refer to current setbacks and other requirements within the UDO.

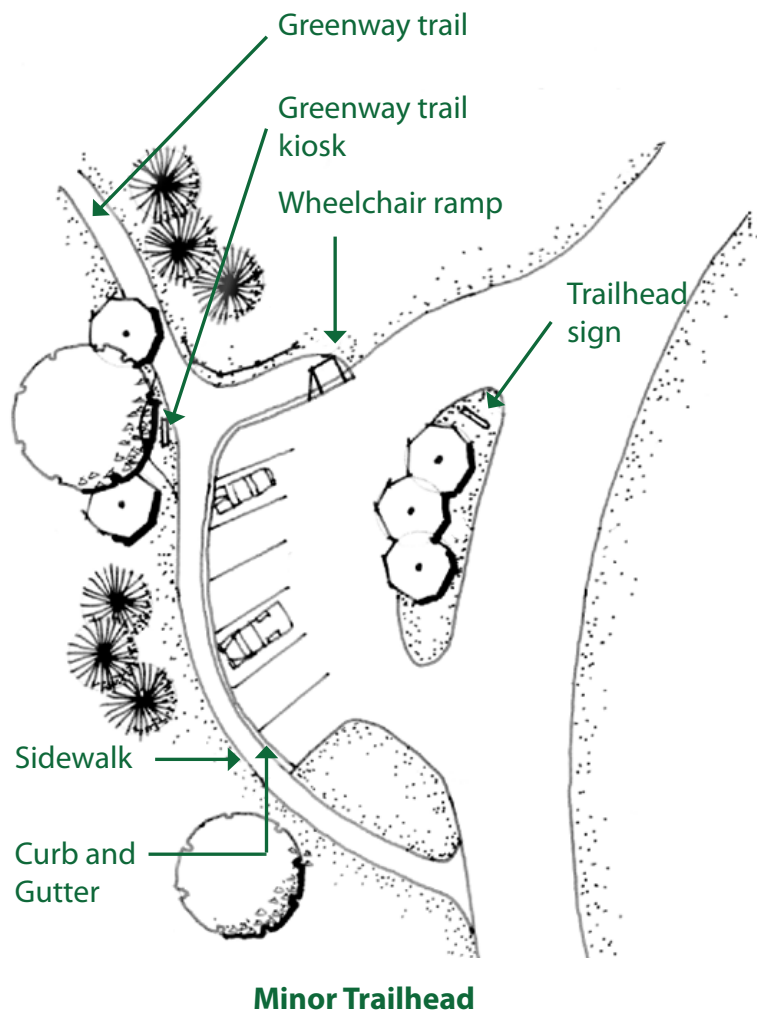
Minor Trailheads

Minor trailheads are greenway trail access points with very minimal infrastructure. They can occur at parks and residential developments. Some minor trailheads could include a small parking lot for five to

six passenger vehicles. In addition to vehicle parking, minor trailheads may include drinking fountains, benches, trash and recycling receptacles, an information kiosk, and signage about the greenway trail network.

Guidance

- Minor trailheads can provide parking for up to ten vehicles. The parking area may be asphalt or gravel, as long as ADA requirements are met
- Minor trailheads should provide emergency and maintenance vehicle access.
- Minor trailheads should be ADA accessible and provide at least one accessible space near the accessible route.
- Provide adjacent wayfinding signage that directs greenway trail users to minor trailheads.



Trail Edge Definition

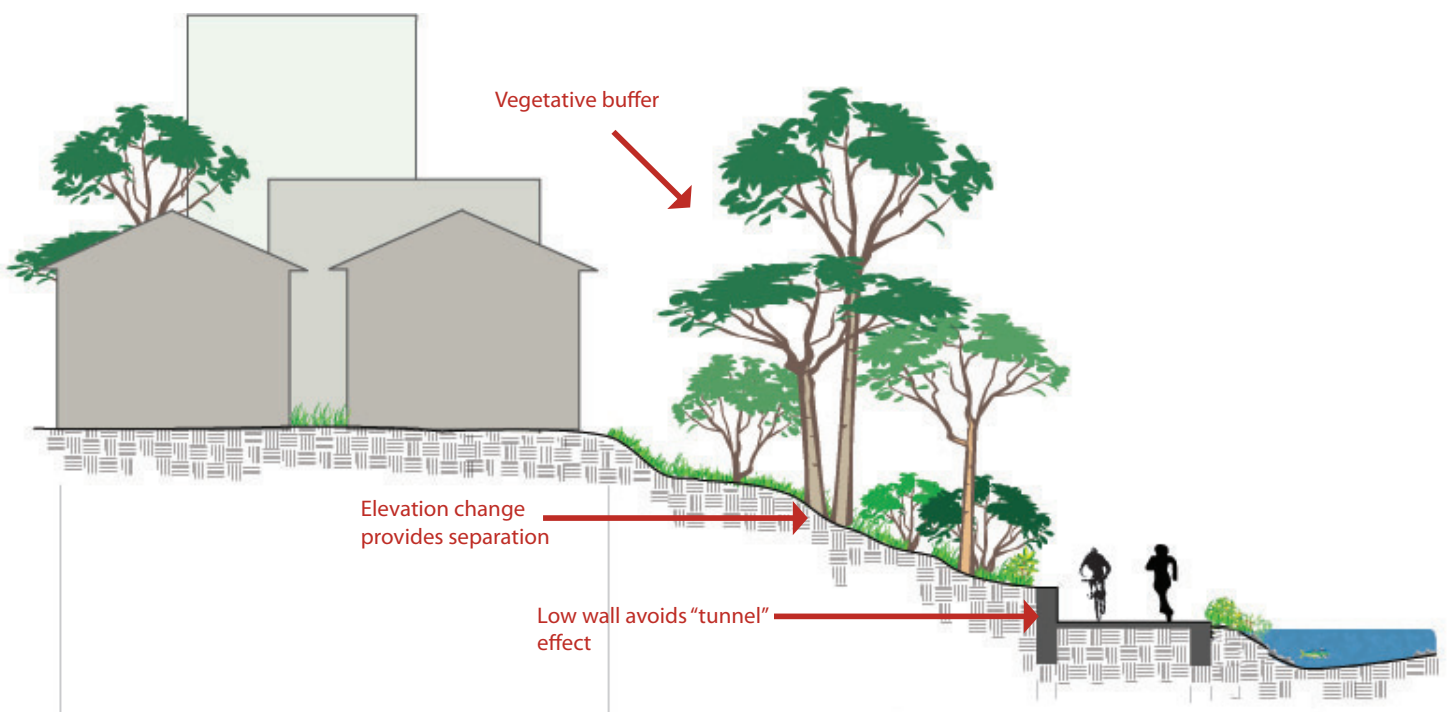
Vegetation, topography, ditches, fencing, railings, or walls may be used to clearly mark greenway trail edges. Such features serve multiple purposes, including:

- Providing visual separation/privacy screens
- Delineating public space from private property adjacent to the greenway trail
- Discouraging the development of unauthorized foot trails
- Separating users from hazardous drop-offs or adjacent non-compatible land use

Wildlife passage and safety for greenway trail users are important factors in determining appropriate greenway trail edge treatments. Although the public often perceives fencing as a means of providing safety by prevention of unwanted access, fencing that blocks visual access completely can have the opposite effect by impairing informal trail surveillance (see *CPTED* guidelines for more information).

Guidance

- If separation is desired purely for privacy reasons, native vegetation buffers or the use of topography are recommended where possible.
- For physical separation aimed at preventing trespassing or guarding against hazardous slopes, consider the use of topography, ditches, semi-transparent fencing or railings, and hostile vegetation.
- Fencing should strike a balance between adjacent residents' privacy and informal surveillance of the greenway trail. Permeable fencing of four feet tall or less can provide a barrier sufficient to denote property boundaries or to deter most access. Opaque fencing or walls can degrade the experience of greenway trail users, obscure views, and create a "tunnel" effect that creates the effect of users feeling "trapped."
- Railings on bridges, boardwalks, and at the edges of steep slopes should be provided. For more information, see the *Fencing and Railings* guideline.



Vegetative Screening

The presence or absence of vegetation and the type of vegetation present in a greenway corridor affects habitat quality, the greenway's effectiveness as a wildlife corridor, ecological sustainability, and the aesthetic experience for the greenway trail user. Greenway trails are more effective at providing wildlife habitat and corridors when they have native trees and shrubs present. Trees and shrubs can also shade users from sun and shelter users from rain. When possible, protecting, preserving, and maintaining existing native vegetation when constructing greenway trails through riparian corridors is the first choice for creating separation between the greenway trail and adjacent properties. Vegetative buffers create a natural privacy screen, provide habitat for wildlife, and stabilize erodible soils.

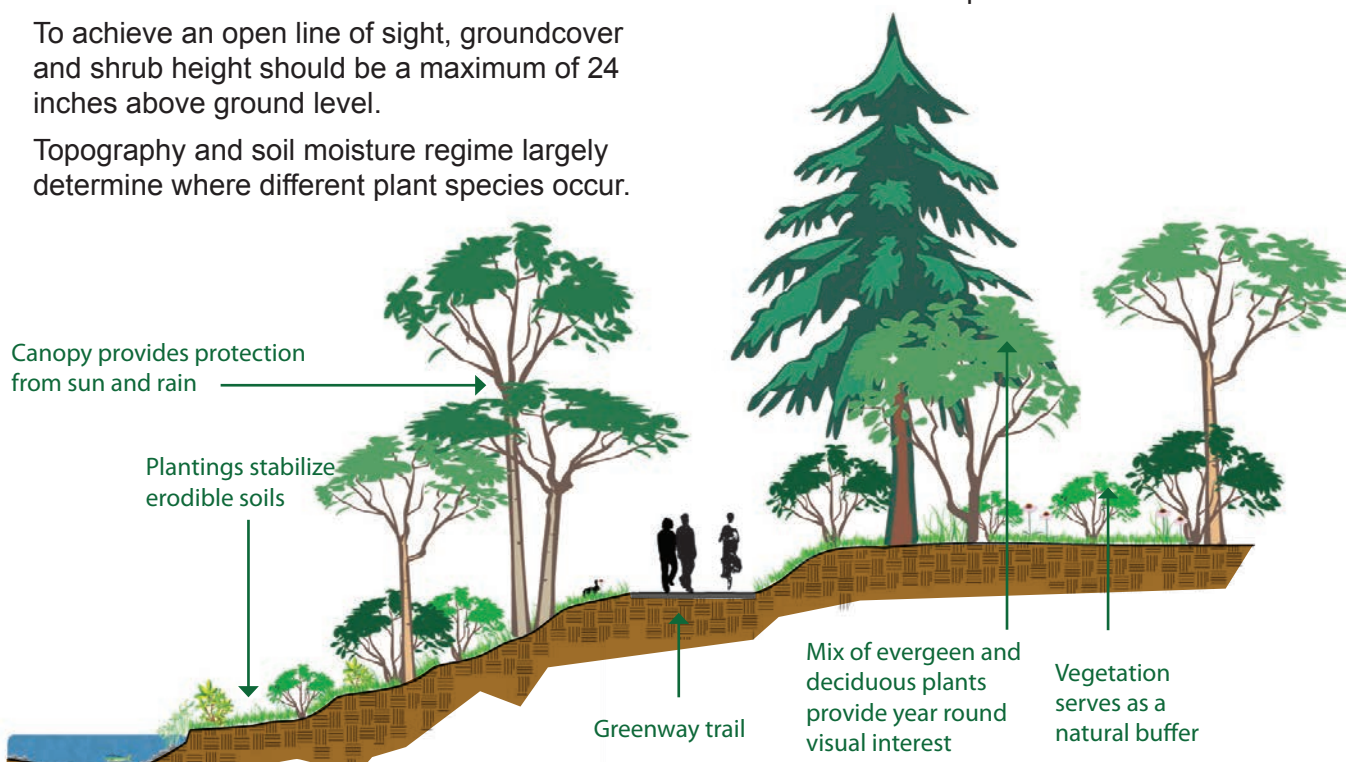
Guidance

- In locations where trees and shrubs are lacking and can be planted, native species are the most ecologically sustainable choice. As a group, native species require less maintenance than horticultural plantings and often provide wildlife with a food source.
- To achieve an open line of sight, groundcover and shrub height should be a maximum of 24 inches above ground level.
- Topography and soil moisture regime largely determine where different plant species occur.

- Tree canopies should not obstruct greenway trail illumination.
- Select and place greenway trail vegetation to provide seasonal comfort: shade in the warmer months and sunlight in colder months.
- Select native landscaping material that can deter users from using unauthorized foot trails, access points, or exits (e.g. vegetation with thorns).
- Follow CPTED requirements per page 62.

Maintenance and Establishment

- Larger plants require more water to survive than seeds and smaller plants. Plant seeds and/or plants either right before or during the rainy season to take advantage of seasonal rainfall (spring and fall).
- Remove all competing invasive vegetation and or mulch regularly to conserve water.
- Trees should be trimmed to provide a minimum of 8 feet of vertical clearance within greenway trail circulation.
- Fertilizing native plants is only necessary in extreme cases when the condition of the soil is still in need of repair.



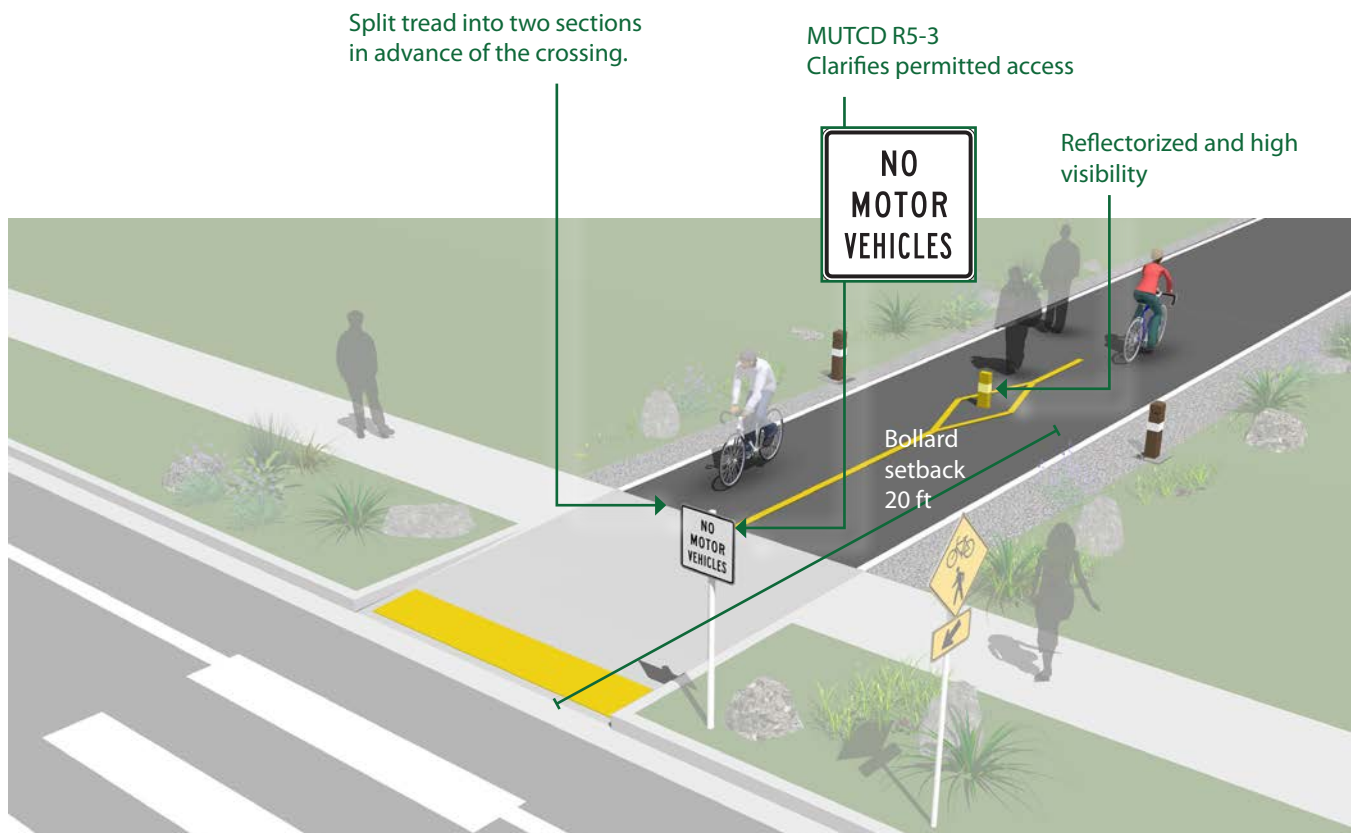
Bollards

Bollards are physical barriers designed to restrict motor vehicle access to greenway trails. Sometimes physical barriers are still ineffective at preventing access, and can create obstacles to legitimate greenway trail users. Alternative design strategies use signage, landscaping, and curb cut design to reduce the likelihood of motor vehicle access.

Bollards are effective in preventing unauthorized motor vehicle entry and should be utilized at all major access points and trail heads.

Guidance

- Bollards should be a minimum height of 40 inches and a minimum diameter of 4 inches.
- Bollards should be set back from the roadway edge a minimum of 20 feet.
- When more than one post is used, an odd number of posts spaced 6 feet apart is desirable.
- Posts should be permanently reflectorized for night time visibility and painted a bright color for improved daytime visibility.
- Striping an envelope around the post is recommended.
- Lockable, removable bollards allow entrance by authorized vehicles. Where used, the top of the mount point should be flush with the path surface.
- Flexible bollards and posts are designed to give way on impact and can be used instead of steel or solid posts.
- “No Motor Vehicles” signage (MUTCD R5-3) may be used to reinforce access rules.
- Vertical curb cuts should be used to discourage motor vehicle access.
- Consider targeted surveillance and enforcement at specific intrusion locations.



ENVIRONMENTAL MANAGEMENT

Drainage and Erosion Control

Drainage and erosion control is necessary to maintain a stable greenway trail system and low maintenance facility. Excessive soil erosion near a greenway trail is usually the result of water collecting and flowing along the trail edge or onto the surface with enough volume and velocity to carry away soil. This results in a degraded greenway trail area and potential impacts to adjacent or downstream water resources. When managing stormwater along all CAG Trails, use dispersed infiltration systems such as vegetated swales, over engineered stormwater control structures such as storm drains, and catch basins for reduced maintenance and improved aesthetic.

Guidance

Paved Surfaces:

- A 2 percent cross slope will resolve most drainage issues on a paved greenway trail and should be used for both the tread and its shoulders. A maximum 1:6 slope is used for the shoulders although 2 percent is preferred. For sections of cut where uphill water is collected in a ditch and directed to a catch basin, water should be directed under the greenway trail in a drainage pipe of suitable dimensions.
- Following land contours helps reduce erosion problems, minimizes maintenance, and increases comfort levels on all greenway trail classifications.
- Provide low groundcover vegetation up to the edge of the greenway trail to prevent erosion on shoulders.

Natural Surfaces:

- Erosion will occur on natural surface greenway trails. Natural surface greenway trails should be designed to accommodate erosion by shaping the tread to limit how much erosion occurs and to maintain a stable walkway and tread. The goal is to outslope the greenway trail so that water sheets across, instead of down, its tread.
- Contour trails are also outsloped 5 percent from the face of the ridge to aid in sheeting water off the trail during rain events. These trails disperse and shed water in a non-erosive manner.
- Avoid fall line greenway trails when possible.
- Designing trails with rolling grades is the preferred way to build sustainable natural surface trails. “Rolling grade” describes the series of dips, crests, climbs, and drainage crossings linked in response to the existing landforms on the site to form a sustainable trail.
- Frequent grade reversals (grade dips, grade brakes, drain dips, or rolling dips) are a critical element for controlling erosion on sustainable trails. A general rule-of-thumb is to incorporate a grade reversal every 20 to 50 linear feet along the trail to divide the trail into smaller watersheds so the drainage characteristics from one section won’t affect another section.



Example of a silt sock controlling drainage along a riparian greenway trail corridor

Boardwalks

Boardwalks are structures that bridge over sensitive natural or inundated areas while limiting the potential for environmental impact. They are typically used when crossing small creeks and wetlands. Boardwalks range in length and can span as little as 10 feet or stretch for longer distances depending on site conditions. Bridges are used where greater span lengths are required and when the objective is to reduce base flood elevations. Boardwalks are usually constructed of timber, concrete, or recycled plastic decking. Recycled systems such as Trex® are popular for their material durability, however they have structural limitations. Modular concrete boardwalk systems are gaining popularity due to their low-impact installation methods and durability within wet areas. Permatrak™ is a system being used in some communities in the state and by the National Park Service.

Guidance

- Boardwalk clear span width should be a minimum of 10 feet when no rail is used. A 12 foot width is preferred in areas with higher anticipated use and whenever railings are used.
- A 6 inch curb rail is recommended, however, a 42 inch guardrail is required at locations where there is a 30 inch or greater difference in the low water bridge elevation and the ground elevation below. Maximum opening between railing posts is 4 inches.
- Boardwalks should be designed to structurally support 5 tons of capacity.
- Evaluation of boardwalk footings should include uplift as well as loading consideration for flood events.
- Consult a structural engineer for member sizing and post footing design. The foundation normally consists of marine-grade timber posts or auger piers (screw anchors). Screw anchors provide greater support and durability.
- Give careful consideration to minimize slippery decking surfaces following storm events. A topcoat of non-skid paint, sandy compounds, or a light asphalt overlay can be effective on timber decking. Concrete is the most reliable non-skid surface.
- Local, state and federal permits will be required where a boardwalk is located within wetlands. Any construction in wetlands is subject to regulations and should be avoided.



Bridges

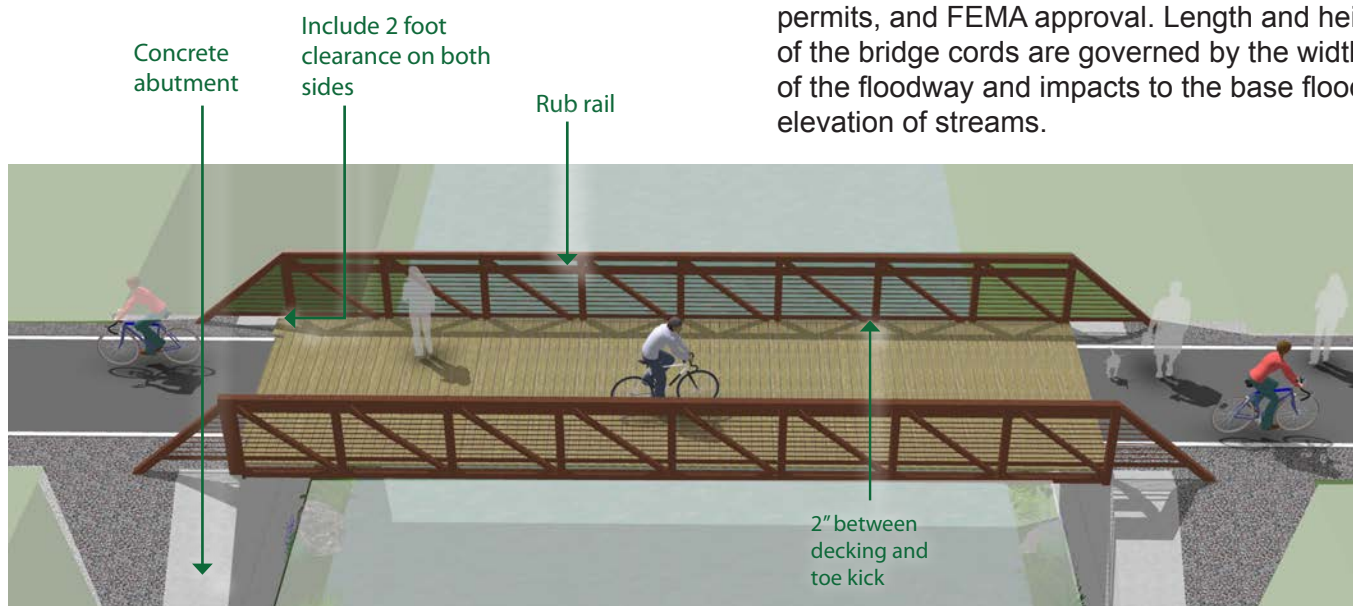
Greenway trail bridges are most often used to provide user access over natural features such as streams and rivers, where a culvert is not an option or the span length exceeds 20 feet. The type and size of bridges can vary widely depending on the greenway trail and specific site requirements. Bridges often used for greenway trails within the CAG System include suspension bridges and prefabricated clear span bridges. When determining a bridge design for greenway trails, it is important to consider emergency and maintenance vehicle access.

Greenway trails that are poorly designed through water features can impact wetlands and streams, and become conduits for delivering sediments, nutrients, and pathogens to the watershed. Greenway trails that cross streams can exhibit bank and streambed erosion if not properly constructed.

Guidance

- The clear span width of the bridge should include 2 feet of clearance on both ends of the bridge approach for the shoulder.
- Bridge deck grade should be flush with adjacent greenway trail tread elevation to provide a smooth transition. Any gap between bridge deck and trail tread should be covered with steel plate.

- Railing heights on bridges should include a 42 inch minimum guard rail, and 48 inches where hazardous conditions exist.
- A minimum overhead clearance of 10 feet is desirable for emergency vehicle access. Maximum opening between railing posts is 4 inches.
- A greenway trail bridge should support 10 tons for 10 foot wide greenway trails, and 20 tons for wider than 10 feet for emergency vehicle access.
- Bridges along greenway trails that allow equestrian use should be designed for mounted unit loadings.
- When crossing small headwater streams, align the crossing as far upstream as possible in the narrowest section of stream channel to minimize impact.
- Greenway trail drainage features should be constructed to manage stormwater before the greenway trail crosses the watercourse (see *Drainage and Erosion* guideline).
- All abutment and foundation design should be completed and sealed by a professional structural engineer licensed in the State of North Carolina.
- All greenway trail bridges will require local building permits, stormwater and land disturbance permits, floodplain development permits, and FEMA approval. Length and height of the bridge cords are governed by the width of the floodway and impacts to the base flood elevation of streams.



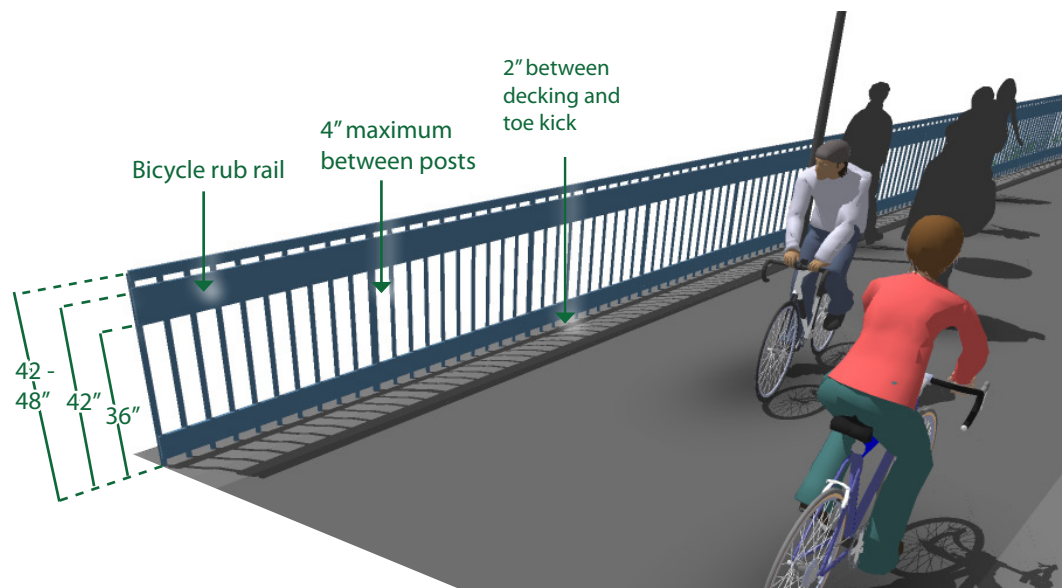
SAFETY MANAGEMENT

Fencing and Railings

Railing and fences are important features on bridges, some boardwalks, or in areas where there may be a hazardous drop-off or incompatible adjacent land uses.

Guidance

- At a minimum, railings and fences should consist of a vertical top, bottom, and middle rail. Picket style fencing should be avoided as it presents a safety hazard for bicyclists.
- Railings should be at least 42 inches above the finished grade, and up to 48 inches where more hazardous conditions exist, such as a bridge over a highway.
- Openings between horizontal or vertical members on railings should be small enough that a 6 inch sphere cannot pass through in the lower 27 inches. For the portion of railing higher than 27 inches, openings may be spaced such that an 8 inch sphere cannot pass through.
- Use durable fencing and railing materials, such as vinyl or recycled plastic, for reduced maintenance and sustainability.
- The middle railing functions as a 'rub rail' for bicyclists and should be located 33 to 36 inches above the finished grade.
- Local, state, and/or federal regulations and building codes should be consulted to determine when it is appropriate to install a railing and comply with current standards.



Section 3.4 | Intersections

Overview

At-grade roadway crossings can create potential conflicts between greenway trail users and motorists, however, well-designed crossings can mitigate many operational issues and provide a higher degree of safety and comfort for users. In most cases, at-grade greenway trail crossings can be properly designed to provide a reasonable degree of safety and can meet existing traffic and safety standards. Generally speaking, greenway trail facilities for bicyclists require additional considerations due to the higher travel speed of bicyclists versus other greenway trail users.

Special consideration must be given when delineating at-grade greenway trail crossings. The sign types, pavement markings, and treatments will vary based on the roadway type the greenway trail crosses. Proper signage and pavement markings alerting greenway trail users of at-grade crossings must also be utilized. Care must be taken not to place too many signs at crossings lest they begin to lose their visual impact. The City of Raleigh's Public Works Department should be consulted prior to design and installation of roadway crossing treatments.



Walnut Creek Trail at-grade roadway intersection

Intersections with Other Greenway Trails

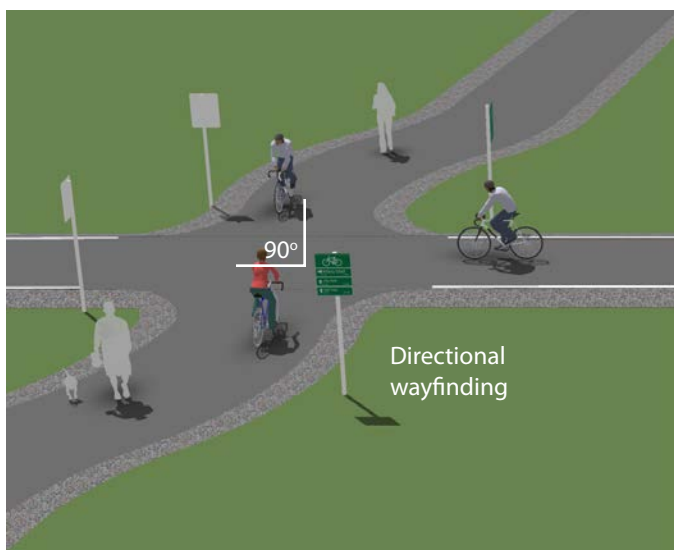
At the intersection of two greenway trails, users should be aware that they are approaching an intersection and of the potential for encountering different user types from a variety of directions. This can be achieved through a combination of regulatory and wayfinding signage and unobstructed sight lines.

Greenway trail intersections treatments are typically found along Cross City Greenway Trails, Greenway Connectors, and Greenway Collectors.

Guidance

- Greenway trails should be aligned to intersect at 90 degree angles when possible.
- Sight lines should be clear for all users, as determined by expected user speeds in Chapter 2.
- Consider off-setting the greenway trail intersection and creating two three-way intersections rather than one four-way intersection.
- A roundabout may be a viable design option to slow speeds and clarify expected operation.
- Include directional signage at intersections.
- If a roundabout design is used, consider the use of landscaping with low growing (no more than 24 inches high) and minimally spreading native shrubs and groundcover that require little maintenance and provide clear sight lines.
- Other material can be used within roundabouts such as boulders and public art to discourage shortcut paths through the central island as long as clear sight lines under 36 inches are maintained.

Reorient angled crossings to approach at 90 degrees



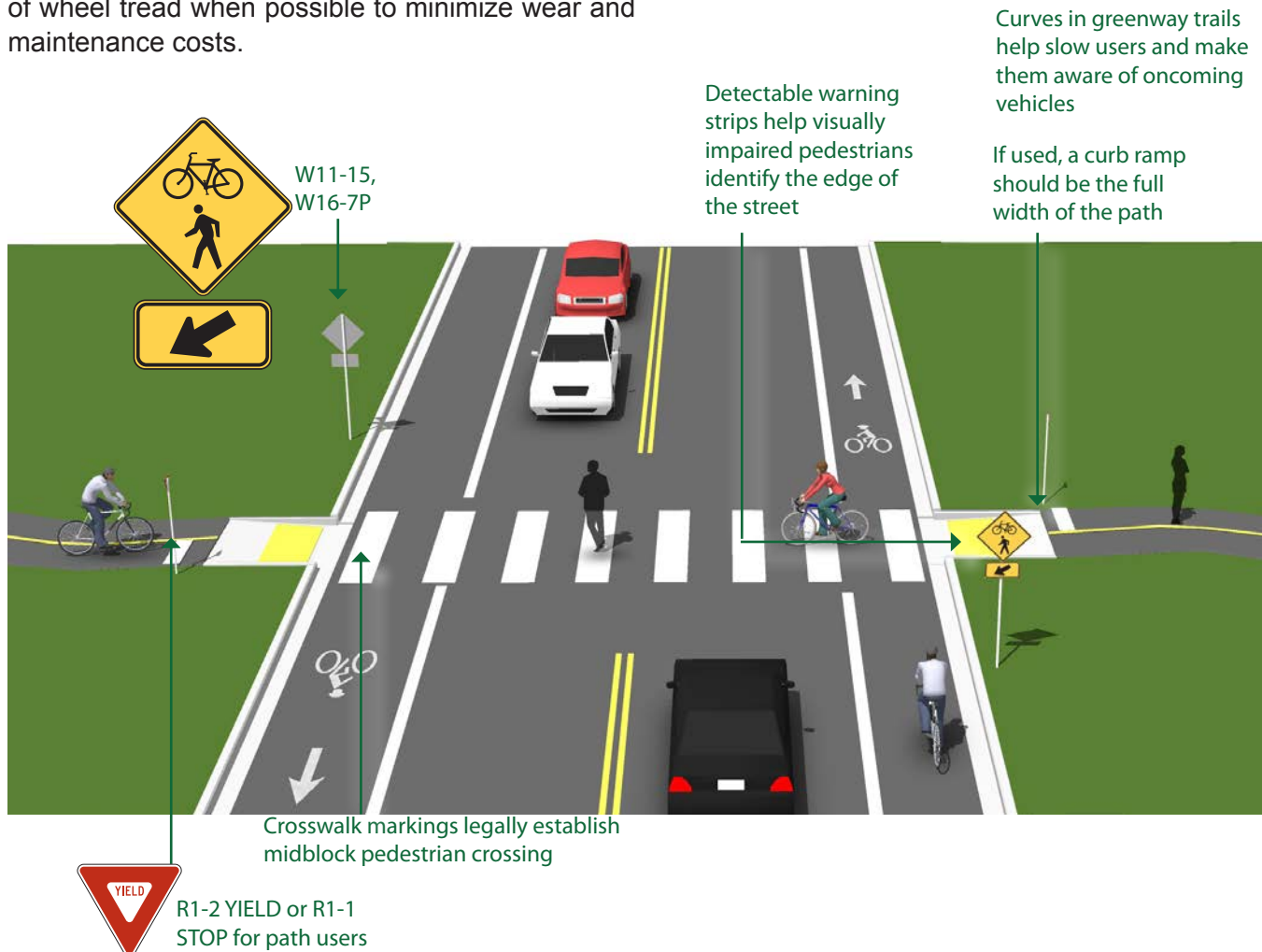
Trail roundabout



Marked/Unsignalized Crossings

A marked/unsignalized crossing typically consists of a marked crossing area, with signage and other markings to slow or stop traffic. The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, greenway trail traffic, use patterns, vehicle speed, road type, road width, and other safety issues such as proximity to major attractions.

When space is available, using a median refuge island can improve user safety by providing pedestrians and bicyclists space to perform the safe crossing of one side of the street at a time. Locate markings out of wheel tread when possible to minimize wear and maintenance costs.



Median Refuge Islands

Median refuge islands are located at the mid-point of a marked crossing and help improve greenway trail user safety by directing crossing in one direction of traffic at a time. Refuge islands minimize user exposure by shortening crossing distance and increasing the number of available gaps for crossing.

low growing, minimally spreading native shrubs and ground cover that require little maintenance and are no higher than 18 inches.

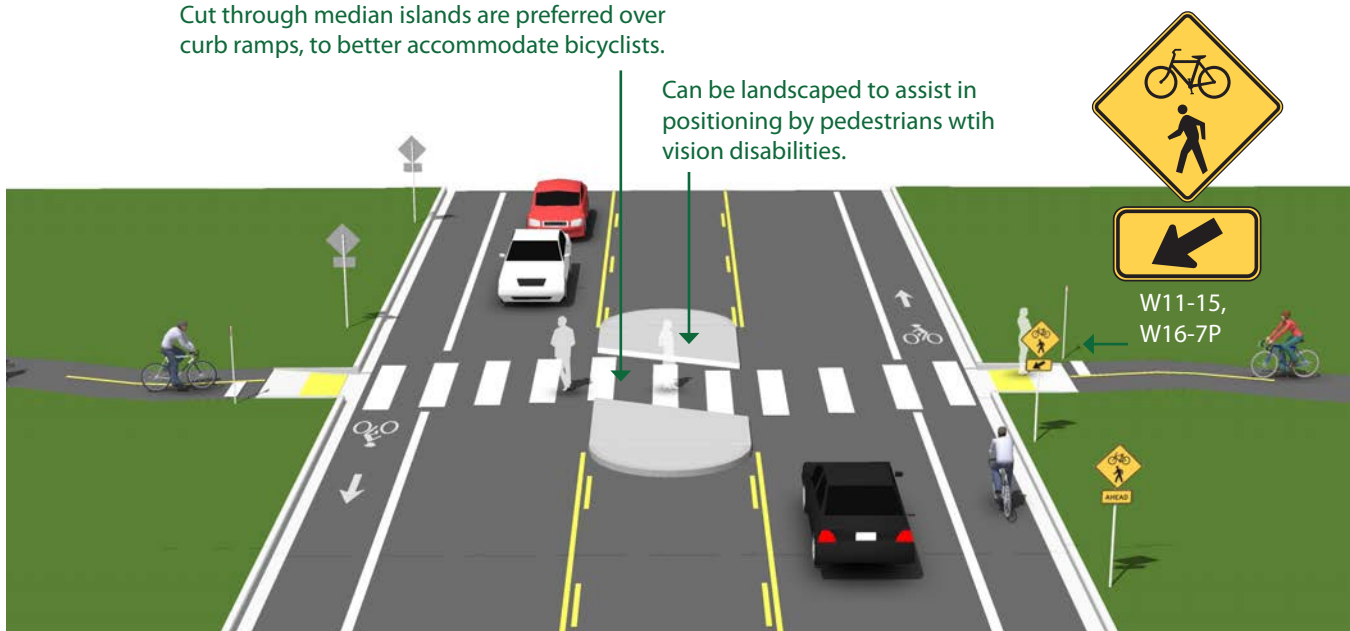
- Refuge islands may collect road debris and may require somewhat frequent maintenance.
- The approach nose should be highly visible.

Guidance

- Appropriate at signalized or unsignalized crosswalks.
- The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.
- If a refuge island is landscaped, the landscaping should not compromise the visibility of greenway trail users crossing in the crosswalk. Consider the use of landscaping with

Cut through median islands are preferred over curb ramps, to better accommodate bicyclists.

Can be landscaped to assist in positioning by pedestrians with vision disabilities.

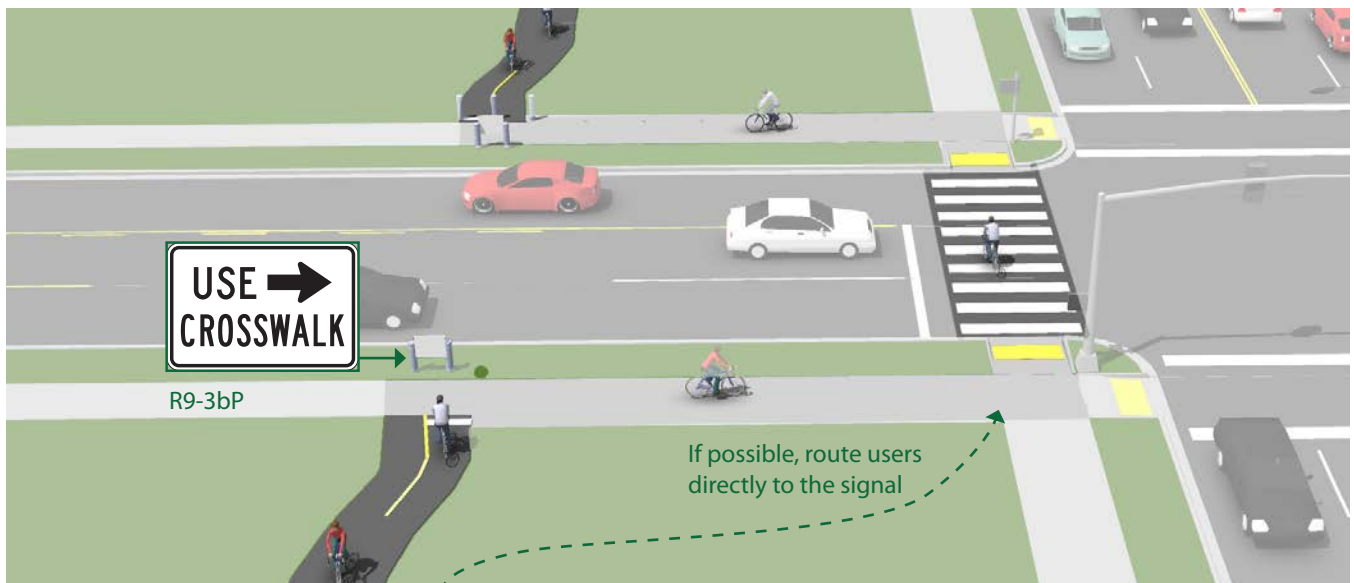


Signalized Crossings

Signalized crossings provide the most protection for users through the use of a red-signal indication to stop conflicting motor vehicle traffic.

Greenway trail crossings within approximately 400 feet of an existing signalized intersection with crosswalks are typically diverted to the signalized intersection to avoid traffic operation problems when located so close to an existing signal.

If possible, route users to signalized crossing. If no crossings are in vicinity, use appropriate crossing treatment. Any signal or “hawk” specific to greenway crossings has to be evaluated to have met FHWA warrants for the appropriate control device.

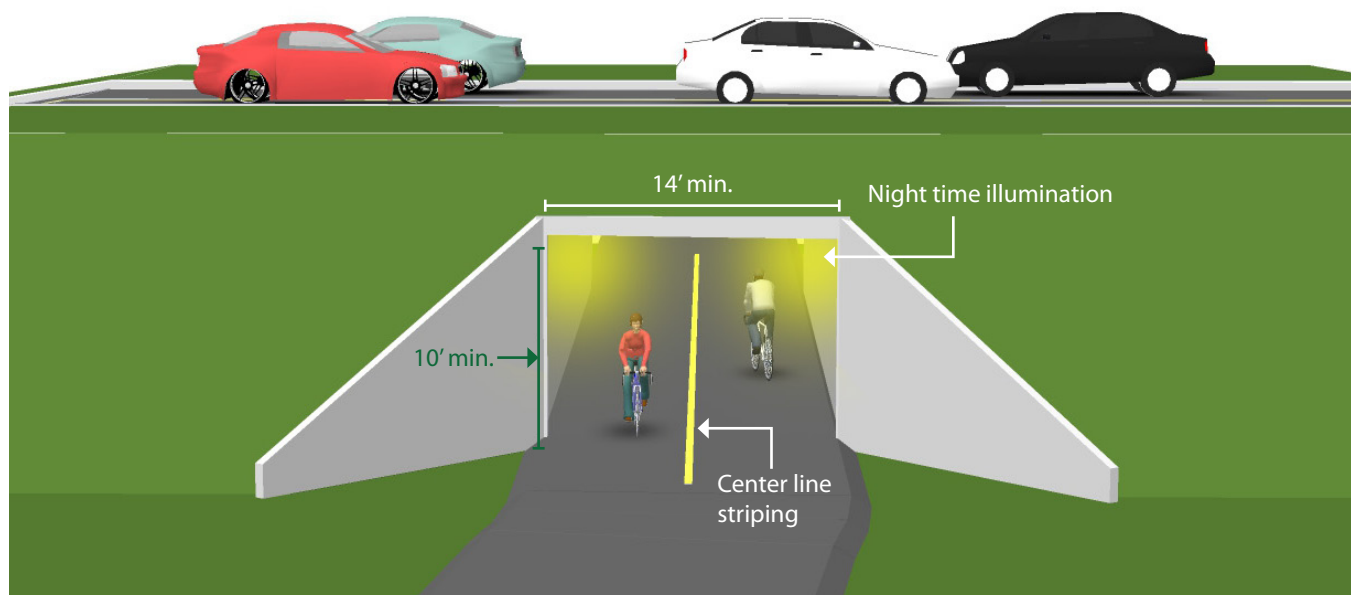


Greenway Trail Underpass

Greenway trail underpasses provide critical CAG System links by joining areas separated by barriers such as railroads and roadway corridors. Safety is a major concern with underpasses. Greenway trail users may be temporarily out of sight from public view and may experience poor visibility conditions within the underpass.

Guidance

- Fourteen foot minimum width, greater widths preferred for lengths over 60 feet.
 - The underpass as well as the trail approach should have a centerline stripe even if the rest of the greenway trail does not have one.
 - Underpasses work best with favorable topography when they are open and accessible, and exhibit a sense of safety.
 - Underpasses should have a daytime illuminance minimum of 10 foot-candles achievable through artificial and/or natural light provided through an open gap to the sky
- Proper drainage must be established to avoid pooling of stormwater, however, some underpasses can be designed to flood periodically. Where appropriate, incorporate trench drains at the tunnel entrance to intercept water. Provide a 2% minimum longitudinal slope for positive drainage.
 - Post advanced warning signage on opposite ends of the underpass approach with information on visibility, and other safety regulations.
 - Headwalls with wing walls are required at both ends of the tunnel.
 - Convex mirrors should be provided at blind corners and at the approaches to underpasses with poor sight lines.



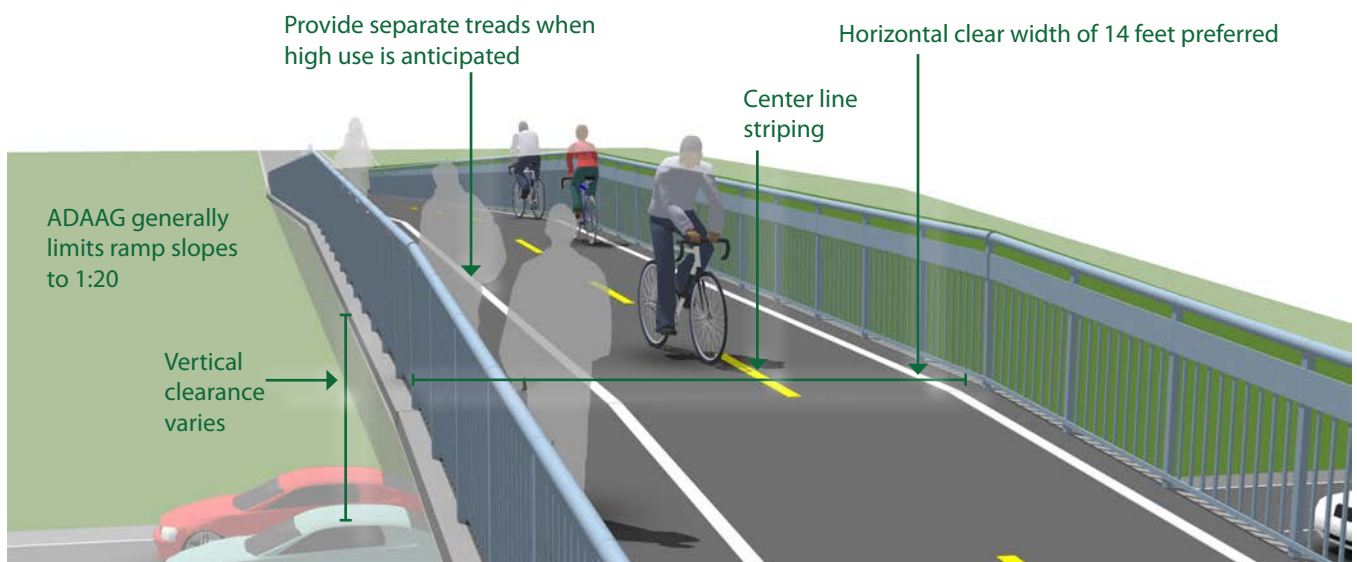
Greenway Trail Overpass

Greenway trail overpasses are most often used to provide user access over large man-made features such as highways and railroads. Safety should be the primary consideration in overpass design.

Specific design and construction specifications will vary for each overpass and can be determined only after all site-specific criteria are known. A 'signature' bridge should be considered in areas of high visibility, such as over major roadways in Raleigh. While often more expensive, a more artistic overpass will draw attention to the CAG System, and could serve as a regional landmark. Greenway trail overpasses are prohibitively expensive and should only be placed in areas of substantial need.

Guidance

- Ten foot minimum clear width, 14 feet preferred. A separate 5 foot pedestrian area may be provided for facilities with high anticipated use, such as Cross City Greenway Trails or Greenway Collectors.
- Ten foot minimum vertical clearance on overpass decking. Vertical clearance from bridge cords to roadway will vary based on roadway type.
- When bridging NCDOT-owned roadways, air space permits and other encroachment approvals will be required.
- Overpass decking should include centerline striping.
- Always consult a structural engineer before completing bridge design plans, before making alterations or additions to an existing bridge, and prior to installing a new overpass.
- ADAAG strictly limits ramp slopes to 5 percent (1:20) with landings at 400 foot intervals, or 8.33 percent (1:12) with landings every 30 feet. See *Accessible Greenway Trail Design* guidelines for more information.
- Handrails must be of uniform height, no less than 34 inches and no more than 38 inches in height from the finish surface of the ramp slope. Refer to local or state jurisdiction for guardrail specifications.
- Vertical woven wire curved fencing can be installed to protect both users and motorists below. Refer to local specifications for material and vertical height requirements.



Section 3.5 | Amenities

Overview

When designing functional, attractive, and inviting greenway trails, the small details matter. Elements such as a lighting fixtures, public art, benches, and other amenities help create a unique identity for each greenway trail within the CAG System. It is important that these details work together to create a complete experience for all users.



Amenity area with dedication signage along House Creek Trail

Trash and Recycling Receptacles

Trash and recycle receptacles provide for proper maintenance and appearance of the greenway trail system. For recycling receptacles, signage should be provided indicating what recyclables are accepted. Consider including educational signage about the importance of recycling and the environmental benefits. Trash and recycling receptacles should be prioritized along Cross City Greenway Trails, Greenway Collectors, and Neighborhood Greenway Trails.

Guidance

- Locate receptacles at each trailhead and each seating area (one per every one picnic table, one per every two benches).
- In areas with adequate sunlight, consider compacting receptacles for trash and recyclables that use smart technology (such as Big Belly®).
- Placement of other receptacles will depend upon the location of concessions, facilities and areas of group activities.
- Receptacles need to be accessible to maintenance personnel and greenway trail users.
- Receptacles should be selected using the following criteria:
 - Expected trash/recycling amount
 - Maintenance and collection program requirements
 - Types of greenway trail classification
 - Durability
 - Animal proof
- Receptacles should be set back a minimum of 3 feet from the edge of the greenway trail.



Restrooms

Public restrooms are one of the most critical building amenities because they need to be responsive to a wide range of human needs and abilities. Careful consideration should be given to a number of factors before locating restrooms, including available land, size of trailhead, existing restroom facilities within the within the PRCR system, utility availability, and user need.

Prior to undertaking any restroom building design, consultation with a structural and civil engineer, state building codes, health and safety codes, ADAAG and Public Rights-of-Way Accessibility Guidelines (PROWAG) standards, and local development codes (UDO) is required. The space required for each restroom building depends on the number of toilets to be provided.

Restrooms require considerable maintenance and service. Access to these resources should be a strong consideration when planning for restroom buildings.

Guidance

- Local, state, and federal codes take precedence for all restroom facilities.
- Prioritize location of restrooms at trailheads within existing parks and review gaps for placement at other trailheads or locations within the system.
- Restroom structures should be located adjacent to vehicular access points for security, maintenance, and access to water and sewer (unless they are self-composting).
- Restrooms should also make use of natural light and ventilation to the extent possible.
- Place bicycle parking close to restroom structures so that bicyclists do not impede greenway trail access. Inadequate bicycle parking encourages informal propping of bicycles at or against restroom buildings.
- Provide restroom facilities that are durable and resistant to vandalism.
- Always provide restroom facilities outside of floodprone areas.
- Where other restroom facilities are available within the park and greenway trail system, use wayfinding signage along greenway trails to direct users appropriately.
- Composting toilets should be considered in remote areas or where utility connections are unavailable.



Worthdale Restroom

Drinking Fountains

Drinking fountains provide opportunities for users to replenish fluids and potentially extend their trip. Access to City water service must be available. Review Regulatory Flood Protection Elevation prior to locating.

Guidance

- Locate drinking fountains at least 5 feet from greenway trail edge.
- Locate drinking fountains near restrooms, at trailheads, parks and other public gathering places along the greenway trail.
- Standard and accessible fountains should be installed to accommodate all greenway trail users.
- Consider grouping amenities together (seating, bicycle parking, drinking fountains, and bicycle repair stations) at a rest stop or comfort station. Consider prioritizing these groupings at Cross City and Collector Trails.
- Drinking fountains should be placed on a well-drained surface (2 percent sloped concrete slab).
- Consider the use of durable and vandalism-resistant materials such as steel, or stone.
- Drinking fountains must be ADAAG compliant; see *Accessible Greenway Trail Design* guideline, p. 61, for more information.

Bicycle Repair Stations

Bicycle repair stations are small kiosks designed to offer a complete set of tools necessary for routine bicycle maintenance.

Popular locations for placement include major or minor trailheads and rest stops along CAG trails.

Guidance

- Bicycle repair station tools are secured by high security cables, but will still be an attractive target for theft. Proper placement of kiosks in areas of high activity is one key strategy to reduce potential vandalism.
- Consider grouping repair stations together with other amenities (seating, bicycle parking, and drinking fountains) at a rest stop along Cross City Greenway Trails.



Bicycle Parking

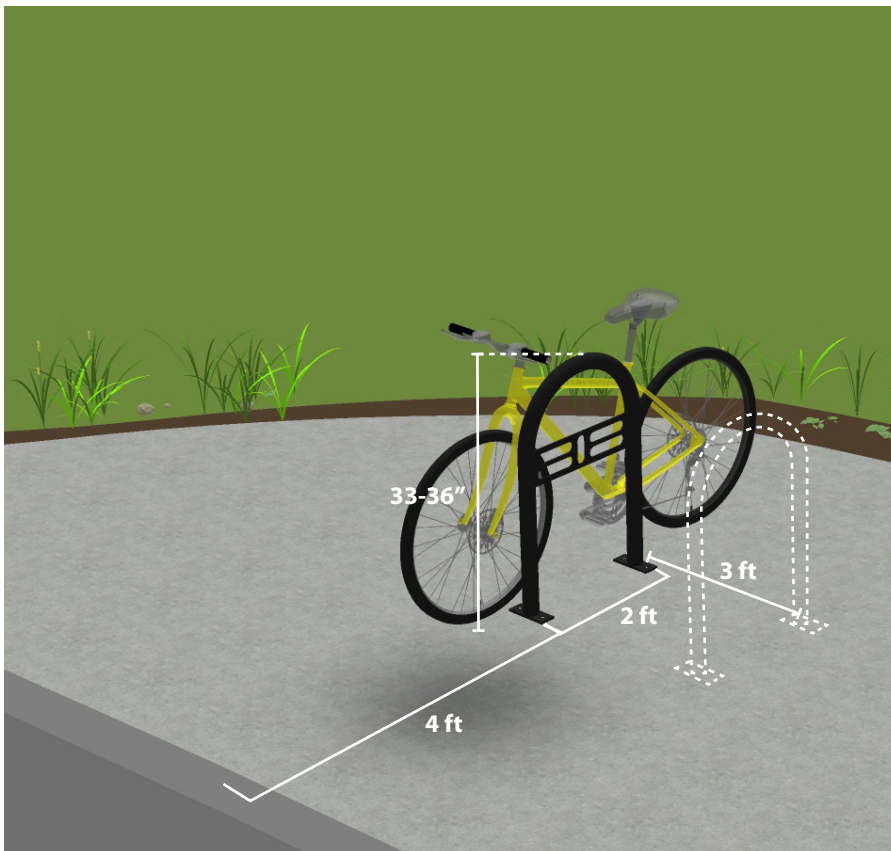
Bicycle parking should be as convenient as the majority of automobile parking and should be easily accessible from the associated greenway trail. Entrances and exits should be designed to minimize conflict with greenway trail user traffic patterns.

Bicycle parking should be located on a hardscape surface and not be located directly in front of other greenway trail amenities. Ideal rack location should be parallel along the greenway trail approach. Parking should be located no more than 25 feet from ingress/egress and at least 5 feet from the edge of greenway trail to avoid traffic conflict. Location should be highly visible.

Consideration should be given to avoid emergency ingress/egress, service access, and vehicular conflict areas.

Guidance

- Locate bicycle racks at restrooms, select trailheads, points of interest, and rest stops.
- The bicycle rack should support the bicycle in at least two places, preventing it from falling over.
- The bicycle rack should allow locking of the frame and one or both wheels with a U-lock.
- When installing racks on concrete surfaces, use 3/8 inch anchors to plate mount. Shim as necessary to ensure vertical placement.
- When installing racks on pavers or other non-stable surfaces, embed into base. Core holes no less than 3 inches in diameter and 10 inches deep.
- Ensure the rack is securely anchored to ground.
- Consider bicycle racks that resist cutting, rusting, and bending or deformation.



MUTCD D4-3

Signage may be desired to direct users to bicycle parking areas

Seating

Seating along greenway trails provides a place for users to rest, congregate, contemplate, or enjoy art, nature, and interpretive elements throughout the CAG System. Benches can be designed to create identity along the greenway trail or be strictly utilitarian. Picnic tables provide places for greenway trail users to congregate for meals or to relax.

Guidance

- Locate benches and other site furniture a minimum of 3 feet from the edge of the greenway trail.
- Locate benches along the greenway trail where appropriate, or where there is a demand by users. Providing seating at one mile gaps is the goal. Seating within 1/2 mile of trailheads is recommended.
- Provide benches and picnic tables in areas that provide interesting views, are close to an interpretive element, and offer shade or shelter from seasonal winds.
- Drainage should slope away from the bench and the greenway trail.
- Locate benches a minimum of 4 feet from restrooms and drinking fountains and a minimum of 2 feet from trash and recycling receptacles, lighting poles, and sign posts.
- Wheelchair access should be possible at some picnic tables and alongside benches. Provide access with a hardened surface such as concrete or asphalt.
- Seating should be securely anchored to the ground. Consider durable materials or native materials such as boulders that are vandalism-resistant.



Public Art and Sculpture

Public art engages the community through artists' work and creates a memorable experience for greenway trail users. Art and sculpture can create an identity for the greenway trail and strengthen the emotional connection between the CAG System and its users. Depending on the scale and form, it can become an "event" in itself and serve as a public attraction.

Public art can be aesthetic and/or functional, and double as sitting or congregational areas. Memorable installations can act as landmarks and serve as valuable wayfinding tools. Public art can be a device for telling a compelling and memorable story about the greenway trail and area history.

Work with the City's Public Art Policy and the Raleigh Arts Commission when incorporating art along greenway trails.

Guidance

- Artists can be commissioned to provide art at one or multiple locations along CAG trails.
- When appropriate, artists could be engaged as part of the corridor planning and development process.
- Artists should be encouraged to produce artwork in a variety of materials for sites along the corridor.
- When appropriate, consider developing greenway furnishings and amenities with artistic intent. Key locations such as turns or landscape changes could be areas to highlight through the inclusion of public art. Consider how to provide continuity between elements while maintaining the unique styles of multiple artists.
- Provide art displays on greenway trails with anticipated high use and user exposure.
- Consider community based art and temporary installations.



North Carolina Art Museum Park



Temporary organic art sculpture along Reedy Creek Trail

Lighting

Lighting for greenway trails should be analyzed on a case-by-case basis with full consideration of the maintenance commitment lighting requires. In general, lighting is not appropriate for greenway trails in remote areas, trails with low use, or where there is little to no development.

Lighting can improve visibility along the greenway trail and intersection crossings at night for commuters. If a greenway trail is determined to be unlit and closes at sun down, extended hours for commuters should be considered, particularly during winter months when trips to and from work are often made before sunrise and after sunset. Lighting may also be necessary for day-time use in greenway tunnels and underpasses.

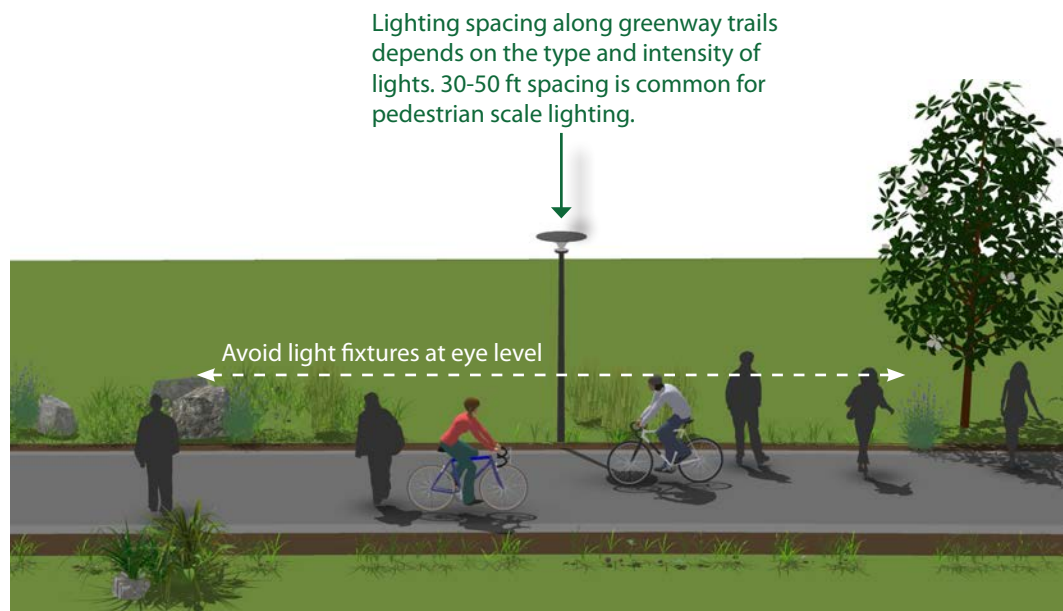
Prior to designing or installing lighting, review the current Raleigh UDO for limitations and guidance on lighting.

Guidance

- Recommended locations for lighting include the following:
 - Trailheads and parking areas
 - Restroom facilities
- Major trailhead intersections to use as a navigation aid
- Entrances and exits of bridges and underpasses and in tunnels, see pg 80
- Street crossings
- Low-cost light emitting diodes (LED) offer a wide range of light levels and can reduce long term utility costs.
- Design lighting levels appropriate to each situation.
- Greenway trail lighting should be at pedestrian scale.
- Solar powered lighting is available where utility collection is difficult or when alternative energy sources are desired.
- Avoid light fixtures at eye level that could impair visibility.
- Per the Raleigh UDO, no direct glare or excessive illumination on to adjacent properties, streets, or sidewalks is permitted.
- Dependent upon trail hours, consider uses in urban and/or commercial land use areas.



Solar Power with LED



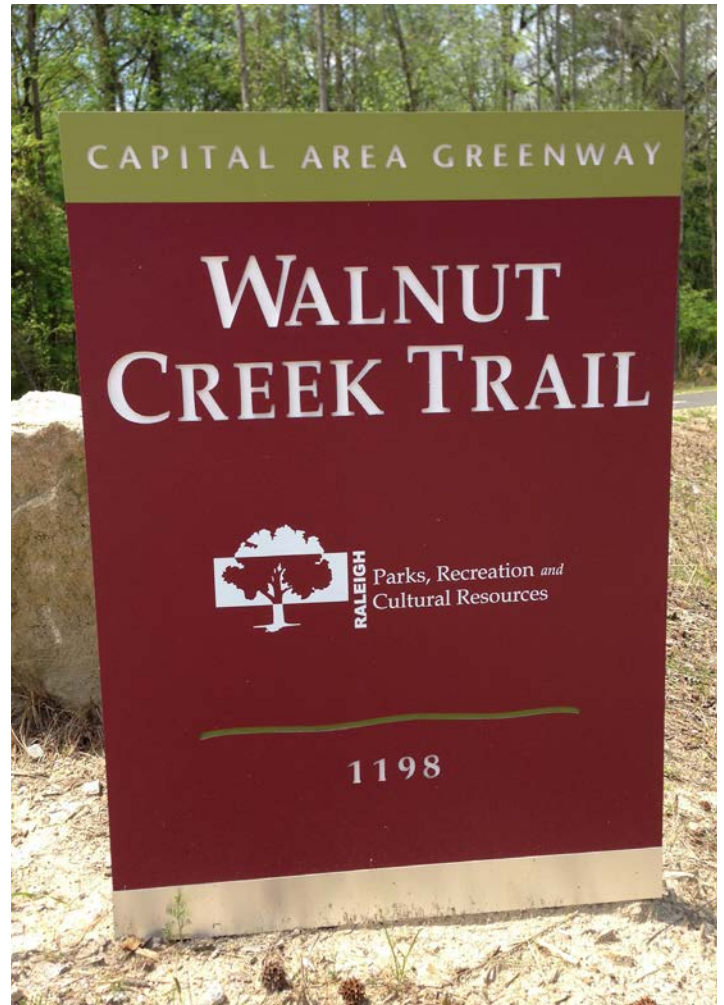
Section 3.6 | Signage and User Regulation

Signage Overview

In 2006, a Master Sign Program was developed for the CAG System. The goal of the updated sign program is to provide a sense of identity and utility for the existing greenway trail network. Signage types include informational, directional, regulatory, confidence markers, access identification, and interpretive panels. The program adheres to a consistent, selective, and strategic manner so as not to clutter or dominate the visual character of the greenway trails.

The adopted Master Sign Program includes signage families, dimensions, placement guidance, and other standards specific to the CAG System. The Master Sign Program should be used for all proposed greenway trails, and over time, installed along all existing facilities.

An action item in the System Plan has identified the need to update this Master Sign Program to include identified needs during the Needs Assessment in the short term, 1-5 years. The guidance in this section identifies the specific sign direction unique to the specific trail classifications as well as signage not included in the original Master Sign Program.



Trailhead signage at Walnut Creek Trail

Destination/Directional Signs

The ability to navigate through a city is informed by landmarks, natural features, and other visual cues. Wayfinding signs throughout the CAG System indicate:

- Direction of travel
- Location of destinations
- Location of access points

These signs increase users' comfort and accessibility to the greenway trail network. Wayfinding signage can serve many purposes including:

- Helping to familiarize users with the greenway trail system
- Helping users and emergency responders identify locations, in case of emergency on the trails.

- Helping users identify the best routes to destinations
- Helping overcome a “barrier to entry” for people who do not use the greenway trail system
- Helps users find access points to the greenway trail system

Wayfinding signs also visually cue motorists that they are driving near a greenway trail corridor and should use caution. Signs are typically placed at key locations leading to and along routes, including the intersection of multiple routes.

Classifications	Destinations	Information
Cross City, Greenway Collector, Collector Loop, Neighborhood Greenway Trail	Parks, Bike Shops, Shopping Centers, Employment Centers	Time or distance to destination



Regulatory Signs

Regulatory signs give a direction that must be obeyed, and apply to intersection control, speed, vehicle movement and parking. The adopted Master Sign Program includes regulatory signs within its signage family. The examples below are types of regulation that could be integrated into the Master Sign Program.

Guidance

- Smaller scale signs or plaques may be used for greenway trail applications.
- See the MUTCD 9B for a detailed list of regulatory sign application and guidance.

Classifications	Location	Displayed
Cross City, Greenway Collector, Collector Loop, Neighborhood Greenway Trail	per MUTCD	Speed, regulatory, and rules



R1-1



R1-2



R5-3



R9-7



R15-8

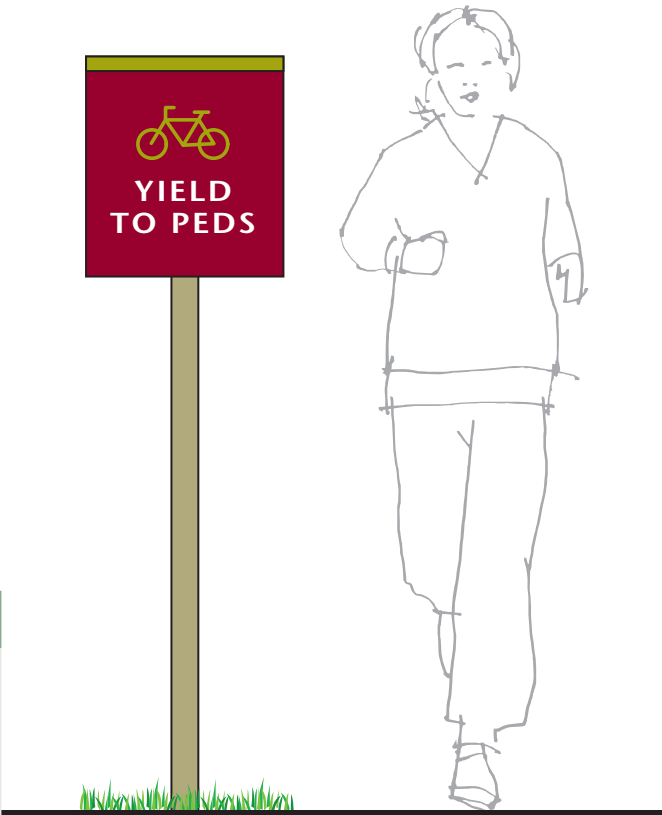
Etiquette Signage

Informing greenway trail users of acceptable etiquette is a common issue when multiple user types are anticipated. Yielding the right-of-way is a courtesy and yet a necessary part of a safe greenway trail experience. The message must be clear and easy to understand. The most common greenway trail etiquette systems involve yielding of bicyclists to pedestrians.

Guidance

- Trail etiquette information should be posted at access points and periodically along the greenway trail.

Classifications	Location	Displayed
Cross City, Greenway Collector, Collector Loop, Neighborhood Greenway Trail	at access points and periodically on greenway trail	trail user guidance, safety recommendations, etiquette



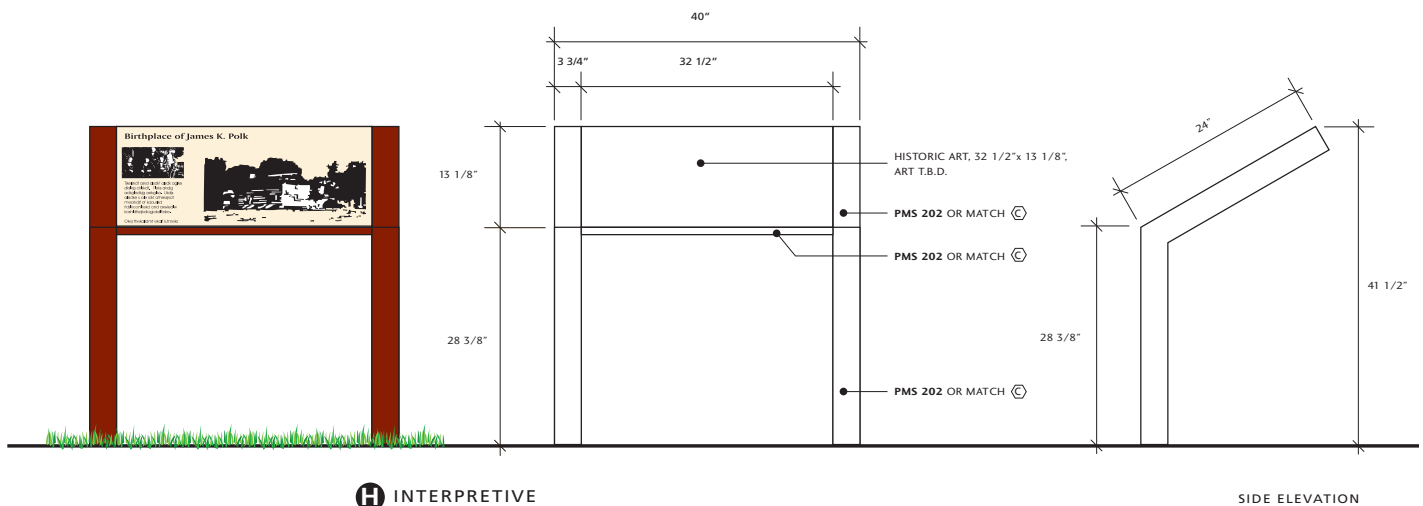
Interpretive Signage

Interpretive displays provide greenway trail users with information about the surrounding environment or site, wildlife, vegetation, history and the significance of cultural elements. Interpretive displays may also be combined with public art and sculpture opportunities along the greenway trail. The adopted Master Sign Program includes interpretive signs within its signage family.

Classifications	Location	Displayed
Cross City, Greenway Collector, Collector Loop	dependent on surrounding elements	Ecological, cultural, historical elements

Guidance

- Consider the character of the greenway trail and surrounding elements when designing these signs.
- Work with experts specific to the information you are conveying on the signs such as historians, ecologists, or artists.
- Separate interpretive signage panels from the main greenway trail circulation so that users can stop and not impede traffic.
- Consider including interpretive signage at rest stops or areas of congregation.
- Panels must be ADA accessible.
- Consider use of technology for interpretation.



Informational Kiosks and Message Centers

Kiosks and message centers provide greenway trails users with information to orient themselves, learn of areas of interest, read the rules and regulations of the greenway trail system, and find the hours of operation. The adopted Master Sign Program includes informational kiosk signage within its signage family.

Classifications	Location	Displayed
Cross City, Greenway Collector, Collector Loop	Trailheads and major intersections	Maps, rules and regulations, hours of operation

Guidance

- Install kiosks at each major and minor trailhead.
- The entire CAG System, rules and regulations, and ADAAG accessibility advisories should be included on each kiosk.
- When locating kiosks next to parking facilities, set the units back far enough from traffic and protect the support posts or structure with appropriately sized barriers.
- Provide ADA access using established guidelines for visual height, clearance, and surface type where kiosks are located.
- Evaluate the use of emerging technology options for implementation of greenway information and messages as part of the signage program.



Greenway trail kiosk Walnut Creek Trail

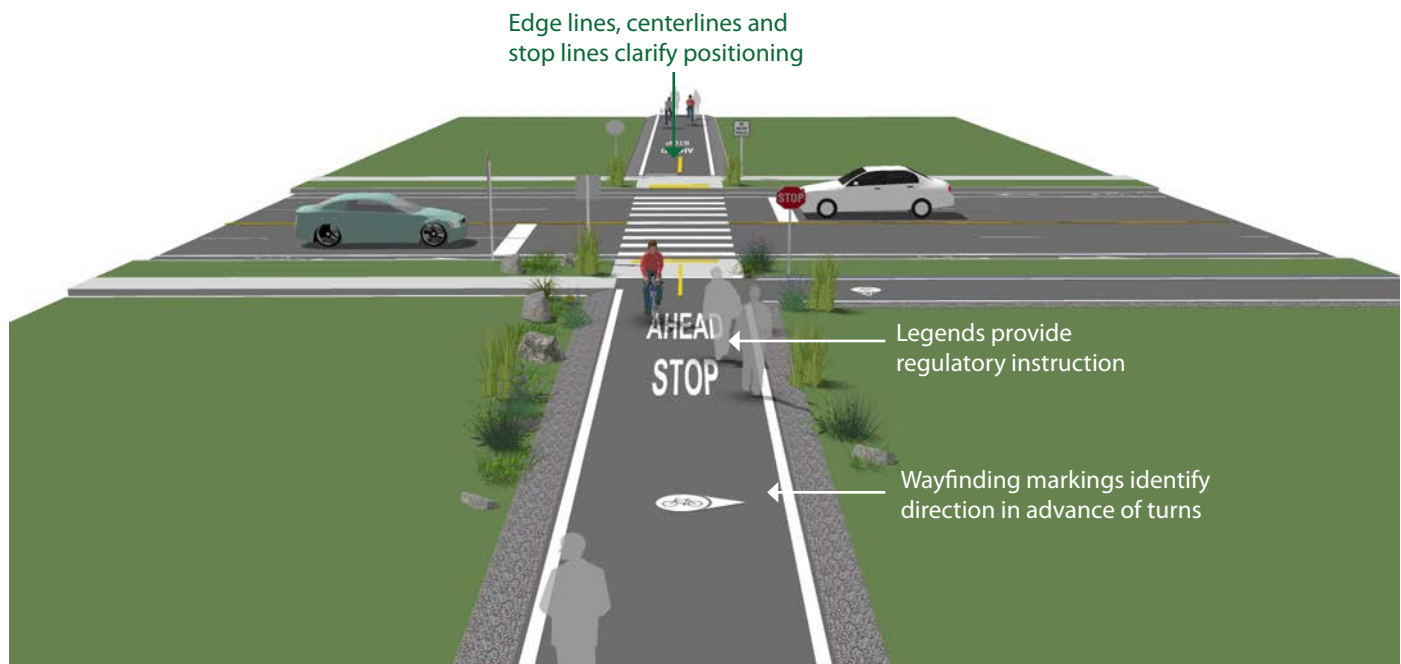
Pavement Markings

Pavement markings are commonly used to reinforce signs along a greenway trail, but they should not be used to replace signs altogether. Center line striping is the most common form of pavement marking, but warning, regulatory, and directional messages can be used. Use pavement markings sparingly and only where necessary to attract additional attention to a possible problem area.

Classifications	Location	Displayed
Cross City, Greenway Collector, Collector Loop, Neighborhood Greenway Trail, Greenway Connector	as needed to supplement signage	Road name intersection identification, directional

Guidance

- Do not use pavement markings at critical stopping or turning points.
- High visibility thermoplastic material is the most durable and visible. Use white or yellow.
- Pavement markings to consider include “Stop,” “Yield,” and “Slow.”
- Place messages at greenway trail access points, prior to roadway intersections or bridges, or near intersections with converging greenway trails.
- When striping is required, use a 4 inch dashed yellow centerline stripe with 4 inch solid white edge lines.
- Solid centerlines can be provided on tight or blind corners, and on the approaches to roadway crossings.
- Non-slip or non skid pavement marking or striping materials should be used in all cases when trails are wet.
- Consider using at road intersections for road name identification.



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Lake Johnson

Appendix

Section 4.1 | Glossary of Terms

The following list is comprised of common terms, acronyms and concepts used in greenway trail planning, design and operation.

AASHTO – American Association of State Highway and Transportation Officials

Accessible route – A continuous route on private property that is accessible to wheelchair users and those with disabilities. There must be at least one accessible route linking the public sidewalk, greenway trail, and parking area.

ADA – Americans with Disabilities Act of 1990; broad legislation mandating provision of access to employment, services, and the built environment to those with disabilities.

ADAAG – Americans with Disabilities Act Accessibility Guidelines published by the U.S. Access Board.

At-grade crossing – A junction where greenway trail or sidewalk users cross a roadway over the same surface as motor vehicle traffic, as opposed to a grade-separated crossing where users cross over or under the roadway using a bridge or tunnel.

Audible pedestrian signals – Pedestrian signal indicators that provide an audible signal to assist visually impaired pedestrians in crossing the street.

Bicycle facilities - A general term used to describe all types of bicycle-related infrastructure including greenway trails and other provisions to accommodate or encourage bicycling, including bike racks and lockers, greenway trails, and showers at employment destinations.

Bollard – Post used to restrict motor vehicle use of space dedicated to bicyclists and/or pedestrians.

Clearance interval – The length of time that the DON'T WALK indication is flashing on a pedestrian signal indication.

Clearance, lateral – Width required for safe passage of users as measured on a horizontal plane.

Clearance, vertical – Height required for safe passage of users as measured on a vertical plane.

Crosswalk – Any portion of a roadway at an intersection or elsewhere that is distinctly indicated for pedestrian crossing. Where there are no pavement markings, there is a crosswalk at each leg of every intersection, defined by law as the prolongation or connection of the lateral lines of the sidewalks.

Curb ramp – A combined ramp and landing to accomplish a change of level at a curb in order to provide access to pedestrians using wheelchairs. Also known as a wheelchair ramp.

Directional signs – Signs typically placed at road and greenway trail junctions (decision points) to guide users toward a destination or experience.

Geometry - The vertical and horizontal characteristics of a transportation facility, typically defined in terms of gradient, radius, and superelevation.

Grade separation - Vertical separation of travelways through use of a bridge or tunnel so that traffic conflicts are minimized.

Grade-separated crossing – A bridge or tunnel allowing pedestrians and bicyclists to cross a major roadway without conflict.

Greenway - Linear, natural areas that are primarily unassigned open space, providing valuable buffers, environmental preserves, or wildlife corridors.

Greenway trail – A paved or unpaved right-of-way that permits more than one type of user.

Medians – Area in the center of the roadway that separates directional traffic; may provide a striped crossing and halfway point for pedestrians (also can be effective traffic calming design). Medians may be level with the surrounding roadway or “raised” using curb and/or gutter. Medians may include landscaping, concrete, paint/striping or any combination thereof.

MUTCD – Manual on Uniform Traffic Control Devices

NACTO - National Association of City Transportation Officials

Pavement marking – An assortment of markings on the surface of the pavement that provide directions to motorists and greenway trail users as to the proper use of the road or greenway trail (the MUTCD determines these standard markings).

Pedestrian – a person afoot; a person operating a pushcart; a person riding on, or pulling a coaster wagon, sled, scooter, tricycle, bicycle with wheels less than 14 inches in diameter, or a similar conveyance; a person on roller skates, skateboard, wheelchair or child in a stroller.

Pedestrian signal indication – the lighted WALK/ DON'T WALK (or walking man/hand) signal that indicates the pedestrian phase.

PROWAG – Public Rights-of-Way Accessibility Guidelines published by the U.S. Access Board.

Refuge islands – Corner raised triangles or medians, used by pedestrians and bicyclists at intersections or mid-block crossings for assistance with crossing wide streets, especially where motor vehicle right turn lanes exist.

Right-of-way (ROW) - The right of one vehicle, bicycle or pedestrian to proceed in a lawful manner in preference to another vehicle, bicycle, or pedestrian. Also the strip of property in which a transportation facility or other facility is built.

Sidewalk – An improved facility intended to provide for pedestrian movement; usually, but not always, located in the public right-of-way adjacent to a roadway. Typically constructed of concrete.

Sight distance - The distance a person can see along an unobstructed line of sight.

Traffic control devices - Signs, signals or other fixtures, whether permanent or temporary, placed on or adjacent to a travelway by authority of a public body having jurisdiction to regulate, warn, or guide traffic.

Traffic volume - The number of vehicles that pass a specific point in a specific amount of time (hour, day, year).



AECOM

