WalkBikeNC

NORTH CAROLINA STATEWIDE PEDESTRIAN AND BICYCLE PLAN

Plan Appendix

9.1 Benefits of Walking and Bicycling

Spring Lake, NC

Benefits of Walking and Bicycling

Bicycling and walking facilities provide a wide range of benefits to individuals, their communities, and the surrounding environment. This report summarizes the many types of benefits that can be gained by accommodating pedestrians and bicyclists within North Carolina's transportation network. The benefits of walking and bicycling are described here according to the five vision themes of the plan: Safety, Health, Economics, Mobility, and Environment.

Safety

Investments in walking and bicycling facilities have a direct, positive impact on safety.

Design Treatments, Traffic Calming, & Reduced Collision Risk

Safety benefits are some of the most important benefits of walking and bicycling improvements. Studies show that installing pedestrian and bicycle facilities directly improves safety by reducing the risk of pedestrian-automobile and bicycle-automobile crashes. Increased enforcement has also been shown to reduce crash risk for pedestrians and bicyclists. The following is a table of common pedestrian and bicycle design treatments and interventions and their resulting collision rate reductions:

In this Chapter

Design Treatment	Crash Reduction Rate
Provide minimum 4' paved shoulder to avoid walking along roadway	71% (pedestrian crashes)
Increase enforcement to reduce speed	70% (pedestrian crashes)
Install sidewalk to avoid walking along roadway	65-89% (pedestrian crashes)
Install pedestrian refuge islands	56% (pedestrian crashes)
Install raised median + crosswalk	46% (pedestrian crashes)
Improve lighting at intersections	42% (pedestrian injury crashes)
Provide bike lanes	36% (bicycle crashes)
Provide a bicycle box (advance stop bar to leave dedicated space for cyclists)	35% (bicycle crashes)
Add exclusive pedestrian phasing to signalized intersection	34% (pedestrian crashes)
Restrict parking near intersections	30% (pedestrian crashes)
Convert unsignalized intersection to roundabout	27% (pedestrian crashes)
Improve/install pedestrian crossing	25% (pedestrian crashes)
Install pedestrian countdown signal heads	25% (pedestrian fatal/injury crashes)
Increase enforcement related to motorist yielding in marked crosswalks + education campaign	23% (pedestrian crashes)
Install pedestrian overpass/underpass at unsignalized intersection	13% (pedestrian crashes)

Federal Highway Administration. (2008). "Desktop reference for crash reduction factors."

Infrastructure for walking and bicycling can also help to reduce collisions and resulting injuries and fatalities by contributing to traffic calming measures. Installing bicycle lanes, sidewalks, or other improvements can help to reduce vehicle travel lane width and make pedestrians and bicyclists more visible to drivers. These changes to accommodate pedestrians and bicyclists are often effective at slowing traffic to a people-friendly speed and can help to ensure speed limit compliance by matching the physical design of the road to the posted speed limit. Slowing traffic by even 10 miles per hour can greatly reduce the risk of a pedestrian fatality in the event of a collision:[1]

Vehicle-Pedestrian Collision Speed	Pedestrian Fatality Rate
40 mph	85%
30 mph	45%
20 mph	5%

UK Department of Transportation. (1987). "Killing speed and saving lives"

Including designated facilities for pedestrians and bicyclists provides safety benefits to all users. Streets with bike lanes have been shown to be safer not just for bicyclists, but for pedestrians and drivers as well.[2] Streets without bicycle facilities pose a greater collision risk: The most bike crashes happen on major streets without bicycle facilities, followed by minor streets without facilities, bike paths, and then bike lanes.[3] Furthermore, installing bike lanes increases cyclist predictability, reduces wrong-way riding and sidewalk riding, and increases traffic control compliance.[4,5]

Safety in Numbers

Not only can pedestrian and bicycle facilities reduce injuries and save lives, but they can also help a greater number of people feel comfortable taking a walk or riding a bike in their community. As walking and bicycling rates increase, streets become safer for pedestrians and bicyclists. This is known as the "safety in numbers" principle: When walking and bicycling rates double, per-kilometer **pedestrian-motorist collision risk decreases by 34%.**[6] Moreover, cities with high bicycling rates tend to have lower crash rates for all road users.[7] In Minneapolis, bicycle commuting increased by 100% between 2003 and 2007, and bicycle crashes have declined an average of 20% every year since 2000.[8] Bicycling rates in New York City increased 289% between 2001 and 2011, and over the same period safety increased for all road users. Traffic fatality rates decreased to their lowest recorded levels in a century while bicycle injury and fatality rates remained unchanged despite a near-quadrupling in the number of riders.[9]

Improved environments for walking and bicycling therefore contribute to the safety of the transportation system in two important ways: by directly reducing collision risk and by making walking and bicycling more visible and more common modes of travel. Safe places to walk and bike are especially important for non-driving populations who require a safe, reliable, and convenient transportation alternative. Non-drivers include children and teens, the elderly, low-income populations, and people with disabilities, among others. These non-driving groups, which together make up about one-third of the U.S. population, are the most at risk when walking and bicycling accommodations are lacking. Integrating pedestrian and bicycle treatments as a basic element in the transportation network helps to make streets safer for everyone.

Health

Providing facilities for walking and bicycling will allow North Carolinians to incorporate physical activity into their daily lives through active transportation, recreation, and exercise.

Increased Physical Activity and Lower Health Risks

Physical activity level has been identified as a key indicator of health, with lower physical activity rates associated with an increased risk for many different diseases and health conditions. Measures that provide opportunities for physical activity are increasingly important in North Carolina, where more than 65 percent of the population is overweight or obese.[10] The lack of physical activity in children and youth has been identified as one of the greatest risk factors for obesity, diabetes, and heart disease in childhood and later in life.[11] It also ranks as the third-highest cause of preventable death in the United States, behind only tobacco use and poor nutrition.[12]

The Centers for Disease Control and Prevention recommend at least 150 minutes (2.5 hours) of moderate exercise each week, yet many people do not have convenient access to places where they can be physically active. Walking and bicycling are some of the most basic forms of physical activity, and improving facilities for these activities and linking to parks and playgrounds would help to better connect communities to convenient recreation and exercise options. These connections also make it possible to take short trips without needing to get in the car, thereby incorporating physical activity into daily life. Regular physical activity such as walking and bicycling:[13]

- Reduces the risk and impact of cardiovascular disease and diabetes
- Reduces the risk of some types of cancer
- Controls weight
- Improves mood
- Reduces the risk of premature death

In a 2008 study, adolescents who bicycle were found to be **48% less likely to be overweight** in young adulthood.[14] Walking and bicycling have been shown to have longevity benefits as well. An adult cyclist typically has a level of **fitness equivalent to someone 10 years younger**, and a **life expectancy two years longer** than average.[15,16] Being physically active for even 10 minutes at a time can produce health benefits.[17] A study on the Charlotte LYNX rail line found that nearby residents who switched from driving to light rail were **on average six pounds lighter** than nearby residents who continued to drive, due to walking to and from transit stops.[18] These health benefits and other benefits of walking and bicycling were found to **outweigh the risks by as much as 77 to 1**.[19]

Health Benefits of Green Infrastructure

A growing body of research shows that green infrastructure such as parks, open space, and greenways can generate health benefits. A 2010 study found that, compared to city environments, exposure to forest environments produced lower concentrations of the stress hormone cortisol, a lower pulse rate, and lower blood pressure in test subjects -- all physiological signs of reduced stress.[20]

Lower Health Care Costs

The health and well-being benefits of increased physical activity also have a positive impact on individual and societal health costs. Each year North Carolinians spend $24 billion on health care related to lack of physical activity, diabetes, excess weight, and poor nutrition.[21] Walking and bicycling act as preventative measures against these and other conditions, potentially saving individuals and families thousands of dollars on health care. A Portland, Oregon study on the benefits of bicycle projects found that by 2040, Portland's investment of $138-605 million in bicycling will have saved **$388-594 million in health care costs and $7-12 billion in statistical lives.**[22] Improving conditions for walking and bicycling in North Carolina will provide safe and accessible physical activity opportunities and help to mitigate the health, health care, and well-being costs of lack of exercise.

Economy

> *Walking and bicycling investments result in increased property values and economic development.*

Walking and bicycling trails and paths are in high demand. According to the National Association of Homebuilders, trails are consistently ranked one of the most important community amenities by prospective homebuyers, above golf courses, parks, security, and others.[23] Seventy percent of Americans say that having bike lanes or paths in their community is important to them, and two-thirds of homebuyers consider the walkability of an area in their purchase decision.[24,25] This preference for communities that accommodate walking and bicycling is reflected in property values across the country.[26]

Increased Property Values

A study of over 90,000 U.S. home sales found that better walking conditions were correlated with higher housing prices in 13 of the 15 housing markets studied, controlling for other factors that influence housing value. The results showed that **houses in walkable neighborhoods have property values $4,000 to $34,000 higher** than houses in areas with average walkability.[27] In Apex, the Shepard's Vineyard housing development **added $5,000 to the price of 40 homes adjacent to the regional greenway** – and those homes were still the first to sell.[28] A similar study in Ohio found that the Little Miami Scenic Trail **increases single-family home property values by $7.05 for every foot** closer a property is located to the trail.[29] These cases show the tangible economic benefits that walking and bicycling projects have for homeowners, and the premium that people are willing to pay to live in places that accommodate walking and bicycling.

Tourism & Economic Development

Investing in walking and bicycling paths and lanes also stimulates the local economy by generating tourism revenue, supporting local business, and creating jobs.[30,31,32] Many tourists seek out places that they can experience outside of their cars, where they feel comfortable walking and bicycling to explore a new area. In the Outer Banks, **a one-time public investment of $6.7 million** in paths and wide paved shoulders has **generated $60 million in annual tourism revenue** from bicyclists. An estimated 1,400 jobs are created or supported each year with expenditures from bicycle tourists. Moreover, quality bicycling conditions played a major part in many tourists' choice of destination and duration of stay: **43% of visitors surveyed considered bicycling in their decision to vacation** in the Outer Banks, while 53% reported bicycling as a major factor in deciding to return to the area in the future. **12% decided to stay in the area longer** because of the quality of local bicycle facilities, with an average extension of 4 days.

Similar tourism benefits are seen elsewhere in the state and around the country. An economic impact analysis of the proposed Hendersonville-to-Brevard Ecusta Rail Trail estimates that the trail will:[33]

- Support 180 jobs
- Generate $1.2 million per year in tourism revenue
- Attract 1,600 new exercisers and 20,000 new visitors to the area each year
- Generate $22 million in property value increases
- Yield $5 million per year in health care cost reductions

In San Antonio, Texas, the River Walk has surpassed the Alamo as the most popular attraction for the city's $3.5 billion tourism industry. This downtown network of walkways was created for just $425,000.[34] The 141-mile Great Allegheny Passage (GAP) trail that stretches from Pittsburgh, Pennsylvania, to Cumberland, Maryland, generated $40 million in revenue from trail users in 2008, and an additional $7.5 million in wages were attributed to the GAP.[35] These projects show the potential for relatively low-

Project	Jobs Created and/or Supported
$1M on road construction	7 jobs
$1M on bicycle facilities	11-14 jobs
Ecusta Rail Trail	180 jobs
Outer banks paths and shoulders	1,400 jobs
Great Allegheny Passage Trail	$7.5 million in wages

cost walking and bicycling improvements to generate a high return on investment, attracting homebuyers, workers, and visitors who increase local revenue and support jobs and businesses year after year.

Mobility

Walking and bicycling facilities provide efficient options for commuting and short trips.

According to the 2011 Bicycle and Pedestrian Safety Survey, at least 70 percent of North Carolinians would walk or bike more for daily trips if walking and bicycling conditions were improved. With appropriate accommodations, walking and bicycling can provide alternatives to driving for commuting to work, running errands, or making other short trips. Half of all trips made in the U.S. are three miles or less, yet 72 percent of these short trips are driven.[36] Many of these could easily be made by walking or bicycling if sidewalks, bike lanes, paths, or other facilities were provided to improve safety, efficiency, and convenience.

Trip Distance	% of Trips	Cumulative % of Trips	Minutes to Walk	Minutes to Bike
1 mile or less	28	28	15	5
1.1 - 2 miles	13	41	30	10
2.1 - 3 miles	9	50	45	15

Source: U.S. Department of Transportation and Federal Highway Administration. (2009). National Household Travel Survey.

Reduced Vehicle Miles Traveled (VMT) & Congestion

Taking short trips by foot or by bike can help to greatly reduce motor vehicle miles driven and traffic congestion. Under the Nonmotorized Transportation Pilot Program, **walking and bicycling investments averted an estimated 32 million driving miles** in four pilot communities between 2007 and 2010.[37] These individual changes in travel behavior can add up to produce significant societal benefits. An individual who shifts 160 annual trips (about three per week) averaging 2.4 miles from driving to bicycling **reduces congestion costs to other road users by approximately $216 in urban areas and about $108 in rural settings**.[38] Traffic on arterials and other streets can be mitigated as people use sidewalks, bike lanes, paths, and other alternatives to get around. Parking lots can also be made less congested by reducing crowding, circling, and waiting for open spots.

Affordable Transportation Options & Cost-Efficient Projects

Walking and bicycling are also among the most affordable forms of transportation. According to an annual study conducted by the American Automobile Association (AAA), the average cost of owning and operating one car for one year is $8,946, while walking is virtually free and owning and operating a bicycle for one year costs approximately $120.[39,40] In addition to the personal savings costs of walking and bicycling, these transportation options also produce a number of benefits for other drivers and society as a whole. A study from the Victoria Transport Policy Institute found that replacing a single car trip with a bike trip saves individuals and society $2.73 per mile in gas costs, congestion reduction, vehicle cost savings, roadway cost savings, parking cost savings, energy conservation, air pollution reduction, and traffic safety improvements.[41] These benefits and the relatively low construction and maintenance costs make walking and bicycling projects some of the most cost-effective transportation investments possible.[42,43] For the cost of 1 mile of four-lane urban highway ($50 million), an **entire network of pedestrian and bicycle facilities for a mid-sized city** could be built,[44] providing feasible travel options that increase the overall efficiency of our transportation system.

Environment

Sidewalks, bike lanes, paths, and greenway trails help to reduce vehicle emissions, fuel consumption, and congestion.

Reduction in Vehicle Emissions & Fuel Consumption

Providing safe accommodations for walking and bicycling can help to reduce automobile dependency, which in turn leads to a reduction in vehicle emissions – a benefit for North Carolinians and the surrounding environment. As of 2003, 27 percent of U.S. greenhouse gas emissions are attributed to the transportation sector, and personal vehicles account for almost two-thirds (62 percent) of all transportation emissions.[45] Primary emissions that pose potential health and environmental risks are carbon dioxide, carbon monoxide, volatile organic compounds, (VOCs), nitrous oxides (NOx), and benzene. Children and senior citizens are particularly sensitive to the harmful affects of air pollution, as are individuals with heart or other respiratory illnesses. Increased health risks such as asthma and heart problems are associated with vehicle emissions.[46]

Decreasing the dependency on daily motor vehicle trips and increasing the availability of alternative travel methods such as walking and bicycling can reduce emissions and assist in improving air quality. Replacing two miles of driving each day with walking or bicycling will, in one year, prevent 730 pounds of carbon dioxide from entering the atmosphere.[47] Other studies have likewise shown air quality benefits as a result of increased walking and bicycling rates and reduced vehicle miles traveled:

- As of 2008, roughly 9.5% of all U.S. trips are made by walking or bicycling. **A modest increase in walking and bicycling to 13% of all trips would save 3.8 billion gallons of gasoline each year and reduce CO2 emissions by 33 million tons.** A substantial increase in walk and bike rates to 25% of all trips would save 10.3 billion gallons of gasoline and prevent 91 million tons of CO2 emissions.[48]
- Minneapolis-St. Paul, MN: If bicycles were used for half of the short trips made on good weather days, the Twin Cities could prevent 300 deaths and save $57 million in annual medical costs due to reduced air pollution and increased physical activity. Collectively, 11 major Midwest cities would save $7 billion in medical costs each year and prevent 1,100 deaths.[49]
- A 5 percent increase in the walkability of a neighborhood is associated with a per capita 32.1% increase in active travel, 6.5% fewer miles driven, 5.6% fewer grams of nitrous oxides (NOx) emitted, and 5.5% fewer grams of volatile organic compounds (VOCs) emitted.[50]

By providing balanced transportation choices, citizens of North Carolina will also have a sense of contributing to the solution of reducing air and noise emissions.

Energy Conservation and Independence

According to the National Association of Realtors and Transportation for America, 89% of Americans believe that transportation investments should support the goal of reducing energy use.[51] The transportation sector currently accounts for 71 percent of all U.S. petroleum use, with 40 percent of daily trips made within two miles or less and 28 percent less than a mile.[52] Providing alternative modes of travel has the potential to reduce dependency on foreign oil and promote more energy-efficient transportation choices in communities. Most of the short trips made in the U.S. and in North Carolina are single-occupancy vehicle trips that could be made on foot or by bike with improved facilities.

The benefits of fully accommodating pedestrians and bicyclists and increased rates of walking and bicycling are diverse and substantial. While increased safety for pedestrians and bicyclists is the most apparent benefit to many, facilities that allow for safe walking and bicycling reduce the collision risk for all users and contribute valuable health, economic, mobility, and environmental stewardship benefits to North Carolinians and to our state.

Improved Water Quality and Wildlife Habitat

Pedestrian and bicycle trails are often included as part of greenway corridors, offering transportation options while also contributing to environmental quality. Greenways help link fragmented tracts of land to provide larger habitats for wildlife while also protecting sensitive natural features, natural processes, and ecological integrity. These tracts of open space also contribute to cleaner air by preserving stands of plants that create oxygen and filter air pollutants such as ozone, sulfur dioxide, carbon monoxide and airborne particles of heavy metal. Vegetation within the greenways also creates a buffer to protect streams, rivers and lakes, preventing soil erosion and filtering pollution caused by agricultural and roadway runoff.[53] Trails that are built within greenway corridors give pedestrians, bicyclists, and other non-motorized trail users access to these natural areas and provide safe off-road facilities for walking and bicycling. Greenways also provide opportunities for restoring wildlife habitat in areas that have been previously disturbed. Invasive, exotic species are often a threat and greenway maintenance is essential to remove these species.

Measured Benefits of Bicycle Design Treatments

Cycle Tracks, Protected Bike Lanes, and Buffered Bike Lanes

- Cyclists feel most secure on roads with cycle tracks and most at risk on roads with mixed traffic.[54]
- Protected bike lanes reduce the risk of cyclist injury by 90% compared to streets with parked cars and no bike facilities.[55]
- New York City: On average, protected bike lanes reduce injury crashes for all users (drivers, cyclists, and pedestrians) by 40%, with reductions of more than 50% in some cases.[56]
- Montreal: Cycle tracks were found to have a 28% lower injury rate compared to streets without bicycle facilities.[57]
- New York City: After installing parking-protected bike lanes, there was a 35% and 58% decrease in injuries to all street users on 8th and 9th Avenues, respectively.[58]
- New York City: When a protected, green-painted bike lane was installed on Columbus Avenue, bicycling increased 56% on weekdays and crashes decreased 34%.[59]
- Copenhagen: The construction of raised cycle tracks resulted in a 10% drop in the total number of accidents and 4% decrease in injuries.[60]
- New York City: When a Union Square North project added a protected bike lane, a pedestrian plaza, and simplified intersections, speeding decreased by 16% and injury crashes fell by 26%.[61]

Colored Bike Lanes

- Portland, OR: Significantly more motorists yielded to bicyclists in the bike lane after the lane was painted blue to improve visibility (92% after versus 72% before).[62]
- St. Petersburg, FL: A greater percentage of motorists yielded to bicycles after the bike lane had been painted green (98.5% after versus 86.7% before). A chi-square test revealed the differences to be statistically significant at the 5% significance level ($p < 0.001$).[63]
- Austin, TX: When a colored bike lane was installed, 78% of motorists yielded to bicyclists, compared to 63% before the treatment. The proportion of motorists who used a turn signal before crossing the lane when a bicyclist was present increased from 38% to 74% after the treatment.[64]

Bike Lanes

- New York City: Dedicated lanes added for both buses and bikes on First and Second Avenues in Manhattan led to a 177% increase in bicycle volumes and a 37% decrease in injury crashes.[65]
- Riding in a bike lane on a street with no parked cars reduces the risk of injury by about 50% compared to a street with no bike lane and parked cars.[66]
- New York City: Adding bike lanes, pedestrian refuges and crosswalks, new signals, and modified timings to Hoyt Avenue at the RFK Bridge in Queens saw a 21% decrease in crashes, 37% increase in weekend bicycle volumes, and 51% improvement in northbound travel times.[67]
- Seattle: After adding bike lanes to Stone Way North Street, bicycle traffic increased by 25%, collisions dropped 14%, and speeding decreased 80%.[68]

Shared Lane Markings

- Austin, TX: When shared lane markings were installed, "motorists were more likely to change lanes when passing, less likely to pass, and less likely to encroach on the adjacent lane when passing, all of which indicate safer motorist behavior."[69]
- San Francisco: Shared lane markings caused an increase of over 2 feet in the distance between cyclists and passing vehicles.[70]
- Chapel Hill, NC: Motorists moved away from the newly installed shared lane markings, providing bicyclists with more operating space.[71]
- San Francisco: The presence of a shared lane marking increases the distance of cyclists to parked cars by an average of 8 inches.[72]
- San Francisco: The bike-and chevron shared lane marking reduced the number of wrong-way riders by 80%.[73]

Increased Ridership with Bicycle Facilities

- Cities with more bike paths and lanes have significantly higher bicycle commuting rates than cities with few or no bicycle facilities.[74]
- Montreal: 2.5 times as many cyclists used cycle tracks compared with reference streets that lacked bicycle facilities.[75]
- Washington, DC: A study of the Pennsylvania Avenue cycle track found that bicycle volumes increased 200% after the facilities were installed. 90% of users reported feeling safer bicycling on Pennsylvania Avenue because of the new cycle track.[76]
- New York City: Women are twice as likely to use greenway paths as on-street bike lanes.[77]
- Philadelphia: After buffered bike lanes were added to Spruce and Pine streets, bicycle ridership increased by 95% and the number of bicyclists riding on the sidewalks decreased by as much as 75%.[78]
- Portland, OR: From 1992 to 2005, Portland increased its bicycle facility miles by 215%. Over the same period, bicycle commuting rates doubled.[79]

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9.2 Public Engagement

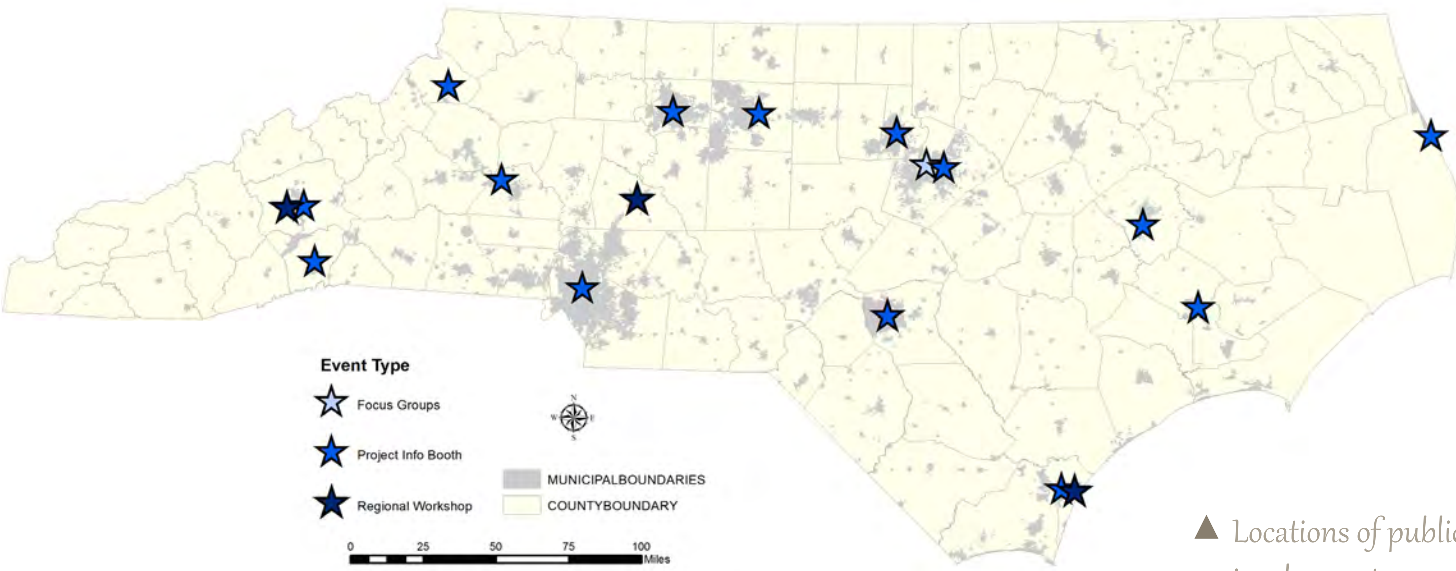
Freedom Park, Charlotte, NC

Overview

Improving avenues of communication and collaboration was a priority and goal of the *Statewide Pedestrian and Bicycle Plan*. Gathering public input from citizens and stakeholders at a statewide scale necessitated a multifaceted, creative, and diverse communications approach. A variety of strategies that speak to a large audience were used to inform the public of the plan and engage thoughtful input and collaboration. Paralleling the vision of the plan, the following strategies were executed with the appropriate message and link to one of the Plan's five pillars: Health, Safety, Mobility, Economics, and Environment.

- Project information booths at public events
- Focus Group Meetings
- Regional Workshops
- Coordination with simultaneous NCDOT pedestrian/bicycle campaigns
- Social media campaign through NCDOT
- WalkBikeNC website

In this Chapter



▲ Locations of public involvement across N.C.

Physical outreach and engagement

Project Information Booths at Public Events

In an effort to engage a diverse number of North Carolina citizens, project information booths were coordinated with 16 festivals and events happening across the state. Each booth was staffed with project consultants, maps of statewide bicycle routes, project information cards with website and social media details, and posters describing the five pillars of the plan. The scheduled events drew 600,000 citizens and project booths drew approximately 1,300 individuals.

25 planning organizations and community groups were contacted prior to the events to provide information about the project, booth location, obtain materials related to walking and bicycling in the area. Information regarding the status of existing or proposed planning projects, bike maps, hike maps, and local walking and biking clubs was provided to booth visitors. The following pages include a summary of each public event and key issues discussed with participants.

Most Common Questions, Comments and Concerns

Maps and Information

- Where can I find local or regional maps for bicycle facilities, hiking, or greenways?
- Do you have extra copies of the regional state bike route maps?

Greenways and Trails

- North Carolinians across the state are very enthusiastic about rail-to-trail and greenway projects. They asked when more of these projects would be built and where.
- Local greenways and trails don't link up; they should be connected.
- Many people do not feel comfortable riding on the road with car traffic. The majority expressed an interest in separated facilities such as greenways and trails for walking and biking.

Safety Concerns

- Cycling on the road isn't safe in my area. If there were more separated paths where I could bike with my kids, we would bike more.
- It isn't safe to walk or bike to the safest walking or biking places (such as greenways and parks).
- Rural roads need shoulders to make cycling safer.
- There has been some crime on trails.

Education

- Need more education for drivers, bicyclists, and pedestrians to understand how they should behave and interact.
- We need more "Share the Road" signs on North Carolina roads.

Infrastructure Needs

- Many pedestrians are frustrated by the lack of sidewalks in their area and see it as a hindrance to getting around on foot.
- We need more sidewalks, bike lanes, and crosswalks on our streets.

State Bike Routes

- Current cycling routes are dangerous and need to be updated.
- Make the updated statewide bike route system more flexible: adjust the route based on road improvements and greenways across the state. Consider providing signage that indicates the level of difficulty/ability level of a particular route (like we have with mountain bike trails or ski routes).

Mountain Region Concerns

- People in the western part of the state feel that they have been left behind when it comes to pedestrian and bicycle infrastructure. They build greenways and trails "over in Raleigh" but not in our area.

- Many people expressed concern that the narrow, steep, winding roads in the mountain region make cycling especially dangerous and difficult. The current bike routes need to be reconsidered.
- People in the mountain region were particularly enthusiastic about rail-trail projects, and several people in Hendersonville said they drive into South Carolina to use the Swamp Rabbit Trail near Greenville (a 45 minute drive).
- We would walk and bike more if we had a separated, relatively flat trail to use.

▼ *Project booths were located at 16 festivals in N.C., including Hickory (below) and Charlotte (right).* ▶

Mountain State Fair

September 8-9, 2012

Davis Event Center • Fletcher, NC

Number of booth visitors: 140

Key questions: Where to find bike maps? Where are there good hiking trails? When will the bike paths be built?

Key comments:

- Many of the local roads are very narrow and windy and with the mountainous terrain, cycling is very difficult.
- Many visitors offered enthusiastic support of rail-to-trail projects, are familiar with the Swamp Rabbit Trail, and would appreciate the opportunity to walk and bicycle on a relatively flat rail corridor.
- Many families commented on their desire to safely bicycle with their children, and that separated facilities would encourage them to bicycle more often with their children.

Agencies/local planning staff contacted prior to event: Land-of-Sky Regional Council of Governments, Buncombe County Planning Department, Asheville Bicycle & Pedestrian Taskforce

Centerfest Arts Festival

September 15, 2012

Downtown • Durham, NC

Number of booth visitors: 90

Key questions: What are the safest bike routes in Durham? Where can I find local bike maps? What is the easiest way to access local greenways and trails? Where is a good place for me to ride with my family?

Key comments:

- Many visitors were excited about walking and bicycling for recreation and transportation, but were unsure of where to find the safest routes and most accessible trails.
- People offered comments on specific pedestrian and bicycle improvements they would like to see in their area and were encouraged to provide feedback on the WalkBike NC website.

Agencies/local planning staff contacted prior to event: Durham City-County Planning Department, Durham Parks and Recreation Department, Durham Bicycle & Pedestrian Advisory Commission, Partnership for a Healthy Durham

Winterville Watermelon Festival

August 25, 2012

Downtown • Winterville, NC

Number of booth visitors: 30

Key questions: When will more greenways be built? Where can I find biking and hiking maps for my area? When will the project be completed?

Key comments:

- Some visitors felt that the current state bike routes near Winterville are very unsafe for cycling. They suggested that some of these be re-routed.
- Visitors were interested in seeing more local places to walk and bike, particularly separated facilities such as greenways and paths.

Agencies/local planning staff contacted prior to event: Winterville Planning Department, Winterville Parks & Recreation Office, Pitt County Planning Department, Pitt County School District Health Services, Pitt County Chamber

NC Apple Festival

August 31-September 1, 2012

Downtown • Hendersonville, NC

Number of booth visitors: 220

Key questions: Are there any local rails-to-trails being developed? Where is a safe place for me and my family to ride? Do you have maps of local trails and greenways?

Key comments:

- Many people feel that there are not enough safe places to walk and bike in western North Carolina in general.
- Narrow, steep, and winding roads make cycling especially dangerous and difficult in this region.
- Many visitors were especially enthusiastic about rails-to-trails projects. Multiple families mentioned that they drive to South Carolina to ride on the Swamp Rabbit Trail near Greenville.

Agencies/local planning staff contacted prior to event: City of Hendersonville Planning Department, City of Hendersonville Administration, Henderson County Department of Public Health, City of Brevard

Journey Through Symphony Concert

September 6, 2012

Cape Fear Botanical Garden • Fayetteville, NC

Number of booth visitors: 10

Key questions: What are the best bike routes nearby? When will the local portion of the East Coast Greenway be completed? Where can I find a map of local routes and trails?

Key comments:

- Local roads feel dangerous for cycling. I am afraid of being hit by a car on my bicycle.
- Greenways and trails would provide a safer option for walking and bicycling. Visitors commented that they would like to see more facilities like this in the Fayetteville area.

Agencies/local planning staff contacted prior to event: City of Fayetteville Planning & Zoning Division, Fayetteville-Cumberland Parks & Recreation, Cumberland County Planning Department, Fayetteville Area Convention & Visitors Bureau

Wilmington Art Walk

September 8, 2012

Front Street, Downtown • Wilmington, NC

Number of booth visitors: 115

Key questions: Where are pedestrian and bicycle projects being conducted in Wilmington? Do you have any maps showing local bicycle routes and trails? What is the progress of local greenways?

Key comments:

- There is a lack of pedestrian and bicycle facilities throughout Wilmington and a lack of connectivity between existing facilities.
- Many roads in the area need wider shoulders or bike lanes to be safe for bicyclists.
- Wilmington needs a safe bicycle route to connect to the beach.

Agencies/local planning staff contacted prior to event: Wilmington Metropolitan Planning Organization, Wilmington Downtown, Inc.

Festival in the Park

September 22, 2012
Freedom Park • Charlotte, NC

Number of booth visitors: 100

Key questions: What is a greenway? Where can I get a bike map or greenway map? What is bikeshare? Where is the Carolina Thread Trail? Where and when are new greenways going to be built?

Key comments:

- Concerns over safety and driver behavior prevent many people from walking and bicycling.
- Visitors would like to see more greenways and local rails-to-trails projects. Local and regional greenways and trails should all connect with each other to form a network.
- There is a need for more sidewalks, bike lanes, crosswalks, and Share the Road signs in and around Charlotte.

Agencies/local planning staff contacted prior to event: City of Charlotte, Charlotte-Mecklenburg County Planning Department, Charlotte Area Bicycle Alliance

Rock the Block

September 22, 2012
Downtown • Winston-Salem, NC

Number of booth visitors: 110

Key questions: Where can I find more local information about bicycle routes and trails in my area? Where are the safest places to walk or bike?

Key comments:

- There is a need for more education for drivers, cyclists, and pedestrians on how to behave and interact.
- There is a lack of connectivity between sidewalks and greenways in the area.
- **Many people feel it is not safe to walk or bike to parks, trails, and other recreation facilities.**
- **Rural roads need shoulders to safely accommodate cyclists already using the roads.**

Agencies/local planning staff contacted prior to event: Forsyth County Planning, Forsyth County Parks & Recreation, Winston-Salem/Forsyth County Planning Board

NC American Planning Association Conference

September 26-28, 2012

Wilmington Convention Center • Wilmington, NC

Number of booth visitors: 50

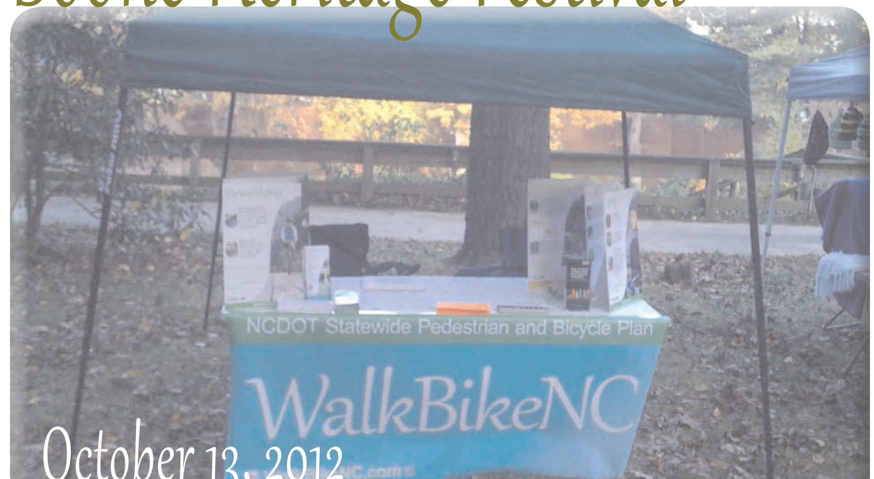
Key questions: How will the statewide plan impact the work that my department/agency is conducting at the local and regional level? How are the statewide bike routes being updated? Are you working with local and regional agencies and groups?

Key comments:

- Many planning professionals at the conference commented that they had heard about the statewide plan through the news, local groups, email, or other sources.
- Visitors were interested in having more and better coordination between local and regional planning agencies and state agencies, including the Department of Transportation.

Agencies/local planning staff contacted prior to event: Wilmington Metropolitan Planning Organization

Boone Heritage Festival



October 13, 2012

Daniel Boone Park • Boone, NC

Number of booth visitors: 50

Key questions: Are there local and regional bike maps online that I can download? Are there any new walking or bicycling projects underway or planned in my area?

Key comments:

- We need wider shoulders on the roadways for bicyclists, more and wider sidewalks, and greenways and trail extensions.
- The Blue Ridge Parkway is a great biking destination, but visitors noted that they felt unsafe because of a lack of bicycle facilities on the route and because of a lack of cycling awareness and education among drivers.
- Multiple visitors mentioned the Virginia Creeper Trail in Damascus, Virginia as a well-done rails-to-trails project.

Agencies/local planning staff contacted prior to event: Watauga County Planning, Watauga County Parks & Recreation

Mumfest

October 13, 2012
Downtown • New Bern, NC

Number of booth visitors: 190

Key questions: Where are the bike routes and trails in my area? How was the plan funded? What happens next after the plan is completed?

Key comments:

- Visitors were most interested in having more facilities for walking and bicycling, more pedestrian and bicycle signage, better education for all road users, and more enforcement of driver behavior.
- Many people were concerned about the lack of pedestrian and bicycle infrastructure and would walk or bike more if the opportunity was there.

Agencies/local planning staff contacted prior to event: City of New Bern Planning Division, City of New Bern Parks & Recreation Department, Craven County Planning and Inspections Department, Craven County Recreation & Parks Department

Hickory Oktoberfest

October 13, 2012
Downtown • Hickory, NC

Number of booth visitors: 110

Key questions: Where can I find maps and more information about existing local trails and bike routes? What are the safest places for walkers and bicyclists?

Key comments:

- Several people who approached the booth noted that they do not walk or bike regularly, but would like to if they had a safe way to do so.
- Safety education for drivers, bicyclists, and pedestrians needs to be better and more widespread.
- Many visitors commented that they would like to see bike paths or rails-to-trails projects in the area.

Agencies/local planning staff contacted prior to event: City of Hickory Planning, City of Hickory Parks & Recreation, Catawba County Planning, Parks, & Development, Western Piedmont Council of Governments

Outer Banks Seafood Festival

October 20, 2012

Roanoke Sound • Nags Head, NC

Number of booth visitors: 300

Key questions: Is there a hike and bike map for my region? What is the purpose of the plan? How will it affect my local area?

Key comments:

Would like to see more pedestrian/bicycle signage, enforcement of driver behavior, and better driver education.

Many people from out of state said they had more and better walking and biking facilities where they were from, and wished they had those options in North Carolina.

Several visitors noted that there is a lack of bicycle infrastructure in the area, and that they would like to see a better network like those in Beaufort and Emerald Isle.

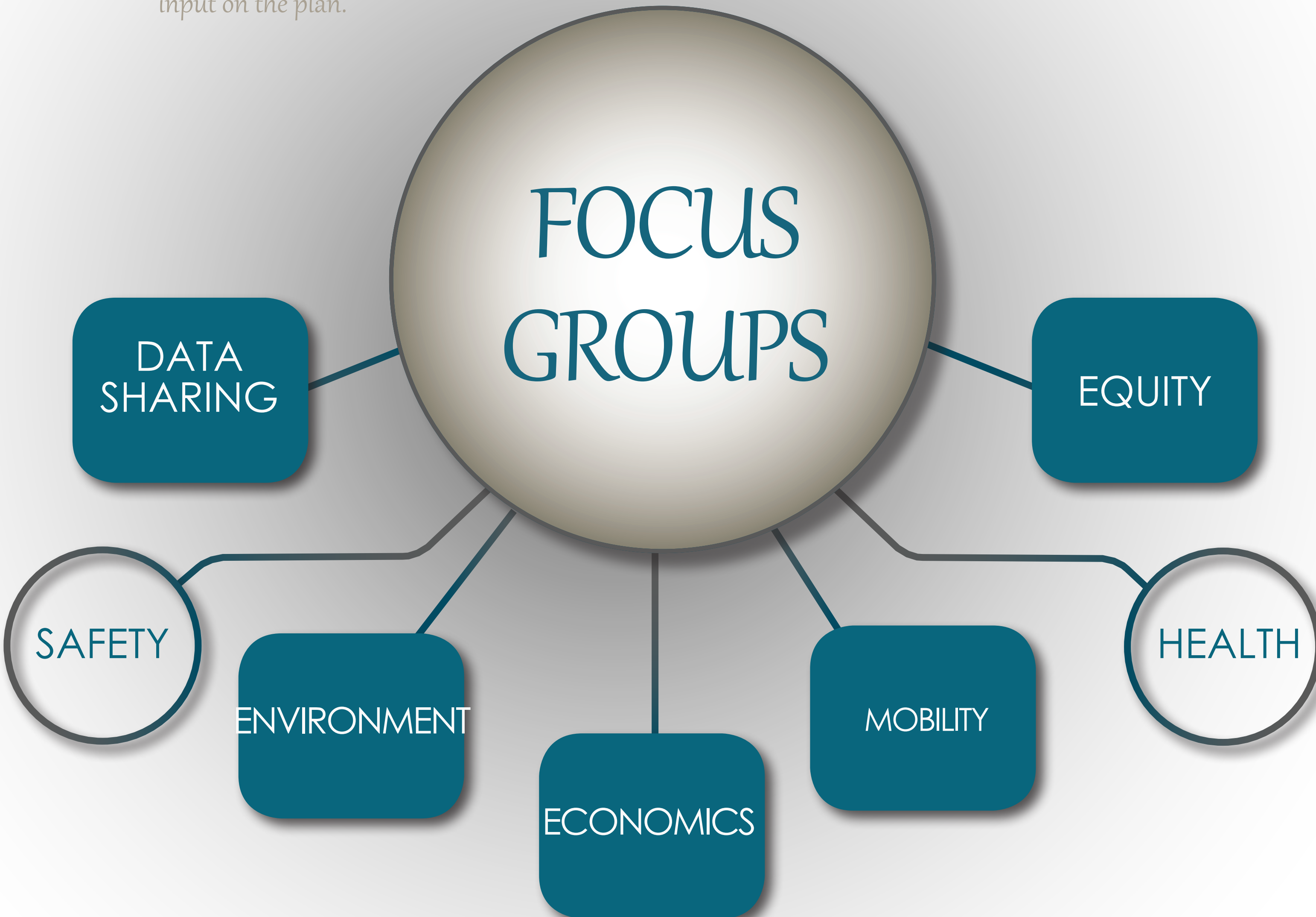
Focus Groups and Meetings

Two sets of focus group meetings were conducted as an additional method of community outreach to identify specific strategies and partnerships among targeted stakeholders to help establish the recommendations in the plan. The goal was to meet with a broadly representative group of agencies and organizations from the public, private, and non-profit sectors. Current and forthcoming issues and solutions regarding walking and bicycling programs, policies, and facilities were discussed across seven focus group topics. 367 individuals were contacted from various organizations requesting their participation during focus group meetings. Opportunities were made available to the participants to attend one or multiple meetings or via teleconference.

Each meeting began with a round of self-introductions, followed by a summary presentation about WalkBikeNC and relevant discussion items for each topic. The summary was followed by an open dialogue including all participants or small group "work sessions" with shared results at the conclusion of the meeting. Key issues and participants for each focus group are summarized on the following tables.

9.2

Two sets of focus groups (for a total of 14 meetings) were organized to gather input on the plan.



Focus Group	Participants	Issues Discussed
Data Sharing	DHHS DPH DPR NHTF NCDOT NCSU ITRE NC Commerce NCRPA	• Local data available in many cases; getting these to county or regional level is work-in-progress • DPH looking for opportunities to work across other agencies for data sharing • Conservation Planning Tool: identify, evaluate and prioritize ecosystem resources. Tailored to meet local regional needs with local governments, being incorporated into the comprehensive transportation planning process • Establishment of GIS standards necessary to share data across regions/state • Encouraging parks departments to upload their data, very little currently available • Need linkage between bike/ped and rural areas to connect people to amenities in rural areas • As part of this planning effort, set up a standard for bicycle/pedestrian attributes and data gathered • NCSU and UNC have clearinghouses of GIS data
Safety	NCDOT City of Winston-Salem City of Greensboro City of Carrboro City of Charlotte ECGA NC PHF UNC HSRC ALBD	• Urban/suburban/rural safety issues • New, innovative pedestrian and bicycle treatments that are needed • Balance physical versus programmatic and educational recommendations • Integrating law enforcement and crash data into day-to-day operations/decisions • Specific infrastructure – lack of connectivity, crosswalks, signals, maintenance, accommodations on bridges and RR crossings, access management • Critical safety-related outcomes of this process • Safety-related benchmarks and performance measures
Mobility	NCDOT City of Wilmington City of Asheville City of Carrboro PTRC NC PHF ITRE	• Cost-sharing and maintenance of bike/ped facilities an issue in municipalities and incorporated areas - need to update or eliminate scale • Low cost/big benefit projects with high impacts matter – signage, resurfacing • Need better process and communication – local governments and Division engineers – resurfacing projects • Requirements need to be present at ordinance level • Utilize new NCDOT Division planning position to help coordination efforts • Land use and transportation decisions • Driveway access management • Projects should address more than just reducing congestion – should address connectivity, impacts to land use, etc. • Programming is effective as part of corridor update

AHA: American Heart Association
ALBD: Active Living by Design
BCBS: Blue Cross Blue Shield of NC Foundation
CTNC: Conservation Trust for North Carolina
CTT: Carolina Thread trail
DHHS: Department of Health and Human Services
DPH: Division of Public Health
DPR: Division of Parks and Recreation
DENR: Department of Environment and Natural Resources
ECGA: East Coast Greenway Alliance
GCPH: Gaston County Public Health ITRE: Institute for Transportation and Research
MCPH: Mecklenberg County Public Health
NCATA: North Carolina Active Transportation Alliance
NC Commerce: North Carolina Chamber of Commerce
NC CNP: North Carolina Center for Non-Profits
NCDOT: North Carolina Department of Transportation
NCPHF: North Carolina Public Health Foundation
NCRPA: North Carolina Recreation and Parks Association
NCSU: North Carolina State University
NHTF: Natural Heritage Trust Fund
PTRC: Piedmont-Triad Reg. Commission
REI: Recreation Equipment, Inc.
UNC HSRC: University of North Carolina Highway Safety Research Center
WCPH - Wake County Public Health

Focus Group	Participants	Issues Discussed
Environment	NCDOT DPR CTNC NC CNP ECGA City of Wilmington REI WCPH	• Greenway maintenance • Trail Design guidelines • Connectivity • Formulate working group (part of HEC) • Avoid but access environmentally sensitive areas • Nature deficiency disorders • Environmental education • 10,000 non-profits • 24 land trusts – Nature access goal • Conservation Planning Tool • Environmental education and trails for schools • Trail connectivity within state parks and connecting to state parks
Economics	NCDOT NC Commerce NCATA CTT City of Charlotte City of Greensboro City of Winston-Salem	• Need economic fact-sheet (elevator pitch) • Need public information/maps about trails • Walking/biking info needed on VisitNC website • Need to track why employers choose NC – impact of livable, walkable communities • Public-private partnerships • Incentives for developers • Land use planning and implementation • Maintain/expand Main Street Program – Dept. of Commerce and NCDOT
Health	NCDOT ALBD DHHS BCBS UNC HSRC NC ATA Greenville MPO Wilmington MPO Piedmont-Triad MPO City of Carrboro City of Wilmington City of Aberdeen City of Charlotte WCPH GCPH MCPH AHA NCSU/ITRE	• Barriers to "active transportation" • Potential actions transportation planners can take to help reduce health disparities through active transportation among: • Children, older adults, low income people, people with disabilities, rural residents • Potential actions public health professionals/advocates can take to increase active transportation • Potential health data and indicators to contribute to planning, implementation, and evaluation of transportation projects
Equity	NCDOT City of Wilmington City of Asheville City of Carrboro PTRC NC PHF ITRE Greensboro MPO Gaston County DHHS ALBD	• NCDOT needs single point of contact for EJ/equity issues • NCDOT needs to ensure ADA compliance • Universal design standards needed • Low-income, minority, age issues should be coordinated with locals and be a part of a balanced priority system • NCDOT should formalize processes for engaging non-traditional stakeholders in health and other fields • Creating physical connections to schools should be an imperative, and is a strong part of equity

Regional Workshops

Three regional workshops were scheduled in Asheville, Salisbury, and Wilmington to engage local planning organizations and transportation professionals. Participants from local MPO's and RPO's, bicycle advocacy groups, and local planners helped to identify priorities and offered informed opinions for recommendations.

At each workshop, a summary presentation was given of the plan background and participants were asked to break out into groups of different sizes for brainstorming. Each group identified bicycling and walking issues and strategies for overcoming the issues. The results were shared with the larger group after a given time period. A summary of the participants and issues discussed is provided in the following tables.

Regional Workshop Participants	
NCDOT	Division 14, DPBT, Ports Authority, etc.
Municipalities	Asheville, Boone, Salisbury, Kannapolis, Mooresville, Charlotte, Greensboro, Wilmington, Lenoir, Gaston Co., Henderson County, White Lake, Whiteville, Lumberton, New Hanover Co., Rockingham Co., Huntersville
MPO's/RPO's	Wilmington MPO, Lake Norman RPO, Unifour RPO, TARPO, PTRPO
COG's	High Country COG, Land of Sky COG, PTCOG, WPCOG,
Health, Safety, Environment, Economics	Dept. of Commerce Region A Bike Clubs (4) Advocacy Groups (4) Land Conservancies (9) ITRE UNCC

Key Issues	Key Strategies
1. Statewide Bike/Ped Culture/Education 2. NCDOT Policy/Culture to Support Ped/Bike Infrastructure and Programs 3. Funding Support/Prioritization for Bike/Ped Projects 4. Better Coordination Between Agencies/Partners 5. Coordinating Land Use/Economics/Connectivity 6. New Design Standards and Policy 7. Lack of Support for Economic Development benefits 8. Short-Term Achievable Projects + long term goals and plans 9. Ecological Footprint/Impact of transport infrastructure 10. Health Impacts of Transportation System	1. Showcase Successes 2. NCDOT Policy and Procedure Reform 3. Improve project coordination 4. New Sources of Funding 5. Education of motorists, peds, and cyclists 6. Incentives/Encouragement programs 7. Marketing/changing public opinion 8. Other: School siting guidelines, include equity, "see it, click it, fix it", maintenance

NC Bicycle Summit

On October 12 and 13, 2012, bicycle and pedestrian advocates, professionals, business owners, nonprofit leaders, and elected officials gathered in Raleigh for the inaugural bicycle summit. Speakers and workshops offered opportunities to network and learn from others across the state about local and regional initiatives covering topic areas such as education and public outreach, health and recreation, on-road and off-road facility design and engineering, economic development and creative funding sources.

A project booth was set up during the summit as well as a flip chart area during the luncheon where participants could provide written input about their preferred recommendations. A workshop was also scheduled where approximately 75 participants offered input on the plan. The top results are summarized in the table below.

Top Priorities of Bike Summit Participants	Key Panel Discussion Points
1. Connectivity	1. Rural issues – funding obstacles
2. Complete Streets for all projects	2. Connectivity
3. Education	3. Education/encouragement/enforcement
4. Increase bike/ped funding	4. Policies to address safety
5. Tourism – bike routes – bike maps	5. Ambiguity of laws an issue
5. Bike lanes/shoulders with resurfacing – rural areas included	6. Need to sync local and regional plans, CTP's
	7. Funding equity – cost-sharing
	8. Land use-transportation link
	9. Need coordinated, organized state advocacy
	10. Make friends in legislature (likely supporters AND likely non-supporters)
	11. Maintenance of facilities

NCDOT Watch for Me Campaign

A pedestrian safety campaign was launched during planning efforts for WalkBikeNC in the Triangle region. The purpose of Watch for Me NC was to increase pedestrian and motorist safety awareness, educate the public about pedestrian safety laws, and enforce pedestrian law violations in the Triangle region. The campaign used a combination of methods to increase awareness, including signage on public transit and at gas stations, radio advertising, and enforcement education training. Bumper stickers and brochures were developed for distribution across the state. Partners for the effort included the North Carolina Department of Transportation, UNC Highway Safety Research Center, Institute for Transportation Research and Education at NCSU, area universities, and planning, engineering, transportation, and police departments in Raleigh, Durham, Chapel Hill and Carrboro.

Although the Watch for Me NC campaign was separate from WalkBikeNC, its message and materials was incorporated into the project's public outreach efforts. The level of public awareness and success the campaign raised around pedestrian safety was considered a model for other potential walking and bicycling campaigns that could be used in the state.

Stickers, brochures, and posters were developed for the Watch for Me NC safety campaign ▲

Internet Outreach and Engagement

North Carolina Department of Transportation Social Media

NCDOT regularly updated its project webpage, Facebook page and Twitter account to keep information fresh and relevant throughout the project. Project milestones and upcoming public participation events were posted on all social media to encourage participation in the planning process. A YouTube video featuring Paul Morris, Deputy Secretary for Transit, spreading the message of DOT's endeavor to create an environment in North Carolina where walking and bicycling become a part of everyday living was developed and made public during project launch. The video served as the anchor welcome message on WalkBikeNC and provided the mission of the project and other project information to new website visitors.

News Releases

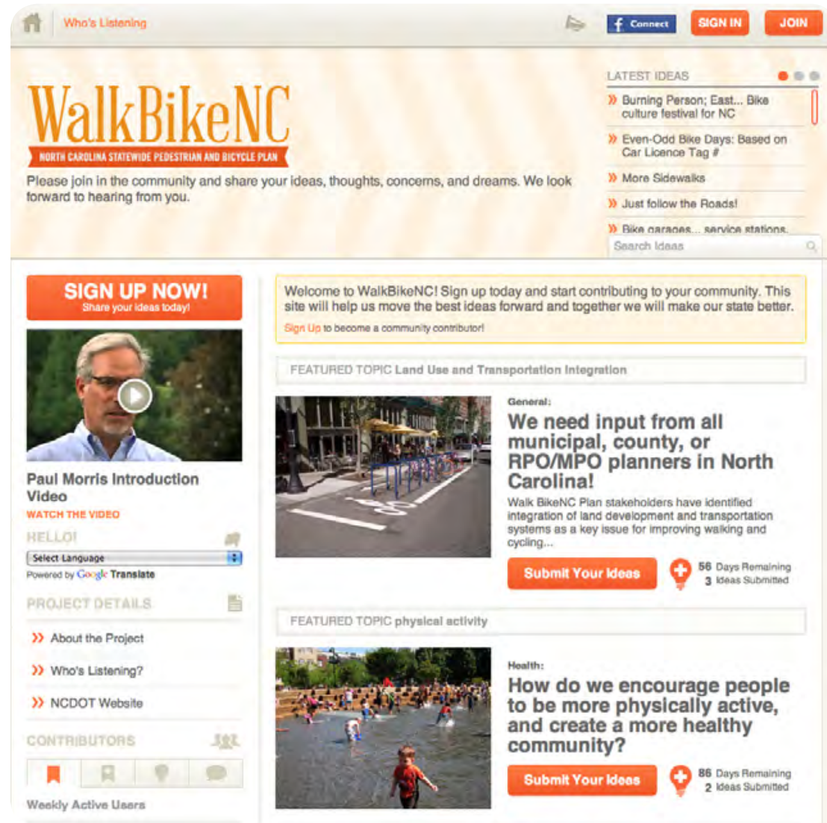
A statewide launch effort by NCDOT alerted North Carolinians of the Department's commitment to creating a pedestrian and bicycle plan. The news release was sent to statewide media outlets on July 27, 2012. A second news release was sent to statewide media outlets in August that announced the launch of the WalkBikeNC website and encouraged North Carolinians to share their thoughts and ideas related to pedestrian and bicycle transportation through the interactive website.

WalkBikeNC Website

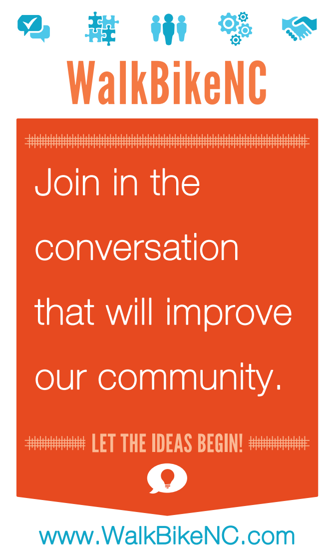
The WalkBikeNC website was developed and launched by the private company MindMixer, in collaboration with NCDOT staff and consultant staff. Mindmixer is a social media tool allowing NCDOT to communicate with the public and for the public to communicate with each other. It is a forum for discussion on any topics posted, where NCDOT can empower North Carolinians to provide candid thoughts and ideas as well as participate in guided survey questions, polls, prioritizations, and decision-making mechanisms. Users are required to login for access to participate in discussions and can do so by creating an account, or simply entering their Facebook user and password. This generates a database of people interested in the topic who will receive occasional updates on new postings as well as alerts on their comments.

Webinar Summary

Agencies, advocacy groups, and identified supporters of the Plan, were invited to attend a webinar on August 14, 2012. This session, much like the presentation given at the Joint Committee Meeting served as a public kick-off for the plan. The planning process and vision from the Joint Committee Meeting were shared, and all attendees were encouraged to join the WalkBikeNC online forum and continue to participate and comment through this social media tool, and be alert for additional opportunities to provide feedback by registering to become a member of WalkBikeNC.com.



▲ *The WalkBikeNC project website offered multiple opportunities for idea generation and public input.* ▶



Outreach	Participants	Details
Twitter @NCDOT	8,963 followers	• Sent out Tweets every time a news release is issued, as well as various reminder Tweets when a new topic or challenge was posted. • Twitter followers who asked a question regarding bicycle and pedestrian issues, were answered and encouraged to sign up for WalkBikeNC to participate in online conversations. • Example Tweets: • New #WalkBikeNC Challenge – going out 2 eat? • Burn off that meal by walking/biking/riding the bus. http://ht.ly/e191L • Where would you like to see new greenways & trails?
Facebook	1,353 likes	• All Facebook posts, announcements, and news was posted on Secretary Conte's page, capitalizing on the already well-established audience.
News / Press Release		• News Releases were distributed to statewide media outlets o "NCDOT Looking for Public Input on Future of Walking and Biking in North Carolina" o Second press release was issued to promote WalkBikeNC website
NCDOT Now	500-600 views per episode	• NCDOT's weekly news broadcast on YouTube • Plan kickoff and WalkBikeNC Challenge both featured in different episodes
NCDOT Project webpage		• Provided up-to-date project information • Provided a link to WalkBikeNC website • Announced project milestones and upcoming events
WalkBikeNC	>745 participants >1300 comments >575 Ideas	• The WalkBikeNC website was developed and launched by the private company MindMixer, in collaboration with NCDOT staff and Alta/Greenways staff. Mindmixer is a social media tool allowing NCDOT to communicate with the public and for the public to communicate with each other. It is a forum for discussion on any topics posted, where NCDOT can empower North Carolinians to provide candid thoughts and ideas as well as participate in guided survey questions, polls, prioritizations, and decision-making mechanisms. Users are required to login for access to participate in discussions and can do so by creating an account, or simply entering their Facebook user and password. This generates a database of people interested in the topic who will receive occasional updates on new postings as well as alerts on their comments. • WalkBikeNC premiered with a video from Paul Morris to North Carolinians • A weekly Challenge was run in September and October for WalkBikeNC members • Semi-weekly Topics were posted to WalkBikeNC to facilitate discussion between members and solicit input that serves to guide the Plan • WalkBikeNC members receive a weekly e-mail outreach that highlights the new weekly Challenge, Featured Topics, and upcoming public engagement events • Weekly event announcements were featured through the "Announcement" tool on WalkBikeNC • Weekly "Did You Know" Factoid Announcements were also featured through the "Announcement" tool on WalkBikeNC • Over 1300 comments were entered into WalkBikeNC in the first 100 days.
Webinar	Agencies, advocacy groups, and identified Plan supporters	• The webinar was held on August 14, 2012. This session, much like the presentation given at the Joint Committee Meeting served as a public kick-off for the plan. The planning process and vision from the Joint Committee Meeting were shared, and all attendees were encouraged to join the Mindmixer forum and continue to participate and comment through this social media tool, and be alert for additional opportunities to provide feedback by registering to become a member of WalkBikeNC.com.

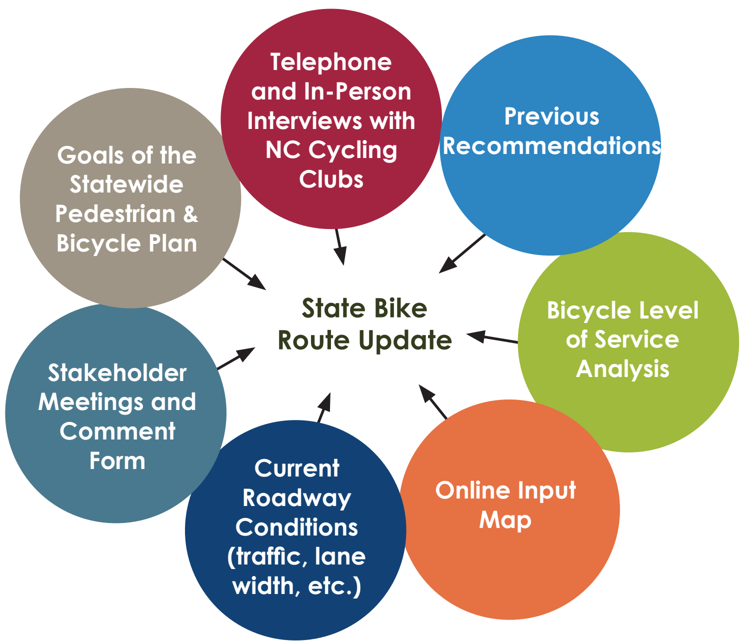
9.3 State Bike Routes

Orange County, NC

The State Bike Route System Update

North Carolina's bicycle route system was developed in response to the 1974 Bicycle and Bikeway Act. The system located those roads across North Carolina that were safer for bicycling, designating a network of ''Bicycling Highways'' that provided access to small towns, state parks, historic sites, and other points of interest. The system also included the first interstate route that was approved by AASHTO in 1982, US Bike Route 1. The current network consists of nine different routes covering 2,400 miles. The 700+ mile NC 2 Mountains to Sea route is the main artery of the system, connecting east and west as well as most of the system's other routes. Bicycle tourists and adventurers use maps created for each route to navigate the state.

Given the extensive development that has occurred across North Carolina since the 1970's and associated changes to the roadway network, NCDOT recognized the need to re-evaluate and update the state bike route system as part of this 2013 plan. The following chapter summarizes the results of this evaluation, which was completed with an extensive stakeholder and public outreach process. The figure below details the many inputs used during that process. A quantitative, data-driven analysis was combined with qualitative, stakeholder-driven input to ensure a complete evaluation.



In this Chapter

Stakeholder input

Several themes emerged through the stakeholder and public input process, which helped to frame the goals of this plan and inform its recommendations. At the beginning of the process, over 150 key stakeholders including bike club members, bike tour operators, and cycling enthusiasts were reached through an initial comment form. Based on the results of that form, an online input map was used to gather localized feedback on existing route conditions, key destinations, and potential new routes. The map also reached 150 stakeholders and received over 130 unique comments. Beyond these strategies, additional feedback was provided through extensive emails and meetings with local planners and route experts. At least X groups and individuals were reached through this direct approach.

A selection of recurring comments and the major themes they address are summarized below:

Re-route where development has changed the character of the existing routes

"Some…pieces are now on roads that are unsafe due to development and traffic volume"

"Many were nice rural roads 20 years ago, and have become high-traffic bottleneck roads now"

"Beauty of scenery along the route is very important"

Routes should include bicycle facilities

"There is a widespread lack of shoulders on these roads"

"More riding room on the side of the road"

"Provide consistency and minimum improvements/ safety feature standards to roads marked as 'bike routes'"

"Routes…exhibit only signage, and no genuine improvements to ensure cyclist safety and consistency; ie. lack of shoulders, damaged shoulders, traffic signals inoperable by bicycles, lack of proper turning lanes"

Routes should connect major cities in North Carolina

"Link towns and cities with bike routes instead of avoiding them"

"Better routes through/around urban areas"

"More (routes) that would actually connect Point-A with Point-B with the idea that distance cycling between cities would be an actual way to travel"

Ensure routes link to necessary amenities

"Many routes are down rural roads that….have few places to stop for food/drink"

"Start routes near parking areas"

Routes should be clearly marked for both cyclists and motorists, and easy to follow

"They are sometimes not well marked…"

"Please consider using larger bike route signs in those places where very small signs (or very few) are used"

"Not well advertised"

Route information should be easy to access, up to date, and available online

"The last time I tried to look at the online routes, several years ago, those were not easy to get to or look at with accurate up to date maps"

"Offer downloadable maps, cue sheets, GPS files"

"High quality maps need to be available for these routes to be more readily used"

"A website with maps and information"

Project Goals

The goals identified for the 2013 system were built upon the input received before and during this planning process as well as the broader goals for the Statewide Plan. These goals, which supplement the system's original goals, are summarized below:

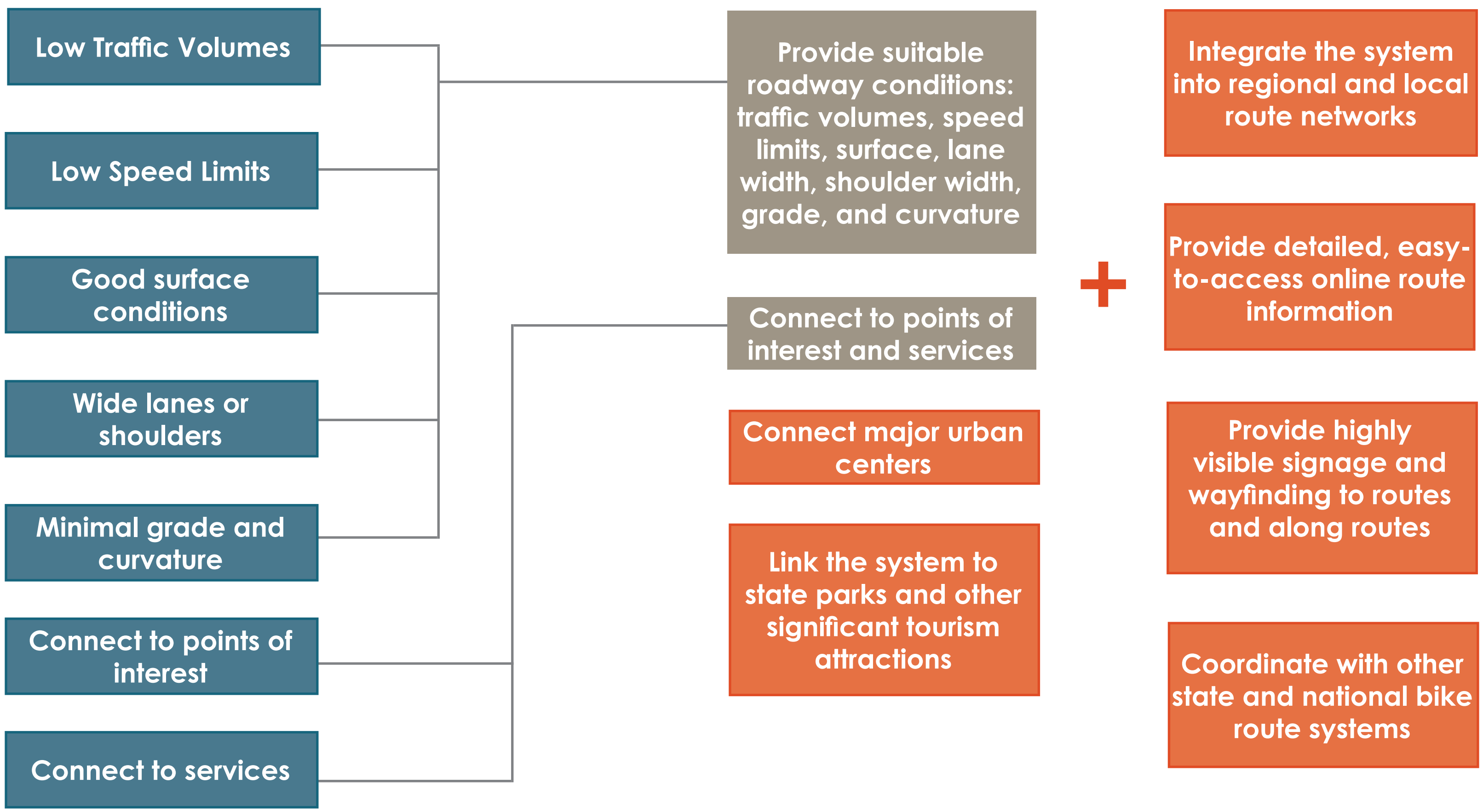
State Bike Routes Today

Route Descriptions

The nine routes of the existing statewide bicycle route system are summarized on the following pages.

1975 System Goals

2013 System Goals



NC 2 – MOUNTAINS TO SEA

The 700+ mile NC 2 Mountains to Sea route serves as the main artery of the North Carolina bicycle route system, bisecting the state west to east. It ties the mountains in the west with the piedmont in the center; and the piedmont with the coastal region of the east. While traversing the rugged mountains, rolling pastures of piedmont farm country, and the flats of the coastal region, it connects many of North Carolina's larger cities including Asheville, Winston-Salem, Greensboro, Durham, and Raleigh. The route begins in Murphy in the mountainous southwestern corner of the state and finishes in Manteo at the Outer Banks in the east.

US 1 - CAROLINA CONNECTOR

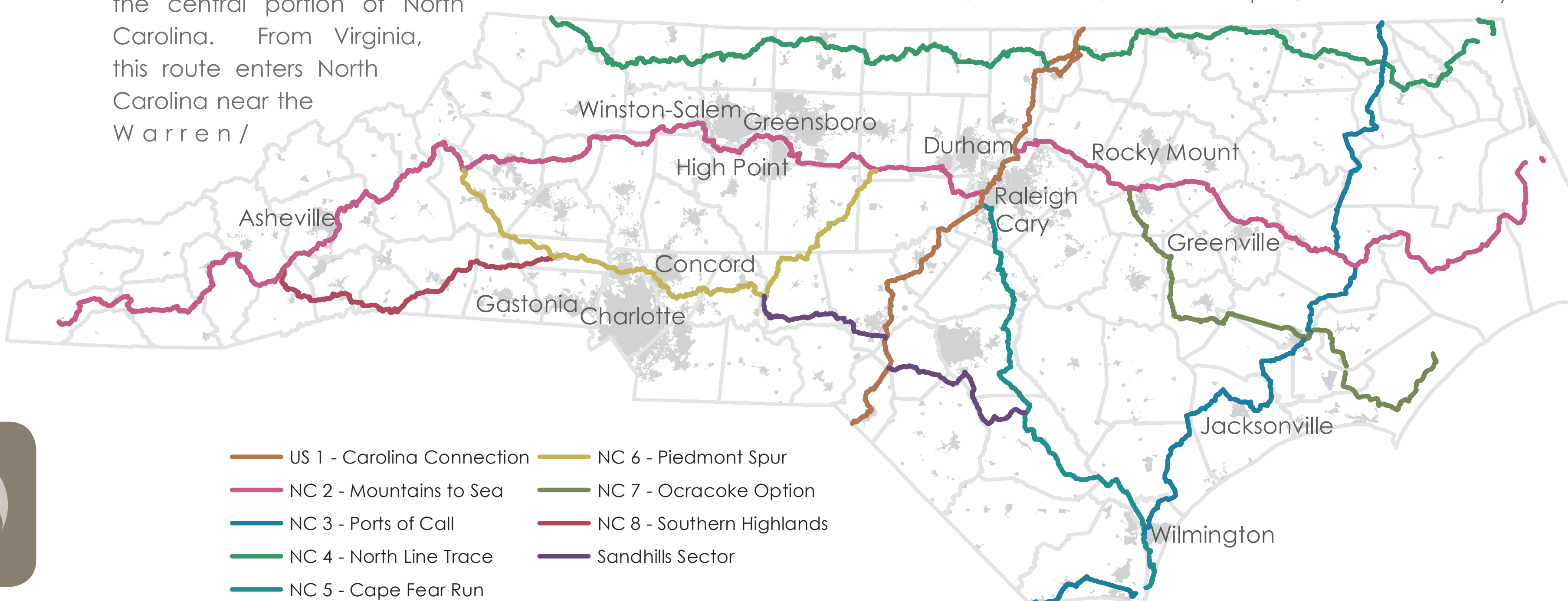
Designated as a portion of US Bike Route 1, which runs from Maine to Florida, this route covers almost 200 miles of rolling terrain. It is the main north/south connector route through the central portion of North Carolina. From Virginia, this route enters North Carolina near the Warren/Vance County border. US 1 continues south between Raleigh and Durham and eventually through Sanford, Southern Pines, and Laurinburg before advancing into South Carolina.

NC 3 - PORTS OF CALL

This route traverses North Carolina's long and varied coastline including two major sounds - the Pamlico and Albemarle Sounds. The ~300 mile route from Virginia to South Carolina passes through the major ports of the colonial era; Edenton, Bath, New Bern, Wilmington, and Southport among numerous other coastal communities.

NC 4 - NORTH LINE TRACE

Running east/west from the mountains to the coast, this ~400 mile route runs just south of and parallel to North Carolina's border with Virginia. It travels through or near numerous small towns including (from west to east) Eden, Roxboro, Henderson, Roanoke Rapids, and Elizabeth City.



NC 5 - CAPE FEAR RUN

This 160 mile route roughly parallels the course of the Cape Fear River through the southeast coastal plain to the coast. Rolling hills give way to flat land in the swamps and Carolina bays typical of this region of the state. Just south of the Triangle, NC 5 begins at its connection with US 1 in Apex, continuing through Fuquay-Varina, passing near Fayetteville, and ending in Wilmington at its intersection with the NC 3 Ports of Call route.

NC 6 - PIEDMONT SPUR

The NC 6 Piedmont Spur is a ~200 mile route that is a southern alternate to the piedmont portion of the NC 2 Mountains to Sea route. The western endpoint of NC 6 is located in the foothills of the Blue Ridge Mountains west of Lenoir and Morganton in Burke County before making its way southeast toward Charlotte. The route stays north of Charlotte, turning northeast to its reconnection with NC 2 in central North Carolina. It passes through smaller towns such as Morganton, Lincolnton, several Charlotte suburbs, and Albemarle before eventually finishing near Snow Camp.

NC 7 - OCRACOKE OPTION

From its western terminus along the NC 2 Mountains to Sea route near Wilson, this ~170 mile route winds its way through the coastal plain to the Cedar Island Ferry over to Ocracoke. It passes through or near several smaller towns including Wilson, Goldsboro, Kinston, New Bern, and eventually Ocracoke.

NC 8 - SOUTHERN HIGHLANDS

This ~120 mile route begins northwest of Brevard with a 15-mile downhill from its connection with NC 2 Mountains to Sea on the Blue Ridge Parkwaw, passing through small mountain towns such as Brevard, Saluda, Flat Rock, and Tryon. It traverses the foothills of the Blue Ridge Mountains southeast toward the South Carolina border before turning northeast through Forest City and finishing at its intersection with the NC 6 Piedmont Spur in Lincolnton.

SANDHILLS SECTOR

The western terminus of the Sandhills Sector is its connection with the NC 6 Piedmont Spur near the Pee Dee River and the town of Albemarle. Ending near the Cape Fear River at its connection with the NC 5 Cape Fear Run, this route traverses ~125 miles of sandhills terrain characterized by rolling topography rising from 500 to 700 feet above sea level. The Sandhills Sector passes near Pinehurst/Southern Pines and meanders south of Fayetteville.

Scenic Byways

The N.C. Department of Transportation has designated 54 scenic byways from one to 173 miles long around the state. Scenic byways are typically rural roadways that give visitors and residents a chance to experience North Carolina history, geography, and culture while raising awareness for the preservation and protection of scenic landscapes. They provide an alternative to the highways and interstates filled with high-speed traffic and surrounded by commercial areas.[1]

Scenic byways currently overlap the state bicycle route system in a handful of locations. While the state bicycle route system extends continuously across North Carolina, scenic byways are generally discontinuous routes that function as destinations. Both systems highlight the dynamic geographies of North Carolina, seeking pleasant, low-traffic roads.

Where North Carolina's scenic byways and state bicycle routes overlap, opportunities exist to pool resources for roadway and bicycle facility improvements. Roadway additions like paved shoulders provide separated space for cyclists and reduce the frequency of required roadway maintenance. Where scenic byways are located away from the state bicycle route system, these roads should be incorporated into county or local bicycle route planning.

*North Carolina Department of Transportation. http://www.ncdot.gov/travel/scenic/default.html.

Route Conditions

While significant portions of the state route system remain comfortable and scenic, many of the roads have changed since their designation and are no longer ideal for bicycling. In addition, many miles of roadway around the state have been paved since the 70's and now hold potential to become part of the route system. The tables below summarize several of the key roadway characteristics of the routes in 2012. While all shown data has a degree of error, this information provides an overview of conditions today and allows for comparison between routes.

TRAFFIC VOLUMES

Traffic volumes on some segments far exceed the original goal for the system of average daily traffic (ADT) less than 1,200 and make cycling uncomfortable even where paved shoulders exist. At the same time, over half of the current system does still hold less than 3,000 ADT, a comfortable level for most cyclists, particularly when a shoulder is present.

PAVED SHOULDER

Only six percent of the current system has a paved shoulder equal to or greater than three feet. The route with the largest percentage of paved shoulder, NC-5 Cape Fear Run, still only contains a three foot paved shoulder on 18.5% of roads.

Route	< 3'	3' - 4'	> 5'	No Data
US 1 - Carolina Connection	97%	2%	0.1%	0.9%
NC 2 - Mountains to Sea	90%	7%	3%	0.4%
NC 3 - Ports of Call	94%	4%	1%	0.4%
NC 4 - North Line Trace	98%	2%	0.02%	0.0%
NC 5 - Cape Fear Run	81%	18%	0.5%	0.3%
NC 6 - Piedmont Spur	95%	4%	1%	0.2%
NC 7 - Ocracoke Option	93%	6%	0.2%	0.2%
NC 8 - Southern Highlands	99%	1%	0.1%	0.03%
Sandhills Sector	98%	2%	1%	0.01%
Grand Total	93%	5%	1%	0.3%

NC Bicycle Route Paved Shoulder Width (as a percentage of route mileage)

NC Bicycle Route Annual Average Daily Traffic (as a percentage of route mileage)

Route	<= 1,200	1,200-3,000	3,000 - 5,000	5,000 - 10,000	10,000 - 15,000	15,000 - 25,000	25,000 - 50,000	50,000 - 75,000	75,000 - 150,000	No Data
US 1 - Carolina Connection	20%	29%	12%	5%	3%	2%	1%	0%	0.002%	29%
NC 2 - Mountains to Sea	33%	33%	13%	8%	2%	3%	0.2%	0%	0%	7%
NC 3 - Ports of Call	22%	16%	12%	15%	5%	3%	0.3%	0.001%	0%	28%
NC 4 - North Line Trace	26%	29%	11%	6%	2%	0.4%	0%	0%	0%	26%
NC 5 - Cape Fear Run	34%	23%	10%	13%	6%	5%	0.01%	0%	0%	11%
NC 6 - Piedmont Spur	22%	9%	6%	16%	9%	4%	1%	0%	0%	33%
NC 7 - Ocracoke Option	19%	29%	13%	12%	3%	4%	1%	0.04%	0%	19%
NC 8 - Southern Highlands	33%	28%	11%	5%	1%	0%	0%	0%	0%	22%
Sandhills Sector	19%	32%	12%	7%	1%	2%	0%	0%	0%	27%
Grand Total	26%	26%	11%	9%	3%	3%	0.4%	0.003%	0.0002%	20%

State Bike Routes

SPEED LIMITS

A large percentage of the current bike route system is on roadways with a speed limit of 55mph. Where traffic levels are below 1,200 ADT, these roadways still meet the original criteria established when the system was developed, but where traffic has increased such speeds are problematic for cyclists.

Route	<= 25	30 - 35	40 - 45	50 - 55	60 - 70	No Data
US 1 - Carolina Connection	0.3%	12%	29%	56%	0.1%	3%
NC 2 - Mountains to Sea	1%	8%	13%	59%	0.001%	18%
NC 3 - Ports of Call	0.1%	8%	12%	79%	0.003%	1%
NC 4 - North Line Trace	3%	6%	9%	81%	0.002%	1%
NC 5 - Cape Fear Run	1%	9%	8%	78%	0.01%	4%
NC 6 - Piedmont Spur	1%	8%	19%	72%	0%	0%
NC 7 - Ocracoke Option	1%	8%	17%	75%	0%	0.004%
NC 8 - Southern Highlands	3%	14%	20%	62%	0%	1%
Sandhills Sector	1%	5%	6%	88%	0.003%	0.001%
Grand Total	1%	8%	14%	70%	0.01%	6%

NC Bicycle Route Speed Limits (as a percentage of route mileage)

SURFACE CONDITIONS

Almost two-thirds of the current route system lie on roads with high pavement condition ratings. A small percentage, however, are on roads with a rating below 50/100. Roadways with a low-quality surface can cause discomfort or flat tires for cyclists and are less enjoyable for long rides.

Route	0 - 25	25 - 50	50 - 75	75 - 100	No Data
US 1 - Carolina Connection	0.04%	3%	21%	73%	3%
NC 2 - Mountains to Sea	2%	6%	19%	54%	19%
NC 3 - Ports of Call	6%	16%	26%	52%	1%
NC 4 - North Line Trace	1%	6%	25%	67%	1%
NC 5 - Cape Fear Run	1%	10%	24%	61%	4%
NC 6 - Piedmont Spur	1%	7%	22%	70%	0.003%
NC 7 - Ocracoke Option	3%	5%	35%	57%	0.01%
NC 8 - Southern Highlands	0%	8%	30%	62%	1%
Sandhills Sector	1%	4%	14%	81%	0.003%
Grand Total	2%	7%	23%	61%	6%

NC Bicycle Route Pavement Condition Rating (as a percentage of route mileage)

LANE WIDTH

Almost a quarter of the current routes lie on narrow roadways with 9' wide lanes or less. These roadways can be comfortable for cycling where traffic volumes are very low, but are uncomfortable when motorists pass closely in the case where no additional shoulder exists. The majority of the routes with 10' to 11' lanes can similarly present a problem when no additional shoulder exists.

Route	<= 9'	10' - 11'	12' - 14'	15' - 17'	> 17'
US 1 - Carolina Connection	27%	53%	18%	1%	0.1%
NC 2 - Mountains to Sea	16%	43%	39%	1%	1%
NC 3 - Ports of Call	17%	51%	31%	1%	1%
NC 4 - North Line Trace	25%	51%	22%	1%	1%
NC 5 - Cape Fear Run	13%	57%	27%	1%	2%
NC 6 - Piedmont Spur	25%	52%	21%	0.5%	1%
NC 7 - Ocracoke Option	17%	36%	47%	0%	1%
NC 8 - Southern Highlands	32%	56%	10%	2%	1%
Sandhills Sector	25%	42%	30%	2%	2%
Grand Total	21%	48%	30%	1%	1%

NC Bicycle Route Lane Widths (as a percentage of route mileage)

NC Bicycle Route Level of Service (as a percentage of route mileage)

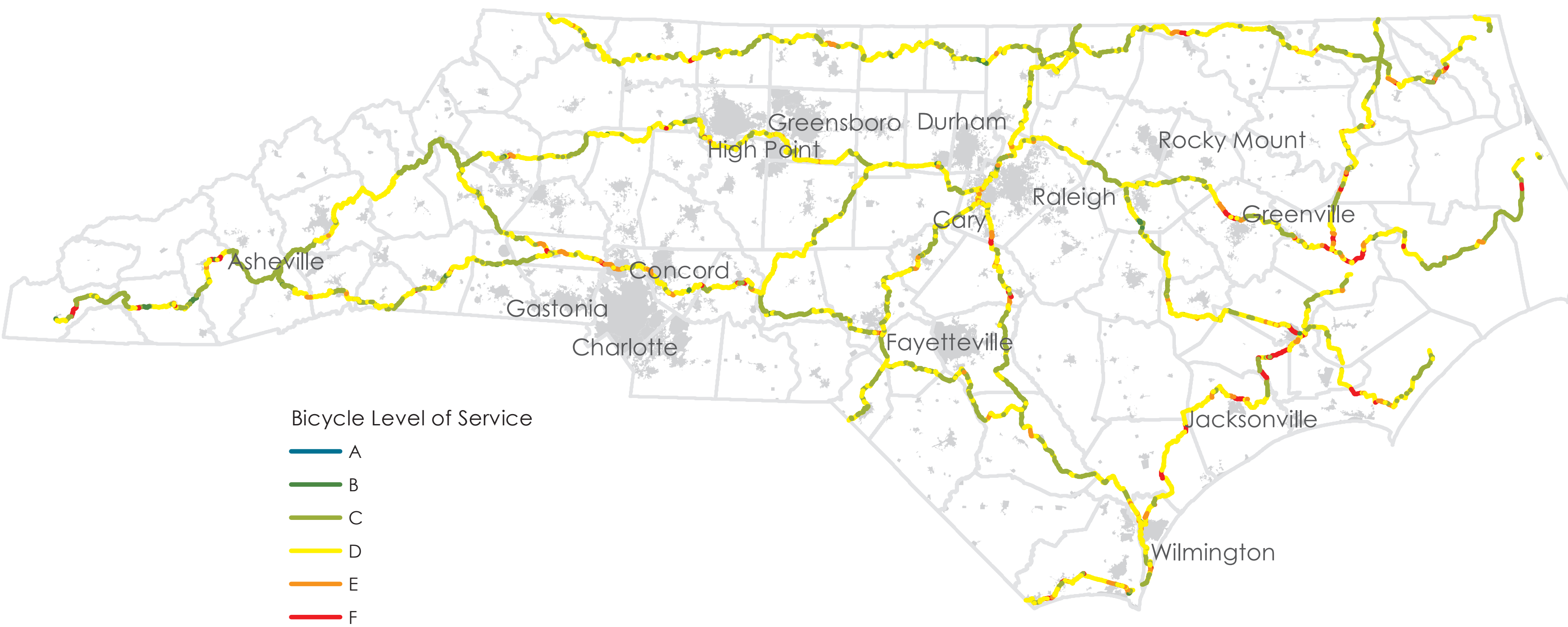
Route	B	C	D	E	F
US 1 - Carolina Connection	0.2%	41%	53%	5%	1%
NC 2 - Mountains to Sea	1%	39%	48%	6%	6%
NC 3 - Ports of Call	0.1%	21%	57%	10%	13%
NC 4 - North Line Trace	1%	31%	58%	4%	5%
NC 5 - Cape Fear Run	0%	37%	48%	10%	4%
NC 6 - Piedmont Spur	1%	19%	62%	13%	5%
NC 7 - Ocracoke Option	1%	22%	62%	8%	7%
NC 8 - Southern Highlands	1%	44%	49%	5%	2%
Sandhills Sector	0.1%	46%	46%	5%	3%
Total	1%	33%	53%	7%	6%

COMPREHENSIVE LEVEL OF SERVICE

The previous tables provide a snapshot of roadway conditions along the state routes, but do not provide a comprehensive picture of quality since the optimal level of each characteristic depends on the state of the others. The following level of service analysis provides an integrated picture of the quality of the routes. Levels of service were calculated for route segments based on a combination of each segment's roadway characteristics using available data.[1] Where data gaps existed, median values were assumed.

The following below and table at left detail the comparative level of service results for each segment. While data limitations prevent accurate comparison of service levels shown here to those calculated elsewhere[2], the LOS findings allow intra- and inter-route comparison within the system.

NC Bicycle Route Level of Service



Route Connections

Just as many roadways across North Carolina have changed over the last several decades, towns and cities have transformed. These changes warrant the consideration of new connections and additions to the state bike route system. One of the major themes of stakeholder feedback was the need for connections into cities. In addition, the development and increasing popularity of routes in neighboring states and in larger systems like the East Coast Greenway present opportunities for interstate connections. The following list details the major additional connections recommended.

THE VIRGINIA CREEPER TRAIL

NC 4's current western terminus at the Virginia border in the northwestern part of North Carolina lies approximately 25 miles from the Virginia Creeper Trail's eastern extent. The Virginia Creeper Trail is one of the most popular rail-trails on the east coast, running 34 miles through scenic southwest Virgina. Furthermore, the Creeper Trail's midpoint in Damascus, Virginia intersects with the US 76 TransAm cross-country bike route, offering an opportunity to connect to a major coast-to-coast route system. NC 4 should be extended to link to this trail and thus US76.

TENNESSEE ROUTES

Tennessee recently updated their state bike route system. The former route system, Bike Routes Across Tennessee (BRAT) is still signed with route details listed on the Tennessee Department of Transportation's website. While neither route system includes any direct connections to North Carolina's system, there are linkage opportunities. With the potential to shift NC 2 west of the Blue Ridge Parkway and include a northern mountains extension route to Virginia, the following towns along this route near the Tennessee border could serve as gateways. These potential gateways and connectors include:

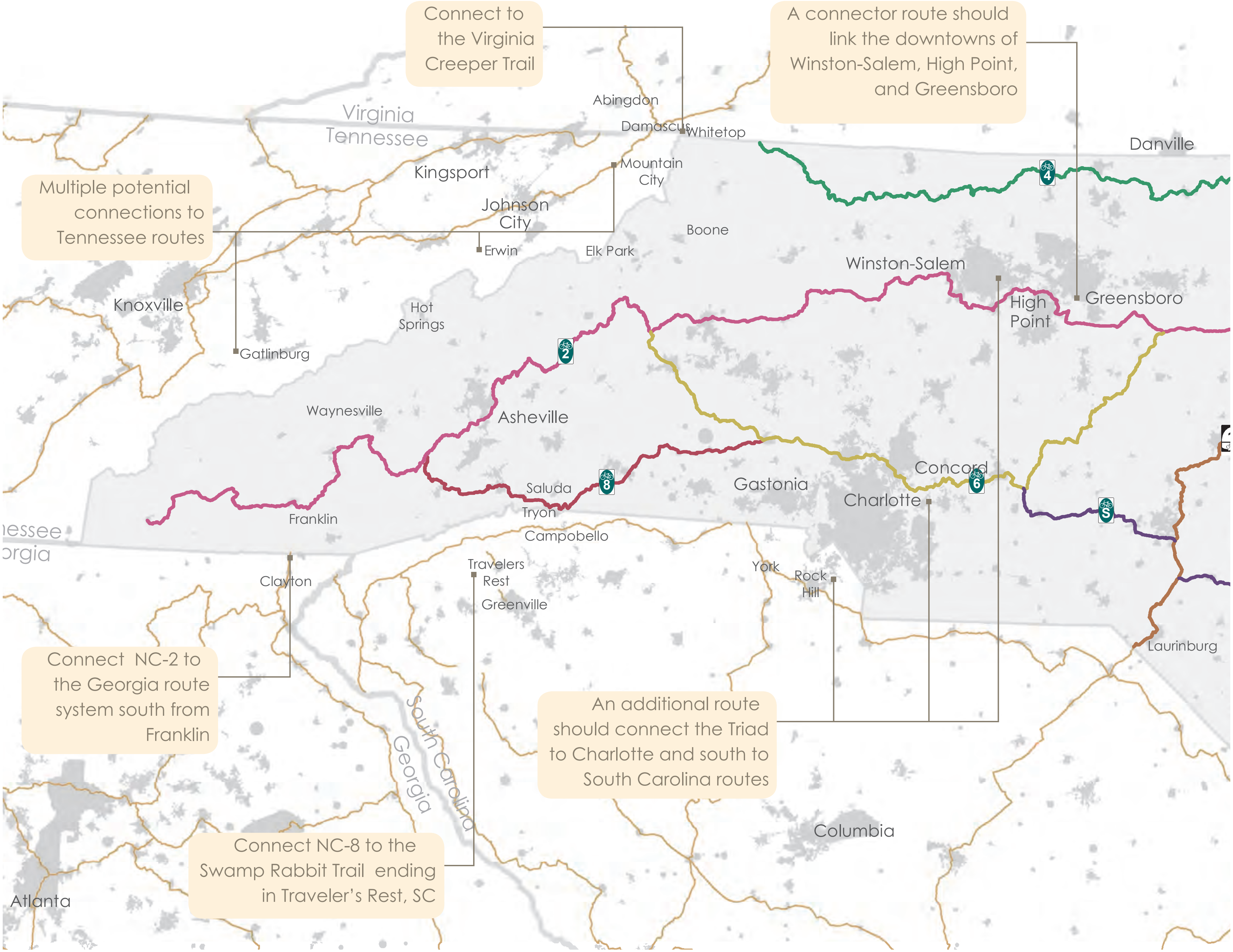
- Boone, NC - northwest of Boone, US 421 crosses into Tennessee and Mountain City. Tennessee's Chattanooga to Mountain City route passes west of Mountain City, Tn. The US 421 corridor could serve as a potential connector.
- Elk Park, NC - US 19E runs west from Elk Park and connects with the Mountains route of the BRAT system at Roan Mountain State Park in Tennessee.
- Hot Springs, NC - NC 208 heading west will connect (via Tn 70/107) to the Chattanooga to Mountain City route near Greeneville, TN less than 30 miles away
- Between Hot Springs and Burnsville, NC, NC 212 and US 19W will connect to Erwin, TN, which lies 15 miles from Tennessee's Chattanooga to Mountain City route.
- Great Smoky Mountains National Park connector - If Tennessee were to extend a bike route through Gatlinburg, TN toward Great Smoky Mountains National Park, US 441 could serve as a connector west of Sylva and Waynesville, NC.

GEORGIA

Georgia's state bike route system has one route directly connecting to North Carolina. It enters North Carolina less than 15 miles south of the town of Franklin and NC 2. US 441/US 23 could serve as a connector between Franklin, NC and the Georgia state bike route system.

THE TRIAD

NC 2 currently meanders south of Winston-Salem, avoiding the city. It similarly misses High Point and Greensboro. The network of bicycle routes identified throughout the triad provides an opportunity for routing directly through the downtowns of these cities. A connector route through the cities would yield potential savings in mileage, as well as provide an option for those interested in travelling between urban centers.



Connect to the Virginia Creeper Trail
A connector route should link the downtowns of Winston-Salem, High Point, and Greensboro
Multiple potential connections to Tennessee routes
Connect NC-2 to the Georgia route system south from Franklin
An additional route should connect the Triad to Charlotte and south to South Carolina routes
Connect NC-8 to the Swamp Rabbit Trail ending in Traveler's Rest, SC
Virginia
Tennessee
Abingdon
Damascus
Whitetop
Mountain City
Kingsport
Johnson City
Erwin
Elk Park
Boone
Danville
Winston-Salem
High Point
Greensboro
Knoxville
Gatlinburg
Hot Springs
Waynesville
Asheville
Saluda
Tryon
Campobello
Franklin
Gastonia
Concord
Charlotte
Clayton
Travelers Rest
Greenville
York
Rock Hill
Laurinburg
South Carolina
Georgia
Columbia
Atlanta

NORTH-SOUTH CONNECTOR

The current system does not include a north/south connector in the western half of the state. The counties encompassing and between Charlotte and Winston-Salem - Mecklenburg, Cabarrus, Rowan, Davidson, and Forsyth - have all published bicycle route systems (Davidson's has not been finalized). These localized route systems present a potential opportunity in developing an additional segment of the statewide route system that serves as a north/south connector in the western half of North Carolina.

SOUTH CAROLINA ROUTES

North Carolina's current state bike route system connects to South Carolina's bike route system in two places. NC 3 connects to South Carolina's Coastal Route along the east coast and US 1 continues through South Carolina, entering near Laurinburg, NC.

The new North-South Connector could serve as a connection to two South Carolina routes: the Central Route finishes in the town of York, SC less than 30 miles from Charlotte and the NC border, and the Northern Crescent route runs east/west through SC, closely paralleling the NC border. Rock Hill, SC and York, SC are potential connection points to the Northern Crescent route near the the Charlotte border. NC 8 southeast of Tryon straddles the NC/SC border on Hunting CountryRd/Webster Rd. Through the town of Landrum, SC, a direct connection could be established to the Northern Crescent route in Campobello, SC, ~5 miles to the south.

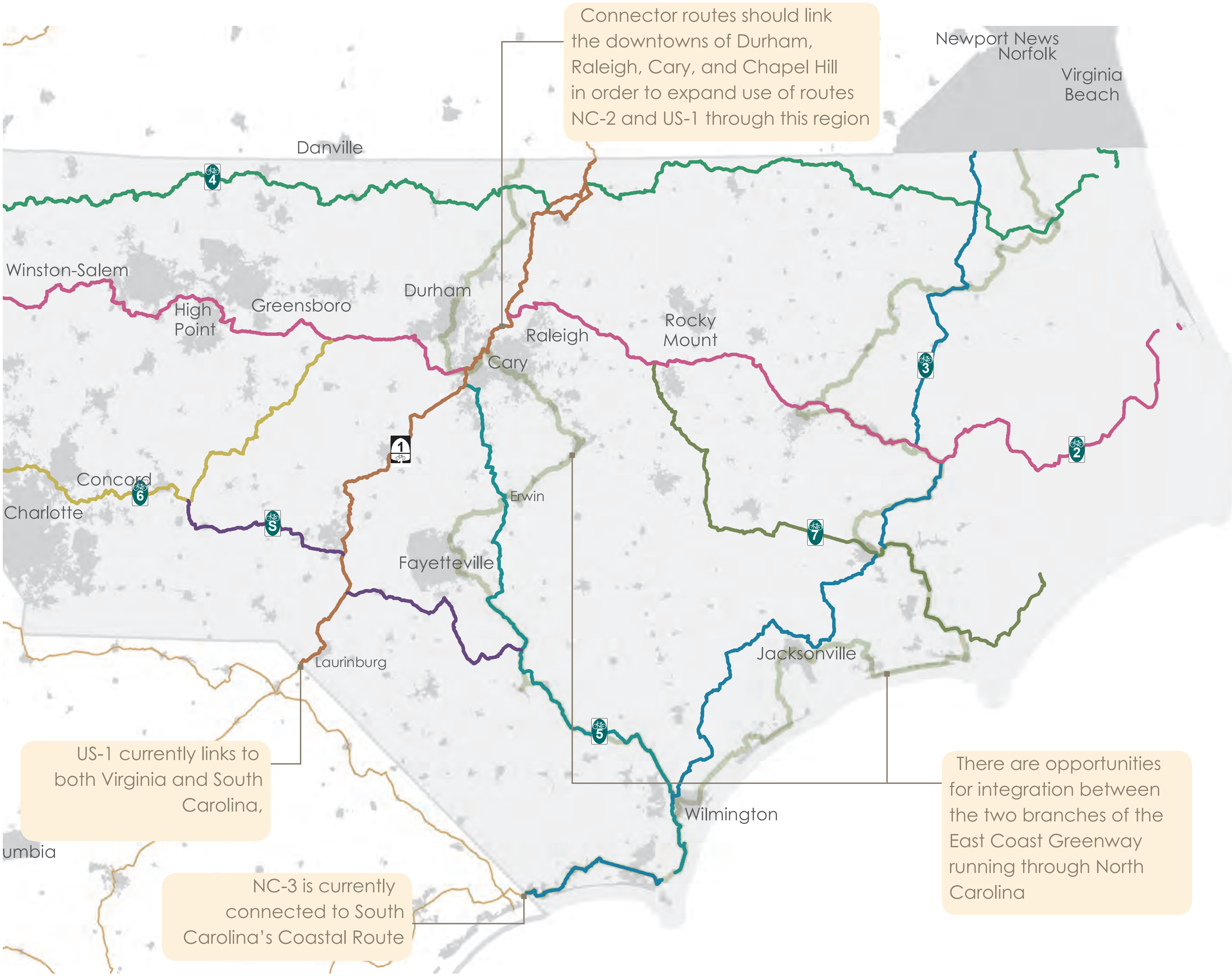
Another connection opportunity exists where the popular Swamp Rabbit Trail beginning in Greenville, SC finishes in Travelers Rest, SC - less than 30 miles from Saluda, NC and NC 8 near the NC/SC border.

THE TRIANGLE

Similar to the routing in the Triad, NC-2 and US-1 avoid the downtowns of Raleigh, Durham, Cary, and Chapel Hill. Given the amount of development in this region, this avoidance does not yield a pleasasnt rural route but is instead difficult for cyclists and identified as a problem area. A connector route or routes between these downtowns would both serve touring cyclists interested in visiting these urban centers, and provide a connection for residents of the triangle to travel between the cities by bike. Connector routes should be added through this area.

THE EAST COAST GREENWAY

The East Coast Greenway is planned to be a traffic-free long-distance urban trail project that will connect 25 major cities from Maine to Florida, incorporating waterfront esplanades, park paths, abandoned railroad corridors, canal towpaths, and other pathways designated for non-motorized use. This route system is in development, and follows roadways where trails haven't yet been developed. The main spine of the route runs through Durham utilizing the American Tobacco Trail and then southeast to Wilmington where it meets a coastal route. These two branches parallel US-1, NC-5, and NC-3 for significant sections. Routes should be coordinated with the East Coast Greenway, overlapping where appropriate and signed to emphasize the other system where the routes cross. This will allow resources invested in roadways of each to benefit the other and generate the benefit of additional travelers along shared routes, which makes routes more comfortable by increasing awareness of them and influencing motorist behavior.


Connector routes should link the downtowns of Durham, Raleigh, Cary, and Chapel Hill in order to expand use of routes NC-2 and US-1 through this region
Newport News
Norfolk
Virginia Beach
Danville
Winston-Salem
High Point
Greensboro
Durham
Raleigh
Cary
Rocky Mount
Concord
Charlotte
Erwin
Fayetteville
Laurinburg
Jacksonville
Wilmington
umbia
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S
US-1 currently links to both Virginia and South Carolina,
NC-3 is currently connected to South Carolina's Coastal Route
There are opportunities for integration between the two branches of the East Coast Greenway running through North Carolina

Route Information

Two items stood out from the public feedback gathered on state bike routes: route information should be improved both on the ground in the form of better signage, and online for use during trip preparation.

SIGNAGE

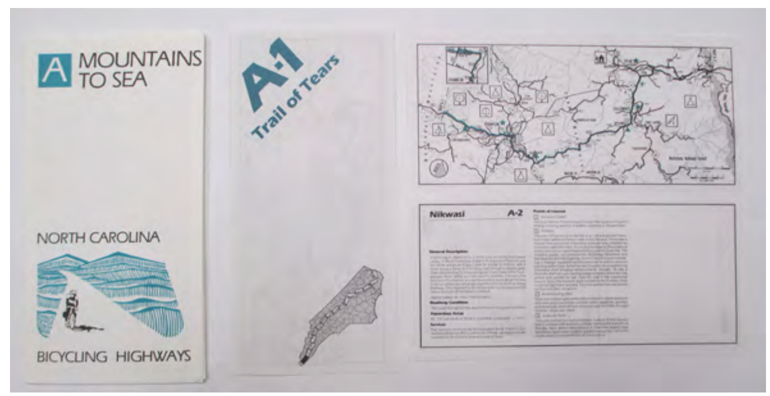
Originally, routes were signed at each turn with the green bike route sign, shown below. While these wayfinding signs are useful for those following a route exactly, they do not provide additional information such as distance to the next town, or information about connections to local and regional routes where these touch or come close to the state bike routes. Further, as development has occurred along the routes, many signs have been removed, making it difficult to follow the routes with signs alone.

Current signage for NC-2 in Carrboro

GUIDES

Paper maps are currently available to order through the NCDOT Bicycle and Pedestrian Division's website. The maps come with a guide full of useful information including bicycle laws and safety tips, detailed route descriptions, and the location of hazardous segments, camping areas, bicycle shops, services, and other points of interest.

While these guides provide much of the information cyclists are looking for, they sometimes take several weeks to arrive upon order and are out of date in some areas. This makes them inconvenient for use by cyclists who plan trips on short notice or visitors interested in comparing different route options. Cyclists around the state have requested that the information contained in these guides be made available on the web. Even further, cyclists are interested in using interactive maps that can be viewed on smart phones or imported into other trip planning tools.



The current Bike Route Guide for NC-2

Recommendations for the System

Route Changes

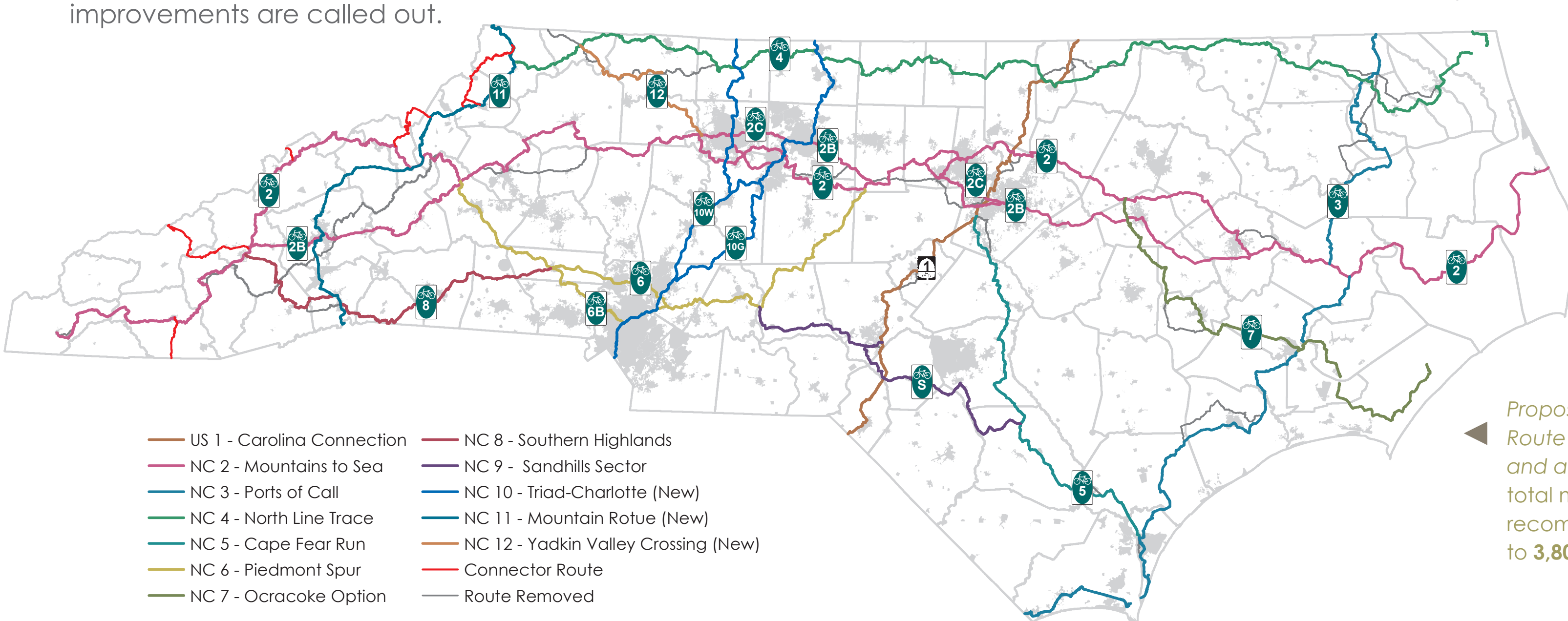
Using a combination of the following inputs, detailed re-routing recommendations for each state bike route are provided on the following pages. **A total of 805 miles of re-routes are recommended.**

- Bicycle Level of Service along the current routes
- Local and regional route locations
- Neighboring state route locations
- Online map input
- Local cyclist input

While in some cases re-routing can address segments that have become unsuitable for cycling, in many cases no suitable alternatives exist through developed or environmentally sensitive areas. In these cases, improvements are recommended. For each segment of the system, priority areas requiring short-term improvements are called out.

Additional Routes and Connections

Many additional route connections are recommended to make the system comprehensive, efficient, and useful to a broader range of cyclists. This includes three new routes as well as other connectors that tie into neighboring state systems, link to key destinations, and fill current gaps in the system. **A total of 1,167 additional miles are recommended** and detailed on the following pages. One key additional route type is the 'business route'. Business routes complement the existing system where it avoids cities, providing connections directly through downtown areas. While current rural routes bypassing cities are useful for cyclists interested solely in scenic, undeveloped landscapes, many cyclists have expressed an interest in routes connecting directly to urban areas. Business routes provide this option for routes travelling near the major urban centers of the state. Beyond their use for touring cyclists interested in seeing cities, business routes will also be useful to local cyclists interested in travelling around their own urban areas. Improvements on these routes will therefore benefit many different groups.



*Proposed State Bike Route System: Re-routes and additions bring the total mileage of the recommended system to **3,800 miles.***

US 1 - CAROLINA CONNECTOR

Re-route through the Triangle in coordination with re-routes of NC 2 and other planning efforts, such as the Triangle Commuter Bike Initiative

No changes further south of Sanford

Re-route near Middleburg to avoid possible roadway flooding

Evaluate and incorporate re-routing recommendations proposed by local cyclist Larry Sams

Re-route southwest from Sanford using Carbonton Rd, Franklin Dr, Henley Rd, Center Church Rd, and Plank Rd

US 1 - Proposed Route
US 1 - Alternative Considered
Proposed Route System
Current Route System
East Coast Greenway
State Park
Federal Land

0 10 20 Miles

9.3

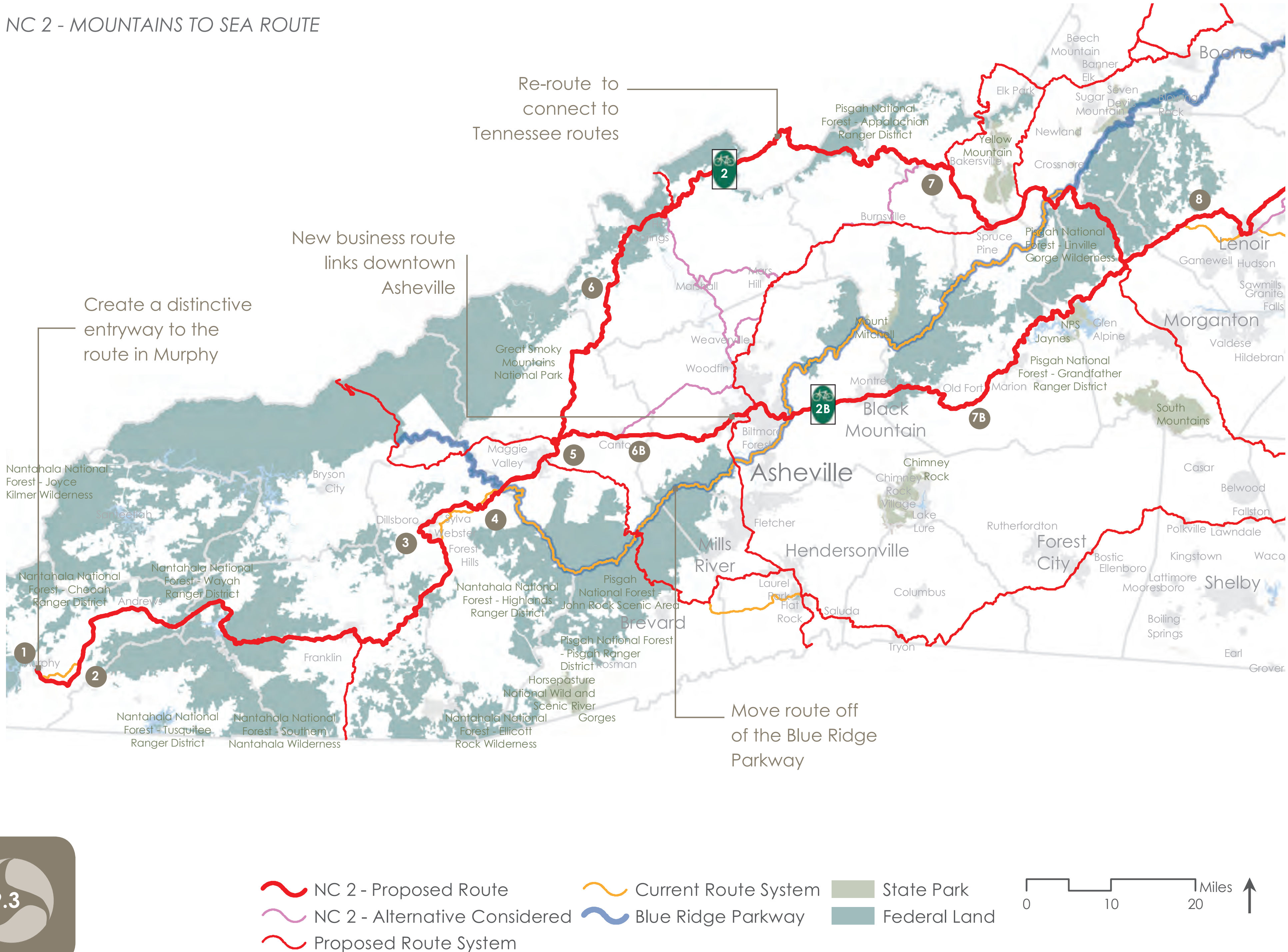
ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	Virginia border to the Triangle region north of Falls Lake	Generally pleasant riding conditions, rural	Eliminate the section of US 1 Carolina Connector going over Kerr Lake between Hicksboro Rd and Jacksontown Rd. Eliminate section from Middleburg to intersection of Jacksontown Rd and Manson-Drewery Rd via Manson; utilize Jacksontown Rd/N Lee Ave to connect Middleburg to Jacksontown Rd and Manson-Drewery Rd.	NC 39 heading west into Henderson; US 158 heading north from Henderson	Tony Goodnight; Mike Dayton; Dave Connellly
2	Triangle Region	This section has been affected by development from the growing triangle region.	Cyclist Larry Sams studied this section and proposed re-routing recommendations for US 1 through the triangle. Re-route Six Forks Rd/Norwood Rd section to Durham Rd and Carpenter Pond Rd in order to connect New Light Rd and Norwood Rd. Also, align with East Coast Greenway utilizing Cary greenways from Umstead Park to Davis Dr.	Due to high traffic volumes on roads through this area, a large majority will need bicycle facility upgrades. *Prioritize Carpenter Pond Rd and Davis Dr	Larry Sams; input map comments; Cary bike map; Triangle Bike Commuter Initiative; Donna Kidder (Team CBC)
3	South of the Triangle region to the South Carolina border	Generally pleasant riding conditions, rural; Heavier traffic closer to Apex	Besides one change southwest of Sanford (see 4), no changes; some sections through towns should be prioritized for upgrades	*Prioritize Charlotte Ave and Carthage St through Sanford; Old Hwy 1 and Salem St entering Apex	Rainbow Cycles bike shop in Southern Pines; Tony Goodnight; Bob Oderkirk (Team CBC); input map comments; field review
4	Sanford area	Higher amounts of traffic on current route between Sanford and S Plank Rd	Re-route from Sanford heading southwest utilizing Carbonton Rd, Franklin Dr, Henley Rd, Center Church Rd, and Plank Rd		John Mueller - Rainbow Cycles bike shop in Southern Pines; Bob Oderkirk (Team CBC)

US Bike Routes

US Bike Route 1 Carolina Connector, adopted as part of the North Carolina State Bike Route system, is part of a developing network of long-distance bicycle routes across the United States. It is a collaborative effort spearheaded by a task force under the auspices of the American Association of State Highway and Transportation Officials (AASHTO). Members of the task force include officials and staff from state DOTs, the Federal Highway Administration, and non-profits, including Adventure Cycling Association, the East Coast Greenway Alliance, and Mississippi River Trail, Inc. North Carolina designated US 1 as part of the State Bike Route system in 1982. Changes to US 1 will need final approval from AASHTO.

Source: Adventure Cycling Association. http://www.adventurecycling.org/routes-and-maps/us-bicycle-route-system/usbrs-101/

NC 2 - MOUNTAINS TO SEA ROUTE



ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
	General	The Mountains to Sea Route bike route is often confused with the cross-state Mountains-to-Sea Trail , an off-road hiking trail.	Rename NC 2 to avoid this confusion.		
1	Terminus of NC 2 in Murphy	The current "end" sign is placed at the intersection of US 64 with US 19/74/129 in Murphy. This is a barren, high traffic intersection with little to highlight Murphy.	Extend route into downtown Murphy continuing straight across the intersection to SR 1326, Hiwassee Street, which should be followed to US 19 Business. This is the "square" in Murphy and is much more interesting and unique than the current "end" intersection.		Reuben Moore
2	Murphy to Cullowhee	Quality route from Murphy past Cullowhee to the intersection of 107 and River Rd. While a back route alternative exists going through Cullowhee, which the higher-traffic current route on 107 skips, 107 has bike lanes until River Rd.	Re-route small section east of Murphy, utilizing new US 64 rather than Old US 64 - use NC 141 to reconnect with current NC 2. Show links to Cullowhee.	Paved shoulder generally	Smoky Mountain Bicycle bike shop in Franklin; Cherokee County CTP Committee
3	107 & River Rd to north of Sylva	Current NC 2 on 107 north of River Rd is a high traffic section with little to no space for cyclists.	Eliminate this current section. Re-route via River Rd to the west. Although this alternative adds distance, it is more scenic and connects through downtown Sylva.	Paved shoulder generally	Reuben Moore
4	North of Sylva to Balsam Gap and the intersection of US 23/74 and the Blue Ridge Parkway	US 23/74 Expressway is carries high volume and high speed traffic	Re-route using parallel county roads that are now paved and offer an alternative to the current route on the US 23/74 Expressway toward Balsam Gap.	Paved shoulder generally	Kent Cranford

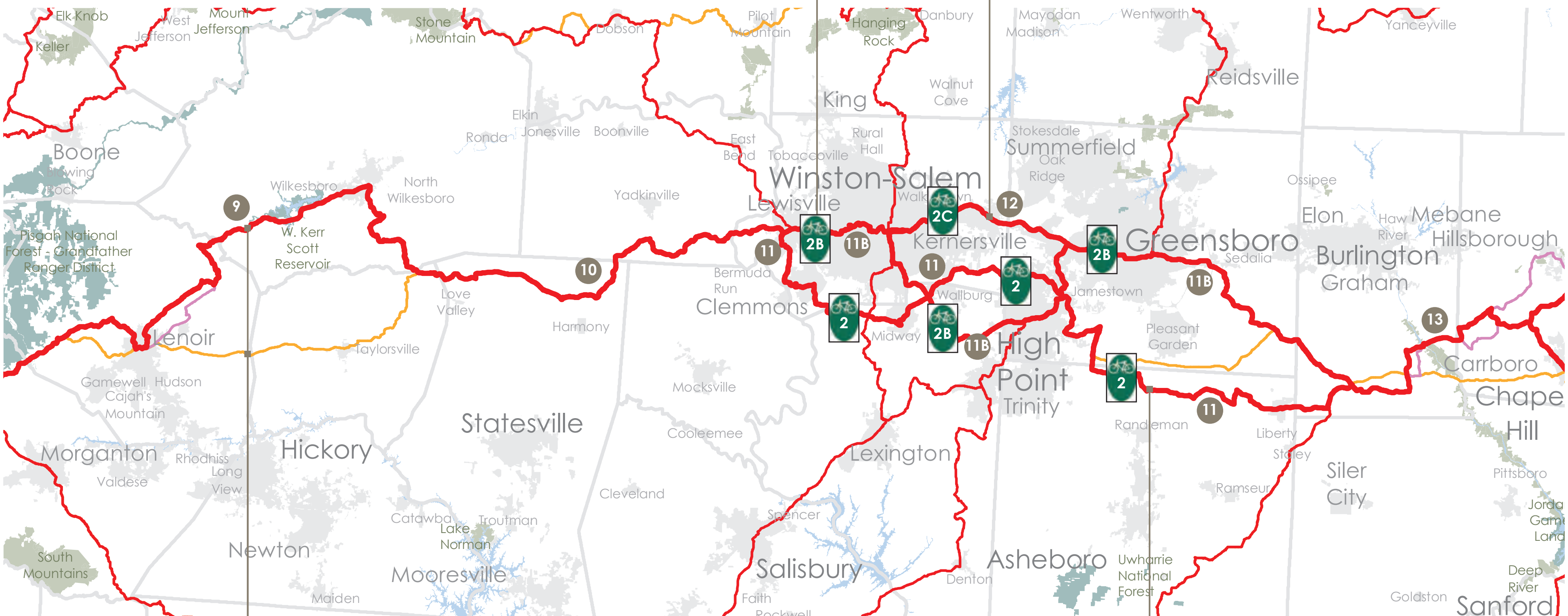
ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
5	Balsam Gap heading northeast from the intersection of US 23/74 and the Blue Ridge Parkway to Lake Junaluska	Existing route runs along the Blue Ridge Parkway. A lack of shoulders, pavement deterioration, and significant touring traffic make this road difficult for cyclists. In addition, the Blue Ridge Parkway is a well-known signed route, so those cyclists interested in riding it can easily access information about the route whether or not it is a designated state bike route.	Re-route NC 2 off of the Blue Ridge Parkway. Route through Waynesville, Lake Junaluska, Clyde, and Canton. From west to east, take Old Balsam Rd from near Balsam Gap toward Waynesville. From east to west, must take US 23/74. If bicycle facility improvements are implemented along the N Main St corridor in the future, consider utilizing the N Main St corridor through Waynesville rather than the greenway.	East to west section of US 23/74 - high speed, high traffic climb to Balsam Gap	Cecil Yount
6	Lake Junaluska to Spruce Pine via Tennessee	Tennessee is currently updating their state bike route system and interested in establishing connections to North Carolina's updated statewide bike route sytem. This would provide a link in addition to linking scenic, rural, and rugged mountainous terrain in western NC.	Route on NC 209 north from Lake Junaluska to Hot Springs. Significant climbing but spectacular route. From Hot Springs, head north through very scenic but challenging route to Spruce Pine via Tennessee connection and Bakersville, NC. This skips Asheville, Weaverville, and Burnsville but serves as a regional connector to eastern Tennessee and rural western NC. Aligns with segment 7 of the (Draft) High Country Regional Bike Plan route from Bakersville to Spruce Pine	Paved shoulder generally	Cecil Yount; John Mudge - RollsRite bike shop in Waynesville; Sam White - Liberty Bicycles in Asheville; Phil Trew; Asheville/ Buncombe area bike map; Jessica Wilson of Tennessee DOT
7	Spruce Pine to the Blue Ridge Parkway and current NC 2	Three-Mile Hwy and US 221 currently provide a low level of service for bicyclists	Follow 19E east/north of Spruce Pine eventually connecting to Three Mile Hwy and eventually the Blue Ridge Parkway. Aligns with segment 9 (partially) and 9A of the High Country Regional Bike Plan (Draft)	Three-Mile Hwy and US 221 connecting to NC 183	Randy Raskin

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
6B	Business Route: Lake Junaluska to downtown Asheville	Pavilion in Clyde has water, bathrooms, and parking available - gathering spot for bicyclists.	Highlight pavilion in Clyde. Heading east of Canton, use a combination of US 19/23, Old 19/23 through Candler and Sand Hill Rd to connect to downtown Asheville. Running parallel to Sand Hill Rd, highlight Sulphur Springs Rd on which lies a school, city pool, and heavily used park.	US 19/23 Asheville Hwy east of Canton; *Prioritize Haywood Street into Asheville	Cecil Yount; input map comments
7B	Business Route: downtown Asheville to current NC 2 (intersection of Brown Mountain Beach Rd and NC Rt 181 north of Morganton)	There is a lack of bike route options heading east out of downtown Asheville. Low bicycle level of service between downtown Asheville and Black Mountain	Add this route to the NC 2 Business Route. This section will need improvements, but would make a much needed connection east from downtown Asheville toward Black Mountain, Old Fort, Marion, and the Morganton area.	*Prioritize Tunnel Rd/US 70, and Swannanoa River Rd	Julie White; Lyuba Zuyeva
8	Blue Ridge Parkway to Lenoir	Abington Rd currently provides a low level of service for bicycling; better alternative exists on NC 90.	Re-route section on Abington Rd into Lenoir with NC 90.	Paved shoulder on NC 181 from Blue Ridge Parkway toward Lenoir.	Bob Giduz; Shawn Moore and Jeff Welch of Luna Cycles bike shop in Lenoir
9	Lenoir to the intersection of Brushy Mountain Rd and Sulphur Springs Rd/Linneys Mill Rd.	Wide road with varying shoulder (1-2 feet); heavy traffic including trucks (for motor vehicles, this road is used as a more direct route to the mountains as I-40 turns southwest toward Asheville)	Re-route this section. Route north along 268 (Happy Valley) toward Wilkesboro; reconnect to current NC 2 east of Taylorsville. Route is beautiful and scenic but adds significant distance. New route highlights greenways in Lenoir and links Wilkesboro.	Paved shoulder generally	Bob Giduz; Shawn Moore; Jeff Welch; input map comments
10	Love Valley to Lewisville (western edge of Winston-Salem)	Rural, lower traffic, currently a good route	No change	Paved shoulder generally	Tony Goodnight

NC 2 - MOUNTAINS TO SEA ROUTE

Add a business route through Winston-Salem, High Point, and Greensboro to complement the existing rural route through this region

As part of the new business route system, the Triad Connector will link downtown Winston-Salem to downtown Greensboro



268 provides a scenic alternative to the heavily trafficked 64/90 between Lenoir and Taylorsville

Groomstown Rd is the preferred option from High Point to Snow Camp and connects through the Town of Liberty

NC 2 - Proposed Route
NC 2 -Alternative Considered
Proposed Route System
Current Route System
State Park
Federal Land
0 10 20 Miles

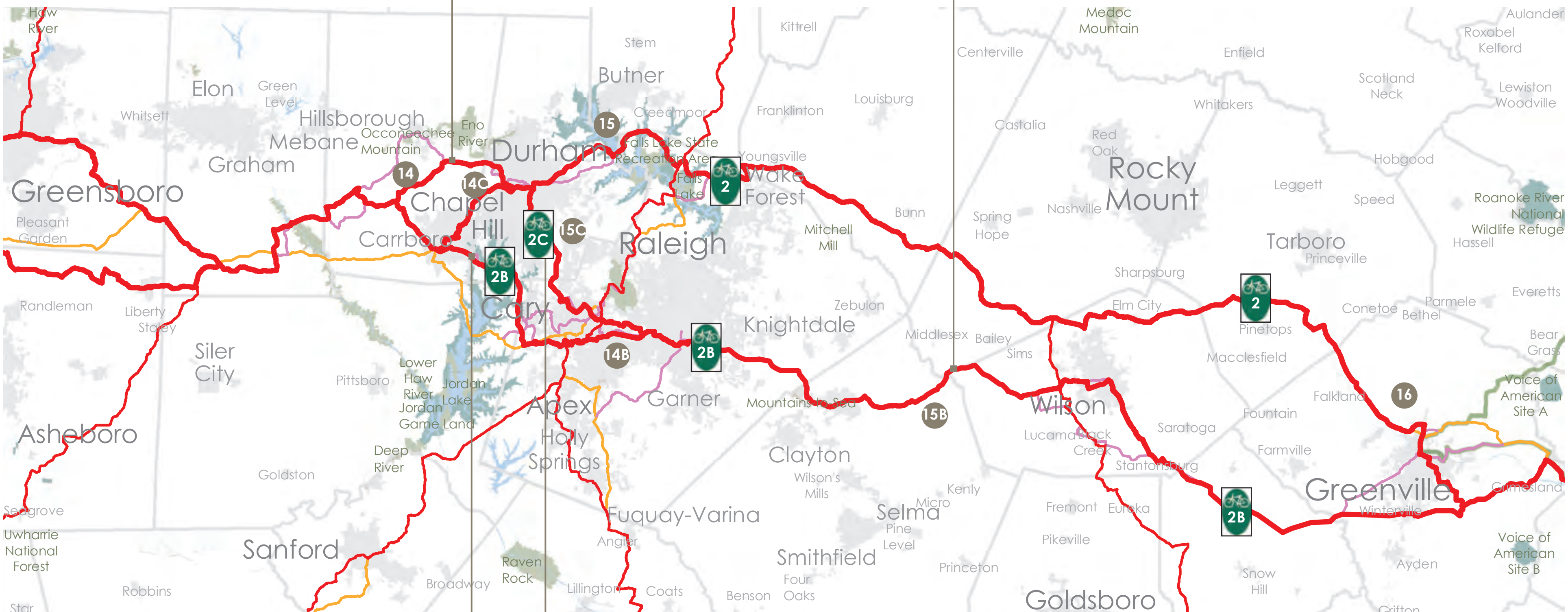
9.3

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
11	Lewisville to Snow Camp	These roads are still bicycle friendly and well selected; preserve as a complementary rural option to the urban business route.	Re-route section on NC 62 south of Greensboro using Groomtown Rd to Snow Camp via the town of Liberty.		Aaron Daniel and the Greensboro Velo Club team; input map comments
11B	Business Route: Lewisville to Snow Camp	This route links the hearts of downtown Winston-Salem, High Point, and Greensboro. Improvements will be needed to ensure safe passage through these urban centers.	Connect Lewisville to downtown Winston-Salem, downtown High Point, and downtown Greensboro. This Business route criss-crosses NC 2 twice before reconnecting near Snow Camp in Alamance County.	*Prioritize improvements to the urban center segments- particularly S Main in W.S., Lexington Ave through downtown High Point, and sections of Market St, McConnell Rd, and Alamance Church Rd in and around Greensboro.	Clemmons Bicycle; Zach Lail – Mock Orange Bikes, Winston-Salem; Aaron Daniel – Greensboro Velo Club president; Bicycle Toy and Hobby, High Point; Bike Maps - Winston-Salem, High Point, Greensboro, Davidson County, Randolph County
12	Triad Connector: downtown Winston-Salem to downtown Greensboro	This will serve as a direct connection between downtown Winston-Salem and Greensboro. However, it will need improvements to provide an appropriate bicycle level of service.	Make this connection between the downtown urban centers; prioritize improvements to make safe connection through Kernersville	*Prioritize improvements to Old Greensboro Rd, Mountain St, and W Market St.	
13	Snow Camp to Carrboro	Old Greensboro Rd is the most direct route to Carrboro/the Triangle from the Snow Camp area. This route is scenic, but carries higher traffic with limited shoulder and misses the rural destination of Saxapahaw. The section closer to Carrboro was recently resurfaced with 1-2 feet of shoulder added.	Re-route to the village of Saxapahaw along country roads that carriy less vehicular traffic, including Dairyland Rd. Proposed route is more scenic and connects to the popular rural cycling destinations of Saxapahaw and Maple View Farm while adding minimal distance.	*Prioritize section of Old NC 86 between Calvander and Hillsborough Rd northwest of Carrboro - this is a dangerous pinch point for bicyclists. Add paved shoulders generally, especially Sax-Beth Rd leading into Saxapahaw	Jeremy Pinkham; Eric Wiebe; Tamara Sanders – The Clean Machine bike shop in Carrboro; Dave Connelly; input map comments

NC 2 - MOUNTAINS TO SEA ROUTE

Re-route to downtown Durham and connect to Orange County routes that link historic Hillsborough

Business route continues out to Greenville and the main NC 2 route, linking NC 5 along the way, to provide a more direct alternative for cyclists heading east toward the coast from Raleigh



Along with re-routing of current NC 2 through the triangle, additional business and connector routes between each of the urban centers would provide more choice for riders interested in visting city centers

- NC 2 - Proposed Route
- NC 2 - Alternative Considered
- Proposed Route System
- Current Route System
- East Coast Greenway
- State Park
- Federal Land

0 10 20 Miles

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
14	Maple View Farm to downtown Durham	Scenic route with lower traffic volumes through rural parts of Orange and Durham Counties leading to downtown Durham.	Re-route NC 2 to connect through the northern Triangle area and downtown Durham. Proposed business route (see below) replaces original route and connects Chapel Hill and Raleigh.	Paved shoulder generally	Eric Wiebe; Casey Collings; Dave Connelly; Orange County bike map
15	Durham to Youngsville area	Main route continues through Durham to current NC 2 crossing Falls Lake	Make this connection continuing east, north of Raleigh to the bicycle friendly sections of current NC 2 heading east from Youngsville	Improvements needed in Youngsville	Mike Dayton; Eric Wiebe
16	Youngsville area to Greenville area	Generally pleasant riding conditions; low bicycle level of service along Old River Rd and US 264	Retain majority of route, except the section east of Greenville - Old Creek Rd and US 264; connect this route south through downtown Greenville toward Washington	*Prioritize improvements to Old River Rd northwest of Greenville	Mike Dayton; Ryan Danell (EC Velo Team)
14B	Triangle Business Route: Carrboro/ Chapel Hill to Raleigh via Cary	Current NC-2 was once a great route but bicycle facility improvements have not kept pace with development; Proposed NC-2 Business utilizes a combination of recent greenway developments and on-road connections to replace this route.	Eliminate current NC 2 from Carrboro to the intersection of Purnell Rd and Stony Hill Rd near Youngsville. Add business route that connects Chapel Hill; utilizes greenways along 54, a significant paved section of the American Tobacco Trail, and a developing greenway system in Cary; aligns with the East Coast Greenway; and connects to downtown Raleigh via the NC State campus and greenways	*Prioritize improvements to Raleigh Rd/54 leaving Chapel Hill, Barbee Chapel Rd, and Stagecoach Rd	Dave Connelly; Durham bike commuters meet-up; Larry Sams; Mike Dayton; Branson Kimball; input map comments; Durham, Cary Bike Maps; BLOS
15B	Triangle Business Route: Downtown Raleigh to Greenville area	Pleasant riding conditions east of Poole Rd; lower bicycle level of service through Wilson and Winterville; connects to ECG and Neuse River Greenway	Include this direct route for bicyclists not wanting to route north to connect with NC 2 main route (Current NC 2) heading east; cross the Tar River after Grimesland heading east	*Prioritize improvements to Poole Rd (Raeligh area) NC 42 through Wilson; improve Worthington Rd through Winterville; Improve Covered Br Rd (Wilson County)	Mike Dayton; Ryan Danell (EC Velo Team); Jimmy Eatmon
14C	Triangle Connector: Carrboro/Chapel Hill to Durham	Erwin Rd currently provides a low level of bicycle service	Utilize Erwin Rd as the main connection from Chapel Hill to Durham. This road needs improvements to serve as this connection and should be highly prioritized.	*Prioritize improvements to Erwin Rd	Eric Wiebe; Casey Collins; Tamara Sanders; input map comments
15C	Triangle Connector: Durham to Raleigh	This route utilizes greenway connections and on-road facilities, but also includes a few sections that provide a low bicycle level of service	Utilize the American Tobacco Trail, Davis Dr, Cornwallis Rd, and other connectors before linking with the Carrboro/Chapel Hill-to-Raleigh connector route northeast of Cary en route to downtown Raleigh	*Prioritize Davis Dr, Aviation Pkwy, Evans Rd, and Trinity Rd	Mike Dayton; BLOS data

NC 2 - MOUNTAINS TO SEA ROUTE

The current route ends before officially hitting the 'sea'. The trail end should be shifted either to the fishing pier in Nags Head or another significant destination along the Outer Banks.

Main route and business route meet up west of Washington, where proposal re-routes around US 264 to connect downtown Washington

The current route goes past Lake Mattamuskeet, the largest natural lake in NC and a wildlife-viewing destination

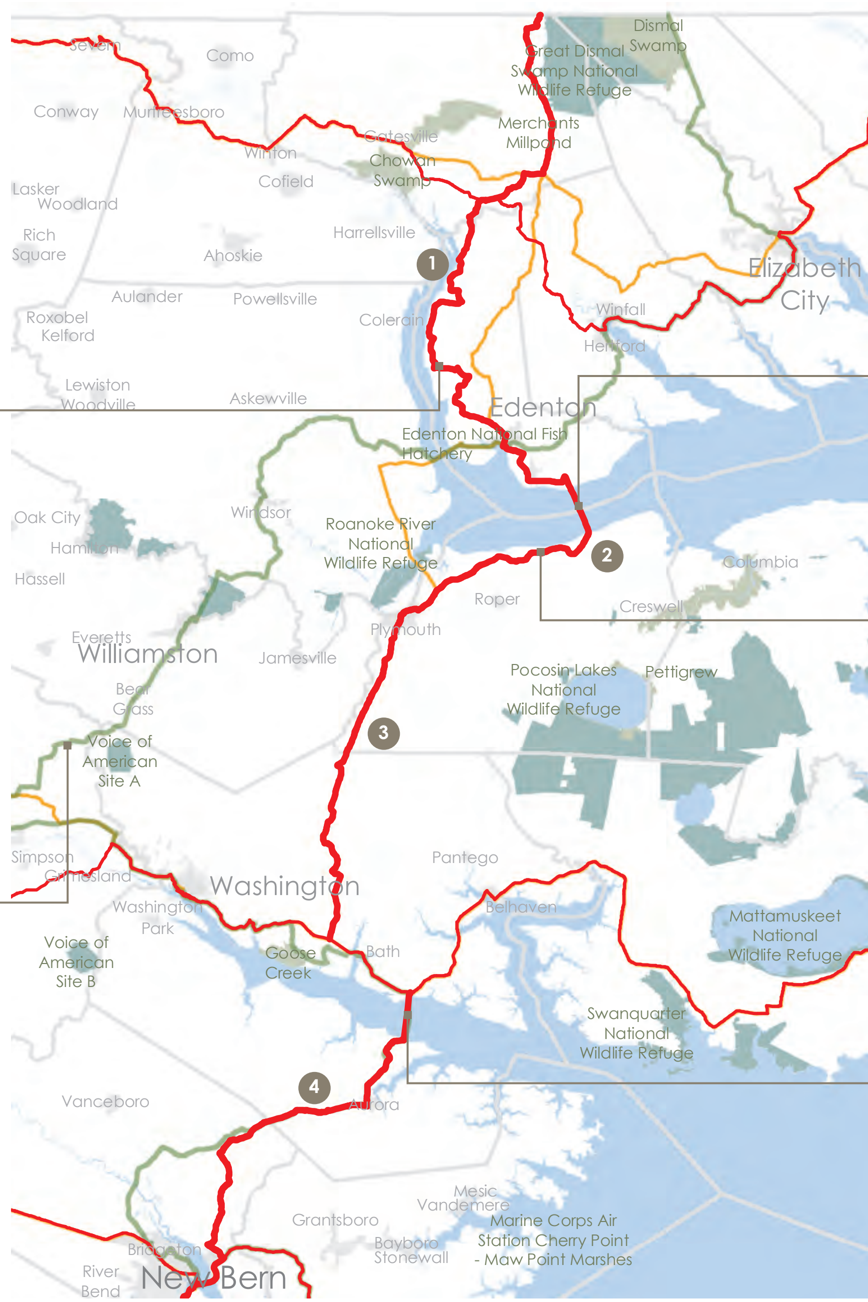
NC 2 - Proposed Route
NC 2 - Alternative Considered
Proposed Route System
Current Route System
East Coast Greenway
State Park
Federal Land

0 10 20 Miles

9.3

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
17	Washington Area	US 264 provides low bicycle level of service	Re-route to avoid 264 west of downtown Washington; use Grimes Rd, Plymouth St, and W 3rd St; Through downtown, use W. Stewart Pkwy		Mike Dayton and Jonathan Kuhn
18	Washington to Manteo	Generally good section	Re-route NC 2 bridge into Manteo: southern bridge is preferable because of limited shoulder on northern bridge. However, northern bridge may be decommissioned in the future and become bike/ped only - adjust accordingly		Mike Dayton, Albemarle Bike Plan Existing Conditions, and Steve Lambert
19	Eastern terminus	Currently ends in Manteo	Consider shifting finish to the Outer Banks. Options: Continue straight across Virginia-Dare Trail bridge to Nags Head, finish at fishing pier; finish at Hatteras Island destination; tie into regional Outer Banks		

NC 3- PORTS OF CALL



Re-route to scenic roadways along the Chowan River, connecting to the Arrowhead Beach community

The NC 32/94 bridge over the Albemarle Sound has limited shoulder space and low walls - improvements needed

Routing via the NC 32/94 bridge and Mackeys Rd will benefit the many local cyclists who use this connection to begin loops out of Plymouth, while avoiding the current higher-traffic route

The East Coast Greenway follows a similar corridor but takes a less direct route in order to connect existing trails. NC 3 and the ECG can benefit from clear wayfinding where they cross and overlap.

Much of the current alignment is scenic and should remain but requires improvement, such as the Neuse River Bridge Connection

NC 3 - Proposed Route
Proposed Route System
NC 3 - Alternative Considered
East Coast Greenway
Current Route System
State Park
Federal Land

0 10 20 Miles

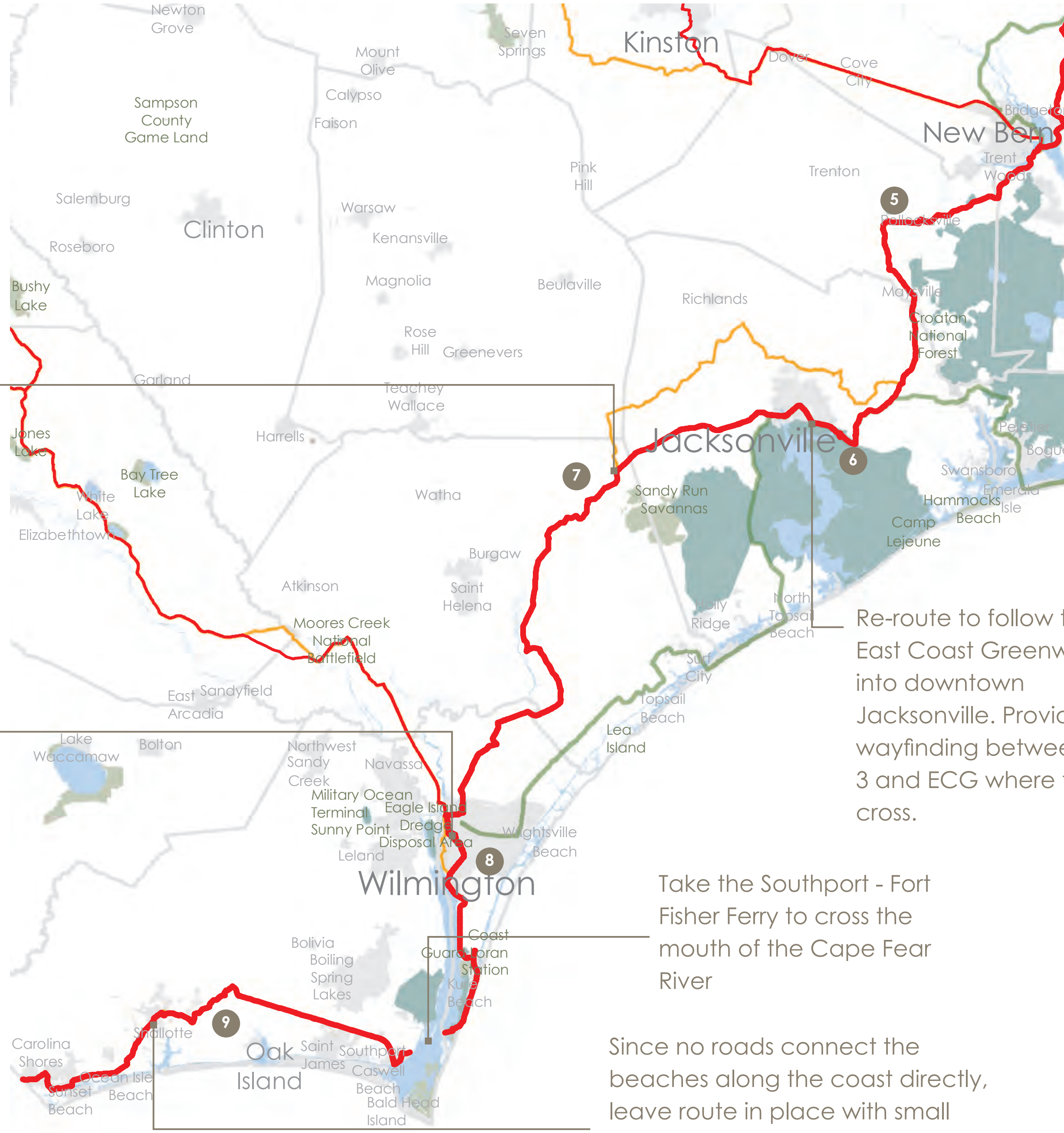
9.3

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	VA border to Edenton	Current NC 3 parallel to the Arrowhead Beach area uses higher traffic roads while skipping the Arrowhead Beach community and the Chowan River en route to Edenton.	Utilize the Arrowhead Beach option along quieter roads that offer a more scenic option along the Chowan River. It connects to the Arrowhead Beach community en route to Edenton. The ECG represents an alternative north/south route east of the Great Dismal Swamp, utilizing the Dismal Swamp Canal en route to Elizabeth City and further south through this area.	Current NC 3 north of the Arrowhead Beach area to the VA border is narrow - recommend paved shoulder in future road upgrades; *Prioritize NC 32 into Edenton	Sam Barrow, Planner, Edenton; Albemarle Field Work Team
2	Edenton to Plymouth	Current NC 3 crosses the Chowan River and uses US 17 and NC 45 to the Plymouth area. These roads have truck traffic and limited space for cyclists	Re-route heading east southeast from Edenton, more enjoyable riding conditions exist before and after the Albemarle Sound bridge - this bridge does not provide a high comfort level for a cyclist; however NC 32 and Mackeys Rd provide a good option into Plymouth	*Prioritize Albemarle Sound bridge improvements - add higher railing, limited shoulder and debris are also concerns	Inner Banks Cycles bike shop - Plymouth; Albemarle Field Work team; Mike Wright, Plymouth, General Services Director
3	Plymouth to Bath	Current NC 3 on Long Ridge Rd contains truck traffic and limited space for a cyclist	Current NC 3 on Long Ridge Rd is the preferable option to parallel side roads, but should be improved	*Prioritize Long Ridge Rd improvements - needs paved shoulder	Inner Banks Cycles bike shop - Plymouth; Albemarle Field Work team; Mike Wright, Plymouth, General Services Director
4	Bath to New Bern	Current NC 3 aligns with the East Coast Greenway (ECG) and Adventure Cycling Association (ACA) routes and connects with the Croatan Plan route in this area - lower traffic volumes; bridge crossing over the Neuse River should be improved	Keep current alignment	Neuse River bridge improvements needed - has some shoulder but also has debris and high speed traffic	Inner Banks Cycles bike shop - Plymouth; Albemarle Field Work team

NC 3- PORTS OF CALL

Reconnect to the existing NC 3 west of Jacksonville. The current route from this junction to Wilmington is scenic and pleasant to ride

Re-route through downtown Wilmington utilizing a route selected by the Cape Fear Cyclists and a Cycle NC ride



Re-route to follow the East Coast Greenway into downtown Jacksonville. Provide wayfinding between NC 3 and ECG where they cross.

Take the Southport - Fort Fisher Ferry to cross the mouth of the Cape Fear River

Since no roads connect the beaches along the coast directly, leave route in place with small tweaks and wayfinding to beaches

- NC 3 - Proposed Route
- NC 3 - Alternative Considered
- Proposed Route System
- East Coast Greenway
- Current Route System
- State Park
- Federal Land

0 10 20 Miles

9.3

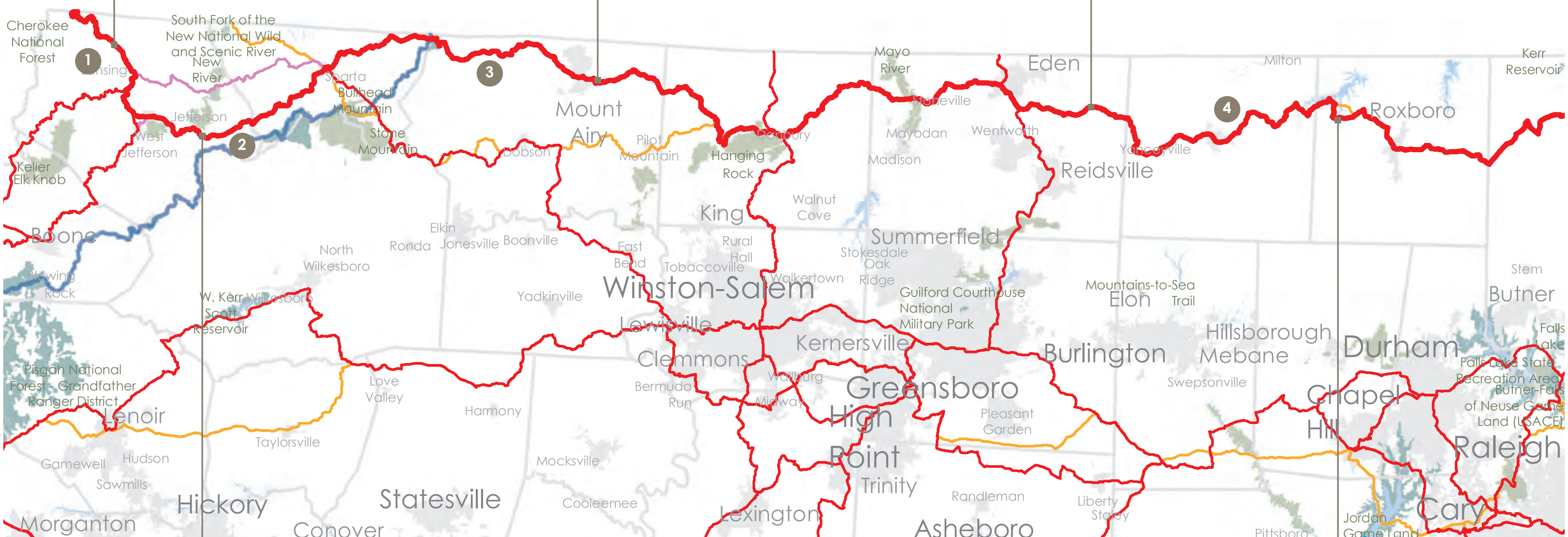
ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
5	New Bern to Maysville	Current NC 3 runs on scenic, low-traffic roads; NC 3 also loosely aligns with the ACA and ECG routes	Keep current alignment	Paved shoulder generally	Croatan Plan; Steve Bzomowski
6	Maysville to Jacksonville	Current NC 3 east and north of Jacksonville was flagged as dangerous by several people on the online input map; this route also avoids downtown Jacksonville	Re-route following ECG route through downtown Jacksonville utilizing greenway into downtown; highlight connections to the ECG which also provides alternative links to Emerald Isle and Beaufort	Improvements needed on Old 30 Rd; Rocky Run Rd; and NC 24	Bicycle Gallery bike shop - Jacksonville; ECG route; statewide input map comments
7	West of Jacksonville en route to Wilmington	Current NC 3 routes north and west of Jacksonville, missing the town	Re-route through downtown Jacksonville to the Burgaw Hwy/53 and further west to Old Maple Hill Rd and current NC 3; current NC 3 is good from there to Wilmington, pleasant riding conditions; ECG and ACA also provide busier, but interesting beach route alternative from Jacksonville	Improvements needed to US 17; Richland Hwy; and NC 53 heading west out of downtown Jacksonville	Tony Goodnight; Eileen McConville - president of the Cape Fear Cyclists; Bicycle Gallery bike shop - Jacksonville; statewide input map;
8	Downtown Wilmington	Market St should be avoided: busy road with little room for cyclists; Port Authority does not want Front St to be used for bicycle routes (large truck traffic shipping goods from port); the route into town is okay	Re-route utilizing route selected by the Cape Fear Cyclists and Cycle NC for the Fall 2012 Cycle NC ride. Improvements through downtown Wilmington needed. Highlight connections to local routes such as the River to Sea trail connecting downtown to Wrightsville Beach.	*Prioritize N 23rd St; S 5th St; 17th St; Independence Blvd; River Rd; Carolina Beach Rd bridge	Eileen Mcconville - president of the Cape Fear Cyclists; Cycle NC; field review
9	New Hanover County to the South Carolina border	Limited options - beach towns divided by inlets that are not connected by bridges or regular ferries; ACA and ECG routes are mostly similar through here	Use current route; small change at intersection near Shallotte - combines with ECG; short spurs or appropriate signage to beach towns/beaches are recommended	*Prioritize improvements to 211, important connector but not bicycle friendly	Tony Goodnight; Cape Fear Cycling Club

NC 4- NORTH LINE TRACE

Extend the current route to connect to the Viriginia Creeper Trail and ultimately US Bike Route 76

Re-route NC 4 between Sparta and Hanging Rock to avoid use of the Blue Ridge Parkway and connect the City of Mount Airy

Much of NC 4 is currently scenic and pleasant



Route south to connect West Jefferson and align with the High Country Regional Bike Plan

Re-route at the Hyco River to avoid heavy truck traffic on NC 57

NC 4 - Proposed Route
NC 4 - Alternative Considered
Proposed Route System
State Bike Route
Blue Ridge Parkway
State Park
Federal Land

0 10 20 Miles

9.3

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	Western Terminus Extension: VA Creeper Trail to West Jefferson	Mostly quiet rural roads, scenic from the Creeper Trail and VA border to Lansing	Add an extension from the Virginia Creeper Trail to NC 4; the beginning of this route should connect the Virginia border to West Jefferson	Improve 194 near West Jefferson; paved shoulders generally needed	US Bike Route System; VA Bike Routes; High Country COG Bike Plan Draft
2	West Jefferson to Sparta	This section carries some traffic and connects to rural services - also connects to West Jefferson	Utilize this connection to extend current NC 4 from Sparta toward the VA Creeper Trail. Aligns with segment 36 of the High Country Regional Bike Plan (Draft).	Paved shoulders generally needed	High Country COG Bike Plan Draft
3	Sparta to Hanging Rock	Current NC 4 utilizes a small section of the BRP southeast of Sparta near Stone Mountain State Park - tough climb up US 21 and BRP if heading northwest, but current route generally has good riding conditions to Hanging Rock State Park from there	Re-route using northern route connecting through Mt. Airy. This section is scenic, avoids using the BRP without adding mileage, connects with the destination town of Mt. Airy, allows for an easy link toward Galax, Virginia and the New River Trail, and generally provides pleasant riding conditions. A Yadkin Valley connector will utilize some of the current NC 4 corridor to the south.	NC 18 leaving Sparta toward Mt. Airy; Pine St in downtown Mt. Airy; NC 89 leaving Mt. Airty	Tony Goodnight; Dave Connelly; VA Bike Routes
4	Hanging Rock to Henderson	This long stretch of current NC 4 is generally pleasant for cycling; rural, lower traffic	Small change at the Hyco River - avoid NC 57 due to heavy truck traffic - use Deer Meadow Rd and Concord Church Rd; eliminate section over Kerr Lake, re-route to the south through Henderson	NC 62 through Yanceyville; NC 39 into Henderson	Tony Goodnight; input map comments

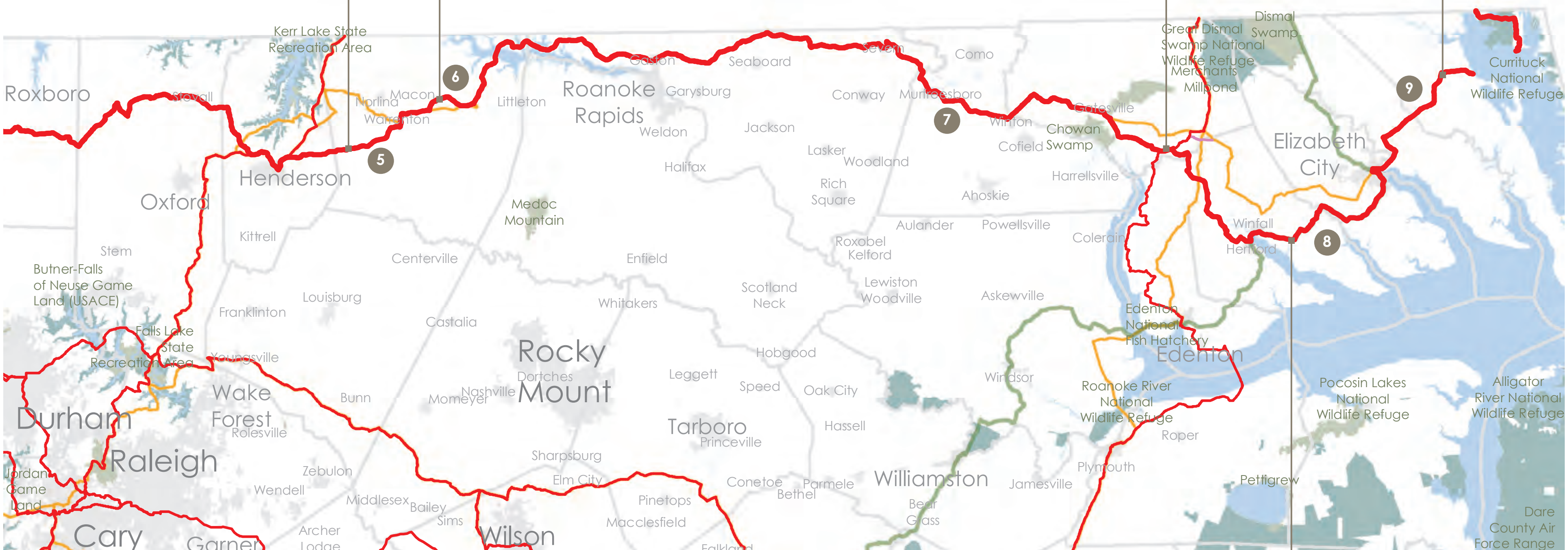
NC 4- NORTH LINE TRACE

Re-route to southern alternative running east from Henderson to avoid possible road flooding from Kerr Lake

This short re-routing provides a connection to the Town of Macon

Re-route off of NC-37 south of Gatesville

Improvements needed as NC 4 approaches the Ferry



Southern alternative through the Albemarle region connects Hertford and coordinates with a section of the East Coast Greenway

NC 4 - Proposed Route
NC 4 - Alternative Considered
Proposed Route System
East Coast Greenway
Current Route System
State Park
Federal Land

0 10 20 Miles

9.3

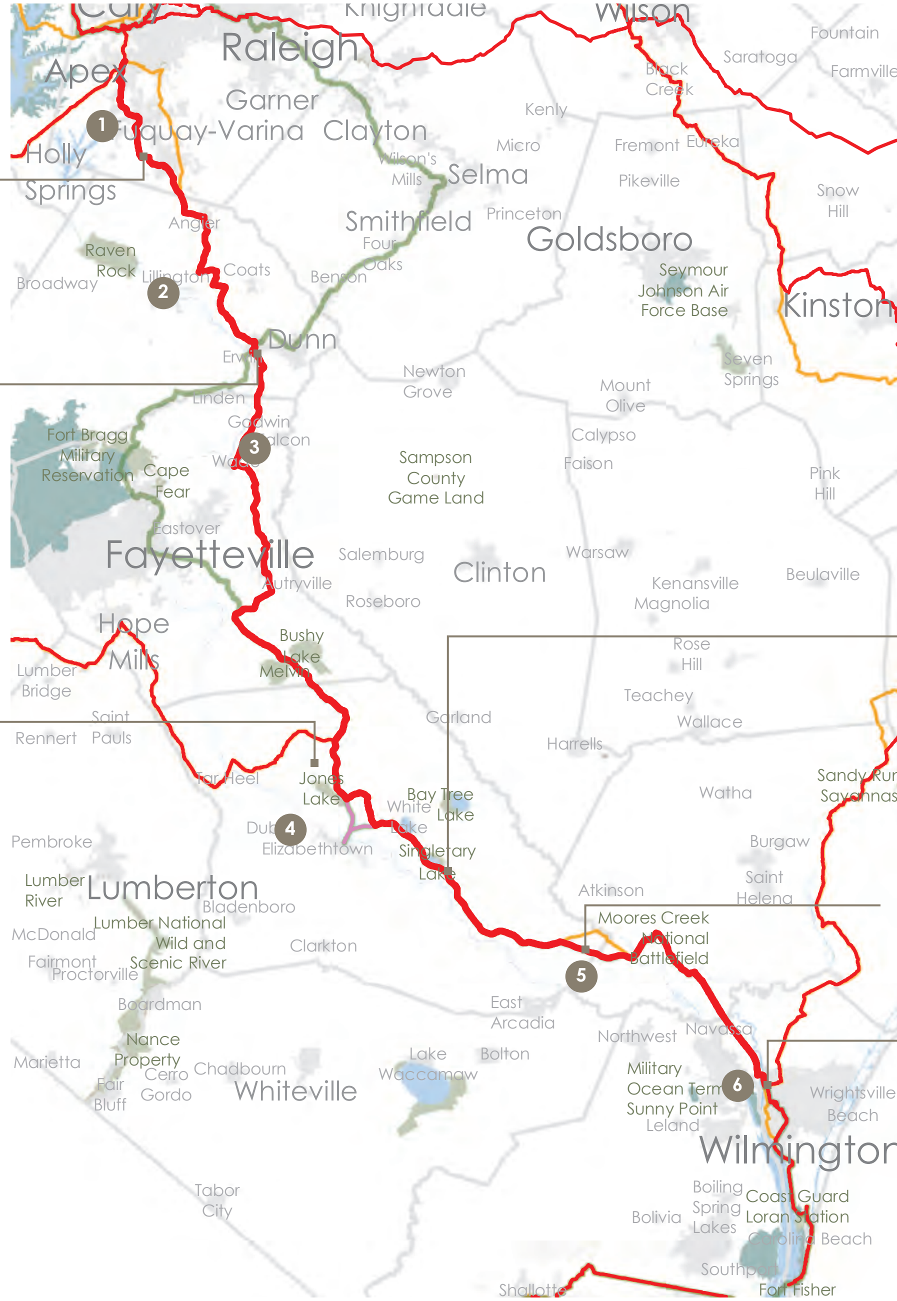
ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
5	Henderson to Warrenton	More direct connection; pleasant riding conditions	Re-route from Henderson directly to Warrenton	US 1/US 158 heading north from downtown Henderson	Tony Goodnight
6	Village of Macon northeast of Warrenton	Good riding conditions exist on current NC 4 and on the proposed alternative through the village	Re-route to connect Macon		Tony Goodnight
7	Macon to Gatesville	This section of NC 4 is rural with low traffic volumes - pleasant riding conditions	No change	Improve bridge over the Chowan River	Tony Goodnight; input map comment
8	Gatesville to Elizabeth City	Current NC 4 misses Hertford and utilizes a section of NC 37 in Gates County that should be avoided if possible	Avoid NC 37 in Gates County; route through Hertford; join with the ECG from Hertford to Elizabeth City entering town along the waterfront	Improve North Church St bridge (Hertford); *Prioritize Halls Creek Rd, Four Forks Rd, Pitts Chapel toward Elizabeth City;	Albemarle Regional Bicycle Plan fieldwork and meetings with local planners
9	Elizabeth City to the Virginia border	High traffic, high speed roads through this section; limited alternatives	No changes to alignment; current route is the best option northeast toward the ferry; route needs improvements.	*Prioritize the following: Camden Causeway; NC 34 has limited shoulder with high traffic volumes;168 has some shoulder but is 4 lane highway with very high traffic volumes toward the ferry	Albemarle Regional Bicycle Plan fieldwork and meetings with local planners

NC 5- CAPE FEAR RUN

Improvements needed along northernmost re-routed section

Provide clear wayfinding at the connections with the East Coast Greenway indicating that it connects to Fayetteville

Add wayfinding directing cyclists to Elizabethtown



Much of NC 5 is currently scenic and comfortable for cycling, and it connects to several state parks

Re-route to the more direct NC-210

End NC 5 in downtown Wilmington at intersection with NC 3

NC 5 - Proposed Route
NC 5 - Alternative Considered
Proposed Route System
East Coast Greenway
Current Route System
State Park
Federal Land

0 10 20 Miles

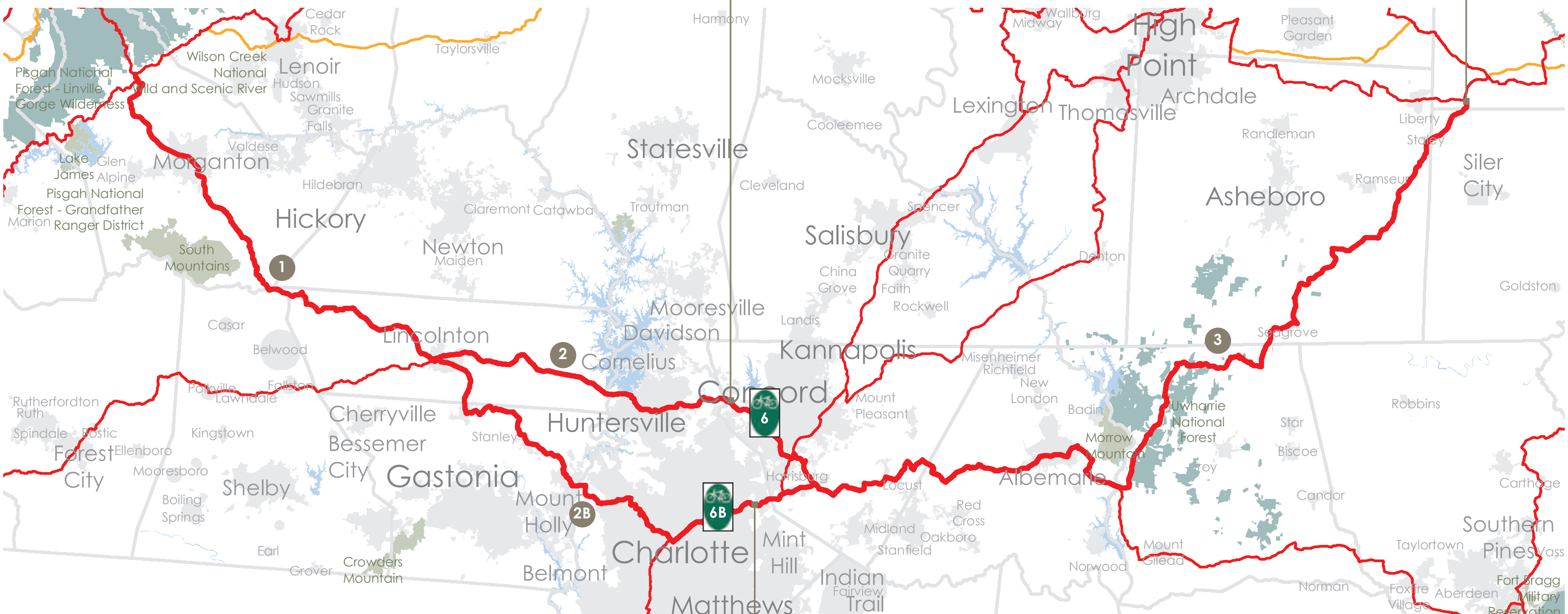
9.3

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	Apex to Angier	The current NC 5 provides a low level of service for cycling	Re-route utilizing Tingen Rd to Old Holly Springs/Apex to Holly Springs, then combination of Piney Grove-Wilbon Rd and Angier Rd through Fuquay-Varina to Angier; highlight connection with Avent Ferry Rd leading to Harris Lake	*Prioritize: This re-route will still need improvements	Alan Johnson; Bob Oderkirk; Dean Ness; input map comments
2	Angier to downtown Wilmington	This section is generally great for cycling, with some areas requiring improvement; US 421 into downtown Wilmington is the best/only connection, but is a major highway with wide shoulders, high traffic volumes, railroad tracks, and debris	Keep route generally the same; several smaller changes noted below. Highlight connection to the Dunn-Erwin Trail (connects Dunn and Erwin); put signage at both Erwin and Cedar Creek to show the ECG current travel route connecting Fayetteville; also highlight connection to Elwell Ferry Rd and Lake Waccamaw from NC 5	*Prioritize US 421 into Wilmington	Alan Johnson; Eileen McConville - president of Cape Fear Cyclists; Dave Connelly
3	US 13 and Wade Stedman intersection	Wade Stedman no longer goes through this intersection; must use US 13 for 1/4 mile	Re-route briefly along US 13		Mike Dayton
4	Elizabethtown spur	NC 5 currently runs near Elizabethtown in the Bladen Lakes area - this could be a good opportunity to spur into the town (as does the ECG) without much additional distance	Keep current NC 5 route that skips Elizabethtown (pleasant ride); note Elizabethtown and services nearby with wayfinding and signage also highlighting ECG routing		ECG; Dave Connelly
5	210/ECG alignment in Bladen County	While NC 5 and ECG cross over and intertwine on several occasions along this route, NC 210 is one small section where they deviate - little difference between the routes but ECG on NC 210 is a little more direct	Align NC 5 with this small section of NC 210/ the ECG in Bladen County		ECG; Dave Connelly
6	Downtown Wilmington	NC 5 currently aligns with NC 3 through downtown Wilmington, ending at Fort Fisher	End NC 5 at intersection with NC 3 in downtown Wilmington. NC 3 already continues south through Fort Fisher. Ending NC 5 here will avoid confusion and simplify signage through Wilmington.		

NC 6- PIEDMONT SPUR

NC 6 through the greater Charlotte region requires significant improvements to be comfortable for cycling, but provides key links to the Lake Norman Bike Route, Carolina Thread Trail, and developing Red Line Trail

Shift eastern terminus of NC 6 southwest to its intersection with the proposed NC 2 reroute east of Liberty



Proposed NC 6 usiness makes use of locally-identified routes, existing facilities, and provides a link to downtown Charlotte, but will also require improvements to be safe for cycling

NC 6 - Proposed Route
Proposed Route System
NC 6 - Alternative Considered
Current Route System
State Park
Federal Land

0 10 20 Miles

9.3

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	From NC 2 intersection to intersection with NC Rt 16 near Lake Norman and Charlotte	Route is generally good through here, but improvements through downtowns needed; no dangerous sections flagged	No changes	Route through downtown Morganton needs improvement (S Sterling and S Green); same with E. Main St through Lincolnton	Cycles-Wright bike shop in Morganton; Ride-A-Bike bike shop in Lincolnton; Tony Goodnight
2	North of Charlotte - between NC 16 and NC 49	Very low level of service for a bicyclist; roads and towns through here have developed without bicycle accommodations; avoids downtown Charlotte	This entire section needs major improvements; the NC Rt 73 bridge over the Catawba River is scheduled to be improved with bicycle facilities sometime in the next 20 years. Highlight connectivity to the Lake Norman Bike Route system and surrounding towns. Also highlight Buffalo Shoals Rd as link toward the Lake Norman routes from Lincolnton. Highlight connections to Carolina Thread Trail and developing Red Line Trail north/south through Charlotte. Work with city officials, DOT engineers, and local cyclists to identify priority improvement sections.	*Prioritize - Vast majority of this section of the NC 6 Piedmont Spur between NC 16 northwest of Charlotte and NC 49 northeast of Charlotte	Matt Hartman; Tony Goodnight; Right Gear bike shop in Concord; The Spoke Easy in downtown Charlotte; John Boggiano; Bjorn Hansen; input map comments
2B	Business Route: Lincolnton southeast through downtown Charlotte to current NC 6 east of NC 49	This route was developed using a combination of local bike maps, bike lanes/ facilities, and local insight - it will also need improvements	This business route connects downtown Charlotte and avoids the worst parts of NC 6 north of Charlotte; however, segment will still need improvements. Work with city officials, DOT engineers, and local cyclists to identify priority improvement sections. Highlight connections to Carolina Thread Trail.	*Prioritize - The majority of this route will need improvements as well	Gaston County bike map; Charlotte/ Mecklenburg bike map; Central Carolina Cycling Club; Bjorn Hansen; Drew Skau; input map comments
3	From intersection with NC 49 northeast of Charlotte to terminus near Snow Camp, NC	This is generally a great route travelling through low traffic, rural, and scenic areas of the North Carolina piedmont.	Shift eastern terminus to the intersection with NC SBR 2 east of Liberty. Improvements to the NC 24/27 section and bridge must be highly prioritized - major re-routing adding much distance would be required to avoid this section, and it provides the best connection to the Uwahrrie National Forest and the rest of NC 6 Piedmont Spur. Otherwise, this is generally a great route, no other specific changes recommended.	*Prioritize NC Rt 24/27 section and bridge over the Pee Dee River. It is not safe for bicyclists and should be a high priority - bridge has limited space, high traffic volumes, and low walls.	Matt Hartman - Central Carolina Cycling Club, pesident; Tony Goodnight; Alan Johnson; Right Gear bike shop in Concord; Central Park bike route meeting; fieldwork

NC 7- OCRACOKE OPTION

NC 7 links the current NC 2 route as well as the proposed NC 2 Business route

Connect to historic downtown Kinston

Take the Cherry Branch-Minnesott Beach Ferry to cross the Neuse River

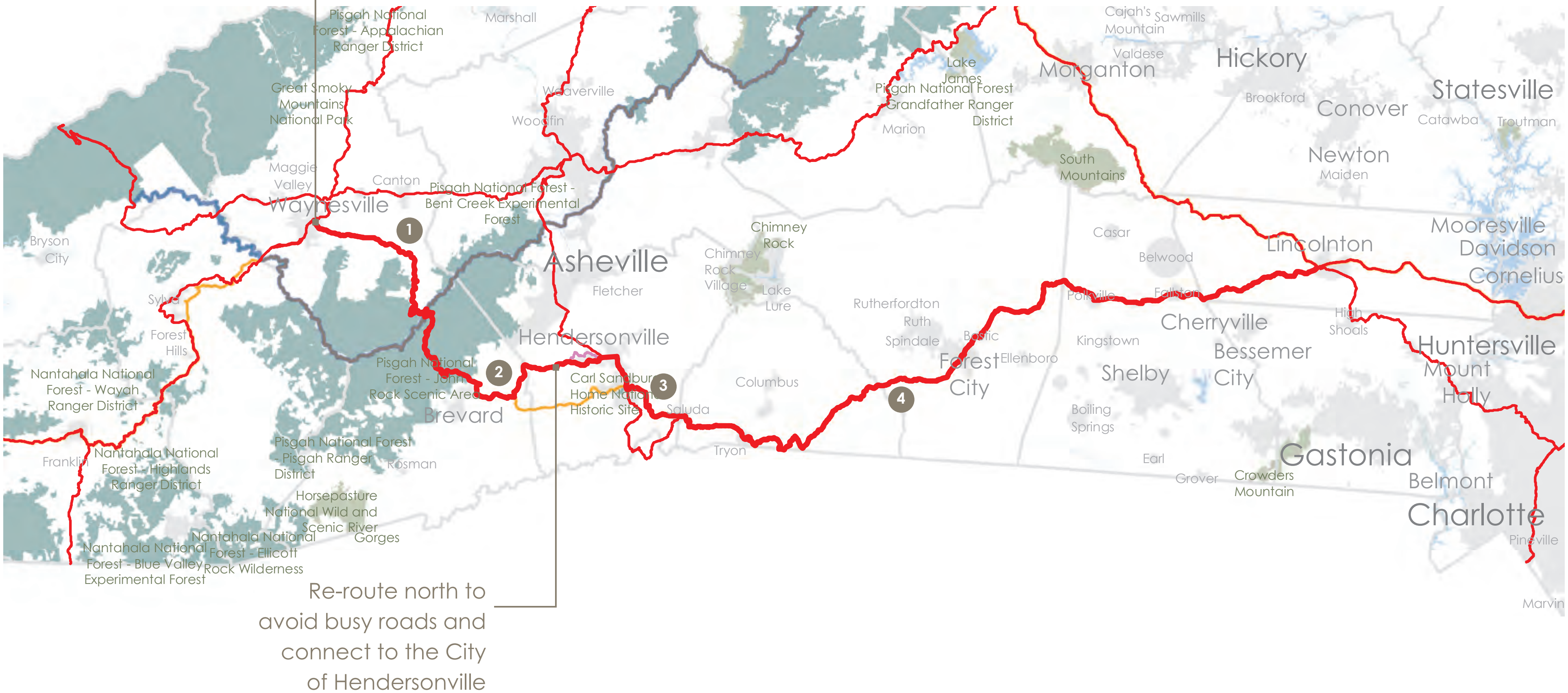
The route currently overlaps with both the East Coast Greenway and the Adventure Cycling Association's Atlantic Coast Route along some segments. Provide clear wayfinding at intersections with these routes.

NC 7 - Proposed Route
NC 7 - Alternative Considered
Proposed Route System
East Coast Greenway
Current Route System
State Park
Federal Land

0 10 20 Miles

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	Intersection with NC 2 near Wilson to New Bern	This route generally follows roads suitable for cyclists; this section avoids Kinston, adding distance	No changes besides re-routing through downtown Kinston. See below. Highlight connections with ECG.	*Prioritize Neuse Blvd entering New Bern	Lenoir County bike map; Riverside Bicycles and Outdoor Sports in Kinston; Mike Dayton; Croatan field work
2	Through downtown Kinston	This route takes NC 7 through downtown Kinston and is more direct; improvements will be needed in connecting through downtown	Re-route NC 7 through downtown Kinston	*Prioritize Carey Rd into downtown - 4-lane into Kinston; NC 258 leaving Kinston to the south - 4 lane road, traffic	Lenoir County bike map; Riverside Bicycles and Outdoor Sports in Kinston
3	New Bern to the Cedar Island Ferry and Ocracoke Island	This route aligns with the ECG until north of Beaufort; then aligns with the ACA Atlantic Coast route to the Cedar Island Ferry	No changes, but improvements needed. Highlight connections with ECG. Highlight connection to and amenities located in town of Oriental.	*Prioritize US 17/NC Rt 55 bridge over the Neuse River. It is designed for high speed traffic; Paved shoulder generally needed	Croatan Trails Plan fieldwork team; Atomic Cycles bike shop in New Bern; Mumfest public engagement; Doug Sligh; Dave Connelly; input map comments

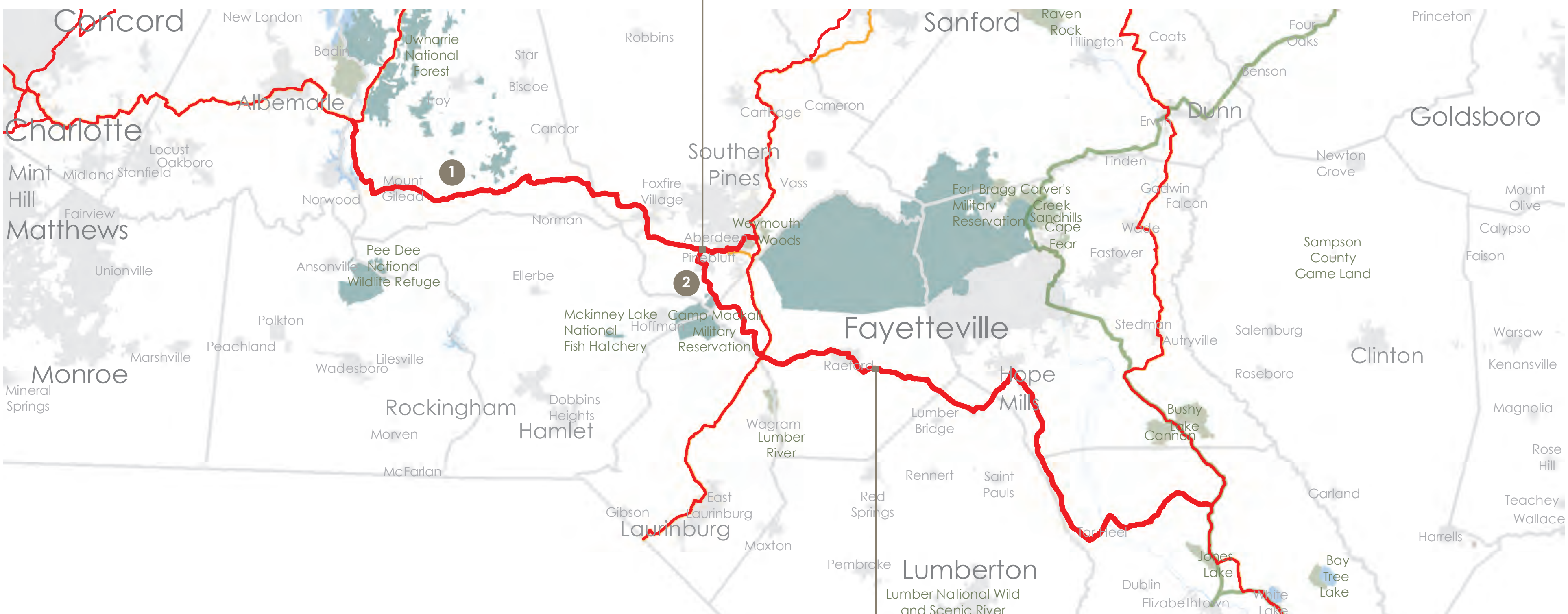
NC 8- SOUTHERN HIGHLANDS



ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	Western Terminus Extension: From new NC 2 in Waynesville to the Blue Ridge Parkway and current NC 8 via US 276	276 is a mountainous route, limited shoulder - only direct connection from new NC 2 to current NC 8	Use US 276 to make this connection. Make improvements to this road.	Paved shoulder generally needed	Sycamore Cyles bike shop in Brevard; Sycamore Cycles bike shop in Hendersonville
2	Blue Ridge Parkway to Hendersonville area	The Crab Creek Rd section of current NC 8 is narrow, curvy, and contains heavy traffic at times; skips Hendersonville; better routing option to the north	Eliminate Crab Creek Rd section. Re-route to the north and connect to downtown Hendersonville.	Add shoulder to US 276; improve 5th Ave into Hendersonville	Sycamore Cyles bike shop in Brevard; Sycamore Cycles bike shop in Hendersonville; Joe Sanders; Tamara Sanders; input map comments
3	South of Hendersonville toward Saluda	US 176 of the current NC 8 is curvy and narrow with traffic but direct	Keep route the same, but improvements should be a priority. Highlight connection towards South Carolina and routes such as the Swamp Rabbit Trail and Crescent Route.	*Prioritize US 176 between Hendersonville and Saluda in addition to South Main St leaving downtown Hendersonville and NC Rt 225;	Sycamore Cyles bike shop in Brevard; Sycamore Cycles bike shop in Hendersonville; input map comments
4	Saluda to NC 8's eastern termus in Lincolnton	This route is generally rural with limited traffic and good riding conditions	No change	US 176 between Saluda and Tryon: needs improvement through Saluda - generally a narrow road; add paved shoulder where possible	Sycamore Cyles bike shop in Brevard; Sycamore Cycles bike shop in Hendersonville; input map comments

NC 9 - SANDHILLS SECTOR

Split route west of Aberdeen to provide two options - NC Highway 5 to head north to US bike route 1 and Addor Road to head south to US bike route 1. This re-route also avoids using NC Route 21east of Aberdeen, which offers poor bicycling conditions.



The vast majority of the Sandhills Sector remains pleasant and scenic today

- NC 9 - Proposed Route
- NC 9 - Alternative Considered
- Proposed Route System
- Current Route System
- East Coast Greenway
- State Park
- Federal Land

0 10 20 Miles

9.3

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
	General		Designate Sandhills Sector as NC 9		
1	From the Sandhills Sector's western terminus at the Pee Dee River to its eastern terminus in Cumberland County	This route is generally rural with low traffic - pleasant riding conditions	Besides minor shifts near its intersection with US BR 1 (see below) no changes.		Tony Goodnight; John Mueller at Rainbow Cycles
2	Aberdeen area	Better route through downtown in crossing US Hwy 1 (road) and connecting with US 1 (bike route). Avoid NC Rt 211 through here.	Re-route using NC Rt 5 through downtown Aberdeen to connect north to US BR 1. Make change utilizing Addor Rd and routing through Pinebluff to route South to US BR 1 and the eastern segment of the Sandhills Sector. Sandhills Sector should split on Roseland just west of Aberdeen.	Downtown Aberdeen	John Mueller at Rainbow Cycles

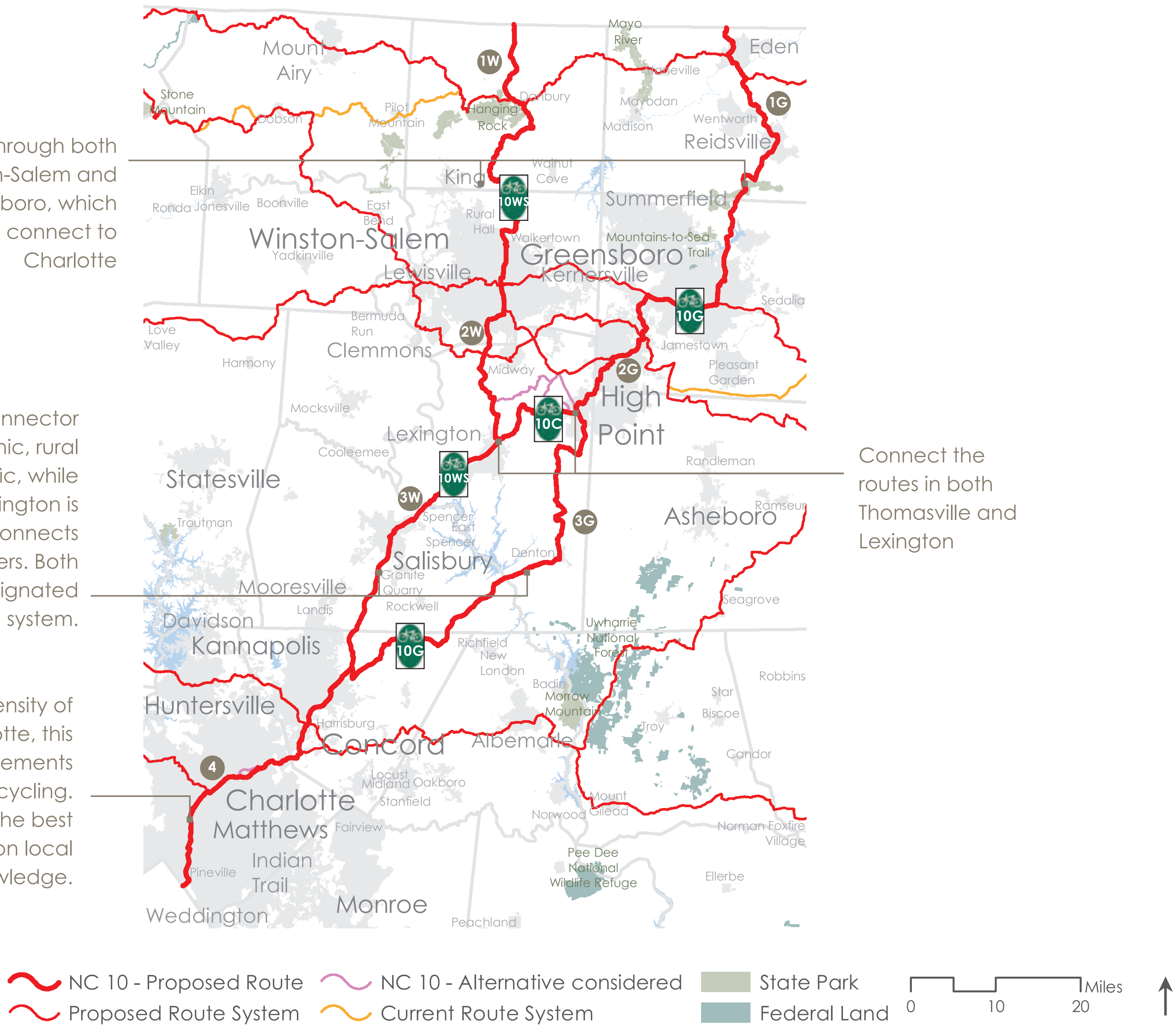
NC 10 - TRIAD-CHARLOTTE (NEW)

Provide a new route through both downtown Winston-Salem and downtown Greensboro, which then funnel together to connect to Charlotte

The Thomasville connector provides a more scenic, rural option with less traffic, while the route via Lexington is more direct and connects towns/urban centers. Both routes should be designated as part of the system.

Given the density of development in Charlotte, this route requires improvements to be comfortable for cycling. It was selected as the best option based on local knowledge.

Connect the routes in both Thomasville and Lexington



ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
	General		Assign this route as NC 10		
1W	NC 10 (WS): Virginia border to downtown Winston-Salem	Route provides north/south route through Winston-Salem and between the VA border and downtown Winston-Salem.	Highlight connections to Winston-Salem City Bike Routes. Highlight connection to NC 4 North Line Trace. Call this route NC 10 WS. Highlight connections to Stuart, VA and Martinsville, VA.	*Prioritize Glenn Ave; Old Rural Hall Rd; Old Hollow Rd; Baux Mountain Rd;	Mock Orange Bikes - Winston Salem; Winston-Salem/Forsyth County bike map; Tony Goodnight
1G	NC 10 (G): Virginia border to downtown Greensboro	Route provides north/south route through Greensboro and between the VA border and downtown Greensboro.	Highlight connections to Greensboro City Bike Routes. Yanceyville Rd is long and narrow - important north/south connector that needs improved. Highlight connection to NC 4 North Line Trace. Also highlight connections to Martinsville, VA and Danville, VA. Call this route NC 10 G.	*Prioritize US 158 as well as Yanceyville Rd	Bill Davis at Reidsville Bicycles; Aaron Daniel - Greensboro Velo Club president; Greensboro bike map
2W	NC 10 (WS): Downtown Winston-Salem to Lexington via Welcome	Provides connection between downtown Winston-Salem and southerly routes.	Designate this connection to Lexington. Highlight connections to Winston-Salem City Bike Routes. Highlight connections to NC 2 east/west routes.	*Prioritize S Maint St (WS) as well as Leonard Rd and Rt 8 (Lexington)	W.S./Forsyth County bike map
2G	NC 10 (G) Greensboro to Lexington via Thomasville	This route goes directly through Thomasville en route to Lexington on higher traffic roads; allows for connection to country route heading from Thomasville to Concord	Designate this connection from downtown Greensboro to Lexington via Thomasville and High Point. Highlight connections to Greensboro City Bike Routes. Highlight connections to NC 2 east/west routes.	*Prioritize the following: Market St in downtown Greensboro; Between High Point and Thomasville - NC Rt 68; Burton Ave; another section of NC Rt 68; National Hwy; Unity St; and Salem St (downtown); Between Thomasville and Lexington - highlight roads, especially at the entrance/exit of Thomasville and Lexington (Lexington Ave out of Thomasville, Rt 8/Main St in downtown Lexington)	Aaron Daniel - GVC president; Greensboro bike map; High Point bike map; Bike Toy and Hobby bike shop in High Point; Davidson County bike map; C. Scott Leonard - Davidson County Planner, Central Park bike route proposals

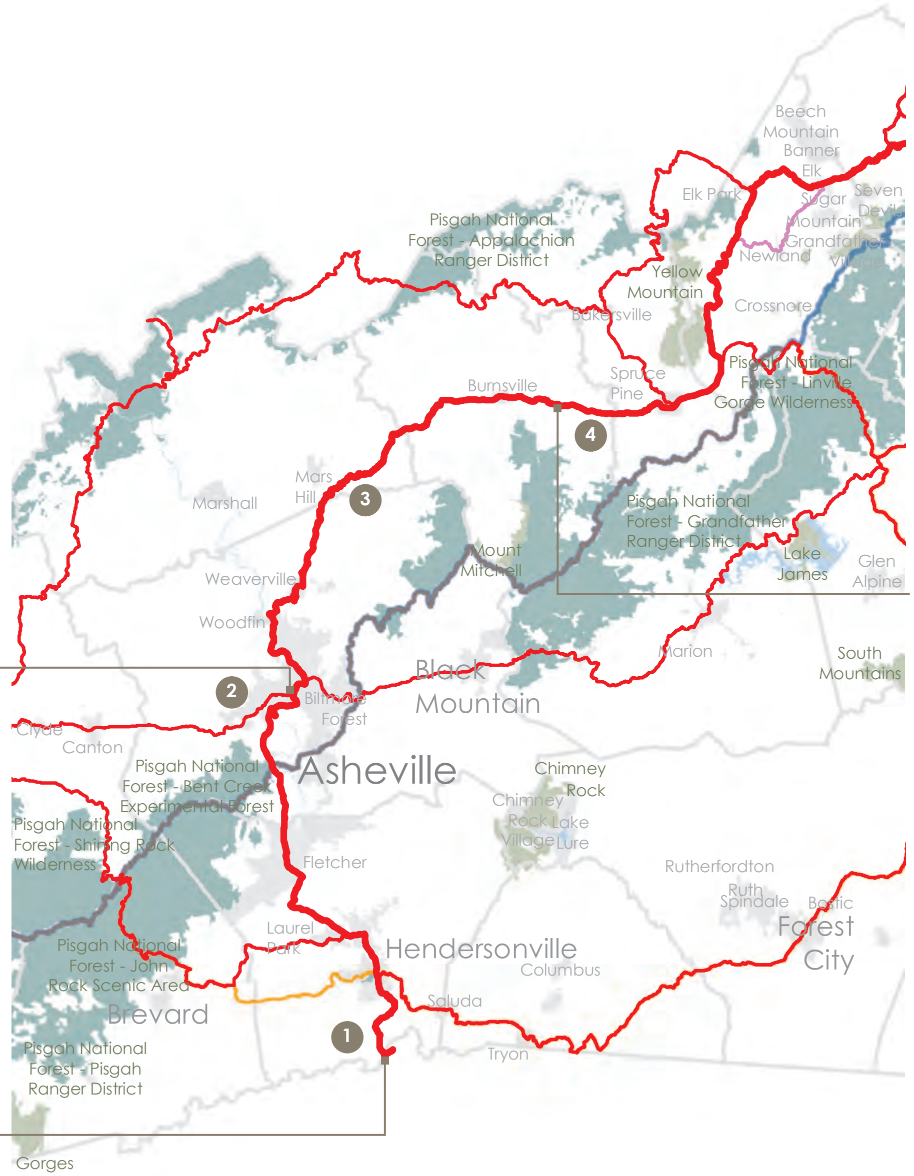
ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
3W	NC 10 (WS): Lexington to Concord	Direct route from Lexington to Concord via Salisbury. Shorter distance but with lower bicycle level of service. Improvements along this route should be a high priority.	Utilize this route as a direct option through the cities and towns connecting the Triad and Charlotte regions.	*Prioritize all of the following: Lexington to Salisbury section (the majority of this section contains higher traffic with limited bicycle facilities), the section between Lexington and I85, downtown Salisbury (except for Rowan Ave thru town) to the Yadkin River bridge, Salisbury to Concord (similary, higher traffic with limited bicycle facilities, especially closer to the entrance/exit to Salisbury and Concord)	Davidson County bike map; C. Scott Leonard - Davidson County Planner, Central Park route proposals, Matt Hartman - president, Central Carolina Cycling Club; Tony Goodnight
3G	NC-10 (G): Thomasville to Concord	Scenic alternative route from Thomasville to Concord. This route is rural, traverses lower traffic roads, and is generally characterized by pleasant riding conditions.	Utilize this route as a scenic alternative between the Triad and Charlotte regions.	*Prioritize the following: 109 and Liberty Dr leaving Thomasville; Bingle Ferry Rd bridge; Old Salisbury/ Concord into Concord	Davidson County bike map; Davidson County Planner C. Scott Leonard, Central Park route proposals, Matt Hartman - president, Central Carolina Cycling Club

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
4	Through downtown Charlotte to SC border	This route highlights the challenge of bicycling through downtown Charlotte. This route is the best option identified by local bicyclists, but utilizes several roads that are characterized by lower bicycle levels of service. Prioritize this important connection through downtown.	Connect through downtown Charlotte. Highlight connections to Carolina Thread Trail as well as NC 6 Piedmont Spur. Make improvements to this route a high priority. Highlight connections to SC routes.	*Prioritize all of the following: From Pineville to downtown Charlotte - North Polk St/South Blvd near Pineville, England St, Hebron St, College St through downtown; Downtown to Concord - N Davidson St, Dinglewood/ Eastway Dr intersection, Eastway Dr, Old Concord Rd, Grier Rd, Rocky River Rd, Roberta, and Old Charlotte	Matt Hartman and fellow Central Carolina Cycling Club members; Carolina Bicycle Company in Pineville; Bjorn Hansen; Drew Skau

NC 11 - MOUNTAIN ROUTE (NEW)

Route links to NC 2 in downtown Asheville

NC 11 begins at the South Carolina border, creating an opportunity for connections to the Swamp Rabbit Trail and SC's Northern Crescent Route.



Proposed connector follows the mountains of western North Carolina, linking its historic mountain towns

NC 11 - Proposed Route
NC 11 - Alternative Considered
Proposed Route System
Current Route System
Blue Ridge Parkway
State Park
Federal Land

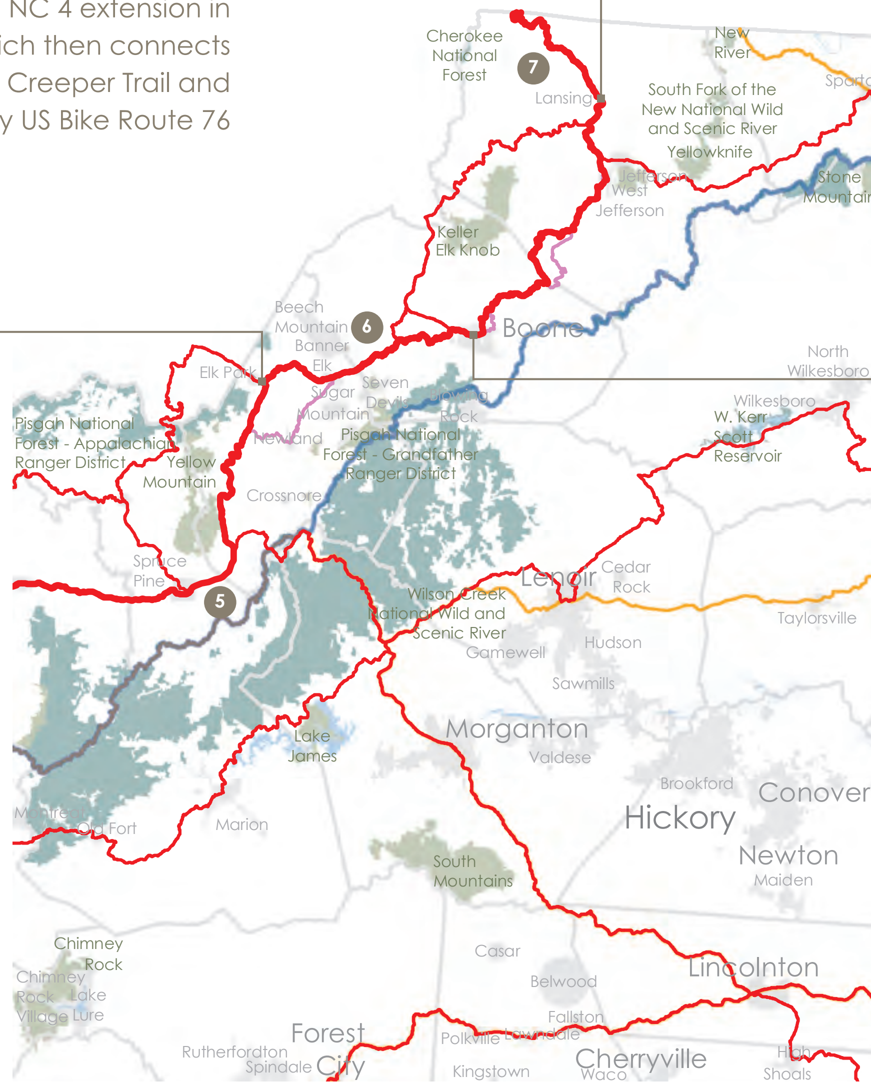
0 10 20 Miles

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
	General		Assign this route as NC 11		
1	SC border to Hendersonville	This route begins at the South Carolina border on Old US Hwy 25 which provides pleasant riding conditions generally until NC Rt 225. NC Rt 225 to Flat Rock is windy and narrow with traffic. High traffic volumes into downtown Hendersonville.	Utilize this route to connect Hendersonville. Highlight connections to routes in South Carolina - Swamp Rabbit Trail in Travelers Rest and SC's Northern Crescent Route. Highlight connection to NC 8 Southern Highlands. Highlight connection to Saluda/ SC connector.	NC Rt 225; Main St (Hendersonville)	Sycamore Cyles bike shop in Brevard; Sycamore Cycles bike shop in Hendersonville; Joe Sanders; Tamara Sanders; input map comments
2	Hendersonville to Asheville	This route links downtown Hendersonville and downtown Asheville.	Follow Haywood/Brevard Rd to make this connection. However, note that Howard Gap to the east is scheduled for bicycle improvements as part of a future modernization project. Adjust accordingly if this becomes the preferred route.	*Prioritize Improvements to Brevard/Haywood Rd	Liberty Bicycles bike shop in Asheville; Sycamore Cycles bike shop in Hendersonville; Kieran Roe; Lyuba Zuyeva; input map comments
3	Asheville to Burnsville	This route makes a direct connection through the center of several mountain towns. Paint Fork Rd has a steep section called 'the wall'. This route is challenging, scenic, and direct.	Utilize this route through Weaverville en route to Burnsville. Highlight steep section along Paint Fork Rd called 'the wall'.	*Prioritize the following: Improve Broadway and Riverside Dr heading north out of Asheville; 19E in the Burnsville area; Old Mars Hill Hwy north of Weaverville in addition to Weaverville thru-roads.	Sam White at Liberty Bikes, Blue Ridge Bicycle Club, local cyclist Randy Raskin, Youngblood Bicycles, and Asheville/ Buncombe County bike map
4	Burnsville to Spruce Pine	This section currently provides a low bicycle level of service.	Follow 19E straight from Burnsville to Spruce Pine. 19E currently carries high truck traffic, but the only alternatives add significant distance. Utilize this section and prioritize improvements. Aligns with segment 4 of the HCCOG Bike Plan (Draft).	*Prioritize this section of 19E. It is currently being resurfaced and will include wide shoulders but no striping for bicyclists.	Randy Raskin; Phil Trew; HCCOG Bike Plan Draft; Solstice Cycles bike shop - Burnsville

NC 11 - MOUNTAIN ROUTE (NEW)

The proposed route links to the proposed NC 4 extension in Lansing, which then connects to the Virginia Creeper Trail and ultimately US Bike Route 76

Proposed route provides the opportunity for a short spur through Elk Park to Tennessee



Proposed route links Boone and West Jefferson

NC 11 - Proposed Route
NC 11 - Alternative Considered
Proposed Route System
Current Route System
Blue Ridge Parkway
State Park
Federal Land

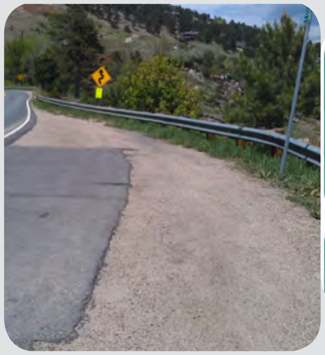
0 10 20 Miles

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
5	Spruce Pine to Banner Elk	Generally pleasant riding conditions, connects through Elk Park.	Utilize this route via Elk Park. Highlight connection to Tennessee west of Elk Park. Highlight intersection with NC 2 Alternative Route. Highlight intersections with HCCOG Bike Plan routes. Aligns partially with segment 9 and completely with segments 10 and 12 of the HCCOG Bike Plan (Draft).		Randy Raskin; Phil Trew; HCCOG Bike Plan Draft; Solstice Cycles bike shop - Burnsville; Magic Cycles bike shop - Boone
6	Banner Elk to West Jefferson via Boone	Direct route from Banner Elk to Boone to West Jefferson; NC 194 is good for cycling up to Valle Crucis, 194 north of Boone is a busy section, narrow	Utilize this route to connect Banner Elk, Boone, and West Jefferson. Highlight connections with HCCOG Bike Plan (Draft). Aligns with segment 18 of the HCCOG Bike Plan, partially with segment 24, 29, and 28. Highlight intersection with NC 4 North Line Trace.	*Prioritize King St through downtown Boone as well as NC Rt 194 north of Boone	Randy Raskin; Phil Trew; Magic Cycles bike shop - Boone; Paul Stahlschmidt (Boone Area Bicyclists)
7	West Jefferson to Lansing to the Creeper Trail Connection	Quiet back roads along abandoned rail line that connects with the Creeper Trail bike path at the Virginia border	Good connector - rural and scenic roads, low traffic volumes.		

Cyclist Waiting Areas

Steep hills and mountain roads are often places where limited shoulder and narrow overall road widths occur for significant distances. Cyclists climbing these sections of road will be traveling at slower speeds. Even with lower traffic volume levels, cars may have difficulty passing cyclists, and traffic may begin to accumulate behind a cyclist. Limited sight lines, narrow roadway widths, and steep grades contribute to this problem. Because of steep drop-offs and geographical constraints, a cyclist may not have the opportunity to pull off to the side of the road and allow cars to pass. As a result, a line of cars may begin to form, slowly following the cyclist up the mountain. With cars sometimes traveling at higher speeds downhill in the opposite direction, opportunities to pass a cyclist (or group of cyclists) can be dangerous.

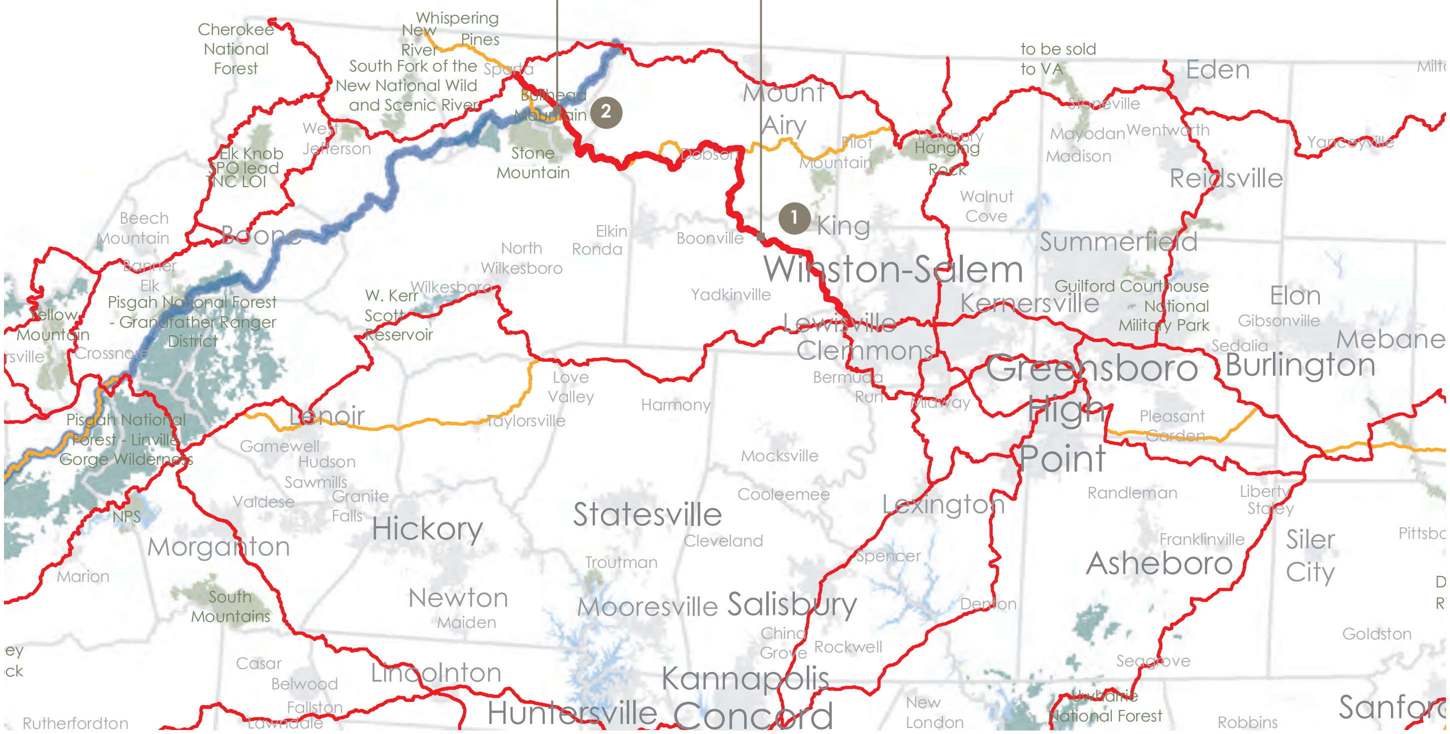
Cyclist waiting areas or periodic segments of paved shoulder are solutions that can ameliorate this problem. These have been implemented in mountainous places such as Colorado. Cyclist waiting areas provide temporary refuge along the ascent of steep roads where cyclists will be able to shift further to the right or pull over altogether, allowing a line of cars to pass. These may be more feasible solutions in places where geographical constraints and/or funding may limit the addition of paved shoulder. The picture to the near right shows an example of a cyclist waiting area space. To the far right is a signage example of what could be included in these areas. The expanded state bicycle route system includes a new route through the heart of the mountains of western North Carolina, and this type of bicycle facility is recommended as needed.



NC 12 - YADKIN VALLEY CROSSING (NEW)

This link to the northwest corner of NC utilizes US 21 in connecting the piedmont to the mountains past Stone Mountain State Park and the Blue Ridge Parkway

This section through the Yadkin River Valley passes several vineyards which are popular destinations through this unique region; also provides link to the Triad

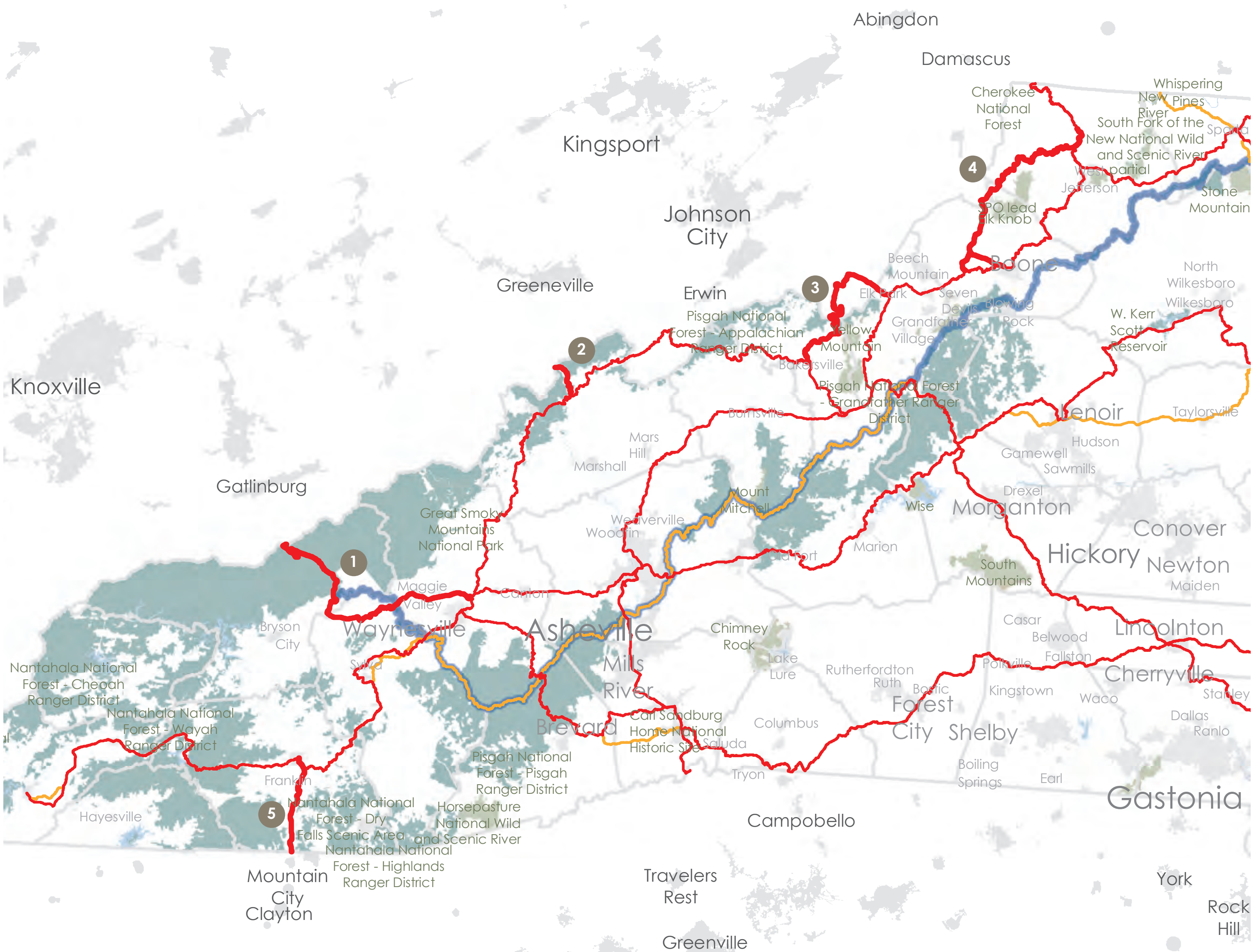


NC 12 - Proposed Route
Proposed Route System
Current Route System
Blue Ridge Parkway
State Park
Federal Land

0 10 20 Miles

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
	General		Assign this route as NC 12		
1	Triad through Yadkin Valley Northwest Connection	This route is generally rural, meandering through the Yadkin River Valley and accompanying vineyards. Establishes a northwest link between the mountainous northwest corner of NC and routes leading to the beaches of NC's southeast corner.	Add this route to complete a link toward NC's northwest corner. Connect the Triad urban population center to rural and scenic cycling routes through Surry County and the Yadkin Valley heading northwest into the mountainous region of North Carolina. Connections to the Triad and other NC state bike routes can be made through Lewisville and NC 2.		Tony Goodnight; Mapmyride; Forsyth County Bike Map; Input Map comments
2	Northwest Link	This section establishes a northwest link to the mountainous northwest corner of NC. While this route stays off the Blue Ridge Parkway, US 21 is a challenging climb toward Sparta. US 21 is a narrow road.	Utilize this connection to NC 4 and the northwest region of NC through Sparta. This route stays off the Blue Ridge Parkway, utilizing US 21 in linking the western piedmont to the Appalachian region of western NC.	US 21 in the Stone Mountain State Park area - narrow road with steep climb past the BRP from the southeast. Cyclist waiting areas (pg 10.3-54) are recommended at a minimum	Tony Goodnight; Brian Graham; Input map comments

ADDITIONAL CONNECTIONS



Proposed Connector Route
Proposed Route System
Current Route System
Blue Ridge Parkway
State Park
Federal Land
0 10 20 Miles

ID	Segment	Current Condition	Recommendation	Improvement Sections	Input Source(s)
1	Tennessee Connector: Through the Smokies to Gatlinburg	If Tennessee extends a connector through Gatlinburg, TN toward the Great Smoky Mountains National Park, this route would link North Carolina to Tennessee via US 421 and US 19 from Lake Junaluska.	Include this connector to provide access to the Great Smoky Mountains National Park and create another linkage to the Tennessee state bike route system. Coordinate with TDOT.	*Prioritize: This is a higher traffic section. Improvements needed on US 441 and US 19	Tennessee state bike route system
2	Tennessee Connector: Hot Springs to Greeneville	If Tennessee extends a connection south from Greeneville, TN to the North Carolina border, this link would utilize NC Rt 208.	Include this connector to provide a link to Tennessee's Chattanooga-to-Mountain City route. Coordinate with Tennessee DOT.		Tennessee state bike route system
3	Tennessee Connector: Bakersville to Elk Park via Tennessee/Roan Mt	If Tennessee extends a link from its Bicycle Ride Across Tennessee (BRAT) system, this link would utilize US 19E from Elk Park, NC and NC Rt 261 from Bakersville, NC.	Include this link to make short connection to Roan Mountain, TN and Tennessee's BRAT system. Coordinate with TDOT.		Tennessee state bike route system
4	Tennessee Connector: Valle Crucis/Boone area through Tennessee to Lansing, NC	If Tennessee extends a connection from Mountain City, TN toward the NC border, this link would utilize Mast Gap Rd from and Old US 421 through Tennessee to NC Rt 88 along the North Fork of the New River. Partially aligns with segment 22 and completely with segments 19 and 26 of the HCCOG Bike Plan (Draft).	Include this link to make connection from Boone and Lansing areas to the Tennessee border and potentially Tennessee's Chattanooga-to-Mountain City route. Coordinate with Tennessee DOT.	Narrow roads but generally low traffic volumes; paved shoulders generally needed; improvements needed for section of US 421 near Boone	Randy Raskin - local cyclist and route planner; Phil Trew (HCCOG Bike Plan); Magic Cycles bike shop - Boone
5	Georgia Connector: Franklin, NC to Georgia border	This link would utilize the US 441/US 23 corridor to directly connect to Georgia's state bike route system from Franklin, NC.	Include this link to complete Georgia connection.	Improvements needed for sections of US 441/23	Georgia state bike route system

* These connections provide key linkages to routes in Tennessee and Georgia where there is limited connectivity. US 1 and NC 2-12 provide several links to Virginia and South Carolina routes and cities.

Signage Replacement

North Carolina's current state bicycle route system was developed in the 1970's and signed later in the 1980's. While certain sections of the current system have consistent signage, significant problems exist with the current scheme. They include the following:

- Current signage uses the symbol shown below, with each route differentiated by its number. County and local route systems often use an identical style, making them difficult to distinguish. The photograph at right shows a signpost that has both a state bicycle route (NC 2 – Mountains to Sea) and a county route. Nothing on the signs distinguishes the state bicycle route from the county route, easily leading to confusion.
- Cyclists have reported missing signage throughout the system. Areas where new development has occurred since the original signage installation often lack replacement signs.
- Current signage does not provide additional information such as distance to the next town or connections to local and regional routes.

This update to the state bicycle route system offers an opportunity to install an effective signage scheme across the state. Appropriate information should be included on each sign panel and panels installed at strategic locations as described in the best practices outlined on the following pages. Where current signage exists, signage panels should be removed and replaced with updated signs. The following criteria should guide the prioritization of sign placement and replacement:

1. Install signs where currently missing
2. Replace signs at junctions with regional and local routes
3. Replace signs within incorporated areas
4. Replace signs within ten miles of incorporated areas
5. Replace remainder of signs

NCDOT divisions should maintain comprehensive inventories of the locations and ages of signs and replace as needed on an ongoing basis.

Signage Recommendations

Based on feedback from cyclists around the state and a review of best practices, an updated and enhanced wayfinding system is proposed for the state bike route system. Recommended improvements are listed below:

INCREASE THE FREQUENCY OF SIGNS IN ACCORDANCE WITH CURRENT BEST PRACTICES

- Cyclists approaching a route junction need an advance warning sign, directing them if and where they should turn off.
- Riders also look for reassurance after the junction that they are still on the correct route.
- Signs should be visible from a distance of 100 feet prior to approach.
- On steep downhill segments, the sign should be placed further upstream from the intersection to provide a cyclist adequate time to make a directional decision. Signs should also be placed further from the intersection on busier streets with a center turn lane or left turn pocket to decrease the possibility of conflicting cyclist/motorist movements while preparing for a left turn.
- Place Bicycle route markers with "straight-ahead" arrows periodically on straight stretches.

INCORPORATE DESTINATIONS INTO THE WAYFINDING SYSTEM

- Show destination, direction, and distance for destinations along the route. Destinations can be included all on one panel along with the bicycle route symbol and number.
- Follow the rule of continuity: once a destination is stated it should be included on every sign until it is reached

DISTINGUISH 'BUSINESS' BIKE ROUTES FROM STANDARD ROUTES

- Add a 'B' or 'C' after the route number along business route and connector route sections respectively, such as the proposed NC 2 business route connecting Downtown Greensboro, High Point, and Winston-Salem and connector route between Greensboro and Winston-Salem.
- Clearly indicate the direction of business routes versus rural routes at forks in the system.

PROVIDE CONNECTIONS TO LOCAL, REGIONAL, AND OTHER SIGNIFICANT ROUTES

- Place similar destination signs at junctions with other bike routes that reach destinations off of the state bike routes.
- Provide clear, distinctive crossing signs at intersections with major routes such as the East Coast Greenway, the Blue Ridge Parkway, and the Lake Norman Bike Route.
- Distinguish between state bike routes and local or regional routes with sign types. Local routes should use a distinct color and/or shape from that of the

An example of wayfinding signage in Portland, OR; www.pedbikeimages.org / Brad Crawford

National Wayfinding Signage Guidance[3]

MUTCD

Some practitioners find the MUTCD signage system unwieldy and duplicative, especially where multiple bicycle routes cross. MUTCD requires both the use of the words "Bike Route" and a bicycle symbol on a bicycle route sign, then another panel showing the destination name, and another for the route number.

AASHTO

Bicycle route signs along designated bikeways include 'destination plates' directing cyclists to specific locations (e.g., downtown). In situations where a route is not officially designated as a bikeway, directional signage may still be used. Signs should be placed every 1,600 feet (500 meters), at all turns along the route, and at major signalized intersections.

NACTO

Recommends decision signs should include destinations, direction arrows, and distance. Travel time required to reach the destination provides bicyclists with additional information and may also be included. It is recommended that a 10 mph "urban average" bicycle speed be used for travel time calculations.

state bike route signs. Routes with unique signage, such as the Lake Norman Bike Route, should keep that signage for easy recognition and distinction. Include both signs with their distinct designs at crossings.

The Lake Norman Bike Route's signs will display the route's unique logo. Sign courtesy of the Lake Norman Regional Bicycle Signage Plan, lakenormanrpo.org/lake-norman-bike-route

SET UP ONGOING COMMUNICATION BETWEEN THE BICYCLE & PEDESTRIAN DIVISION AND LOCAL DIVISIONS RESPONSIBLE FOR SIGN MAINTENANCE TO ENSURE UPKEEP

- On the webpage where route guides are housed (see Route Guides recommendations), provide an online form for individuals to report missing or damaged signs.
- Assign one point person within the Bicycle & Pedestrian Division to field sign reports and communicate with local divisions to get the signs fixed or replaced. This point person should also coordinate the addition of route crossing signs when new local or regional routes are signed.

SIGNAGE INSTALLATION COSTS

- Types of signage needs for the state bike route system are varied and would need an in-depth study to obtain a comprehensive cost estimate. Warning, destination, regulatory, routing and other informational signage would be needed.

- However, a significant component of signage would include simple route identification signs, (similar to the Lake Norman Bike Route sign example on the previous page, but with a logo specific to the state bike route system) along every stretch of each route for a cyclist to follow. Based on current material and installation costs, and minimum size requirements, each routing sign would cost $158.75 to make and install.
- Calculating approximate routing sign needs for long stretches (generally every five miles for affirmation), urban areas (generally every two to three blocks for affirmation), and turns (generally four needed at each turn - each way, one to signal the turn and one to reaffirm correct route after turn). With an average of 1 sign per 1.875 miles for affirmation signage not along turns (assumes equal amounts of routing on roads anywhere between the rural and urban extremes), and an average of 1 turn (four signs needed) per 2.83 miles (this average was calculated from using NC 5 as a sample stretch), routing signage needs for the 3,800 miles of the recommended system would be 7,410 signs. Multiplied by $158.75, the total cost would be $1,176,337.50 for routing signage. It is important to note that this number does NOT consider other variable signage needs such as warning, destination, regulatory, and other informational needs, and this is a planning level cost estimate only.

Sources: Long-distance signage needs - Adventure Cycling association; signage dimensions - Manual on Uniform Traffic Control Devices (MUTCD) Chapter 9B; urban signage needs - National Association of City Transportation Officials (NACTO) guidelines; pricing - North Carolina Department of Transportation (NCDOT)

Route Guides

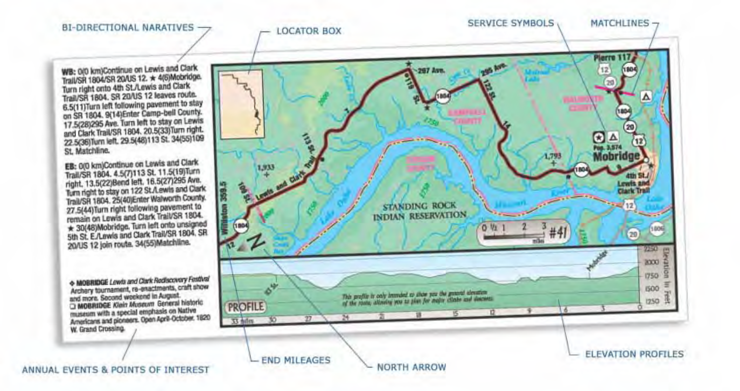
The current guides for the state bike routes should be improved and supplemented in several ways. The following improvements are recommended:

MAKE ROUTE GUIDES AVAILABLE FOR DOWNLOAD ON THE BICYCLE & PEDESTRIAN DIVISION'S WEBSITE

- Provide route maps in printer friendly PDF form for download. NCDOT will be able to reduce paper usage by allowing public to print as needed.
- Provide interactive route maps that can be viewed on a computer or a smart phone. These maps should include the basic points of interest and services along with the routes themselves with basic pan/zoom capabilities.

Adventure Cycling Association Route Guides

The Adventure Cycling Association's (ACA) route guides are an industry model. These guides provide 30-40 mile map panels with associated turn-by-turn directions and detailed service information. Their clear, concise maps show elevation information in the form of contours or elevation profiles, distances between destinations, and zoom-ins of tricky intersections, along with the basics. The full guides provide a service directory for towns and cities along the route, climate information, and scenic and cultural descriptions of the landscape. These maps are made available for purchase on the ACA website.



Route map images available at www.adventurecycling.org/routes/

MAKE GPX OR SIMILAR FILES OF EACH ROUTE AVAILABLE FOR DOWNLOAD ON THE BICYCLE & PEDESTRIAN DIVISION'S WEBSITE

- Select a format for route files that are easily imported into common route planning applications, such as mapmyride.com.
- Consider smartphone application development.
- Keep route files up to date as routes are modified.

UPDATE GUIDES WITH ROUTING RECOMMENDATIONS FROM THIS PLAN AND CURRENT POINTS OF INTEREST, AND MODERNIZE MAPS FOR IMPROVED CLARITY

- Provide full-color, downloadable PDF maps with routes identified sharply against the background.
- Include turn-by-turn directions along with general route and destination descriptions.
- Indicate the presence or absence of the following points of interest by town: camping, bicycle shops, service stations, grocery stores, restaurants, hostels, hotels, bed and breakfasts.
- Show the locations of historic downtowns and sites, museums, other cultural attractions, and scenic areas.
- Show connections to local and regional routes.
- Indicate distances between towns or cities and include elevation profiles.

Amtrak Bicycle Service

Currently, the Piedmont, Carolinian, Crescent, and Silver Service/Palmetto Amtrak routes provide train service through North Carolina. However, only the Piedmont between Raleigh and Charlotte offers walk-on bicycle service, limited to 6 bicycles per train. For the other routes, bicycles may be checked in a bicycle container where checked baggage service is available. Where checked baggage service is unavailable, bicyclists have no opportunity to travel with their bicycle.

NCDOT should work with Amtrak to establish walk-on bicycle service on all Amtrak routes throughout North Carolina. Such a policy change will allow long-distance cyclists using the state bike route system to travel to their starting point by train and return by bicycle or vice versa.

Bicycle Storage on Amtrak's Piedmont Line

9.3

Policy Support

North Carolina's Complete Streets policy recommends a multi-modal transportation network that safely accommodates access and travel for all users including bicyclists. However, legislation supported by this policy does not exist in North Carolina's General Statutes. Such a law, supported by the Complete Streets policy, is critical to the development of the statewide bicycle route system given the significant mileage of that system in need of improvement.

Wisconsin, Illinois, Florida, Oregon, and Massachusetts have all passed state laws that require transportation projects to safely accommodate access and travel for all users including bicyclists.[4] Wisconsin's Department of Transportation has conducted several studies finding that the benefits of paved shoulder bicycle facilities to both motorists and bicyclists outweigh the costs. They've since established a policy of including 5' paved shoulders on roads with ADT of 750 or more. These findings should guide improvements to North Carolina's statewide bicycle route system. For all state bicycle routes, as well as regional, county, and local routes, North Carolina should aim to have paved shoulder widths of 5 feet or greater on roads where ADT is 750 or greater. When funding resources are limited, roads where ADT is 1,200 (consistent with the goals of the original route system) or greater should be prioritized. While North Carolina's Complete Streets policy provides existing support for these recommendations, the state should consider their incorporation into transportation legislation. These improvements will enhance safety for both motorists and bicyclists, and it is recommended to include highway safety funds as a resource for implementation.

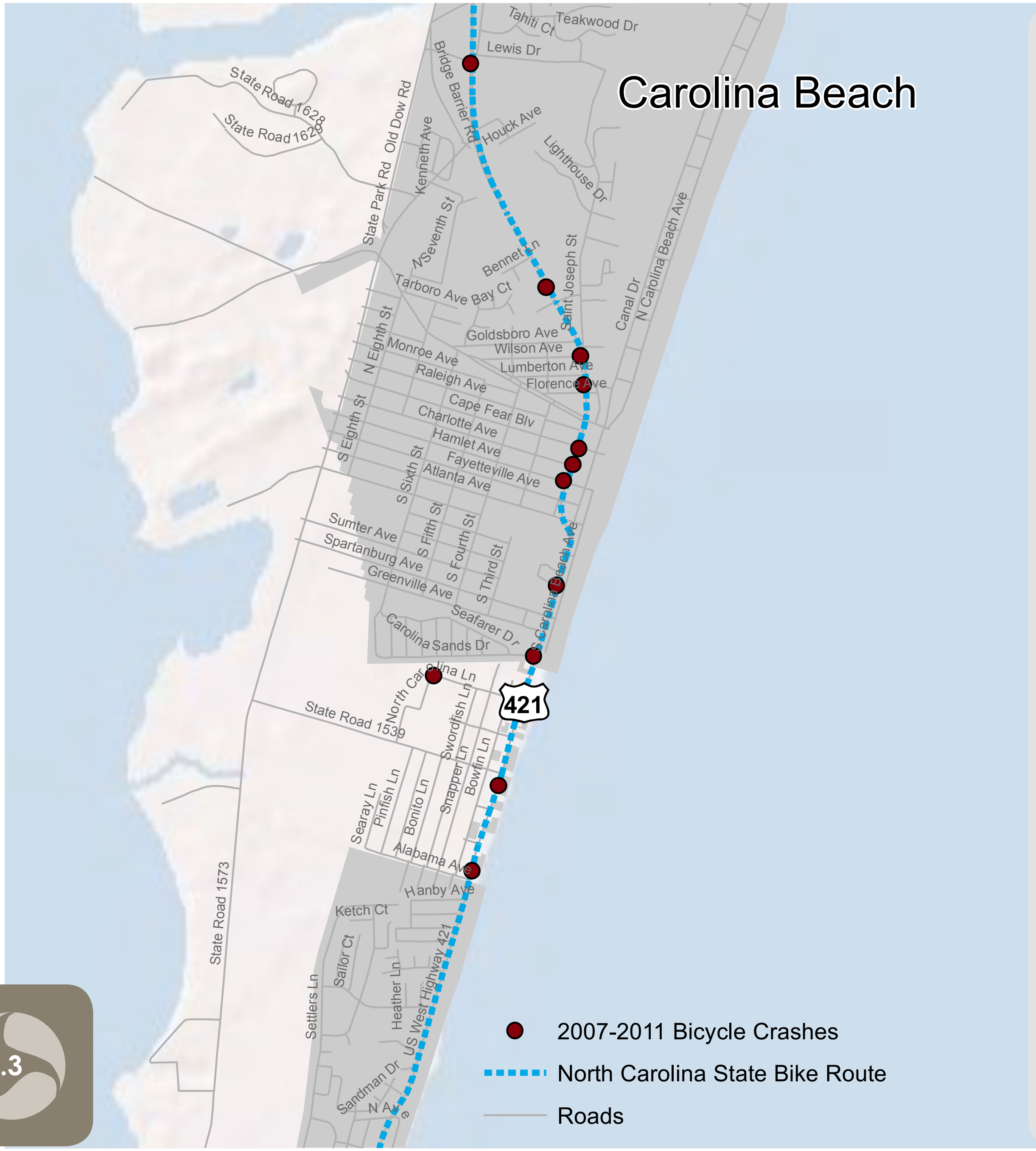
The Evolution of Wisconsin's Shoulder Paving Policy

Wisconsin's Department of Transportation (WisDOT) conducted a study in the 1980's to determine the fiscal and safety impacts of providing paved shoulders, citing benefits for cyclists as a secondary benefit. The findings of that study indicated that the addition of three-foot paved shoulders would be cost beneficial for roadways with ADT of 1,250 and above; savings are due to reductions in motor vehicle crashes and maintenance costs. This finding led to widespread shoulder paving in Wisconsin.[1]

In the 1990s, Wisconsin's shoulder paving policy was amended to paved shoulder widths of 5 feet or greater for highways exhibiting a need to accommodate bicyclists. Wisconsin then adopted a version of Complete Streets legislation in 2009 that requires bicycle and pedestrian facilities on all new and reconstructed projects and most pavement replacement projects.[2] This legislative effort is helping to drive the continued development of bicycle facilities across the state.

Due to the increased benefits of paved shoulders to both bicyclists and motorists, Wisconsin is now modifying its paved shoulder policy to include roads with ADT of 750 or more. Findings from WisDOT's bicycle level of service models point to the significance of these numbers; the doubling of ADT has about a 10-fold negative impact on bicycle level of service.[3]

1 NCDOT case study PDF
2 http://www.smartgrowthamerica.org/documents/cs/policy/cs-wi-legislation.pdf
3 http://www.dot.wisconsin.gov/projects/state/docs/bicycle-rural-guide.pdf



Strengthening Safety: Carolina Beach Crash Study

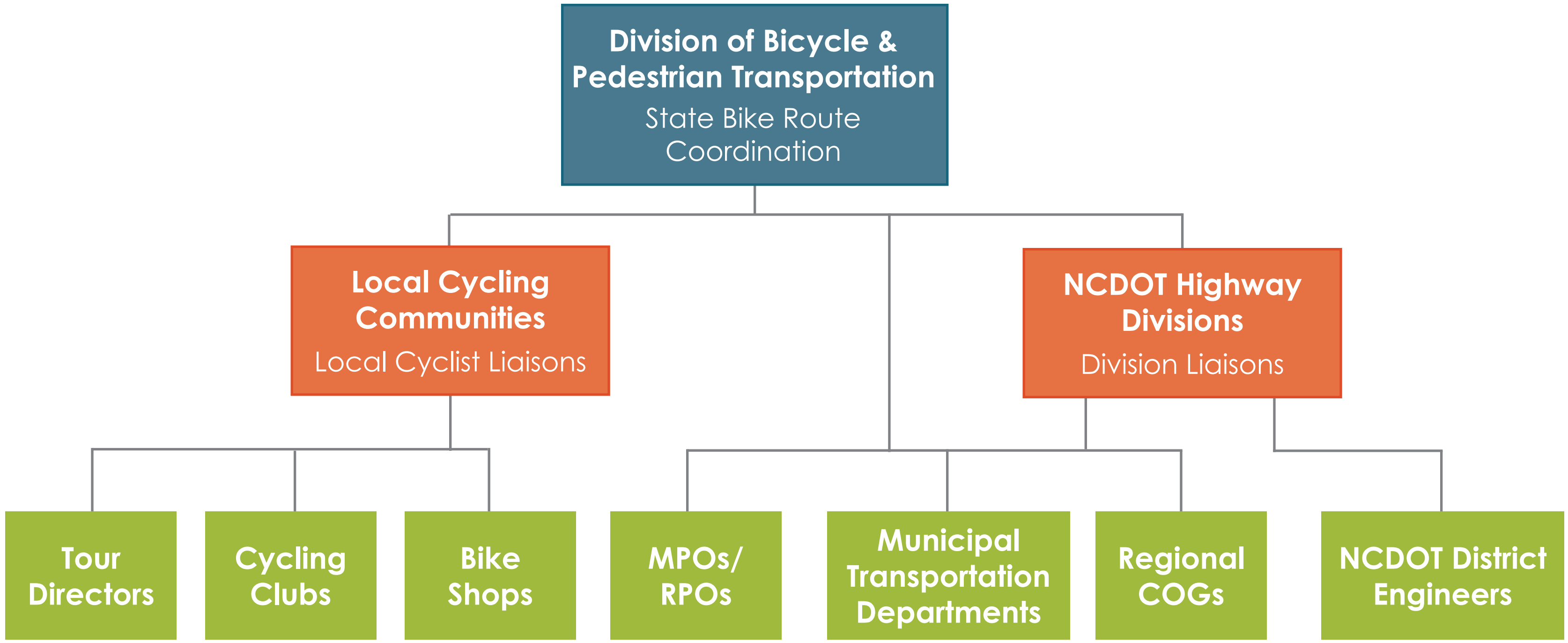
Improving North Carolina's state bicycle routes can have a measurable, positive impact on bicycle safety. Bicycle crash data can be displayed on top of the proposed routes to determine high priority corridors that improve the safety of the state bicycle route system. For example, there were 11 bicycle crashes along US 421 (State Bike Route #3) in Carolina Beach from 2007-2011 (see map at left). As described in Chapter 4, the addition of bicycle lanes creates a 36% reduction in bicycle crashes (FHWA). In addition, other research shows similar positive impacts for the addition of paved shoulders, sharrows, protected bicycle lanes, and cycle tracks. NCDOT should consider making improvements first along priority state bike routes indicated in this appendix and where high incidences of crashes occur.

IMPLEMENTATION OF STATE BIKE ROUTE UPDATES

Administrative Framework

Local experts including cyclists, planners, bicycle shop owners, bicycle tour directors, and many others provided invaluable input that guided the recommendations of this chapter. Continuing communication with these local experts throughout North Carolina is critical to the maintenance of a high-quality statewide bicycle route system. As a starting point for implementation, assign state bike route coordination responsibilities within the Division of Bicycle and Pedestrian Transportation (DBPT).

DBPT should then identify a point person in the bicycling community within each NCDOT highway division to act as a local cyclist liaison for that division. This can be the president of a bicycle club, bike shop owner, avid cyclist, or other involved person or organization in the area. This person can be a direct link to on-the-ground cycling conditions and communicate regularly with the cycling community. Similarly, the DBPT should identify a liaison within each NCDOT highway division itself. Because state bike routes cross NCDOT highway division lines, cooperation and communication across NCDOT highway divisions will be critical. Upon acceptance of their roles, these liaisons will play important roles in driving implementation.

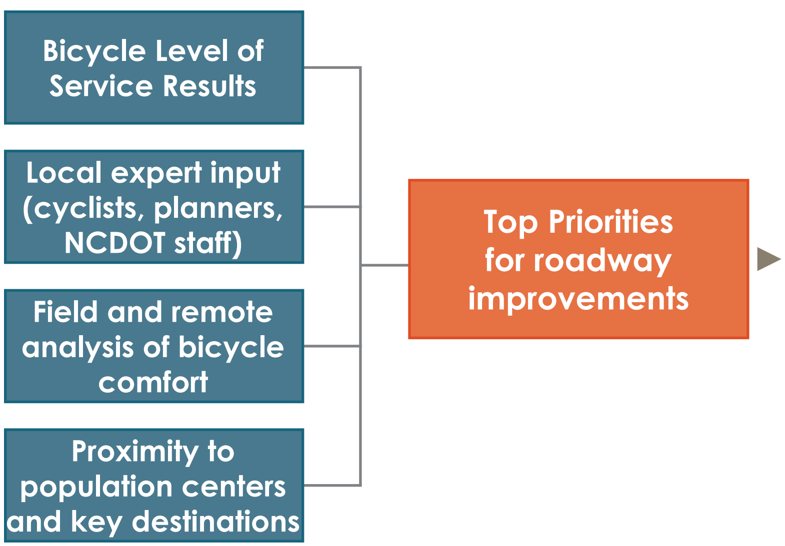


Prioritization of Facility Improvements

95% of the portion of the current statewide bicycle route system lying along roads with traffic volumes of 750 ADT or greater does not have paved shoulders of 5 feet or greater. Given the scope of additions necessary to meet the goal stated above, the policy recommendations of this chapter will play a critical role in ensuring that state bike routes are improved as roadways are repaved or rebuilt. Certain improvements should take place as stand-alone projects as well, however, to address critical pinch points in the system. These projects should be prioritized with the following process.

SHORT TERM IMPROVEMENTS (2017)

First, the top priorities identified through this planning process should be implemented where feasible. Top priority projects are summarized in the following table. These priority projects were selected using several inputs.



Route	Road(s)	Location
US 1	Carpenter Pond Rd and Davis Dr	North Raleigh
US 1	Charlotte Ave and Carthage St	Downtown Sanford
NC 2B	Haywood St	Asheville
NC 2B	Tunnel Rd, US 70, and Swannanoa River Rd heading east from Asheville	Asheville, Buncombe County
NC 2B	Downtown Winston-Salem including S Main St	Winston-Salem
NC 2B	Lexington Ave	High Point
NC 2B	Market St, McConnell Rd, and Alamance Church Rd	Greensboro
NC 2C	Old Greensboro Rd, Mountain St, and W Market St	Winston-Salem, Kernersville, Greensboro
NC 2B	Old NC 86	Calvander, Carrboro - between Dairyland Rd and Hillsborough Rd
NC 2	Old River Rd	Northwest of Greenville
NC 2B	Raleigh Rd/NC Rt 54, Barbee Chapel Rd, and Stagecoach Rd	
NC 2C	Erwin Rd	Chapel Hill to Durham
NC 2C	Davis Dr, Aviation Pkwy, Evans Rd, and Trinity Rd	Durham to Raleigh
NC 3	NC Rt 32	Edenton area
NC 3	Albemarle Sound Bridge - NC Rt 32	Edenton to Plymouth
NC 3	Long Ridge Rd	Plymouth to Bath
NC 3	N 23rd St, S 5th St, 17th St, Independence Blvd, River Rd, Carolina Beach Rd Bridge	Wilmington to Carolina Beach
NC 3	NC Rt 211	Brunswick County
NC 4	Halls Creek Rd, Four Forks Rd, Pitts Chapel toward Elizabeth City	Hertford to Elizabeth City
NC 4	Camden Causeway/US 158, NC Rt 34, US 168	Elizabeth City to Currituck

Route	Road(s)	Location
NC 5	Entire section from Apex to Angier	Apex to Angier
NC 5	US 421	Wilmington to the northwest
NC 5	N 3rd St, S 5th St, 17th St, Independence Blvd, River Rd, Carolina Beach Rd Bridge	Wilmington to Carolina Beach
NC 6	Between NC Rt 16 and NC Rt 49 - northwest Charlotte Area to northeast Charlotte Area	Charlotte area
NC 6 B	Gaston Country through downtown Charlotte generally	Charlotte area
NC 6	NC Rt 24/27 section and bridge over the Pee Dee River	east of Albemarle
NC 7	Neuse Blvd	Downtown New Bern
NC 7	Carey Rd, NC Rt 258	Kinston
NC 7	US 17/NC Rt 55 bridge over the Neuse River	New Bern
NC 8	S Main St, NC Rt 225, and US 176	Hendersonville to Saluda
NC 10	Glenn Ave, Old Rural Hall Rd, Old Hollow Rd, and Baux Mountain Rd	VA border to Winston-Salem
NC 10	US 158 and Yanceyville Rd	VA border to Greensboro
NC 10	S Main St, Leonard Rd, NC Rt 8	Winston-Salem heading south
NC 10	W Market St in Greensboro; Between High Point and Thomasville - NC Rt 68; Burton Ave; another section of NC Rt 68; National Hwy; Unity St; and Salem St (downtown); Between Thomasville and Lexington - highlight roads, especially at the entrance/exit of Thomasville and Lexington (Lexington Ave out of Thomasville, Rt 8/Main St in downtown Lexington)	Greensboro to Lexington

Route	Road(s)	Location
NC 10	Prioritize all of the following: From Pineville to downtown Charlotte - North Polk St/ South Blvd near Pineville, England St, Hebron St, College St through downtown; Downtown to Concord - N Davidson St, Dinglewood/Eastway Dr intersection, Eastway Dr, Old Concord Rd, Grier Rd, Rocky River Rd, Roberta, and Old Charlotte	Charlotte area - Concord to the SC border
NC 11	Brevard/Haywood Rd	Hendersonville to Asheville
NC 11	Broadway and Riverside Dr heading north out of Asheville; 19E in the Burnsville area; Old Mars Hill Hwy north of Weaverville in addition to Weaverville thru-roads.	Asheville through Weaverville
NC 11	US 19E	Burnsville to Spruce Pine
NC 11	King St through downtown Boone and NC Rt 194	Boone and north of Boone
TN Conn.	US 441 and US 19	Waynesville area through the Smokies

◄ *Top Priorities for roadway improvements continued*

State Bike Routes

MID-TERM IMPROVEMENTS (2020)

In addition to the top priority projects, specific segments were highlighted for facility improvements throughout this chapter. These were identified using a similar approach as that used to select top priority projects, and should be considered the next block of improvements for implementation.

Significant to these types of projects are bridge improvements, which may not be feasible in the short-term. Certain bridges that must be utilized as part of the state bike route system provide very low level of bicycle service (i.e.: the US 17 bridge connecting New Bern and Bridgeton; the NC 32/94 bridge over the Albemarle Sound; the NC 73 bridge south of Lake Norman; and the NC 24/27 bridge connecting into Uwharrie National Forest). Paved shoulders and appropriate railing heights should be essential components of future bridge improvement as soon as resources are available.

The NC 32/94 (Haughton Rd) bridge over Albemarle Sound has low railings and limited shoulder

LONG-TERM IMPROVEMENTS (2030)

In the long-term, the DBPT team should continue to monitor system quality and communicate areas in need of improvement to responsible agencies. Ongoing communication with division and local cyclist liaisons will be critical to continuous maintenance and improvement of the system. The following resources should be maintained and used in this long-term process:

1. Maintain a website and standardized comment form allowing the general public to highlight areas needing attention. This website should also house the reporting feature for missing signs. All comments will be collected by DBPT and reported to the appropriate liaisons.

2. Update the Bicycle Level of Service analysis periodically as data is updated and new data is collected – After each update, Identify the worst segments based on BLOS results. Examine the input variables to determine why each section is receiving a low score.

3. Hold semi-annual meetings with liaisons to check on the status of improvements to priority segments and communicate the findings of Numbers 1 and 2. Re-prioritize outstanding projects accordingly. Discuss funding options at these meetings and coordinate with other stakeholders as appropriate.

During long-term implementation, the cities and areas of higher population should continue to be prioritized over other segments that are identified through the BLOS or public feedback. These are areas of the current route system needing the most attention (i.e. northern Charlotte, the Triangle, the Triad, etc). As cities and towns around North Carolina have expanded without incorporating bicycle facilities, these sections have become unsuitable and are therefore avoided and distrusted by local cyclists. Many recreational cyclists drive to rural areas to safely enjoy a bicycle ride, rather than using closer routes. These difficult sections in high population areas do not advertise state bicycle routes well. If these areas are improved and enhanced with new business routes, it will allow cyclists to commute across town, connect to beautiful country routes, and generally rely on the statewide bicycle route system as a viable means of transportation, recreation, and adventure.

Action Steps

The action steps table below summarizes the implementation steps described in this section along with responsible agencies and time frames.

Action Step	Lead	Support	Details	Timeframe
Designate State Bike Route coordination responsibilities	NCDOT Division of Bicycle & Pedestrian Transportation		Establish State Bike Route coordination responsibilities within the Division of Bicycle & Pedestrian Transportation.	Short-Term (2013)
Identify local cyclist liaisons	NCDOT Division of Bicycle & Pedestrian Transportation	Bike shops, Cycling Clubs, Tour Directors, Local Cyclists	Identify a point person within the local cycling community of each division to help guide priority planning	Short-Term (2013)
Identify division state bike route liaisons	NCDOT Division of Bicycle & Pedestrian Transportation	NCDOT Highway Divisions	Identify a point person within the staff of each highway division to help guide priority planning and advocate for improvements to the state bike route system at the division and district levels.	Short-Term (2013)
Establish website	NCDOT Division of Bicycle & Pedestrian Transportation	Local cyclist and division liaisons,	Establish a website displaying the new route system and provide online comment forms for ongoing feedback.	Short-Term (2014)
Communicate top priority projects and identify funding sources	NCDOT Division of Bicycle & Pedestrian Transportation	NCDOT Highway Divisions, Municipal Transportation Departments, MPOs/RPOs, COGs	Identify roadway ownership for each top priority project and communicate projects to the responsible agency. Identify funding sources for projects.	Short-Term (2014)
Finalize signage design	NCDOT Division of Bicycle & Pedestrian Transportation	Local cyclist and division liaisons,	Establish design details for the signage system, building on the recommendations of this plan.	Short-Term (2014)
Generate signage implementation plans	NCDOT Highway Divisions	NCDOT Division of Bicycle & Pedestrian Transportation, Local Cyclist Liaisons, Municipal Transportation Departments	Establish signage plans and associated implementation timelines for each division based on the guidelines recommended in this chapter. Confirm destinations with state bike route coordinator and local cyclist liaisons.	Short-Term (2014)
Modify resurfacing/ reconstruction policy	NCDOT Highway Divisions	NCDOT Division of Bicycle & Pedestrian Transportation	Require the addition of a paved shoulder with any reconstruction or resurfacing project along a designated state, regional, county, or local bike route.	Short Term/ Ongoing (2014)
Introduce legislation requiring bicycle facilities as part of highway safety improvements	NCDOT Division of Bicycle & Pedestrian Transportation	NCDOT Highway Divisions	With the support of NC's Complete Streets Policy and highway safety improvement goals, introduce legislation that requires the inclusion of 5' paved shoulders moving forward on all roadways with ADT 1,200 or greater.	Short-Term (2014)
Address Amtrak bike policy	NCDOT Division of Bicycle & Pedestrian Transportation		Work with Amtrak to allow bicycles on all trains in North Carolina.	Short-Term (2014)

Action Step	Lead	Support	Details	Timeframe
Implement Signage of new route system	NCDOT Highway Divisions	NCDOT Division of Bicycle & Pedestrian Transportation, Municipal Transportation Departments	Implement signage plans. Aim to create a fully signed system by 2015 (sign new segments, remove signage at eliminated segments, and fill in missing signage). Aim to create a fully signed system with all new signage by 2017 (replace all existing signs along route segments that were retained with improved signage based on new design standards). When signage is placed along routes recommended for improvement before those improvements are implemented, post warnings and clear information on the wesbite to notify users.	Short-Term (2015-2017)
Develop downloadable printer friendly route guides	NCDOT Division of Bicycle & Pedestrian Transportation	Local cyclist and division liaisons	After sufficient signing has been completed, develop updated route maps based on best practices outlined in this chapter. Make available, downloadable printer friendly PDFs on state bike route website.	Short-Term (2015)
Develop smartphone application	NCDOT Division of Bicycle & Pedestrian Transportation	Software developer	Develop smartphone application/smartphone friendly map display and information on state bike routes	Short-term (2015-2016)
Build top priority projects	NCDOT Highway Divisions, Municipal Transportation Departments	NCDOT Division of Bicycle & Pedestrian Transportation, MPOs/ RPOs	Complete roadway improvements on top priority segments of the route system.	Short-Term (2017)
Re-evaluate priorities	NCDOT Division of Bicycle & Pedestrian Transportation	Local cyclist and division liaisons	Re-evaluate remaining priorities based on updated Bicycle Level of Service analysis and public input through the website.	Ongoing (semi-annual meetings)
Complete recommended priority improvements	NCDOT Highway Divisions, Municipal Transportation Departments	NCDOT Division of Bicycle & Pedestrian Transportation, MPOs/ RPOs	Complete roadway improvements on the remainder of the segments identified in the column 'Improvement Sections' throughout this chapter.	Mid-Term (2020)
Complete improvements to full system	NCDOT Highway Divisions	NCDOT Division of Bicycle & Pedestrian Transportation	Complete 5' minimum shoulder on all bike route segments with ADT over 1,200.	Long-Term (2030)

Endnotes

1. Service levels were calculated using the model described in the National Cooperative Highway Research Program's Report 616. The model is based on empirical research and has been applied in bicycle route system development at the city, county, and state levels.
2. Levels of service shown can generally be assumed to be low estimates relative to those calculated elsewhere, since paved shoulder width data were not available and were therefore assumed to be zero in most places.
3. http://www.mwcog.org/uploads/committee-documents/t1dZW1k20070516090831.pdf
4. http://www.smartgrowthamerica.org/complete-streets/changing-policy/model-policy/model-state-legislation-options/

9.4 Health

Carolina Thread Trail, NC

Introducing health and transportation

Many people associate health with illness, doctors' offices and hospitals. Yet health is as much about how and where we live, work, learn and play. The World Health Organization (WHO) does not define health simply as the lack of illness. In 1946, it declared that "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO). Likewise, the Centers for Disease Control and Prevention (CDC) defines a healthy community as one "that is continuously creating and improving those physical and social environments and expanding those community resources that enable people to mutually support each other in performing all the functions of life and in developing to their maximum potential" (CDC).

Chronic Conditions

The leading causes of death in North Carolina are from chronic diseases, including cancer, heart disease, respiratory disease and stroke (NC SCHS). Seven out of ten deaths result from chronic diseases (Kung, 2005). The most common medical conditions that contribute to mortality are high blood pressure, diabetes and overweight/obesity. While some of the burden from these diseases can be attributed to genetics and lack of access to quality health care, lifestyle behaviors are most significant. In fact, three key preventable behaviors are responsible for the greatest amount of disease and mortality: physical inactivity, poor nutrition and tobacco use.

Disparities in Health

It is critical that public officials consider and address the disparities between communities and vulnerable populations that are most at risk for poor health. These largely preventable conditions are more common in communities of color and in low-income neighborhoods. In addition, older adults and people with disabilities are more likely to live with chronic diseases. Finally, children are perhaps our most vulnerable and yet hold the greatest potential to learn and adopt healthy lifestyles.

In this Appendix

The Financial Cost of Physical Inactivity in North Carolina

Most of us have lost loved ones to chronic disease and/or we live with these conditions within our families. The human burden of pain and suffering is clear. What is increasingly obvious is the financial burden from chronic diseases that are forced on families and society. Recent reports have estimated the annual direct medical cost of physical inactivity in North Carolina at $3.67 billion, plus an additional $4.71 billion in lost productivity (Chenoweth, NCMJ, 2012 and Be Active, "Tipping the Scales" 2012). While these financial figures are bleak, researchers have also found that every dollar invested in accessible pedestrian and bicycle trails can result in a savings of nearly $3 in direct medical expenses (Chenoweth 2012; Wang, et al 2006).

The Benefits of More Physical Activity

Physical activity is a key indicator of health. Increasing one's level of physical activity reduces the risk and impact of cardiovascular disease, diabetes, and some types of cancer. It also helps to control weight, improve mood and reduce the risk of premature death. The Surgeon General recommends the following levels of activities by age group (for more detail on these guidelines, see the 2008 Physical Activity Guidelines for Americans):

- **Children and adolescents should do 60 minutes or more of physical activity daily.**
- **Adults should do at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination**
- **When older adults cannot do 150 minutes of moderate-intensity aerobic activity a week because of chronic conditions, they should be as physically active as their abilities and conditions allow.**

▲ Durham, NC ca. 1900

These recommendations allow individuals to combine 10-minute bouts of activity to achieve the goal of 30 minutes each day (1996 US Surgeon General's Report, and 2008 Physical Activity Guidelines for Americans). In 2012, the National Cancer Institute determined that regular leisure-time physical activity can extend our lives more than three years for meeting the recommended guideline (NCI, 2012, PLOS).

North Carolina and the nation are in the midst of an epidemic of overweight and obesity (F as in Fat, 2012).

Regular physical activity plays a crucial role in weight control and quality of life, along with a healthy diet. Yet the health potential of routine physical activity extends beyond overweight and obesity. Physical inactivity is established as an independent risk factor for chronic diseases. This means that, regardless of one's weight, regular physical activity delays the onset and reduces the likelihood of developing chronic diseases (Telford, 2007).

When the US Surgeon General declared the disease-preventing potential of regular moderate physical activities, particularly walking and bicycling, it created a health promotion prescription within reach of all North Carolinians.

Rather than having to exercise rigorously or join a fitness center, children and adults can lead measurably healthier lives by incorporating 30 or more minutes of activity each day. Using "active transportation" to and from school, work, parks, restaurants, stores and other routine destinations, is one of the best things we can do to prevent chronic diseases. Active transportation typically includes walking, bicycling and transit use (Rodriguez, 2009).

Active Transportation as a Public Health Priority

Both federal and state health officials have prioritized physical activity as a key health objective and one that can be advanced through a transportation system that supports safe walking and bicycling. After carefully considering the best science and converging evidence, public health authorities, including the CDC and the Institute of Medicine, have recommended road improvements, connectivity, land use policies, active transportation to schools and programs to advance walking and bicycling. (CDC, 2009; IOM, 2009)

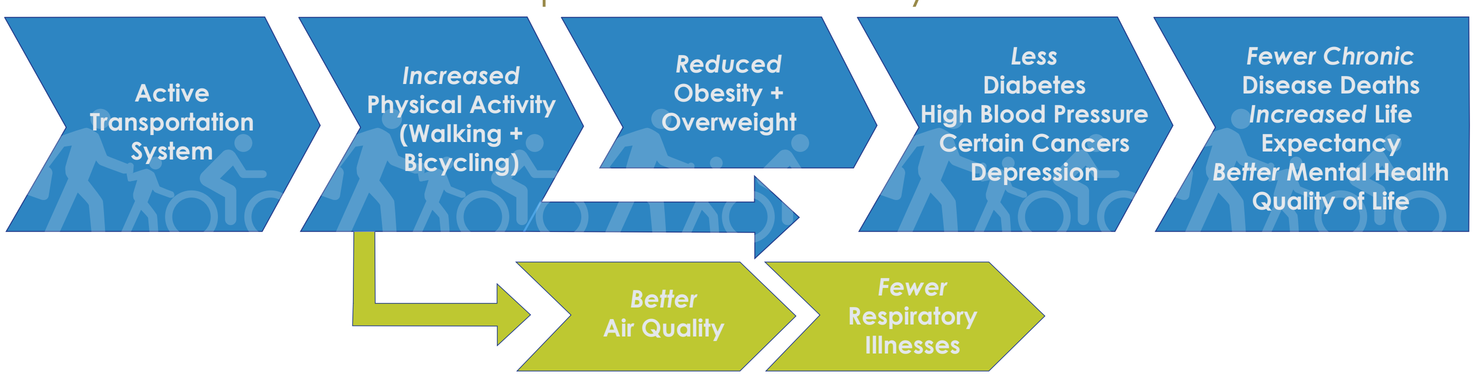
Broader Approach, Greater Collaboration

The roots of collaboration between urban planning and public health professionals date back more than a century. Housing and sanitation systems and standards moved the nation's health forward by reducing the burden of waterborne and communicable diseases (Silver, 2012). City planners helped enact important land use and zoning restrictions to protect people from industrial pollutants. But as chronic diseases replaced infectious diseases as the leading causes of death throughout the 20th century, the public health profession did not actively focus on policies and built environments that impact these conditions. In recent years, public health officials and researchers have come to recognize and better understand the important role that the built environment plays in chronic disease prevention and quality of life. In particular, our transportation system and design of communities directly impacts our choices to lead healthy lives. For this reason, health professionals and advocates have become new partners in promoting and planning for pedestrian and bicycle transportation.

Co-Benefits of an Active Transportation System

The public health impacts of the transportation system extend beyond physical inactivity and obesity. By shifting more North Carolinians to walking and bicycling for

Active Transportation: Pathway to Health



transportation, even for small trips, the state will reduce automobile emissions and improve air quality. Cleaner air leads to fewer symptoms and illnesses for those suffering from asthma and other chronic respiratory conditions. Similarly, a well-developed system that supports pedestrian and bicycle transportation not only improves options for new users, but it improves safety for North Carolinians who already utilize active transportation.

Momentum at Home

Outside the state, North Carolina's departments of transportation and health are highly regarded. For years, the NC Department of Health and Human Services (NC DHHS) has helped lead the way in encouraging local health departments to work collaboratively and implement policy and environmental strategies to create healthier communities. At the state level, NC DHHS convened the Healthy Environments Collaborative (HEC), which includes the departments of Transportation (NCDOT), Commerce and Environment and Natural Resources. The HEC's purpose is to consider the health impacts of each department's work and collaborate in improving health in North Carolina. In 2012, NCDOT's Board of Transportation adapted its mission statement to include "health and well-being" and passed a "Public Health Policy," which declares the importance of a transportation system that supports positive health outcomes.

The Health Appendix provides an overview of health as it relates to pedestrian and bicycle transportation and how North Carolina can improve the health of its citizens, in part, through its transportation system. The sections that follow address the health conditions in the state and the current science on how the transportation system impacts health. This appendix also presents best and promising practices from within North Carolina. Finally, recommendations are

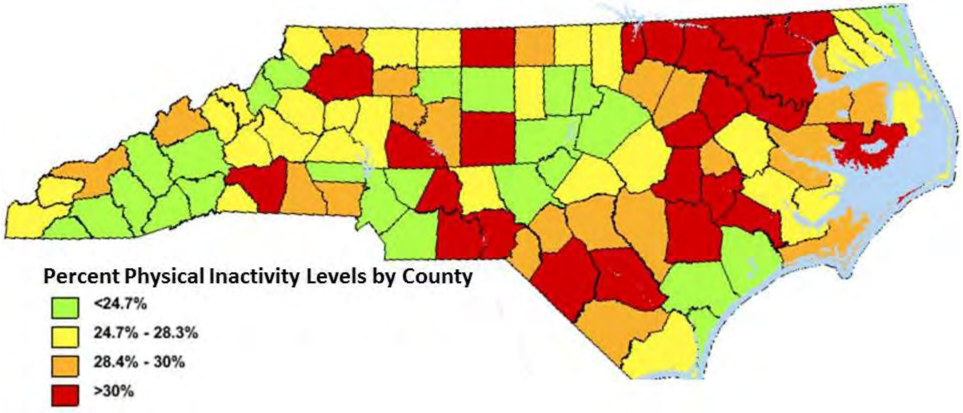
Source: Robert Wood Johnson Foundation
http://www.rwjf.org/en/blogs/new-public-health.html

offered to help our state move forward to create a model pedestrian and bicycle transportation system – one that accommodates and prioritizes active transportation for better health.

The State of Health and Physical Activity in North Carolina

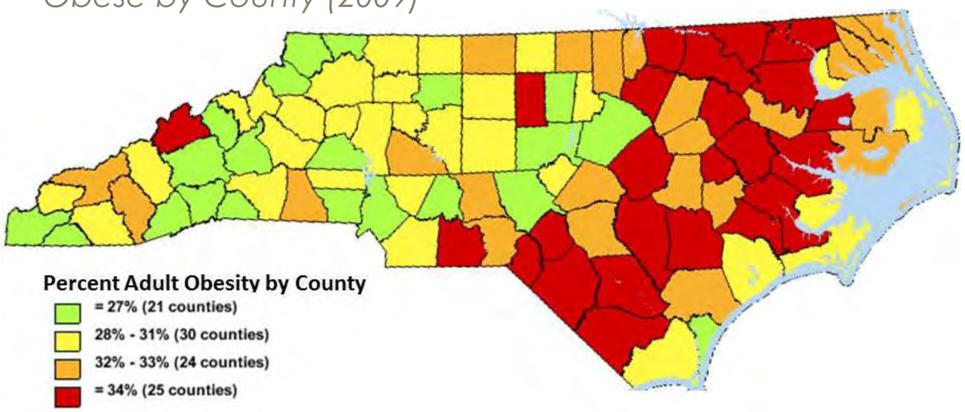
According to America's Health Rankings, North Carolina is the 32nd healthiest state and 36th in premature death. Many factors influence these rankings, including those that have implications for walking and bicycling, like air pollution, injuries and obesity. As of 2011, only 46.8% of North Carolina adults were performing the minimum recommended amount of weekly physical activity (NC BRFSS, SCHS). Lack of physical activity increases the likelihood of overweight and obesity and increases the risk of Type II diabetes, heart disease, hypertension, colon and breast cancers and depression (WHO). The instance of obesity in the United States has greatly increased over the past 20 years and was declared a national epidemic by the US Surgeon

Percentage of NC Adults Who are Physically Inactive by County (2009)



Source: Centers for Disease Control and Prevention, Diabetes Data and Trends

Percentage of NC Adults Who are Obese by County (2009)



Source: County Health Rankings, 2012*

** In some cases, County Health Rankings aggregates data from many years for counties with lower sample sizes.*

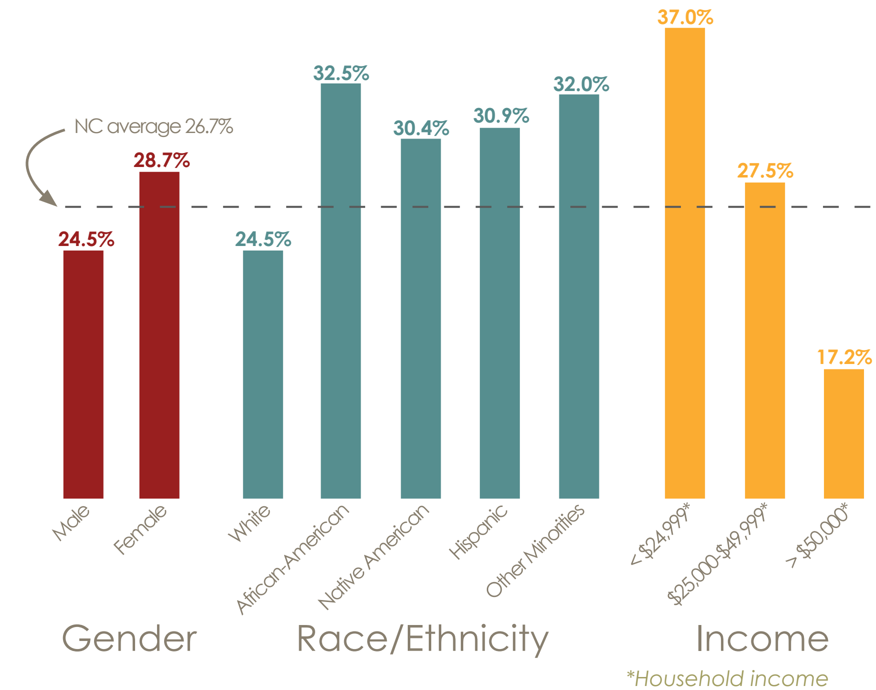
General in 2001. The rate of obesity in North Carolina adults has more than doubled in the past twenty years, from 13% in 1990 to 29.1% in 2011 (NC BRFSS, SCHS).

The lack of pedestrian and bicycling infrastructure leads, in part, to physical inactivity. In recent decades, the cultural shift has moved people from walking and bicycling and into vehicles. In 1960, about 10% of all trips were taken by walking and bicycling, and that number dwindled to just above 3% by 2009 (Ogden and Carroll, 2010. CDC, NHANES, McDonald, 2007. NHTS, 2009). In that same time, the adult obesity rate has gone from 13% to over 29% and a similar trend can be observed among children (NC BRFSS, SCHS, 2011). In 2011, 26.7% of North Carolina adults were physically inactive; in other words, over a quarter of North Carolina residents do not exercise in a month's time (NC BRFSS, SCHS). Physical activity is defined broadly by the CDC as activities that cause increased breathing or heart rate (CDC). Physical activity can include walking, bicycling and other leisure time activities and recreational activities.

Excess weight due to physical inactivity and poor diet cause an estimated 300,000 premature deaths each year in the US, second only to tobacco in causes of preventable death (Ewing et. al., 2008). North Carolina, in particular, has the 17th highest rate of obesity (29.1%) in the country (NC BRFSS, SCHS, 2011). If current trends persist, an estimated 58% of North Carolina adults will be obese by 2030 (RWJF, 2012). This would increase the risk for a number of chronic physical conditions, including heart disease, arthritis and diabetes. The added human toll and economic burdens to North Carolina residents, families, insurers and governments are alarming.

North Carolina counties with higher levels of physical inactivity and diabetes rates are predominantly in the eastern part of the state. Those with lower percentages of physical inactivity and lower diabetes rates tend to be in more urban areas. Health disparities along racial and income lines cause further concern. Among low-income people and people of color, physical inactivity rates are higher than the state average, posing even greater risk among these populations. In North Carolina, non-Hispanic blacks experience

Percentage of NC Adults Who are Physically Inactive by Gender, Race/Ethnicity and Income (2011)

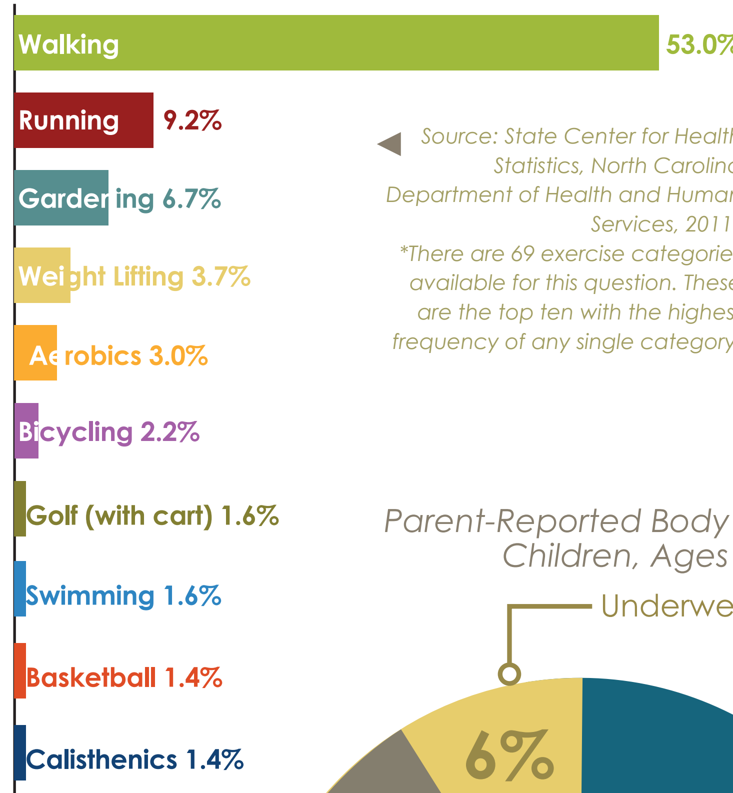


Source: State Center for Health Statistics, North Carolina Department of Health and Human Services, 2011

almost double the rate of obesity to their non-Hispanic white counterparts at 42.4% and 26.7%, respectively. Racial and ethnic differences also exist in diabetes rates; 15.3% of non-Hispanic blacks in North Carolina have diabetes compared to 8.7% of non-Hispanic whites (America's Health Rankings, 2011).

Along with unhealthy diet, physical inactivity is attributed to the leading causes of premature or preventable death in North Carolina. Fifty-three percent of all deaths in North Carolina are preventable by changing health behaviors (NC DHHS). Sixty-five percent of adult North Carolinians are currently overweight or obese, which is just below the

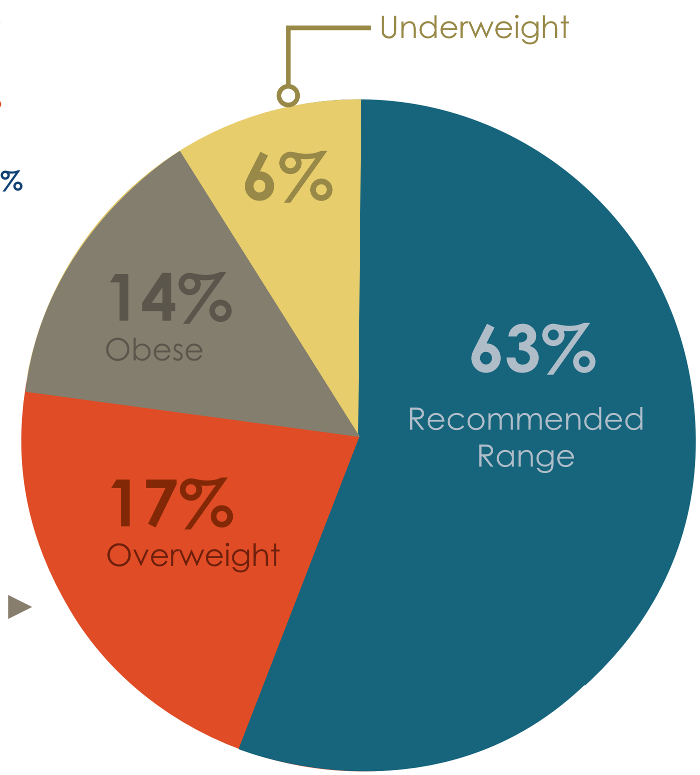
Top Leisure Physical Activities in the Past Month, NC Adults



*Source: State Center for Health Statistics, North Carolina Department of Health and Human Services, 2011**

**There are 69 exercise categories available for this question. These are the top ten with the highest frequency of any single category.*

Parent-Reported Body Mass for NC Children, Ages 10-17 (2011)



Source: NC BRFSS CHAMP, SCHS, 2011

North Carolina and United States Rates for Health Indicators

Chronic Diseases, Conditions and Health Risk Factors	North Carolina (%)	United States (%)	NC National Ranking
Obesity (2010)	*29.1*	*28.3*	*32nd*
Meet physical activity recommendations (2009)	*46.5*	*49.6*	*43rd*
Diabetes (2010)	*9.4*	*8.7*	*41st*
History of cardiovascular disease (2010)	*8.7*	*7.9*	*40th*
High blood pressure (2009)	*30.5*	*28.2*	*42nd*
Disability (2010)	*22.9*	*22.0*	*31st*

Source: Trends in Key Health Objectives for North Carolina and the Nation, 2012

national average (68%) (NC BRFSS, SCHS). Twenty-nine percent are obese, having a body mass index (BMI) of 30 or greater, and 36% of North Carolina adults are overweight, or have a BMI greater than or equal to 25 and under 30 (NC BRFSS, SCHS). Getting the recommended amount of physical activity does not have to include recreational or strenuous activities and can often be incorporated into one's daily routine.

Unfortunately, North Carolina children are not protected from the obesity epidemic. Both at the state and national level, the rate of childhood obesity tripled from 1980 to 2004 (NC DHHS, 2010). In 2011, 16.8% of children ages 10-17 were overweight and 13.8% were obese.

As of 2011 North Carolina fared worse than the US average for many chronic diseases affiliated with physical inactivity (NC BRFSS, SCHS).

Correlation between Income and Physical Inactivity Levels in NC (2009)

Source: County Health Rankings, 2012 and US Census, 2010.*
** In some cases, County Health Rankings aggregates data from many years for counties with lower sample sizes.*

Per capita income and physical inactivity levels are inversely related; as income increases, physical inactivity decreases. North Carolina counties with the lowest rates of physical inactivity – Orange, Wake, Mecklenburg and Durham – are within the top ten counties with the highest median income.

In 2011, the percentage of North Carolinians who have been told they have diabetes is 10.7%.

Adjusting for age, those with lower income (below $24,000) have a diabetes rate almost twice that of the state average (20.5%) (NC BRFSS, SCHS). The percentage of North Carolina adults living with diabetes has risen 2.8% from 2001 to 2010, from 6.6% to 9.4% respectively. The rate of those living with high blood pressure is also increasing, and increasing faster than the US average. From 2001 to 2010, the percentage of North Carolinians living with high blood pressure has risen 3.3% whereas the US average has risen 2.7% (NC BRFSS, SCHS).

Prevalence and Percent Change of Chronic Diseases for Selected NC Groups

	Diabetes		Cardiovascular Disease		High Blood Pressure	
	Prevalence (2010)	% Change (2001-2010)	Prevalence (2010)	% Change (2001-2010)	Prevalence (2009)	% Change (2001-2009)
Male	9.5%	2.7%	9.6%	-0.8%	31.7%	6.3%
Female	10.0%	3.3%	8.3%	1.3%	33.0%	3.8%
White	3.3%	3.3%	9.6%	0.7%	32.1%	6.5%
Black	4.7%	4.7%	9.2%	0.6%	41.7%	4.0%
Hispanic	1.4%	1.4%	data unavailable		13.6%	-6.9%

	Meets Physical Activity Recommendations		Obesity*		Physical Inactivity	
	Prevalence (2009)	% Change (2001-2009)	Prevalence (2010)	% Change (2001-2010)	Prevalence (2010)	% Change (2001-2010)
Male	51.1%	4.8%	29.1%	6.3%	22.3%	-0.7%
Female	41.9%	3.0%	29.0%	5.7%	29.0%	-0.5%
White	48.5%	3.8%	26.1%	6.0%	24.3%	1.1%
Black	37.5%	5.1%	43.7%	7.2%	30.1%	-5.2%
Hispanic	49.3%	2.1%	25.8%	4.9%	27.1%	-0.9%

Source: Source: Trends in Key Health Objectives for North Carolina and the Nation, 2012

**Obesity data include those 20 years old or older*

9.4

The Science of Health and Transportation

Physical Activity Objectives, Active Transportation and Public Health

The nation's top public health authorities have declared the importance of physical activity and healthy weight as priority health indicators and emphasize built environment approaches in preventing chronic diseases. In fact, four of the US Department of Health and Human Services' 26 Healthy People Leading Health Indicators for its Healthy People 2020 plan are impacted by the transportation system: adults who meet current physical activity guidelines; adults who are obese; children and adolescents who are considered obese; and fatal injuries (http://healthypeople.gov/2020/default.aspx). Similarly, North Carolina's Year 2020 Health Objectives include increasing physical activity in adults and healthy weight among high school students. (Healthy North Carolina 2020: A Better State of Health)

To help address these objectives and increase physical activity levels in communities, the CDC Community Preventive Services Task Force recommends three evidence-based strategies to increase physical activity levels that relate to pedestrian and bicycle transportation. These approaches resulted from an extensive review of the scientific literature (CDC, 2011).

- Street-scale urban design and land-use policies, i.e. small area improvements to street lighting, increasing ease and safety of street crossings, introducing or enhancing traffic calming, enhancing the aesthetics of the streetscape and ensuring sidewalk continuity.
- Community-scale urban design and land-use policies, i.e. community-scale urban design and land-use policies to improve continuity and connectivity of streets, sidewalks and bicycle lanes; zoning regulations and roadway design standards that promote destination walking and co-location of residential, commercial and school properties (mixed land-use zoning), as well as transit-oriented development.
- Active transport to school, i.e. school interventions designed to encourage and support youth to engage in active transportation, Walk to School, Walking School Bus and Safe Routes to School.

More recently, other organizations and task forces have highlighted the health-promoting potential of the transportation system. In subsequent reviews of the best scientific evidence, the Institute of Medicine found that local governments have a vital role in impacting childhood obesity through these strategies to increase active transportation: (Institute of Medicine, "Local Government Actions to Prevent Childhood Obesity" downloaded from http://www.nap.edu/catalog/12674.html).

- Encourage walking and bicycling for transportation and recreation through improvements in the built environment.
- Promote programs that support walking and bicycling for transportation and recreation.

Likewise, CDC released the 24 recommended community strategies to prevent obesity as well as suggested measurements corresponding to each approach. Six of these strategies relate to the transportation system ("Recommended Community Strategies and Measurements to Prevent Obesity in the United States" http://www.cdc.gov/MMWR/preview/mmwrhtml/rr5807a1.htm).

Within North Carolina, state health officials have identifies key consensus strategies and objectives to measure progress relating to active transportation.

Strategies

- Inclusion of bike paths, sidewalks, accessible walking trails and parks in communities
- Review of current transportation policy and traffic patterns to provide safe conditions for walking and bicycling

Objectives

- Increase yearly the number of facilities and/or environments that promote physical activity, such as bike lanes, pedestrian/bicycle signage, sidewalks and greenways.
- Increase yearly the policies, practices and incentives to promote physical activity, such as draft and implement a bicycle plan, draft and implement a pedestrian or sidewalk plan, increase funding for pedestrian/bicycle facilities and pursue policy to dedicate a portion of funds for pedestrian/bicycle facilities on a regular basis.

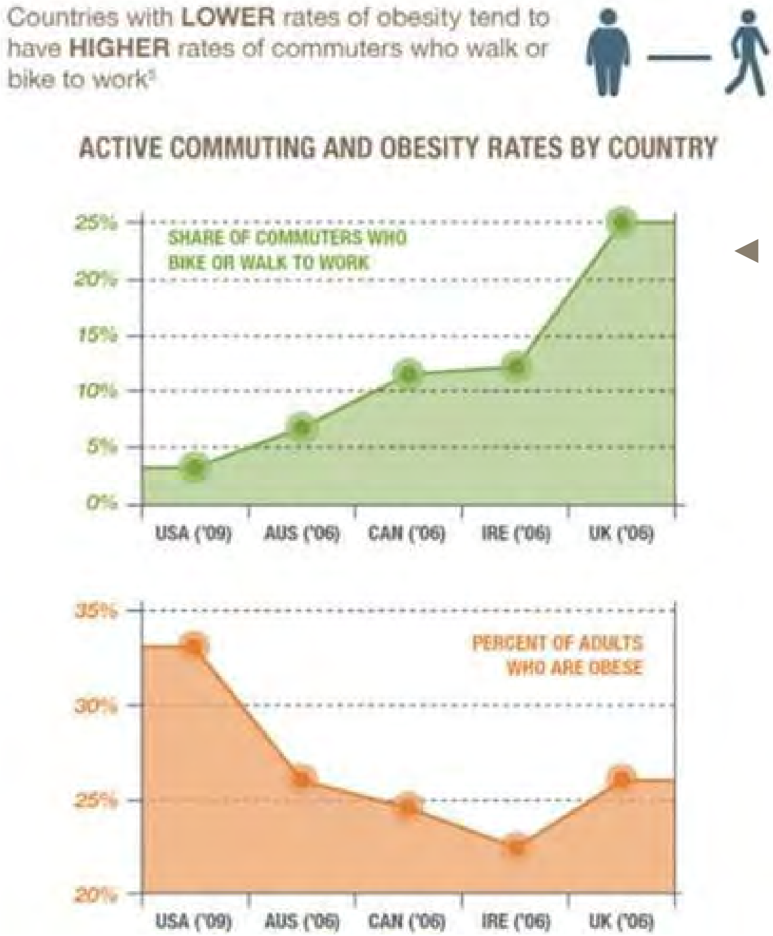
Sources: "North Carolina's Plan to Prevent Overweight, Obesity and Related Chronic Diseases," and "North Carolina Blueprint for Changing Policies and Environments in Support of Increased Physical Activity" (Division of Public Health, NC DHHS).

The Health Benefits of Physical Activity through Active Transportation

Engaging in regular physical activity can help lessen one's risks for chronic disease, control and reduce weight and help reduce premature deaths due to obesity-related

Source: MMWR, 2009, Centers for Disease Control and Prevention

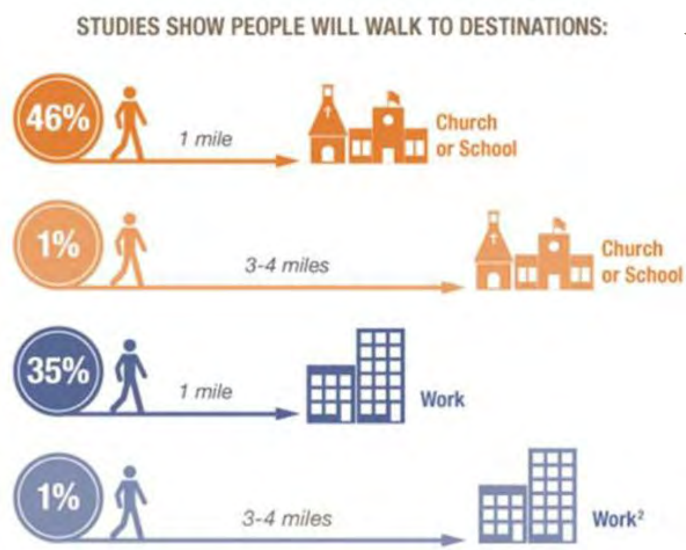
Strategy	Suggested Measurement
Enhance infrastructure supporting bicycling	*Total miles of designated shared-use paths and bike lanes relative to the total street miles (excluding limited access highways) that are maintained by a local jurisdiction.*
Enhance infrastructure supporting walking	*Total miles of paved sidewalks relative to the total street miles (excluding limited access highways) that are maintained by a local jurisdiction.*
Support locating schools within easy walking distance of residential areas.	*The largest school district in the local jurisdiction has a policy that supports locating new schools, and/or repairing or expanding existing schools, within easy walking or biking distance of residential areas.*
Improve access to public transportation.	*The percentage of residential and commercial parcels in a local jurisdiction that are located either within a quarter-mile network distance of at least one bus stop or within a half-mile network distance of at least one train stop (including commuter and passenger trains, light rail, subways and street cars).*
Zone for mixed use development.	*Percentage of zoned land area (in acres) within a local jurisdiction that is zoned for mixed use that specifically combines residential land use with one or more commercial, institutional, or other public land uses.*
Enhance personal safety in areas where persons are or could be physically active.	*The number of vacant or abandoned buildings (residential and commercial) relative to the total number of buildings located within a local jurisdiction.*
Enhance traffic safety in areas where persons are or could be physically active.	*Local government has a policy for designing and operating streets with safe access for all users which includes at least one element suggested by the national complete streets coalition (http://www.completestreets.org)*



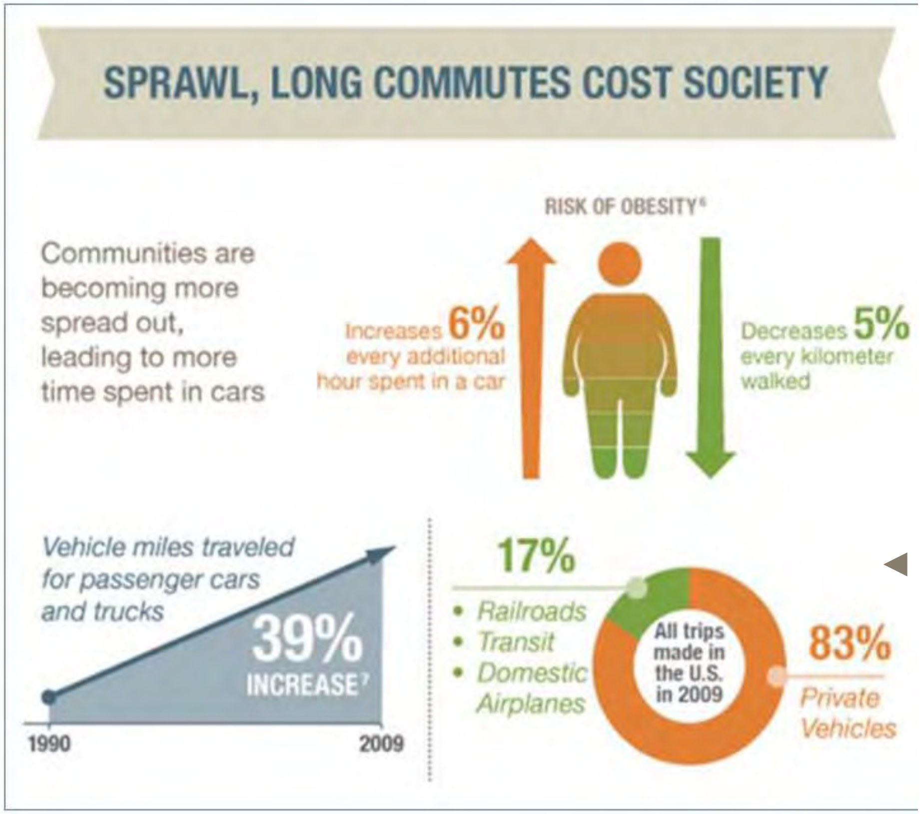
Source: Robert Wood Johnson Foundation http://www.rwjf.org/en/blogs/new-public-health.html

Walking is the most commonly reported physical activity among adults and the most frequently reported activity among adults who meet physical activity guidelines (Kruger et al., 2008, Simpson et. al., 2003). In 2011, the CDC found that 62% of adults say they walked for at least ten minutes or more in the previous week, compared to 56% in 2005. Although the southern states had the lowest rates of walking (47.7% males and 50.6% females), they also saw the greatest increases in walking (CDC, 2012). Walking is a physical activity most people can do because it does not require a special skill or special facilities and can be done indoors or outdoors, alone or with others. In this regard, walking is particularly important for its potential to reduce disparities in health (Lee and Buchner, 2008). Walking and other physical activities have numerous health benefits including weight control, reduced risk for Type II diabetes, cardiovascular disease, certain cancers, strengthened bones and muscles, and improved mental health and mood (Heath et. al., 2006).

illness (Heath et al., 2006). Being physically active can also improve mental health and sense of well-being (CDC, 2011). Health experts have historically attempted to increase leisure-time activity to achieve these goals, but have broadened their view of physical activity to include a lifestyle that integrates physical activity into daily routines (Hoehner et. al., 2005). For example, commuting to work or school is an opportunity for regular physical activity in the form of daily walking or bicycling. Sixty percent of North Carolinians say that better access to sidewalks, trails and paths would encourage them to increase their walking and biking activities (Conti et. al, 2012).



Source: Robert Wood Johnson Foundation http://www.rwjf.org/en/blogs/new-public-health.html



Source: Robert Wood Johnson Foundation http://www.rwjf.org/en/blogs/new-public-health.html

While bicycling is not as prevalent as walking, it is gaining ground in the US. During the past two decades, the number of bike commuters has risen by 64% (Pucher et. al, 2011). Bicycling has also engaged increasingly diverse populations. Between 2001 and 2009, bicycling rates rose fastest among African Americans, Hispanics and Asian Americans. These three groups also account for a growing share of all bike trips, up to 21% in 2009 from 16% in 2001 (Pucher et al., 2011). As communities of color are more likely to be burdened by obesity and associated chronic disease, these increases are especially promising (CDC, 2011). Strong evidence exists for the health benefits of bicycling as a form of physical activity through associated reductions in all-cause mortality, cardiovascular disease and some cancers (Oja, Titze et al. 2011) as well as weight control and mental health (Cavill and Davis, 2007). A number of comprehensive assessments have shown that the health benefits of physical activity achieved while bicycling far outweigh the potential exposures to poor air quality and road traffic. Most recently, researchers comparing risks and benefits of active transportation concluded that even though increased walking and bicycling results in reduced air pollution, the greatest benefit is the health promoting potential of physical activity (Rabl and de Nazelle, 2012). Life years gained among individuals who shift from car to bicycle are estimated to be three to 14 months compared to 0.8 to 40 days lost through increased inhaled air pollution, and five to nine days lost due to an increase in traffic accidents (Johan de Hartog, Boogaard et al. 2010). On balance, the health benefits from bicycling outweigh the risks of exposure to poor air quality and injury.

The Built Environment, Transportation and Health

Generally the built environment is defined as the part of the physical environment that is constructed by human activity. It may consist of land use patterns, the transportation system and urban design (Handy et. al., 2002). While it is up to the individual to make the decision to be physically active, the transportation network can enable or facilitate better health outcomes depending on the safety and feasibility of active transportation alternatives (Conti et. al., 2012). In combination with sprawling development patterns, the transportation network in North Carolina is designed primarily for travel by motorized vehicles (Conti et. al., 2012). Unfortunately, areas where the automobile is the dominant form of transportation for work, school, shopping and leisure activities are associated with physical inactivity, overweight and obesity (Lindstrom, 2008). Additionally, the more time spent in a car increases the likelihood of developing obesity (Frank and Schmid, 2004, Saelens et. al., 2003, Lopez-Zetina et. al., 2006, Pendola and Ren, 2007). Planning and health researchers in Atlanta found that each additional hour spent in a car per day was associated with a 6% increase in the likelihood of obesity, while each additional kilometer walked per day was associated with a 4.8% reduction in the likelihood of obesity (Frank and Schmid, 2004).

In contrast, residents get more physical activity if they live in traditional neighborhoods developed prior to World War II, as well as residents of new neighborhoods built for walkability, (Sallis et al, 2009). A comprehensive review of studies found that sidewalks and connectivity are commonly correlates of walking (Saelens and Handy, 2008). Factors within these neighborhoods that influence walkability and thus physical activity include: connectivity (limiting construction of new cul-de-sacs or connecting existing cul-de sacs), smaller block size, urban design that promotes enclosure, human scale, transparency, complexity, dense land use mix and higher residential density (Sallis et. al., 2009, Ewing et al., 2006, Dill and Voros, 2007). In Seattle and Baltimore, residents of high-income but low-walkable neighborhoods had a 50% increased risk for obesity compared to high-income, walkable neighborhoods (Sallis et al, 2009).

In terms of bicycling infrastructure, many western states (including California, Oregon and Washington) and larger cities that have implemented a range of efforts, including infrastructure, encouragement programs and policies to promote cycling, have seen the largest increases in walking and bicycling (Pucher et al., 2011). Common to these places is a supportive environment and populations motivated to walk and bicycle. These conditions have not occurred by chance; they are the outcome of intentional policies that address both environment through infrastructure and motivation through non-infrastructure projects (Basset et. al., 2008). Southern states, like North Carolina, that have invested the least in walking and cycling have lower levels of bicycling (Pucher et al., 2011). Greater bicycle infrastructure has consistently been associated with higher levels of bicycling (Pucher et. al., 2010). Dill and Carr (2003) found that each additional bikeway mile per square mile is associated with roughly 1% increase in bicycle trips (Dill and Carr, 2003). These studies demonstrate a clear and convincing association between the built environment and physical activity, but certain aspects of the built environment warrant additional explanation.

Many built environment features are correlated with physical activity and include: pedestrian and bicycle infrastructure, parks, street network density, residential density, land use mix and urban design (Sallis, et al, 2009; Saelens and Handy, 2008; Saelens, Sallis and Frank, 2003). Pedestrian and bicycle facilities are associated with more adults and children meeting physical activity recommendations through both leisure and transportation-related physical activity (Owen et al, 2004; Dill, 2009; Pucher, Dill and Handy, 2010).

It is important to consider the type of walking and cycling for tailoring interventions. Walking or bicycling for leisure has the strongest associations with the proximity, quantity and quality of recreational facilities (Brownson et al, 2009). On the other hand, walking or cycling for travel is more likely influenced by route directness, proximity of destinations and walking and cycling facilities (Brownson et al, 2009; Dill, 2009; Sallis et al, 2009).

Air Quality Impacts of Active Transportation

Air pollution is an environmental risk to health. Transportation-related air pollutants are one of the largest contributors to unhealthy air quality. Exposure to traffic emissions has been linked to many adverse health effects including: premature mortality, cardiac symptoms, exacerbation of asthma symptoms, diminished lung function, increased hospitalization and others (Friedman, 2001). Motor vehicles are a significant source of air pollution in urban areas causing about half of the toxic air pollutant emissions in the United States (EPA, Air Pollution). Walking and bicycling, on the other hand, produce virtually no pollution (Frank, et al. 2010). A number of studies have shown that the benefits outweigh the risks associated with potential injury and exposure to poor air quality for walking and bicycling.

Children are particularly vulnerable to poor air quality because they breathe 50% more air per pound of body weight than adults (EPA, Air Pollution). Childhood asthma is one of the most common pollution-related health problems in America, affecting more than 7 million children (CDC, Asthma). With the majority of children being driven to school, children may face exacerbated conditions near schools. Idling in student drop-off and pick-up lines further diminishes air quality around schools (EPA, Idle Free Schools). Safe Routes to School programs can help improve air quality by increasing the number of children walking and bicycling to school and reducing motor vehicle trips. To improve the respiratory and cardiovascular health of the US population as a whole, the CDC includes improving air quality as one of eight priority recommendations for transportation. Possible strategies include promoting transportation choices and innovative transportation measures that reduce emissions, shifting to active transportation and public transportation modes and reducing vehicle miles traveled per capita (CDC, Transportation). Investing in walking and bicycling infrastructure and programs can play a significant role in improving air quality.

Source: Robert Wood Johnson Foundation http://www.rwjf.org/en/blogs/new-public-health.html

Connecting Walking and Bicycling to Healthy Food Access

People who live in low-income communities tend to be underserved by both the food and transportation systems. Inner-city and rural neighborhoods commonly have fewer and smaller grocery stores, with poorer selections of healthy foods and higher prices than their suburban counterparts (PolicyLink, 2010). Lower income populations also have lower vehicle ownership levels and/or access to direct transit routes to grocery stores. Connecting individuals to healthier foods via transportation is important because children living in neighborhoods with access to healthy food and safe play spaces are 56% less likely to be obese than children in neighborhoods without these features (Saelens et. al., 2012). A Los Angeles based study also found that longer distance traveled to reach a grocery store was associated with higher body mass index (Inagami et. al., 2006). Finally, obesity rates are 20% higher in low-income areas with high densities of fast-food and convenience stores compared to low-income areas with lower densities of outlets selling primarily unhealthy foods (PolicyLink, 2008).

Determinants of Walking and Bicycling

A person's decision to walk or bicycle is influenced by a variety of factors including personal reasons, community norms and the built environment. Personal factors include ability, comfort, confidence, habits and perceptions about walking and bicycling that can evolve over one's lifespan, but may also be modified by targeted intervention programs. Community norms that predicate the social acceptability of walking or bicycling also affect individual motivation and may be difficult to shift. The built environment can be shaped by public investments and development policies over time. Natural features, particularly weather and topography, are also important, though beyond the direct reach of policy (Handy, 2010). A growing number of cities have demonstrated the need to implement integrated strategies - policies, projects and programs - that can address both environment (infrastructure) and individual motivation (non-infrastructure) that significantly increases active transportation (Pucher et. al., 2010).

Health Equity

Unequal exposure to positive social, economic and environmental influences can result in health inequities among different populations. For example, lower-income neighborhoods tend to have less access to healthy foods and fewer options for adequate physical activity (Day, 2006). Transportation is a social determinant that can play a major role in influencing people's health and sense of well-being. Communities of color, low-income communities, people with disabilities and people with language barriers are disproportionately impacted by burdens of the transportation system and do not receive an equal share of the benefits (Upstream Public Health, 2012). The National Surface Transportation Policy and Revenue Study Commission, created by Congress in 2005, determined that "The nation's surface transportation network regrettably exacts a terrible toll in lost lives and damaged health." The toll is highest among low-income people and people of color (National Surface Transportation Policy and Revenue Study, 2007).

From an equity standpoint, active transportation presents both challenges and opportunities. Access to adequate walking and bicycling facilities can improve access to jobs, healthcare, healthy food, and physical activity for households with limited access to cars. Additionally, walking and bicycling can reduce health disparities between low-income and more affluent communities. Safety, however, remains a significant concern. The challenge is to increase walking and bicycling safely, primarily because the population groups that could most benefit from increased walking and bicycling are also the most vulnerable to traffic dangers. Overall physical activity levels are lowest among low-income and minority populations despite the fact that low-income households are more dependent on walking and public transit (Pucher and Renne, 2003, Besser and Dannenberg, 2005). Forty percent of the lowest income transit users meet the recommended levels of physical activity solely from walking to and from transit (Besser and Dannenberg, 2005). Without this, their total physical activity would be far less. Walking or bicycling is often the only viable physical activity option for low-income residents who live in neighborhoods without nearby parks, who cannot afford gym memberships and do not have the luxury of leisure time (PolicyLink, 2010). In many low-income and communities of color the quality of pedestrian and bicycling infrastructure is often worse, despite their greater dependence on it, contributing to higher pedestrian fatality rates (Pucher and Renne, 2003).

Transportation, Income and Health

As distances between housing and employment increased over time, non-drivers have experienced employment barriers. Nationally, 19% of African Americans and 13.7% of Latinos lack access to automobiles, compared with 4.6% of whites. Poverty complicates the problem: 33% of poor African Americans and 25% of poor Latinos lack automobile access, compared with 12.1% of poor whites. Vehicles owned by low-income people tend to be older, less reliable and less fuel-efficient which adds to the unpredictability, expense of commuting and poorer air quality (PolicyLink, 2010).

Source: Robert Wood Johnson Foundation http://www.rwjf.org/en/blogs/new-public-health.html

The potential economic benefits of increased walking and bicycling are apparent. Better health as a result of increased physical activity can reduce healthcare costs while cheaper modes of travel can reduce household spending on transportation (PolicyLink, 2010). Making walking and bicycling more viable, particularly in conjunction with improvements to transit, can increase access while contributing to economic development efforts by encouraging retail stores and restaurants to locate within walking distance of residential areas, particularly in low-income areas (Handy, 2010).

Transportation, Youth and Health

Across the country, children and many adolescents depend on parents and other adults to drive them to school and other activities, a trend that has increased in recent decades (McDonald, 2006). Walking to school dropped from 40.7% of all school trips in 1969 to 12.9% in 2001 (McDonald, 2007). If children were able to safely walk or bicycle more, they would get more physical activity, increase their autonomy and their parents would drive less. However, the risk of injury is a concern: rates of pedestrian and bicyclist fatalities and injuries per capita are highest for those under the age of 15 (Handy, 2010). Parental fears about traffic as well as fear of abductions, or "stranger danger," help explain why children now walk and bicycle less than in the past. According to the U.S. Department of Justice, in 2002 (the most recent year for which data are available), 98% of children reported missing were either family member abductions or were not abductions. In these cases children were lost, injured, or unable to make contact with a caregiver (U.S. DOJ, 2002). Nonetheless, increasing walking and bicycling for children will require addressing removing threats to their safety, both actual and perceived (Handy, 2010).

Transportation, Older Adults, People with Disabilities and Health

Older adults could equally benefit from increased walking and bicycling, but safety remains an issue for them as well. One in five adults ages 65 years and older does not drive, and more than 50% of non-drivers stay home because they lack transportation options (Handy, 2010). Walking, bicycling and transit can provide an important means of accessing healthcare, food and recreation. However, the decline in physical and mental abilities that make driving unsafe can also make walking and bicycling more difficult. Uneven sidewalks, for instance, can pose a greater obstacle for older adults and persons with disabilities. Likewise, many older pedestrians are fearful at intersections where crossing signals do not allow slower walkers enough time to cross safely. The highest rate of pedestrian fatalities per capita is for those over age 70 (Handy, 2010). Increased walking appears to reduce long-term cognitive decline and dementia (Erickson, et al. 2010). Where safe conditions exist, increased walking and bicycling can improve physical and mental health (Handy, 2010).

In 1990, The Americans with Disabilities Act (ADA) expanded its language regarding transportation options for people with disabilities. ADA requires public bus and rail operators to offer accommodations, such as lifts and ramps, to allow people in wheelchairs to ride. However, most communities' street designs make traveling to and from bus stops difficult and unsafe for people with disabilities. Paratransit systems, which are intended to overcome these barriers and are prevalent in rural communities, are often limited in funding and resources and often require users to schedule transit pick-up well in advance, posing additional challenges (Handy, 2010). Designing a safer streetscape for both older adults and people with disabilities will help with independence and mobility and improve physical and mental health.

Rural Communities

Rural communities comprise around 40% of North Carolina's population and are of particular interest as their cultural, social, economic, and geographic characteristics place them at higher risks for many unfavorable health conditions (Gamm, 2004; Census, 2000). According to the Centers for Disease Control and Prevention (CDC), people are more likely to be physically inactive in remote areas (37%) compared to those in urban locations (27%) (CDC, 1998). Opportunities in the physical environment such as access to walking trails, sidewalks, gyms, "walkable" streets, and parks may be limited or non-existent in rural, lower density areas, which can contribute to physical inactivity among residents (Luttfiya, 2007). Pedestrian and bicycle projects may be more difficult in these areas, but are sorely needed to help improve levels of physical activity.

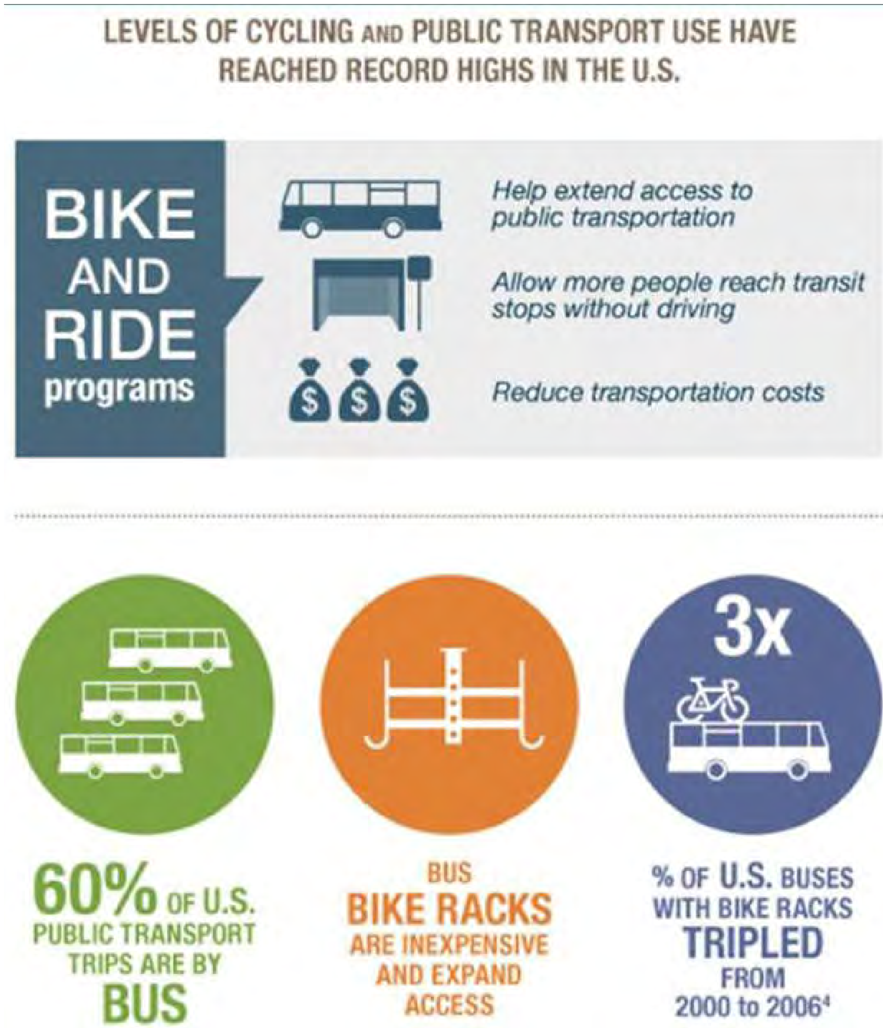
Best Practices and Promising Examples

Throughout the past decade, health and urban planning researchers have devoted considerable attention to the aspects of the transportation system that impact health. This section briefly describes a number of interventions, both infrastructure and non-infrastructure, that have evidence to support increased active transportation levels. Promising case examples, mostly from within North Carolina, are highlighted as illustrations of successful real-world approaches to support health.

Transportation Infrastructure Interventions

Traffic Calming to Lower Vehicle Speeds

Research shows that low-speed traffic designs are not only more appealing but significantly safer for pedestrians and bicyclists. Perceived safety and traffic speed are often cited as major barriers to walking and bicycling (Pucher and Dijkstra, 2003, Dill and Voros, 2007). Traffic calming has been shown to increase the number of bicyclists. In one intervention, engineers improved a high-capacity four-lane road (with 15,000 average daily vehicle trips) by introducing new medians, narrowing the road and/or marking bicycle lanes. These changes resulted in a 23% increase in bicycle use per day (MacBeth, 1999).



Source: Robert Wood Johnson Foundation
http://www.rwjf.org/en/blogs/new-public-health.html

Designing a Network for all Pedestrians and Bicyclists

Many studies have shown the importance of pedestrian and bicycle infrastructure in increasing the numbers of walking and bicycling trips, particularly sidewalks, separate paths and bike lanes (Pucher, Dill and Handy, 2010, Dill and Carr, 2003, Sallis et. al, 2009, Saelens and Handy, 2008). It is also important to design for all users, including older adults, children, people with disabilities and inexperienced bicyclists. While bike lanes are important and favored by some bicyclists in urban or suburban areas, empirical observations of bicyclist behavior suggest that "a network of different types of infrastructure is important and favored by cyclists, but mainly as connections when routes on low-traffic streets are not available" (Dill, J. 2009)

In order to attract new people to cycling, infrastructure beyond bicycle lanes are necessary (Dill, 2009). Even many experienced cyclists are willing to travel far out of their way to access low-stress bikeways such as off-street paths and bicycle boulevards. This suggests that designing for the least experienced users will attract new users and may better serve existing bicyclists (Dill, 2009). Research suggests that by designing for perceived safety concerns and bicyclists' preference, real threats to safety can be mitigated while making bicycling more appealing (Dill, 2009). Many European cities have experienced a decrease in crash rates as the number of pedestrians and bicyclists have increased, referred to as the "safety in numbers" concept (Jacobsen, 2003).

Bicycle Parking

In addition to bicycle lanes, bicycle parking availability has been shown to encourage frequent bicycle commuting (Hope, 1994). Cities with high rates of bicycling have been found to provide ample bicycle parking (Pucher and Buehler, 2008). Compared to other destination facilities such as showers or lockers, bicycle parking has been shown to be more effective in encouraging bicycle commuting (Stinson, 2004).

Infrastructure Maintenance

Research indicates a lack of infrastructure maintenance in low-income and communities of color, even in neighborhoods with sidewalks and adequate connectivity (Zhu and Lee, 2008). Maintaining existing infrastructure is crucial to improving and sustaining walking for physical activity in these neighborhoods (Sallis et. al., 2009). Infrastructure maintenance is important for bicycling as well. Pavement quality is a significant predictor of bicyclists' rating of a road segment (Landis et al., 1998, Parkin et al., 2008).

Manage Automobile Parking

Managed automobile parking reduces single occupancy vehicle use and increases more active modes of transportation (Litman, 2008). Restrictive parking policies that make parking more difficult have been associated with higher levels of walking (Rodriguez et. al., 2008). Disincentives to drive motor vehicles, including limited parking options or parking fees, lead people to take alternative modes, including walking, bicycling and transit. In California, a state "cash-out" requirement of certain employers led to a 39% increase in the number of employees bicycling and walking to work (Shoup, 1997). This law applies to employers who provide subsidized parking for their employees and requires them to offer a cash allowance in lieu of a parking space.

Non-Infrastructure Transportation Interventions

Wayfinding

Depending on the quality and availability, some experts have suggested that active transportation can increase in association with wayfinding (signage). More importantly, wayfinding efforts should be incorporated into the best practices for encouragement and marketing efforts (VPTI, 2010). While there is limited evidence of the impact on pedestrian and bicycling levels of wayfinding as a singular strategy, the practice is growing (Pucher, Dill and Handy, 2010).

Marketing and Publicity

Marketing programs have been successful in increasing active transportation by 10 to 25% (VTPI, 2010). Impacts from marketing can be expected to decline over time and should be implemented after infrastructure changes have been made to maximize benefit (VPTI, 2010). Evaluations of trip reduction efforts in Portland, OR show increases in bicycling mode share following marketing efforts to encourage active commuting (City of Portland Office of Transportation, 2005).

Enforcement

Heightened enforcement has been found to be a contributing factor to increases in walking and bicycling safety (Pucher, 2003). In addition to traffic codes that favor and prioritize the most vulnerable road users, police are stricter in citing violations such as speeding that might put pedestrians at greater risk. Lower speeds are safer for pedestrians and cyclists: the mortality risk at 20 mph is 5% if hit by a motor vehicle, compared to 45% at 30 mph and 85% at 40 mph (United Kingdom Department of Transportation, 1997) Compared to engineering changes such as traffic calming, however, enforcement effect tend to have temporary impact (Transportation for America, 2009).

Safe Routes to School Programming and Education

Safe Routes to School is designed to promote walking and bicycling to school through education, encouragement, engineering, enforcement and evaluation strategies. There is strong evidence that this combination of programming increases physical activity among students. At schools with safe routes to school programming, parents report higher rates of active transportation to school in a wide variety of social and built environments (Boarnet, 2005) and these benefits appear to extend to adults in the community-at-large (Watson and Dannenberg, 2008). Safety education, including bicycle helmet promotion, within and outside of these programs has been shown to improve pedestrian and bicycling skills such as timing and choosing safe crossings (Killoran et al., 2006).

Employee Transit Incentive Programs

By definition, transit users are also pedestrians because buses and trains rarely offer door-to-door service. Without a car at the end of a transit trip, the probability of walking between two intermediary destinations is high. Providing incentive to use transit could in turn promote walking. Indeed, having an employer-sponsored transit pass has been shown to have a positive relationship with meeting physical activity recommendations (LaChapelle et. al., 2009).

Temporary Street Closures

Day long street closures to increase physical activity for pedestrians and bicyclists, commonly known as "open streets" or "play streets," are being implemented world-wide and more recently in the US (Pucher, Dill and Handy, 2010). Such programs have the potential not only to promote physical activity, but improve social cohesion (Holt, 2008).

Non-infrastructure projects have shown to increase walking and bicycling levels on their own. However, unless permanent infrastructure is established, the benefit of such efforts is temporary and may not promote long-term changes in physical activity once those incentives or regulations are gone (Dunton et. al., 2010). A mix of environmental, social and individual interventions are most effective for increasing public transportation use in order to reach individuals of varying readiness to change (Giles-Corti and Donovan, 2002).

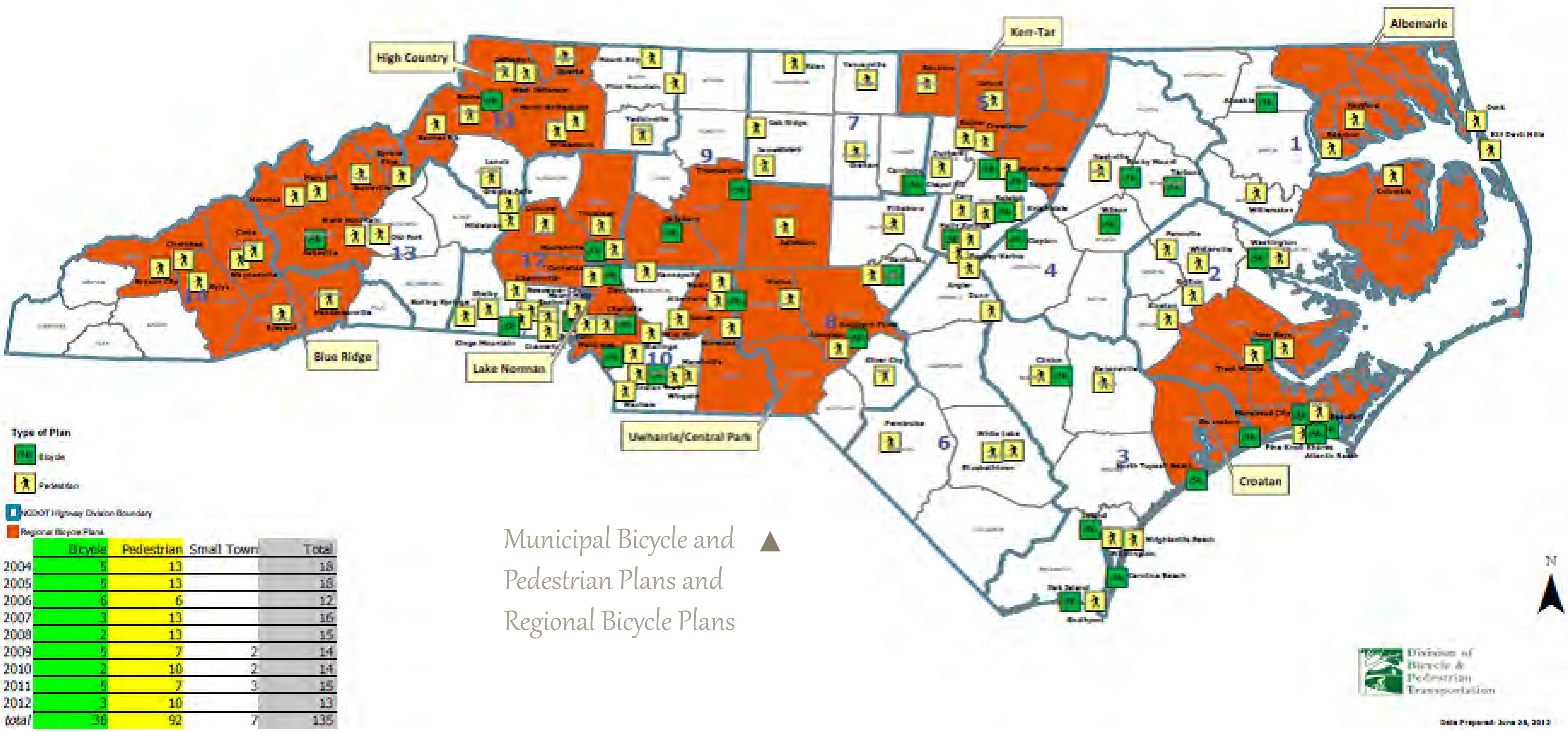
Health Impact Assessment

Health Impact Assessment (HIA) is a relatively new public health tool in the US. More prominent and routine in Europe, HIAs are used to analyze policies, plans, or projects to determine their public health effects. For an HIA to add value, it must be practical and conducted prior to (and inform) the final decision to approve a policy, plan or project (Improving Health in the US, 2011). An HIA may investigate how a policy or project may impact air quality, water quality, noise level, physical activity rates, injury and death rates, access to healthy foods and other potential health factors. HIA identifies the populations affected by a proposed project or policy and, through a six-step process, makes recommendations to key decision makers that are intended to mitigate harmful health effects and promote beneficial ones.

Within North Carolina, a handful of HIAs have been recently completed or are currently underway. Examples include:

- **Aberdeen Pedestrian Transportation Plan (APTP) HIA** - This HIA examined how changes to pedestrian infrastructure such as sidewalks and trails have the potential to increase physical activity rates in children, thereby reducing the risk of obesity. The study listed five major barriers to physical activity for Aberdeen children and identified recommendations for improving access and safe.

- **Haywood County Comprehensive Bicycle Plan HIA** – The Haywood HIA was the first ever conducted in North Carolina for a non-motorized transportation plan and was used to bring a new perspective to the planning process and gather input from non-traditional stakeholders. Planners conducted Rapid HIA and extensive document and data review, a half-day workshop with area health professionals and an assessment of the Bicycle Plan's recommendations (http://bicyclehaywoodnc.org/BikePlan.html).
- **Public Health and Neighborhood Design Standards HIA** - Based in the Town of Davidson, NC, Davidson Design for Life conducted this assessment of the 2011 Senate Bill 731 "Zoning/Design and Aesthetic Controls." The HIA considered the health impacts of this bill, which would limit a municipality's ability to maintain locally adopted design controls in residential areas. The bill was eventually passed by the NC General Assembly despite the HIA's findings. Davidson Design for Life is currently conducting two other related projects: Davidson Planning Ordinance HIA and the Charlotte Red Line Commuter Rail HIA. These projects are funded by a grant from the CDC (http://www.ci.davidson.nc.us/index.aspx?NID=732).
- **Blue Ridge Road Corridor HIA** – Located in Raleigh, NC, Blue Ridge Road connects many



	Bicycle	Pedestrian	Small Town	Total
2004	5	13		18
2005	5	13		18
2006	6	6		12
2007	3	13		16
2008	2	13		15
2009	5	7	2	14
2010	2	10	2	14
2011	5	7	3	15
2012	3	10		13
total	38	92	7	135

Municipal Bicycle and Pedestrian Plans and Regional Bicycle Plans ▲

destinations, including the art museum, fairground, hospital, residences, a greenway and government offices. Although the corridor records the state's highest pedestrian traffic counts, the availability of sidewalks and public transit is poor. The HIA will assess accident risks, lack of physical activity, air pollution and social disintegration to inform development decisions in the corridor. The HIA is being conducted by the UNC Gillings School of Global Public Health and the Department of City and Regional Planning; the Blue Cross Blue Shield of North Carolina Foundation is funding this project.

- **Charlotte LYNX Evaluation: The Effect of Light Rail Transit on Body Mass Index and Physical Activity** – While not an HIA per se, the study evaluated the health impact of the installation of the new LYNX light rail line on nearby residents. Researchers collected information from residents before and after the opening of the rail line to analyze changes in commute mode, body mass index (BMI) and physical activity rates. Residents who switched to using the light rail line weighed an average of six and a half pounds less than those who continued to drive to work. Light rail users were also 81% less likely to become obese over time due to walking to and from transit stops.

North Carolina Leading the Way

North Carolinians are fortunate to live in state that many national experts consider to be a model. For years, NC DHHS has been supporting local health departments to help improve community environments that can promote active transportation. For more than a decade, NC DHHS has done this through training, technical assistance and Eat Smart Move More (ESMM) grant opportunities for local communities. ESMM is a collaborative "statewide movement that promotes increased opportunities for healthy eating and physical activity wherever people live, learn, earn, play and pray." At the state level, ESMM partners released their 2012 Policy Strategy Platform, urging NCDOT to continue developing the Safe Routes to School program in North Carolina, continue to pursue federal funding, and to use this funding efficiently and effectively to encourage children to walk to school.

North Carolina's Department of Transportation was among the first in the nation to create a Division of Bicycle and Pedestrian Transportation (DBPT). In recent years, DBPT developed and implemented an innovation for NCDOT – its bicycle and pedestrian planning grant program. To date, the program has enabled more than 100 North Carolina communities to develop master plans for active transportation.

NCDOT's Complete Streets Policy and design guidelines have the potential to create safer environments for all users, including pedestrians, bicyclists and transit riders. The content of NCDOT's recently approved "Public Health Policy" can be found at the end of this appendix.

Health funders have also contributed to active transportation in the state. Prior to its sunset in 2011, the NC Health and Wellness Trust Fund created the Fit Community Designation and Grant program, which helped many communities develop multi-pronged approaches to improve active transportation. Similarly, Blue Cross Blue Shield of North Carolina Foundation has funded rural community initiatives through its Fit Together grant program. More recently, the Foundation has supported health impact assessment work as well as the health-related components of this document.

Case Studies: Communities Connecting Health and Transportation

Charlotte, NC – Public Transit and Health Impact

Despite Charlotte's past sprawling development, North

Charlotte's light rail line ▲

Carolina's light rail line has become a national model for success, outstripping ridership projections and inspiring millions of dollars in high-density development. Charlotte's successful light rail line presented a unique opportunity to study the impact of transit on physical activity and health. Much research exists that links transit-accessible neighborhoods with more people walking to transit. However, many of these studies are unable to adequately evaluate cause and effect. It may be that people select to live in urban, transit-accessible neighborhoods to fit their active lifestyles. A public health and planning research team examined the health effects of Charlotte's Lynx light rail line before and after the light rail arrived in 2007. They found that people commuting via the light rail reduced their Body Mass Index (BMI) by 1.18 points and were 81% less likely to become obese over time. Participants reported average weight loss equivalent to adding as much as 1.2 miles to a person's daily walking routine. Overall, the results suggest that improving neighborhood environments and increasing the public's use of light rail systems improve health outcomes for many North Carolinians.

Wilmington, NC – Ann Street Bike Boulevard

With the help of a Fit Community grant from the North Carolina Health and Wellness Trust Fund, the City of Wilmington constructed North Carolina's first bicycle boulevard in 2011. The project connects historic neighborhoods, schools, parks, major employers and activity centers with downtown Wilmington and the Riverfront Farmers' Market. A bicycle boulevard gives bicycles limited priority over motor vehicles on an existing roadway corridor. The bicycle boulevard required internal policy changes, as well as modest infrastructure components, such as curb extensions, alley resurfacing, high-visibility crosswalks, pavement markings and signage. The Ann Street Bicycle Boulevard is part of the River to the Sea Bikeway from downtown Wilmington to Wrightsville Beach, making the bicycle boulevard accessible to most of Wilmington's residents. The primary goal of the project was to increase the number of people bicycling to destinations along the routes and to improve

Ann Street Bike Boulevard in Wilmington ▲

access for city residents to purchase fresh local produce, seafood and meat at the Riverfront Farmers' Market. The City of Wilmington also installed machines capable of accepting electronic benefit cards (EBTs) for low-income residents who visit the Riverfront Farmers' Market. These combined efforts have created better access to healthy foods and a safe way to be physically active.

Durham, NC – Bull City Open Streets

In addition to high obesity rates, the UNC Highway Safety and Research Center found that per capita, the city of Durham suffers from more child pedestrian crashes than any community in North Carolina. In an effort to improve the situation, Bull City Open Streets was created to promote health, a sense of community and awareness of pedestrians and bicyclists. Started in 2010 by a coalition of local officials and community organizers, Bull City Open Streets events close selected Durham streets to traffic and allow people to have fun and be active in a safe environment. The first event drew over a 1,000 participants and closed a one-mile loop around the Durham Central Park area and downtown. Free activities and healthy snacks were provided by local organizations, and activities along the route included aerobics, yoga, dance and bicycle tune-ups. Bull City Open Streets was one of the first of its kind in North Carolina, but not the world. The Open Streets idea originated from Bogota, Colombia. Each Sunday, Bogota's "Cyclovia" prohibits automobiles from more than 70 miles of streets, freeing the pavement for walkers, runners and bicyclists. Bull City Open Streets hopes to continue Durham's version by hosting events beyond the downtown, bringing other Durham neighborhoods into the fun. In 2012, Durham was one of ten cities nationwide to be selected for funding open streets events by the Partnership for a Healthier America.

Walking School Bus in Pinehurst ▲

Moore and Montgomery County, NC – Working Across Communities for Safer Routes to School

"Pinehurst Walks!" began in 2008 as a movement to help Pinehurst kids be healthier by walking to school. Led by FirstHealth of the Carolinas, and funded as Fit Community grantee in 2008, the project improved the safety of routes to Pinehurst Elementary School by installing greenway trails and sidewalk infrastructure. Nearly 100 students walk every Wednesday on a greenway between a local park and the school as part of a Walking School Bus. The initiative has adopted a more regional policy approach to ensure that children in Moore and Montgomery counties can walk and bicycle safely as well. The organizers' goal is to ultimately connect existing sidewalks and greenway trails from neighborhoods with high percentages of children to child-centered locations (schools, parks, after-school programs) to encourage bicycle use and walkability. FirstHealth helped secure funding from the Robert Wood Johnson Foundation to prevent childhood obesity. They were also awarded Safe Routes to School funding from NCDOT. FirstHealth also directed a Health Impact Assessment (HIA) of the Town of Aberdeen's Pedestrian Master Plan, which they hope to use in future transportation planning.

Haywood County, NC – Health Impact Assessment: Haywood County Comprehensive Bike Plan

Bicycle Haywood NC, a local bicycle advocacy group, the Haywood County Recreation and Parks Department and Kostelec Planning conducted a health impact assessment (HIA) to determine the potential health outcomes of the Haywood County Comprehensive Bike Plan. This was the first HIA conducted and adopted in North Carolina associated with a comprehensive pedestrian or bicycle plan. The project added value and a new perspective to the planning process. It positions Haywood County as a health-focused community as it pursues funding and gathers support to implement the Bicycle Plan. The HIA focused on key health outcomes that are strongly linked to bicycle activity, including heart disease, cancer, obesity, Type II diabetes and asthma and air quality. Recommendations included locations for bicycle routes to support areas with poor health and a list of health-specific priorities for the county. Specific outcomes resulting from the HIA's recommendations include a new bicycle purchase grant for Haywood County Schools, discussions with Haywood Community College to locate a "park-n-pedal" lot in a nearby park to encourage active commutes to the campus, and the pursuit of implementation measures for the number one health priority identified in the plan.

Belmont, NC – Fostering a Culture of Connectedness

In many cities and towns in North Carolina, housing, shopping, recreation and jobs are spread farther apart as

An HIA was conducted in association with the Haywood County bike plan ▼

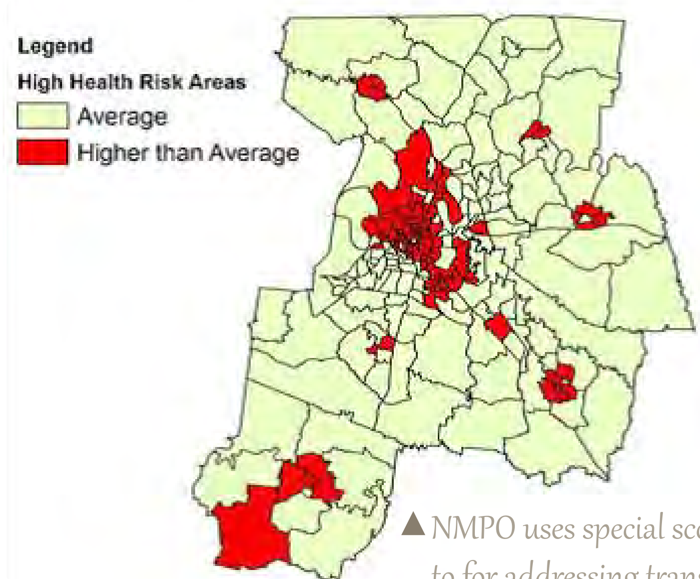
new development happens, leading to more time spent traveling by car. The City of Belmont has worked to reverse this trend. For the past 18 years, new developments in Belmont are required to comply with land codes/zoning that promotes connectivity and walkability. The requirements result in safer and more pleasant walking environments, including sidewalks, street trees, planting strips and houses built closer to the street. This type of development promotes people being more physically active and socially engaged as a community. More recently, Belmont has further focused on health by collaborating with the Gaston County Health Department to encourage active transportation and recreation corridors as public health priorities. With the benefit of an Eat Smart Move More grant, the city installed marked walking loops on the downtown area. They also contributed to a successful Safe Routes to School program at their elementary and middle schools. In 2011, Belmont started bridging this success to promote bicycling in town. They received a grant from NCDOT to

New developments in Belmont are required to comply with land codes/zoning that promote walkability.

develop a bicycle master plan that has already resulted in bicycle lanes as downtown streets are resurfaced. City officials recognize that it takes a multi-layered approach, working with government agencies, schools, businesses and neighborhoods, to create a healthy community that encourages walking and bicycling. It is no surprise that Belmont is attracting new residents and economic opportunities, thus continuing to grow a healthy and vibrant community.

Nashville, TN - Nashville Area MPO Active Transportation Funding Policy

Comprehensive transportation planning and infrastructure development has strong potential for broad impact which, in the Nashville, TN metropolitan area, includes nearly 1.5 million people. The Nashville Area Metropolitan Planning Organization (NMPO) strives to help make it safer and more convenient for people to walk, bike or take transit in and around Nashville. In 2012, the NMPO adopted a policy that dedicates funding for active transportation infrastructure and applies project scoring criteria prioritizing active transportation and health equity. NMPO developed a systematic approach to rating transportation proposals in a way that gives priority for the inclusion of active transportation and for addressing transportation issues in areas with significant health disparities. The NMPO also funds projects based on evidence-based strategies including active transportation, increasing access to and number of places for physical activity and urban design/policy and zoning to facilitate physical activity. Data from the MPO suggest that the policy has been effective by boosting the inclusion of active transportation components within funding proposals. In the most recent funding cycle for the



NMPO uses special scoring criteria to for addressing transportation in at-risk health areas

2035 Regional Transportation Plan, 75% of 420 roadway project proposals incorporated an active transportation component. The policy has also been effective at increasing capital projects for active transportation. In the first round of funding through the Active Transportation Program, the MPO funded eight active transportation proposals (out of ten submissions). While it is too soon to assess the policy's effect on infrastructure and transportation behaviors, the NMPO will measure those outcomes over time.

NCDOT's Board of Transportation – Public Health Policy (Approved October 4, 2012)

The mission of the North Carolina Department of Transportation is to connect people and places safely and efficiently, with accountability and environmental sensitivity to enhance the economy, health and well-being of North Carolina.
Our mission statement includes support of improved public health outcomes. The following policy statement further supports this mission.

Policy Statement

Transportation and public health research has demonstrated there is a link between the built environment and public health. Furthermore, public health may be affected by certain attributes of and risks inherent to the transportation system. Research tends to show that there is a strong connection between the built environment and public health outcomes, including rates of chronic disease, obesity, levels of physical activity, safety and general well-being; therefore, collaboratively planned land use and transportation can create opportunities for improved public health.

Inactivity among North Carolinians has contributed to higher rates of chronic diseases, lower levels of overall health and well-being, and therefore higher health care costs. Increased physical activity has been shown to improve health outcomes and decrease healthcare costs and the benefits of a healthier population include a more productive workforce, a more robust economy and a more globally competitive state.

The North Carolina Department of Transportation may have opportunities to support positive health outcomes by considering public health implications in our decision-making across all transportation modes, programs, policies, projects and services and through all stages of the life of a transportation project from planning to project development, construction, operations and maintenance. Specifically, we can consider:

- a multi-modal transportation system to provide access to and options for customers of all abilities and capabilities;

- the safety for all users and all modes of transportation; and

- the potential for the transportation system to support human health.

Employees are encouraged to develop transportation solutions that consider the health and well-being of North Carolina residents in conjunction with other mobility, fiscal, safety, social, economic and environmental factors.

Omaha, NE – Transforming into a Pedestrian and Bicycle Friendly Community

Residents of Omaha, Nebraska feel their city was built for the automobile. Until recently commuting by bicycle was nearly non-existent. Cyclists have had options on greenways along the city's creeks. But the primary East-West commuting corridors are notoriously challenging for active transportation due to high volume car and truck traffic. In 2005, the newly formed initiative "Activate Omaha" started small: raising awareness of active living through media and social marketing campaigns. From there, Activate Omaha helped organize the employer-based Bicycle Commuter Challenge, a fourteen week program encouraging employees to cycle to work. In the first year, 306 participants rode a combined 77,300 miles. Six years later, the number of bike commuters doubled with over 348,000 combined miles ridden. Activate Omaha now organizes Safe Routes to School initiatives in and around Omaha, helped develop the Omaha-Council Bluffs Metropolitan Bicycle Map and implemented a bicycle program for youth who have never owned bicycles. The growth in active transportation programs has coincided with health funders' support, greater acceptance by city leaders and infrastructure improvements. Financial backing from Alegent Health Systems and other funders helped established the city's first Bicycle/Pedestrian Coordinator position, Bicycle Pedestrian Advisory Committee and created a 20-mile signed bike route system throughout the downtown and nearby neighborhoods. Omaha's mayor and other city leaders now actively support healthier options to get people to where want to go. Activate Omaha, Douglas County Health Department, funders, city government and other partners are helping Omaha realize its vision of becoming a pedestrian and bicycle friendly city.

Commuter cycling has doubled over the last six years in Omaha, NE ▲

Health Impact Assessment Summary of Pedestrian Projects in Three North Carolina Communities

This section provides a summary of the *Technical Report: Quantitative Demonstration Health Impact Assessments in Three North Carolina Communities* that is found at the end of this appendix. For more information on the study, please see the full report starting on page 9.4-51.

A Health Impact Assessment for WalkBikeNC

- Health Impact Assessment (HIA) can be a powerful tool to help state and local decision makers assess the future value of transportation investments that can impact health.

- As part of *WalkBikeNC*, an HIA was conducted to estimate the health and financial impacts of pedestrian and bicycling infrastructure on individuals and communities in our state. Quantitative methods, such as those included in this HIA, enable health and transportation planners to determine the economic value of "active transportation" and for decision makers to consider such investments in a cost-benefit analysis framework.

What is Health Impact Assessment?

- HIA has been used widely in European countries, and more recently in U.S. cities, to better understand the long-term health impacts of proposed policies, plans and development decisions.

- The HIA process includes six consecutive stages: 1) Screening, 2) Scoping, 3) Assessment, 4) Recommendations, 5) Reporting, and 6) Monitoring and Evaluation.

What Health Benefits Can We Expect by Implementing the WalkBikeNC Plan?

- Physical inactivity is a key risk factor that is linked to overall mortality as well as diseases that affect millions of North Carolina residents, including coronary heart disease (CHD), diabetes, hypertension and stroke. The upside is that regular physical activity can be protective in preventing or delaying some of the state's most common health issues.

- Research shows a direct relationship between characteristics of the built environment and the level of active transportation and physical activity in a community. Even in small amounts, regular physical activity can decrease the risk for a wide range of diseases and premature death. Increasing levels of walking and bicycling for transportation reduces the risk of negative health outcomes.

Three NC Communities Chosen to Assess Different Experiences

- As part of WalkBikeNC, three North Carolina communities were chosen for demonstration HIAs: Sparta, Raleigh and Winterville. They were selected from many candidates because of their balance of geography, context and scale of their planned projects. Each demonstration HIA analyzed and compared impacts from building the recommended pedestrian projects to maintaining the status quo of no improvements.

- **Sparta**, a traditional "main street community" located in western North Carolina, completed a Downtown Streetscape Strategy in 2012. The plan calls for significant pedestrian improvements to downtown streets and intersections, such as better signage, pedestrian crossings, signals and streetscape enhancements (e.g., street lights, benches, planters). The Sparta HIA represents an assessment of a transportation corridor plan in a rural context.

- Located just outside **Raleigh's** beltline, the Blue Ridge Road

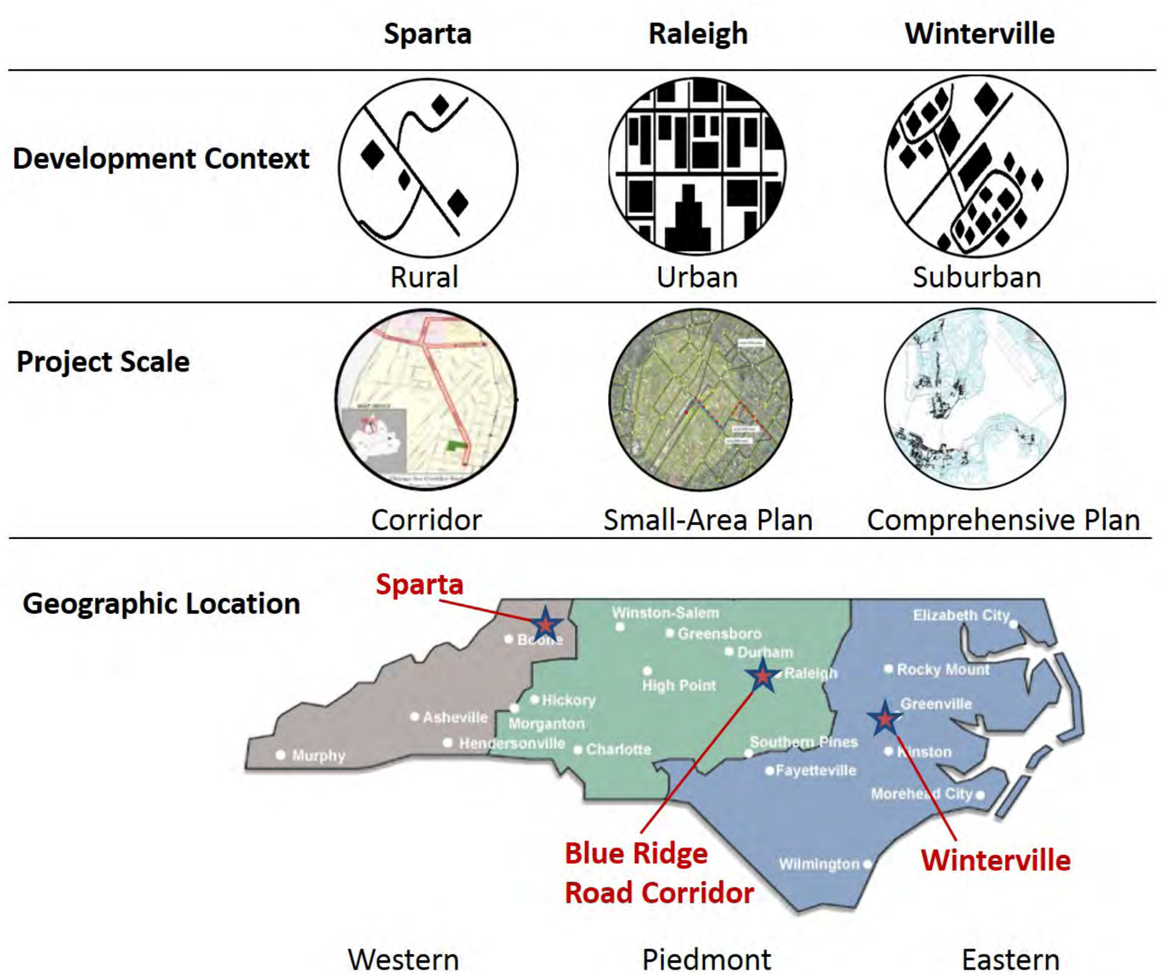
Corridor small-area plan is the result of an ambitious community visioning and planning effort. The small-area plan includes significant land-use changes, new sidewalks and streetscape improvements. The Raleigh HIA is an example of a small-area plan in an urban setting, situated in the Piedmont region of North Carolina.

- Winterville is a small community south of Greenville, North Carolina. In 2011, regional planners completed a Bicycle and Pedestrian Master Plan for the Greenville Metropolitan Area, which includes Winterville. The HIA analyzes the proposed construction of sidewalks within the Town of Winterville. This project represents a comprehensive plan within a suburban context in eastern North Carolina.

The Steps of HIA

1. **SCREENING**
   Determine whether an HIA is needed and likely to be useful.
2. **SCOPING**
   In consultation with stakeholders, develop a plan for the HIA, including the identification of potential health risks and benefits.
3. **ASSESSMENT**
   Describe the baseline health of affected communities and assess the potential impacts of the decision.
4. **RECOMMENDATIONS**
   Develop practical solutions that can be implemented within the political, economic or technical limitations of the project or policy being assessed.
5. **REPORTING**
   Disseminate the findings to decision makers, affected communities and other stakeholders.
6. **MONITORING AND EVALUATION**
   Monitor the changes in health or health risk factors and evaluate the efficacy of the measures that are implemented and the HIA process as a whole.

The HIA process encourages public input at each step.



Community Context: Stakeholders Identify Barriers to Active Transportation

- During the HIA scoping phase, stakeholders and residents in each community highlighted key challenges to walking and bicycling, which are grouped by theme and summarized below.
  - **Built and natural environments** are currently oriented to the automobile and sprawling land-use patterns make it difficult to walk or ride bicycles for transportation. In addition, the mountainous terrain and rural landscape in Sparta can make bicycling very difficult for routine travel.
  - **Transportation infrastructure** tends to lack continuous sidewalks and other safe pathways for walking and bicycling. Streetscapes often feel unsafe and uninviting for pedestrians and bicyclists.
  - **Demographics, culture and prevailing attitudes** also impact active transportation. High rates of poverty require many to walk out of necessity. As a result, walking is viewed as transportation of last resort, especially for the poor. Conversely, bicycling is often viewed as an "elitist" activity done primarily for recreation rather than a viable alternative to travel by motor vehicle.
  - **Transportation services** such as public transit, which have been shown to increase walking for transit users, were also considered to be insufficient in each community.

Pedestrian Enhancements Lead to More Walking and Improved Health

- The protective effects of walking for health are well established in the scientific literature. In all three communities, the HIAs predict that building sidewalks, greenways and making other improvements in pedestrian safety increase walking and lower the risk for CHD, diabetes, hypertension, stroke and early death.
- For Winterville and Raleigh, the HIA predicts an increased likelihood of people choosing walking trips over other means (7% and 11%, respectively) and improved sidewalk networks that will result in more time spent walking for transportation (43% and 47%, respectively).
- For Sparta, sidewalk quality, ease of street crossings, topography and local street connectivity are expected to result in a similar increase in time spent walking for transportation (43%) and an increase in weekly walking distances (0.57 miles/week).
- In each demonstration HIA community, five health outcomes were considered over a period of 50 years: 1) prevented mortality; 2) prevented cases of CHD; 3) prevented cases of diabetes; 4) prevented cases of hypertension; and 5) prevented cases of stroke. It is safe to assume that active transportation behavior would stay the same in the baseline scenario and would increase due to changes in the built environment after the sidewalks and other infrastructure are in place.
- The estimated number of illnesses prevented varies among the three HIA demonstration communities, but the cases of hypertension avoided are most significant in all three locations. The greatest increase in disease cases avoided would occur in the first 10 years after the pedestrian projects are completed. This suggests relatively rapid returns on investment

due to health care savings, higher quality of life and a healthier community overall.

We Can Expect Significant Health Care Savings from Pedestrian Enhancements

- While health outcomes are important in and of themselves, it is also valuable to estimate the economic value of improved health associated with investments in infrastructure for active transportation (i.e. pedestrian projects).

- For Sparta, detailed construction cost estimates enabled benefit-cost calculations. In Sparta, health care cost reductions are predicted to exceed $10 million within 20 years of construction and increase to more than $15 million at 40 years. Given a typical project lifespan of 20 to 40 years, health care savings associated with implementation of the Downtown Sparta Streetscape Strategy will exceed its costs. Every dollar spent on construction would generate a savings of 19 to 22 dollars in health care costs.

- For Raleigh and Winterville, rough cost estimates were developed using unit costs for sidewalk construction. In Winterville, reduced mortality and lower incidence of CHD, diabetes, hypertension and stroke are expected to reach nearly $9 million 20 years after construction and will exceed $12 million within 40 years – resulting in a savings of 1.1 dollars in health care casts per dollar spent 40 years post-construction. In Raleigh, health care cost reductions are predicted to eclipse $25 million within 20 years of construction and will rise to nearly $36 million at 40 years. Each dollar spent on construction would yield 6 to 9 dollars of health care cost savings.

Recommendations for Demonstration Communities, NC DOT and Other Critical Partners

- The WalkBikeNC HIA includes several important recommendations that can improve health and positively impact the economies in Sparta, Winterville and Raleigh. The HIA also suggests NCDOT actions that can support WalkBikeNC recommendations identified by other methods. Finally, partner agencies and other stakeholders play key roles in improving data systems and strategies to help measure the health potential of active transportation in North Carolina.

Demonstration Community Recommendations

- Build out sidewalk networks in Winterville as proposed in the Greenville Bicycle and Pedestrian Master Plan. In addition, invest in programs and promotional strategies to address stigmas and negative perceptions of those who engage in active transportation.

- In Raleigh, ensure all new and reconstructed roads in the Blue Ridge Road Corridor are built with sidewalks on both sides of the street.

- Complete the pedestrian improvements in the Sparta Downtown Streetscape Strategy.

- In each of these communities, coordinate with local and regional institutions (e.g. Metropolitan and Rural Planning Organizations, health departments) to include active transportation-related questions in future local surveys.

Health Impact Assessment Predicted Impacts Following Pedestrian Project Completion

	Raleigh	Winterville	Sparta
Sidewalk Length	+388%	+360%	N/A
Walking for Transportation (150+ min per week)	+7.1%	+2.3%	+1.4%
No Walking for Transportation	-2.5%	-0.9%	-8.8%
Health Care Dollars Saved at 20 Years	$25.6 million	$9 million	$13 million
Benefit-to-Cost Ratio at 20 Years	6:1	0.8:1	19:1

Source: Mansfield and McDonald (2013)

▲

Results of the quantitative health impact assessment (HIA) conducted as part of this planning process. See page 9.4-51 for full report and analysis.

- In each of these communities, coordinate with partners to explore traditional and non-traditional funding options for pedestrian projects, including local, state, regional, private and non-profit resources.

HIA Recommendations Aligned with *WalkBikeNC*

- **Mobility** - Expand community-oriented pedestrian facilities. Provide pedestrian and bicycle access to transit.

- **Safety** - Create a strategic, consistent and connected pedestrian and bicycle network.

- **Public Health** - Increase active living environments. Increase the safety, connectivity and accessibility of the bicycle and pedestrian network.

- **Economic Competitiveness** - Increase attractiveness and quality of life through walkable and bikeable communities. Measure return on investment of active transportation investments. Use return on investment analyses to inform transportation decision making.

Recommendations for Research, Data Systems and Future HIA Efforts

- Improve the data infrastructure for sidewalk and bicycle networks as well as more refined prevalence data for cancer, CHD, diabetes, hypertension and stroke.

- Measure active travel in units relevant to future epidemiological studies (e.g., minutes of physical activity rather than mode choice, number of trips, reductions in vehicle miles travelled).

- Regularly include active transportation questions in the NC Behavioral Risk Factor Surveillance System.

- Continue to develop local communities' capacity to conduct HIA by providing training and resources. Adapt and advance HIA methods to inform decision making on health and economic impacts of proposed policies, plans and development.

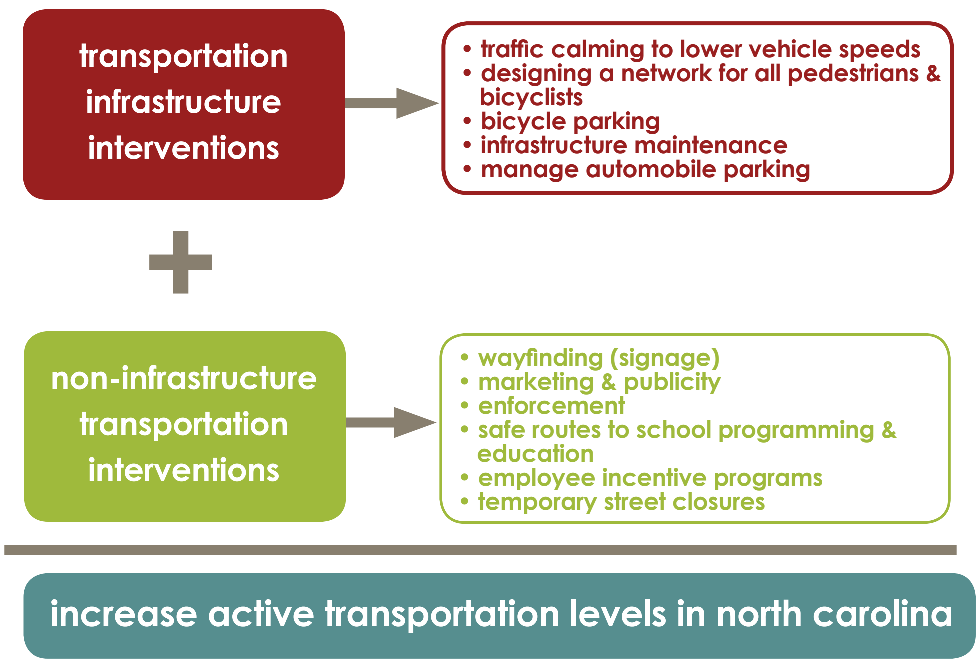
The full HIA Technical Report can be found on page 9.4-51.

Recommendation Steps

To improve health among North Carolina's adults and children, it will be vital to use a multi-pronged approach, including making physical activity options, like active transportation, more accessible for all residents. Many of these recommendations to improve health overlap with other pillars of the state plan.

Proposed Performance Measures for Health Impact

Refer to pages 9.4.42- 9.4.44



	Issue	Direction	Actions
1	*Many citizens and non-traditional community leaders are typically left out of local transportation planning processes.*	*Improve community engagement of non-traditional groups into local transportation planning, i.e. low-income, people of color, older adults, youth, people with disabilities.*	*• NCDOT reach out to other organizations, including non-profits, to identify appropriate ways to boost resident engagement in transportation planning. • NCDOT contract with groups under to engage and build DOT's capacity to achieve resident engagement targets (e.g. Chicago's DOT contracting with Active Transportation Alliance). • Update NCDOT planning guides and/or checklists during planning processes (e.g. CTPs) to prioritize inclusion of low-income, people of color, older adults, youth, people with disabilities. • NCDOT notify statewide and regional organization, including non-profits, as routine transportation planning efforts.*
2	*Walking and bicycling are not necessarily viewed as desirable forms of transportation among some population groups or cultures in North Carolina.*	*Encourage walking and bicycling with culturally-specific approaches and messages.*	*• NCDOT and/or NC DHHS conduct targeted social media, advertisements, marketing campaigns and/or other promotional efforts to increase active transportation. • NCDOT and/or NC DHHS work with non-traditional organizations, e.g. El Pueblo, NAACP, NC Alliance of Disability Advocates, to identify the most effective and appropriate messages to encourage increased active transportation among low-income, people of color, youth, older adults, people with disabilities. • NCDOT and/or NC DHHS develop a focused outreach approach to increase bicycling among woman and girls.*
3	*Pedestrians, bicyclists, transit riders and wheelchair users have limited identity as important user groups and influence in transportation planning and project prioritization.*	*Build a more robust, organized and engaged constituency for active transportation in North Carolina.*	*• Convene an annual pedestrian summit with broad engagement of non-traditional groups and organizations. • Continue to convene an annual bicycle summit; expand to include broader engagement of non-traditional groups and organizations. • Establish user on-line and other networks to educate non-traditional groups and organizations about transportation issues and opportunities.*
4	*Local health officials and other health advocates are either sporadically involved in transportation planning or not at all.*	*Institutionalize health officials, professionals and advocates into transportation planning processes.*	*• NC DHHS reach out to local health directors and boards of health to communicate the importance of participation in local/regional transportation planning. • NC DHHS and NCDOT develop educational and informational materials for local health departments and boards of health regarding transportation planning and implementation. • NC DHHS identify and implement incentives for local health officials to collaborate on transportation planning efforts.*

	Issue	Direction	Actions
5	*Many community leaders, elected officials and boards/ commissions are unaware of the potential health, economic and other benefits of active transportation.*	*Provide consistent and actionable information, tools, and other products and approaches to better inform community leaders about the health potential of active transportation.*	*• NC DHHS and NCDOT develop educational materials for local leaders, elected officials and boards/commissions regarding the benefits of active transportation and informational materials on transportation planning and implementation.* *• NCDOT work through state councils and organizations to reinforce (to local leaders and officials) the importance of health considerations in local planning, e.g. NC League of Municipalities, NC Association of County Commissioners.*
6	*Local public health professionals and advocates do not typically promote safe and active transportation.*	*Integrate better education and encouragement approaches to reinforce and complement built environmental/capital improvements.*	*• NC DHHS provide materials and reach out to local health departments through training and technical assistance to promote active transportation as significant public health goal.* *• NCDOT coordinate with NC DHHS and other agencies to develop materials and other methods to encourage active transportation.*
7	*"Health and well-being" are currently part of NCDOT's mission statement, yet health-related data are not typically considered in transportation planning or project performance.*	*Incorporate practical measures/indicators for transportation planning to prioritize healthy design and for performance to evaluate positive health-related outcomes.*	*• NC DHHS, including the NC State Center for Health Statistics, prepare health data sets and reports that can be used in transportation planning, implementation and performance evaluation.* *• NCDOT continue to convene meetings with NC DHHS and other partners to develop the most relevant and practical indicators for* *• NCDOT and NC DHHS identify and implement the collection of new indicators for ongoing surveillance, such as children walking to school, active commuters, etc.* *• NCDOT set targets and incorporate performance standards, such as mode shift, VMT, women bicycling.*
8	*North Carolina lacks routinely collected data on built environments that impact active transportation.*	*Develop systems and methods to routinely collect built environment data for pedestrian and bicycle facilities on state roads.*	*• NCDOT explore options for utilizing data from existing internal sources, i.e. standard data collected on all state road segments could include presence of sidewalk, bike lane or wide shoulder.* *• NCDOT collaborate with other agencies and provide a data interface/"upload" option for locally obtained data on state roads within municipalities, e.g. sidewalks, bike lanes or wide shoulders.* *• Provide funding, resources and tools for local communities to collect longitudinal data (i.e. measuring the economic and health impacts) before and after pedestrian*

	Issue	Direction	Actions
9	*Roadway planning and construction processes do not explicitly or routinely prioritize health or health equity.*	*Prioritize transportation planning and projects in communities and locations that are more likely to benefit vulnerable groups, i.e. low-income, people of color, older adults, youth, people with disabilities.*	*• Develop criteria that can be easily and objectively rated to indicate transportation projects that are likely to serve low-income, people of color, youth, older adults, and people with disabilities. • Include health/equity criteria in project prioritization.*
10	*Motor vehicle and design speeds are too high in many locations for the safety of pedestrians and bicyclists.*	*Lower vehicle speeds in areas that are likely to have pedestrians and bicyclists, particularly in locations known to be hazardous.*	*• Implement public awareness campaigns such as "Watch For Me NC." • Increase use of real-time speed counters in communities. • Increase the use of traffic calming measures in areas with high active transportation use and latent demand. • Conduct a review of and update NCDOT's design speed standards. • NCDOT identify and implement specific goals and design standards to control speeds, e.g. "20 is Plenty" for residential areas.*
11	*Motor vehicles are often in conflict with pedestrians and bicyclists. Pedestrian right of way laws typically go unenforced.*	*Increase public awareness of walking and bicycling laws regarding right-of-way.*	*• Increase enforcement efforts of vehicles for pedestrian right of way • Enhance driver's education curriculum and testing to broaden the content regarding pedestrians and bicyclists. Shift to a model of "mobility education" that includes instruction and appreciation for all modes. • Increase funding, at the local and state level, for pedestrian*
12	*Schools are typically not involved in pedestrian and bicycle encouragement programs for students or transportation infrastructure planning.*	*Increase Safe Routes to School programs and school officials' participation in transportation planning.*	*• Continue and expand the current Safe Routes to School Program • NCDOT collaborate with NC DPI to incorporate more local school officials into transportation planning efforts • Provide small grants and other incentives to schools and community organizations who implement pedestrian and bicycle programs for children to/from school. • Partnership with state law enforcement (and/or DMV) and schools (DPI) to develop PE/safety education – how to be a pedestrian/cyclist*
13	*North Carolina's current transportation system prioritizes motor vehicles. In some case, motor vehicles are prioritized to the exclusion of active transportation modes.*	*Invest in the transportation infrastructure to improve access, connectivity, convenience and safety.*	*• Increase state funding for pedestrian and bicycle transportation infrastructure projects, such sidewalks, bike lanes • NCDOT promote the eligibility of Powell Bill funds to be used by municipalities for roadway pedestrian and bicycle projects. • NCDOT create more separated ped-bike paths and greenways. DOT explore easing the barriers to approval and implementation of separated pathways, e.g. utility easements (sewer, electric), DENR water quality conflicts, railroad abandonment*

	Issue	Direction	Actions
14	*Current land use patterns decrease feasible options for active transportation.*	*DOT and other state agencies create an incentives structure to improve land use to reduce distances between important destinations*	*• NCDOT provides increased access to funding – places that receive their money, part or all, for local communities and regions that are bringing destinations together and health equity • Encourage all local comprehensive plans to include a health component that includes mixed-use development, higher density and accommodations for active transportation.*
15	*Rural and unincorporated areas rarely provide pedestrian (as well as bicycle) infrastructure.*	*Increase pedestrian infrastructure, e.g. sidewalks/crossings, in unincorporated areas where actual and latent demand exist, i.e. activity centers, trip generators.*	*• Revise NCDOT Policy to include building and maintenance of sidewalks outside municipalities.*
16	*Many North Carolinians live close enough and could walk, ride, or take transit to work but are not supported by their employers.*	*Work with employers to encourage and support active commuting.*	*• NCDOT, NC DHHS and/or partner organizations provide materials, best practices and incentives for employers to promote active commuting.*
17	*North Carolina residents represent a range of user types requiring different accommodations for active transportation.*	*Support the development of active transportation networks in communities that accommodate all users.*	*• Continue the NCDOT Pedestrian and Bicycle Planning Grant Program, which requires communities to specify accommodations for all users during planning.*
18	*Most destinations prioritize motor vehicle parking over other modes.*	*Increase access to bicycle parking and transit stop accommodations. Limit motor vehicle parking accommodations.*	*• NCDOT work with local governments to encourage the establishment of commercial site design standards with bicycle parking and transit stops (where appropriate).*

Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	Requires new data collection program
INPUT				
Percentage of proposed projects that include active transportation component compared to those that do not. (e.g. Nashville Area MPO)	*Increase in percentage of projects*			
OUTPUT				
Proportion of elementary schools with a Safe Routes to School program	*Increase in number of programs*			
Percentage of active transportation projects near census tracts that have a higher than average rate of poverty, minority populations, and zero car households. (e.g. Nashville Area MPO)	*Increase percentage of projects.*			
Percentage of active transportation projects within 2 miles of a school. (e.g. Nashville Area MPO)	*Increase percentage of projects.*			
Percentage of active transportation projects within 1 mile of a full-service grocery store. (e.g. Nashville Area MPO)	*Increase percentage of projects.*			

Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	Requires new data collection program
Ratio sidewalks to roads on state roads (within municipalities)	*Increase in ratio*			
Ratio bicycle lanes/trails to roads on state roads (within municipalities) – modified from Performance Indicators for Transport (the World Bank, 2004)	*Increase in ratio*			
Percentage of signalized intersections with pedestrian crossing signals on state roads (within municipalities)	*Increase in ratio*			
OUTCOME				
Percent of person trips/passenger miles travelled by cycling/ walking - Health Indicators of sustainable cities in the Context of the Rio+20 UN Conference on Sustainable Development	*Increase in percentage*			
Private bicycle ownership (% of households). - Performance Indicators for Transport (the World Bank, 2004)	*Increase in percentage*			
Vehicle Miles Travelled	*Decrease or zero growth*			
Transportation mode shift (Percent of person trips/passenger miles travelled by cycling/walking - Health Indicators of sustainable cities in the Context of the Rio+20 UN Conference on Sustainable Development)	*Shift from automobiles to active modes (Increase in percentage of active trips)*			
Percentage of North Carolinians reporting walking for leisure (BRFSS)	*Increase in rates*			
Percentage of North Carolinians reporting bicycle for leisure (BRFSS)	*Increase in rates*			
Percentage of elementary school children who walk or bicycle to school at least one day per week.	*Increase in rates*			
Physical inactivity rates (BRFSS)	*Reduction in rates*			

Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	Requires new data collection program
Obesity and diabetes rates (BRFSS)	*Reduction in rates*			
Number of asthma-related emergency room visits	*Reduction in asthma-related emergency room visits*			
Number of emergency room visits from bicycle and pedestrian crashed	*Reduction in bicycle and pedestrian-related emergency room visits*			
Pedestrian and bicyclist deaths as a proportion of total traffic mortality; and pedestrian and bicyclist deaths/1000 miles of pedestrian/bicycle travel - Health Indicators of sustainable cities in the Context of the Rio+20 UN Conference on Sustainable Development	*Decrease in proportion*			

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TECHNICAL REPORT: QUANTITATIVE DEMONSTRATION HEALTH IMPACT ASSESSMENTS IN THREE NORTH CAROLINA COMMUNITIES

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In 2012-2013, the North Carolina Department of Transportation updated its Statewide Bicycle and Pedestrian Master Plan, known as *WalkBikeNC*. The plan contains five "pillars" that relate to bicycling and pedestrian transportation: mobility, safety, health, economy and environment. As part of the Health component of *WalkBikeNC*, this report summarizes the projected health impacts following pedestrian and bicycle project implementation in three North Carolina communities.

Health Impact Assessment (HIA) is a powerful tool for communicating to decision-makers the value of investments that support improved health outcomes. However, HIA practice in the United States often relies heavily on qualitative methods that may have limited relevance to decision-making processes, particularly in sectors that have developed highly technical decision-making practices, such as transportation.[1] Further, transportation agencies are facing pressure from funding scarcity and federal policy directives, including the recently re-authorized federal transportation funding bill, MAP-21, to demonstrate the value of transportation investments.[2,3] Quantitative HIA methods provide a means for placing an economic value on health impacts, allowing transportation agencies to demonstrate the value of transportation investments that support an active lifestyle and enabling decision-makers to consider such investments in a cost-benefit analysis framework.[4] To demonstrate the ability of HIA to quantitatively estimate the health impacts of active transportation[a] infrastructure, including construction of new sidewalks, streetscape improvements, and improved pedestrian crossings, we conduct three HIAs on pedestrian improvements throughout North Carolina focusing on state-of-the-art quantitative modeling methods.

The HIA process includes six consecutive stages: 1) Screening; 2) Scoping; 3) Assessment, 4) Recommendations, 5) Reporting; and 6) Monitoring and Evaluation. During the Screening stage, the HIA is broadly defined and it is determined whether or not the HIA is likely to succeed and add value. Scoping includes data collection, stakeholder outreach, and preliminary research to outline and establish goals for the HIA. Health impacts relative to baseline conditions are estimated during the Assessment stage, and the results are translated into useful units and disseminated during the Recommendations and Reporting stages. Monitoring and Evaluation includes an objective assessment of the quality of the HIA performed, the efficacy of the HIA in influencing future decisions, and outcome assessment once the project has been completed and health impacts are observable in the population.[5] We complete the first four stages of this process in this HIA and prospectively discuss reporting, monitoring, and evaluation. Our principle aim is to apply quantitative methods to estimate the health impacts, and related economic implications, of investments in pedestrian amenities in three North Carolina communities.

Screening

As part of the overall Health component of WalkBikeNC, a Health Advisory Team was formed to help establish goals and provide guidance for the HIA demonstration component of the plan. The Health Advisory Team was co-

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[a] Active transportation includes walking and biking for transportation, and walking or biking to/from public transit

led by staff members at Active Living By Design and the Department of Environmental Sciences and Engineering at the Gillings School of Global Public Health at UNC-CH. A full list of team members and affiliations appears in Appendix 1 of this report.

The Health Advisory Team met three times to provide guidance to researchers at UNC-CH. The principal aim of the project – to demonstrate quantitative HIA methods applied to active transportation infrastructure improvements in a variety of contexts throughout North Carolina – was defined during the initial meeting. After developing a list of candidate projects to undergo demonstration HIAs, the Health Advisory Team helped develop several selection criteria to screen projects and develop a final list of three projects. We chose projects so that three development contexts would be represented (urban, suburban, and rural), three project scales would be represented (comprehensive plan, small area plan, project/corridor) and the three geographic regions of North Carolina would be represented (eastern, piedmont, and western). Additionally, we only selected projects for which the results of the HIA could help inform a future decision, such as the allocation of funding for project construction. Based on these criteria, we selected the Blue Ridge Road project in Raleigh, NC; projects from the Greenville Metropolitan Planning Organization (MPO) Bicycle and Pedestrian Master Plan in Winterville, NC; and the second phase of the Downtown Streetscape Strategy in Sparta, NC (see Table 1).

The Health Advisory Team also discussed potential modeling tools that could be applied to conduct a quantitative HIA. Three models were considered: the Health Economic Assessment Tool (HEAT) for Walking and Cycling, developed by the World Health Organization,[6] the Dynamic Modeling for HIA (DYNAMO-HIA) model, developed by the National Institute for Public Health and the Environment in the Netherlands,[7] and the Prevention Impacts Simulation Model (PRISM), developed with the support of the Centers for Disease Control and Prevention (CDC).[8] After discussing the advantages and disadvantages of each modeling tool, we selected the DYNAMO-HIA model due in large part to the power and flexibility of the modeling framework, which are described in detail in the Methods section. Table 2 compares the advantages and disadvantages of these three modeling tools.

Table 1. HIA Demonstration Projects

		Development Context		
		Rural	Suburban	Urban
Planning Scale	Corridor	Sparta Downtown Streetscape Strategy		
Planning Scale	Small Area			Blue Ridge Road Neighborhood (Raleigh)
Planning Scale	Comprehensive		Greenville Bicycle and Pedestrian Master Plan (Winterville)	

Geographic Context
- Eastern North Carolina (blue)
- Piedmont (orange)
- Western North Carolina (green)

Table 2. Comparison of HIA Tools

Model	Advantages	Disadvantages
HEAT	• *Minimal data needs* • *Epidemiological evidence built-in* • *User-friendly*	• *Stationary* • *Rigid model structure*
DYNAMO-HIA	• *Dynamic* • *Flexible* • *Modular*	• *Significant data needs* • *Requires disease prevalence & incidence* • *Epidemiological evidence not built-in* • *Difficult to use*
PRISM	• *Dynamic* • *Minimal data needs* • *Epidemiological evidence built-in* • *User-friendly*	• *Model structure not customizable* • *Cannot specify new risk factors or interventions not included in base model* • *Difficult to focus specifically on built environment interventions*

Greenville MPO Bicycle and Pedestrian Master Plan, Winterville, NC

Winterville is a suburban community located just south of Greenville, NC. In 2011, the Greenville MPO completed a Bicycle and Pedestrian Master Plan for the Greenville Metropolitan Area, which includes Winterville. We conducted an HIA on the complete build-out of the pedestrian elements of the plan in Winterville compared to the baseline, status quo scenario. The plan includes the construction of new sidewalks as well as the construction of bicycle facilities, which are not assessed (Figure 1). This project is in the suburban context, at the comprehensive plan scale, and in the eastern portion of the state.

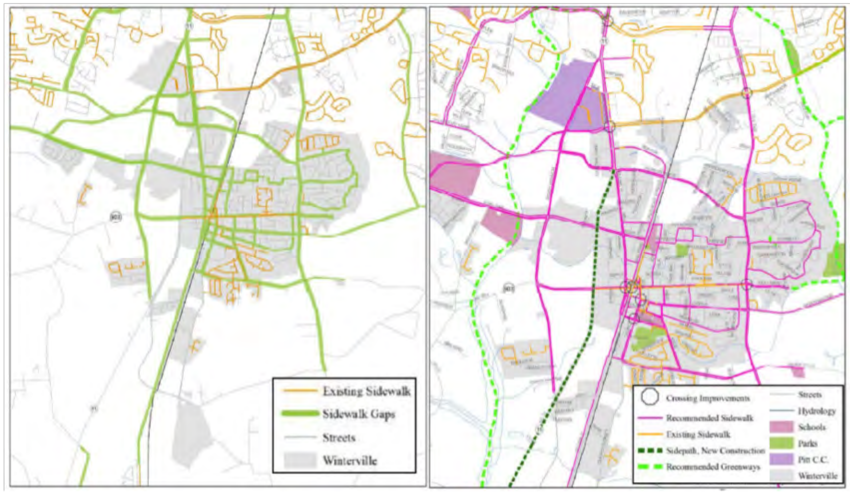

Figure 1. Winterville existing pedestrian facilities (left) and proposed improvements (right)

Blue Ridge Road Project, Raleigh, NC

Situated just outside the beltline in Raleigh, NC, the Blue Ridge Road project is the result of an ambitious community visioning and planning effort. Blue Ridge Road is a key transportation link in a small-area plan that envisions an urban future for the Blue Ridge corridor. We conducted an HIA comparing the built-out vision of Blue Ridge Road as envisioned in the small-area plan to the status quo scenario (i.e., current conditions). The small area plan includes significant land-use change, construction of new sidewalks, and streetscape improvements (Figure 2). The BRRC project is classified as an urban project at the small-area plan scale in the Piedmont region of North Carolina.

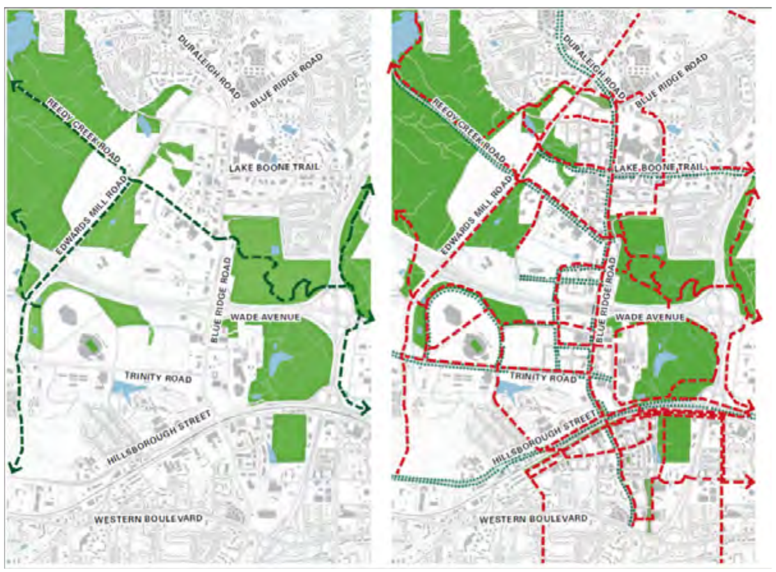

Figure 2. BRRC existing open space and trails (left) and proposed open space, trails, and improved sidewalks (right)

Downtown Streetscape Master Plan, Sparta, NC

Sparta, NC, is a traditional "main street community" located in western North Carolina. The town of Sparta recently completed a Downtown Streetscape Strategy in 2012, including significant pedestrian improvements to downtown. We conducted an HIA on the implementation of the plan and compared the results to the status quo scenario. The project contains streetscape and street crossing improvements along Main Street, which runs through downtown Sparta, as well as complementary improvements to several side streets (Figure 3). This project is in the rural context, at the corridor scale, and is located in western North Carolina.

Figure 3. Sparta proposed downtown streetscape improvements

Our three demonstration HIAs share a common decision point: the implementation of one or more projects as articulated in a planning document. Thus, the results of our HIAs may be used to inform project prioritization processes at the local and state levels. We intend for the results of our HIAs to be used by local decision makers in each community – not only do we demonstrate quantitative methods in conducting HIAs, but we also demonstrate how quantitative health impacts may help inform decision-making processes and enable the consideration of the health impacts in allocating funds for transportation infrastructure in the state of North Carolina. While we selected three demonstration projects to demonstrate the value and validity of quantitative HIA methods across different contexts, caution should be exercised in generalizing the findings of this HIA to other cities and towns in North Carolina.

Scoping

We divided the scoping phase into two primary stages: 1) meetings with local decision-makers in each community to identify existing health concerns and barriers to active transportation behaviors; and 2) screening and selection of appropriate diseases for inclusion in our model.

Community Meeting Summary: Winterville

On December 10th, 2012, we hosted a project meeting in the Town of Winterville offices to identify health disparities and local contextual factors. Three common themes emerged: 1) Underlying socio-demographic characteristics and cultural norms that influence health outcomes; 2) inadequacies in physical infrastructure that present barriers to active transportation; and 3) land use patterns that present barriers to active transportation. The importance of correctly framing active transportation as a normative rather than elitist behavior was also mentioned several times – that is, the perception of cycling as an elite activity may be a barrier for new cyclists whereas the perception of walking as the opposite may also be a barrier. Key health barriers organized by broad topic areas are summarized in Table 3; a full meeting summary and list of participants is provided in Appendix 2 of this report.

Table 3. Winterville Community Meeting Key Issues

Issue Area	Identified Barriers
Built Environment and Land Use	• Non-walkable development scales • Car-oriented development • Segregated land uses • Lack of services and employment within Winterville proper • School siting
Transportation Infrastructure	• Lack of sidewalks • Poor sidewalk connectivity between developments • Road widening projects undertaken without supplementary improvements such as the addition of sidewalks and bike lanes • Barriers presented by the highway and rail line that bisect Winterville • Aesthetic quality of many streetscapes, including NC 11
Demographic and Cultural Factors	• High rates of poverty • High prevalence of risk factors (smoking, alcohol consumption, etc.)
Services	• Lack of public transit service • Poor access to facilities that offer affordable healthcare
Social and/ or economic conditions	• Stigmatized perception of walking and biking for transportation • Poor awareness of the rules of the road by drivers, cyclists, and pedestrians in multi-modal situations
Natural Environment	• Noise and air pollution due to NC Highway 11

Focusing specifically on physical inactivity, participants noted that lack of physical activity is a risk factor for a range of health outcomes including overweight/obesity, heart disease, and mental health. Specific populations susceptible to physical inactivity were identified primarily based on geography rather than socio-demographic characteristics; that is, the workshop participants felt that neighborhood quality was more important than individual characteristics in explaining the propensity to use physically active transportation modes.

Community Meeting Summary: Sparta

On December 18th, 2012, we hosted a project meeting in the Sparta Town Hall to identify health concerns in the community. Three central themes emerged during our discussions: 1) barriers to active transportation related to poor pedestrian safety (both real and perceived); 2) inadequacies in physical infrastructure that present barriers to active transportation; and 3) health disparities associated with high prevalence of poverty and a high number of seasonal workers. Participants also suggested framing active transportation as an issue of personal choice: expanding infrastructure that is supportive of active transportation expands personal choice and gives individuals new opportunities to choose to be active as part of their daily routine. Key issues are summarized in Table 4; a full summary and list of participants is provided in Appendix 2 of this report.

Table 4. Sparta Community Meeting Key Issues

Issue Area	Identified Barriers
Built Environment and Land Use	• Incomplete sidewalk network • Heavy traffic along key routes • Segregated land uses • Rural school siting
Transportation Infrastructure	• Lack of sidewalks • Width and quality of existing sidewalks (e.g., electric poles in the middle of sidewalks) • Lack of passing zones (to pass cyclists) on rural roads • Wide lanes throughout Sparta that encourage high travel speeds • Downtown aesthetics not conducive to walking
Demographic and Cultural Factors	• High rates of poverty • Older population • High proportion of population without health insurance • Cultural bias towards the car due in part to Sparta's rural setting • Poor nutrition/access to healthy foods • Cultural norms that support tobacco use
Services	• Lack of public transit service • Fragmentation of government services downtown - services were historically housed in a single building and residents would park once in downtown and walk to other destinations; now services are offered in different buildings and residents are more likely to drive to each building
Social and/ or economic conditions	• Stigmatization of walking for transportation • Large percentage of the population on fixed incomes • Large number of seasonal workers
Natural Environment	• Extreme elevation changes in the community make cycling very difficult; largely a recreational activity • Lack of programmed open space (e.g., sports fields, playgrounds, etc.)

Focusing specifically on physical inactivity as a determinant of health, participants identified the lack of safe opportunities to cross the street, high traffic speed, and traffic signaling that is unsafe for pedestrians (e.g., right turn green arrows and protected right turn lanes) as primary barriers to increased walking due to negative effects (real and perceived) on pedestrian safety. Participants also identified several sub-populations that may be impacted by targeted improvements, including students who are unable to walk to school due to gaps in the sidewalk network, seasonal workers who do not have a car and must walk to work since there is no public transit, and carless households that also must rely on walking as a primary mode of transportation.

Scoping Summary: Blue Ridge Road Corridor (BRRC)

Five facilitated focus group interviews were previously completed for the BRRC to gather public input regarding health disparities in the community.[12] Specifically, the focus groups were structured around on three general topics:

1. What elements of the BRRC neighborhood and environment, as it currently exists, do stakeholders identify as a concern to public health?
2. What health effects, both positive and negative, can be identified in the BRRC that might be affected through planning, design, and change to infrastructure?
3. How can existing plans or conceptual designs for the BRRC address specific health concerns?

Key issues raised by stakeholders in focus group discussions are summarized in Table 5. Major themes that emerged during focus group discussions included the lack of sidewalks and crosswalks posing a threat to public health, the perception of the BRRC as a dangerous place due to the threat of injury, the lack of convenient public transit, the environment of BRRC being stressful, and the large gaps that exist between destinations along the corridor limiting pedestrian and bicycle travel. Stakeholders specifically defined stress and safety from injury as an important public health impact related to the current design of the BRRC. Focus group discussions were structured to also give participants an opportunity to identify preferred design changes for addressing health concerns in the BRRC. The top seven design changes for the corridor were: 1) Make BRRC more aesthetically pleasing; 2) Ensure that sidewalks and crosswalks are built on the majority of roads; 3) Build more things to walk to (e.g., coffee shops, restaurants, etc.); 4) Build bike lanes and install bike racks; 5) Improve connections to and between modes of public transit; 6) Provide educational opportunities; and 7) Improve publicity (e.g., better mapping, signage, etc.) A number of these design interventions are linked directly to walkability – and active transportation infrastructure is addressed as a specific design intervention for improving public health in the BRRC area.

Table 5. BRRC Focus Groups Key Issues

Issue Area	Identified Barriers
Built Environment and Land Use	• Lack of adequate sidewalks in the BRRC area • Lack of adequate crosswalks in the BRRC area • Large gaps between pedestrian destinations
Transportation Infrastructure	• Lack of adequate sidewalks in the BRRC area • Lack of adequate crosswalks in the BRRC area • Intersections and roads designed primarily for private automobiles • Lack of an efficient roadway network • Lack of clear trail indicators (e.g., wayfinding signs, maps, etc.) • Not all pedestrian facilities open at night
Demographic and Cultural Factors	• Presence of drunk/distracted drivers
Services	• Lack of public transit service • Poor connections to and in between public transit services
Social and/or economic conditions	• No barriers identified
Natural Environment	• No barriers identified

Assessment: Methods

We use the DYNAMO-HIA model to estimate the health impacts of active transportation improvements in the three study areas. DYNAMO-HIA is a powerful, flexible, and dynamic health impacts modeling tool developed by the National Institute for Public Health and the Environment in the Netherlands. To our knowledge, DYNAMO-HIA has not been used in the United States nor has it been applied to a transportation infrastructure project to date; thus, our analysis offers an innovative and unique approach to estimating the health outcomes of active transportation infrastructure. The DYNAMO-HIA modeling framework enables users to combine epidemiological evidence, public health and demographic data, and transportation behavior information to predict age- and sex-specific health outcomes over time. This state of the art model is a significant methodological advancement compared to common HIA practice in the United States today. Specifically, DYNAMO-HIA uses a Markov Chain modeling approach in which the population is divided into a number of baseline health states at the beginning of the simulation and transitions between health states (healthy, diseased, or deceased) are modeled as the population ages through time. Transitions between states are characterized by epidemiological evidence, baseline disease data, and risk factor exposures. The model moves forward through time in 1-year time increments, maintaining population data between time periods. In a sense, the model divides the population into 95 male and 95 female one-year age cohorts and tracks each cohort through time. Previous applications of the DYNAMO-HIA model have predicted the health impacts of smoking cessation in Great Britain and changes in alcohol consumption in Sweden.[13] Outside of the health sector, Markov Chain approaches have been applied to model a wide range of phenomena, stock prices, asset price volatility, and political transitions from authoritarian to democratic regimes.[14-16] Thus, while our modeling approach is unique, a significant body of work exists documenting the ability of Markov Chain approaches to model conceptually similar dynamic processes in the public health field and in other sectors.

Model Development

DYNAMO-HIA provides a great deal of flexibility to the user. While the model contains a predefined structure, the user is free to add layers of detail to the model in a modular fashion. In particular, the user is free to select any number of diseases they wish to include in the model and to select and characterize a single risk factor. We base our DYNAMO-HIA model on a conceptual model in which active transportation infrastructure increases active transportation behavior, and thereby increases physical activity levels in the population, which in turn has an effect on the prevalence of disease and mortality from all causes. This conceptual model is supported by research in transportation behavior that establishes a relationship between built environment characteristics and active transportation behavior and research indicating that physical activity, even at low to moderate intensity and for relatively short durations, has significant implications for a wide range of diseases as well as for all-cause mortality.[17-21] Thus, we selected physical inactivity as the risk factor in our model.

In selecting diseases to include in our model, we reviewed epidemiological evidence to ensure that included diseases are linked to walking for transportation. While recent research has established connections between a wide range of diseases and physical activity, the intensity of physical activity plays a critical role in characterizing this relationship for certain health outcomes. For certain diseases, both moderate and vigorous physical activity reduce disease risk; however, epidemiological studies suggest that the risk of some diseases is attenuated only by vigorous physical activity. Given the typically moderate physical activity levels accrued during active transportation, we focused our attention on diseases with a proven epidemiological link to moderate physical activity.[22] Initially, this process resulted in the identification of seven diseases: 1) Breast Cancer; 2) Chronic Pulmonary Obstructive Disorder (COPD); 3) Colon Cancer; 4) Coronary Heart Disease (CHD); 5) Diabetes; 6) Hypertension; and 7) Stroke. However, this initial list required further screening prior to inclusion in the DYNAMO-HIA model. Diseases were first screened based on the availability of baseline prevalence data at an appropriate geographic scale (the county, if available, or multi-county regions if county data were unavailable) and subsequently screened based on peer-reviewed epidemiological studies linking moderate transportation physical activity to disease risk. After this multi-stage screening process, four diseases were selected for final inclusion in the DYNAMO-HIA model: 1) CHD; 2) Diabetes; 3) Hypertension; and 4) Stroke. Breast and Colon Cancer were not included due to data limitations at the county level while COPD was not included due to a lack of epidemiological studies linking transportation-derived physical activity to health outcomes. The combination of these diseases address many stakeholder concerns identified during the Scoping phase. However, we were unable to consider obesity explicitly in our model due to a lack of detailed epidemiological evidence linking non-vigorous and transportation physical activity to obesity outcomes.

The final choice left in constructing our DYNAMO-HIA model was the characterization of the physical activity risk factor. A comprehensive review of epidemiological studies was used to determine the strength of the relationship between non-vigorous physical activity and health outcomes as well as the manner in which non-vigorous physical activity was measured. Epidemiological studies link physical activity to various health outcomes using relative risks (RR), which is the risk of developing a certain health outcome when exposed to a risk factor divided by the risk of developing the same health outcome when not exposed to the risk factor. Mathematically, a relative risk is defined as:

$$RR = \frac{p_{event\ when\ exposed}}{p_{event\ when\ not\ exposed}}$$

In the context of physical activity, increasing levels of walking for transportation reduces the risk of negative health outcomes. Thus, RR values are less than 1 and lower RR values represent a more powerful relationship between transportation physical activity and the health outcome. Values for RR are typically defined at different levels of transportation physical activity; thus, RR is a function of the level of physical activity as well as the specific health outcome. Disease-specific studies consider physical activity from transportation as a distinct independent variable and classify activity using the same categories (0 minutes per week; 1-149 minutes per week, or 150 or more minutes per week) and provide relative risks for males and females.[18-20] Thus, we characterize the physical activity risk factor as a categorical variable with the same categories as are used in the epidemiological studies reviewed. For all-cause mortality, a recent meta-analysis was identified that provides a continuous dose-response model for transportation physical activity.[21] From these data, we derived RR values for all-cause mortality for each defined risk factor class by calculating the RR value at the mid-point of the middle category (75 minutes per week) and the low point of the higher category (150 minutes per week). These data are not disaggregated by sex. When studies provided several models controlling for various confounding variables, we select the least adjusted RR values because our model does not address typical confounders such as smoking and education. These data are summarized in Table 6 and our final DYNAMO-HIA model is presented schematically in Figure 4.

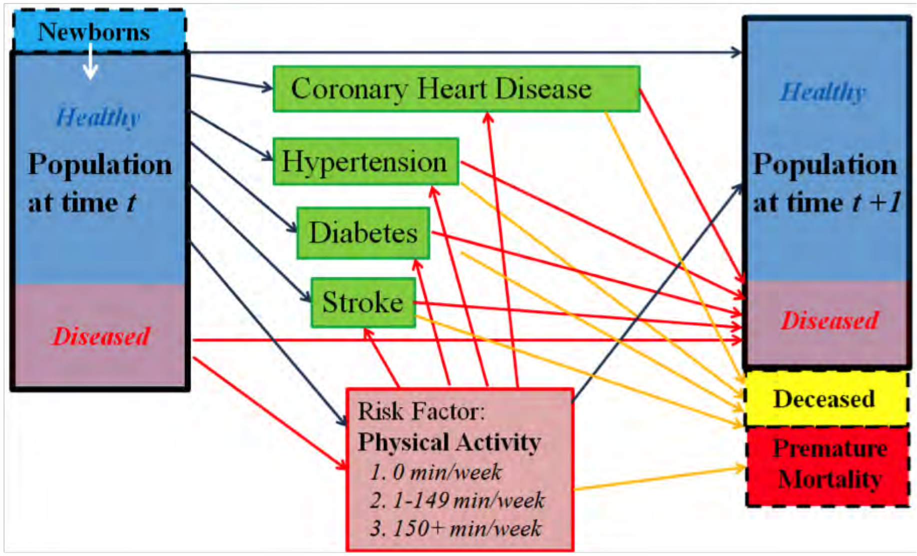

Figure 4. Model Schematic, representing simulation of one time step

Table 6. Summary of Epidemiological Studies Used to Relate Physical Activity to Health Risk

Disease	Study	Sex	Relative Risk of Health Outcome: No PA	Relative Risk of Health Outcome: 1-149 min/wk	Relative Risk of Health Outcome: 150+ min/wk	Model Controls
CHD	Hu et al. 2007	Male	1	**0.88**	**0.80**	Age, study year
		Female	1	**0.89**	**0.64**	
Diabetes	Furie and Desai 2012	Combined	1	**0.77**	**0.69**	Race, education, income, smoking
Hypertension	Furie and Desai 2012	Combined	1	**0.76**	**0.69**	Race, education, income, smoking
Stroke	Hu et al. 2005	Male	1	**0.86**	**0.82**	Age, study year
		Female	1	**0.83**	**0.80**	
Mortality, all-cause	Woodcock et al. 2010	Combined	1	**0.926**	**0.898**	n/a; meta-analysis

RRs for each risk factor category reported for all-cause mortality relative to reference category

Baseline Data: Population

We collected baseline demographic and health data for each study area from the North Carolina State Center for Health Statistics (NCSCHS). All data were collected for the year 2009 because the 2009 Behavioral Risk Factor Surveillance System (BRFSS) survey contained an additional question regarding active transportation behavior in 2009. Population data, stratified by age and sex at the county level, were taken from NCSCHS population estimates.[23] The age distribution of these data within census age groups were then applied to 2009 census data for specific block groups for each study area to refine these data and provide age- and sex-specific populations for each study area. To estimate newborns, the 2009 county birthrate and male to female ratio, both taken from the NCSCHS Vital Statistics records, was assumed to remain constant throughout the study period.[24] Newborns for each year were estimated to equal population size times the birthrate, growing the base population yearly by the natural population growth rate, also reported in the NCSCHS Vital Statistics data. This process is documented in greater detail in Appendix 3 of this report.

Baseline Data: Disease Prevalence

We use a method similar to the one applied to population data to refine disease prevalence into smaller age categories. Four questions from the 2009 BRFSS survey, each corresponding to a different disease, were used to develop population disease prevalence estimates.[25] Questions and corresponding disease are listed in Table 7. In the 2009 BRFSS public data, county-level data for all diseases are reported split into two age groups (18-44 and 45+) whereas regional data are reported split into six age groups (18-24, 25-34, 35-44, 45-54, 55-64 and 65+). We assume that the observed distribution for the five-age group data at the regional level underlies the reported two-age group data at the county level. Thus, we use the five-age range distribution to estimate county-level disease prevalence in the same five age groups by adjusting regional-level values using county-level population estimates and observed prevalence values. We then estimate age-specific prevalence functions for each disease using a fitted second-order numerical function. We then use these continuous disease prevalence functions to estimate prevalence for each 1-year age group used in DYNAMO-HIA (i.e., 1, 2, 3, etc.) This process is described in Appendix 3 of this report.

Table 7. 2009 BRFSS Survey Questions Used

Question	Wording	Data
9.2[a]	*Has a doctor, nurse, or other health professional ever told you that you had angina or coronary heart disease?*	*CHD Prevalence*
6.1[a]	*Have you ever been told by a doctor that you have diabetes?*	*Diabetes Prevalence*
7.1[a]	*Have you ever been told by a doctor, nurse, or other health professional that you have high blood pressure?*	*Hypertension Prevalence*
9.3[a]	*Has a doctor, nurse, or other health professional ever told you that you had a stroke?*	*Stroke Prevalence*
16.1[b]	*In the past week, how much time did you walk or bicycle for transportation, such as to and from work or shopping?*	*Baseline PA from Transportation*

[a]CDC core section question [b]North Carolina added question

Baseline Data: Disease Incidence

The 2009 BRFSS survey data report disease prevalence – the percentage of the population with a given disease at a given time – but do not report disease incidence – the rate of new disease cases in the population over time.[5] However, the DYNAMO-HIA model requires both prevalence and incidence for each disease included. We estimate disease incidence using a method developed by Ralph Brinks, a researcher at Institute for Biometry and Epidemiology in Düsseldorf, Germany.[26] Conceptually, we use age-specific prevalence data, combined with age-specific mortality estimates for individuals with and without the disease, to estimate the rate at which individuals of different ages must develop the disease for the prevalence data to be realized as observed in the 2009 BRFSS survey. This method is described in Appendix 3.

Baseline Data: Walking for Transportation

For the Winterville and Sparta study areas, we obtained baseline active transportation behavior from the 2009 BRFSS, in which the state of North Carolina included a supplementary question regarding active transportation. These data are available at the county level; however, they are not stratified by gender or age. Thus, we assume that active transportation behavior prevalence is constant across all ages and for both genders. For the Blue Ridge Road study area, we used a survey conducted in 2010 based on the International Physical Activity Questionnaire (IPAQ), a validated survey that has been used in a wide range of physical activity studies.[12,27] For both active transportation behavior data sources, we assume that the distribution of minutes of activity per week is constantly distributed within each time category in each survey and that half of all BRFSS respondents who report more than 2 hours of active transportation per week are engaged in active transportation less than 2.5 hours per week and half are engaged in active transportation more than 2.5 hours per week. We use these data to estimate the prevalence of each risk factor category (0 minutes per week, 1-149 minutes per week, or more than 150 minutes per week) in our model.

Baseline Data: Winterville

Baseline data for the Winterville study area are summarized below. Figure 5 shows the 2009 population distribution by age and sex. In total, the study area has a population of 9,269 residents, of which 4,944 are female and 4,320 are male. The study area contains a relatively large number of residents above age 30; however, there are relatively few residents in the 15-30 age range.

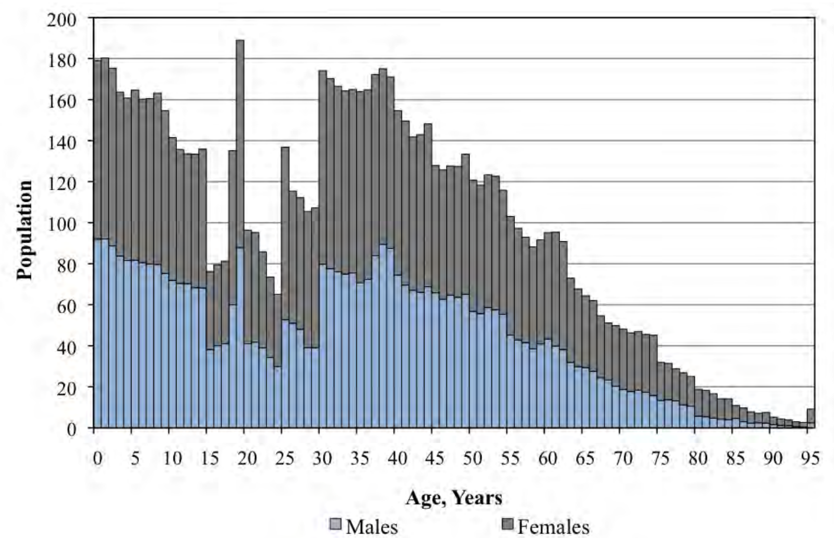

Figure 5. Winterville 2009 Population Distribution by Age

Baseline disease prevalence and estimated incidence by age for CHD, Diabetes, Hypertension, and Stroke for the Winterville study area are summarized in Figure 6. Observed prevalence data are plotted with black crosses and a fitted age-specific prevalence function is plotted with a solid black line. Estimated incidence data are plotted with red crosses and a fitted red line. Data are shown for ages 18-75 only.

Baseline active transportation behavior for the Winterville study area, taken from the 2009 BRFSS survey is presented in Table 8, in both raw form and aggregated based on our physical activity risk factor classifications.

Table 8. Baseline Walking for Transportation, Winterville

2009 BRFSS Survey Results		Grouped Based on Risk Factor Categories	
Min. Transportation PA per Week	Percentage of Population	Min. Transportation PA per Week	Percentage of Population
0	84.3%	0	84.3%
1-29	3.4%	1-149	12.3%
30-59	2.5%	1-149	12.3%
60-119	2.9%	1-149	12.3%
120+	6.9%	150+	3.4%

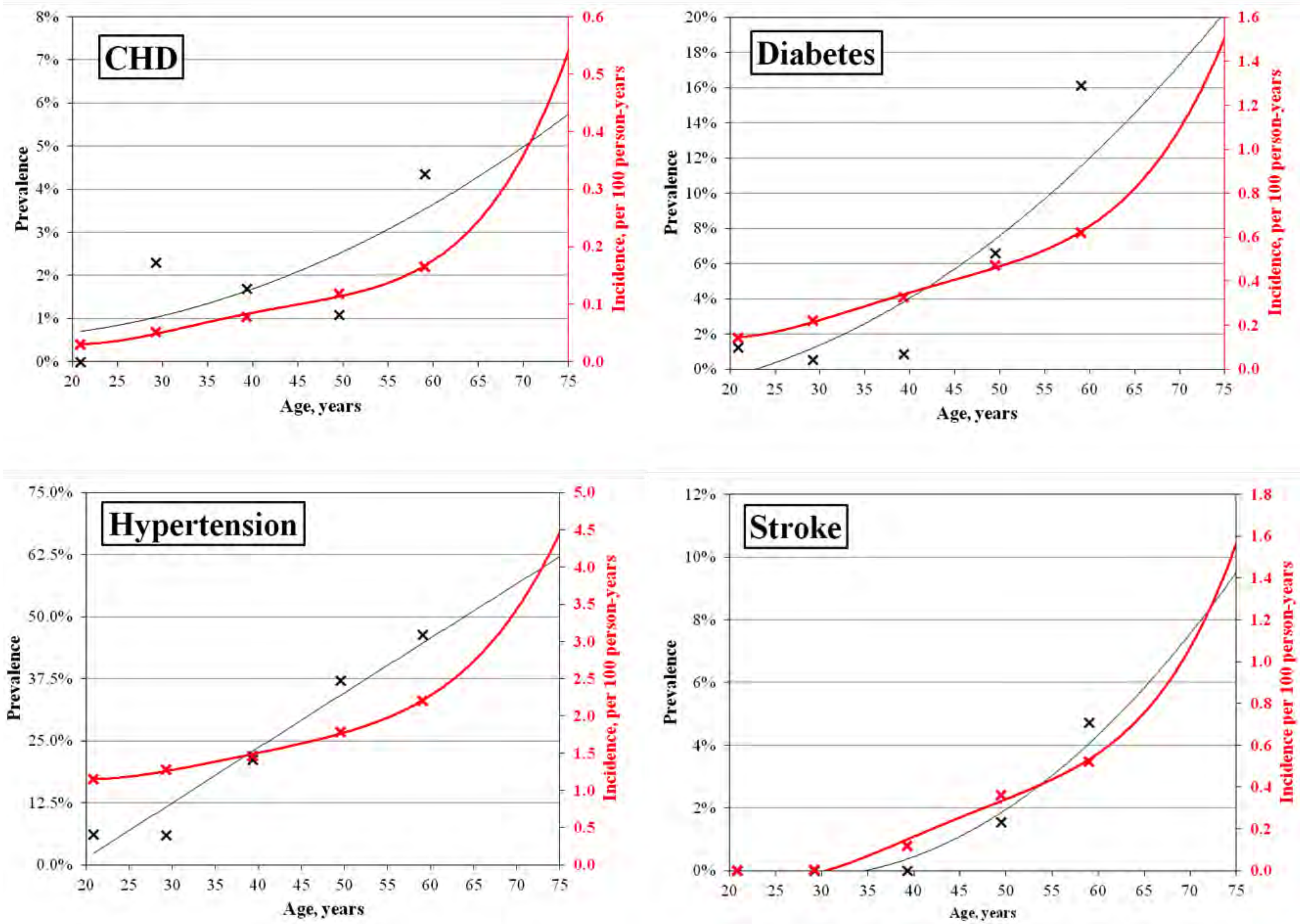

Figure 6. Winterville 2009 Disease Prevalence and Incidence, by Age

Baseline Data: Blue Ridge Road

Baseline data for the BRRC study area are summarized below. Figure 7 shows the 2009 population distribution by age and sex. In sum, the study area contains 10,929 residents, of which 6,056 are female and 4,873 are male. The study area contains a relatively large number of residents between the ages of 18 and 24, especially females in this age group, partially due to its proximity to Meredith College. Baseline disease prevalence and estimated incidence by age for CHD, Diabetes, Hypertension, and Stroke for the BRRC study area are summarized in Figure 8.

Baseline active transportation behavior for the BRRC study area is summarized Table 9, in both raw form and aggregated based on our physical activity risk factor classifications.[12]

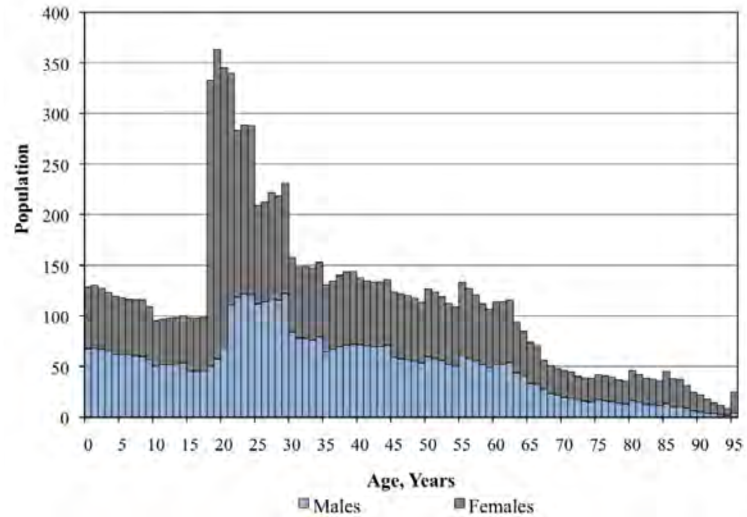

Figure 7. BRRC 2009 Population Distribution by Age

Table 9. Baseline Walking for Transportation, BRRC

BRRC Survey Results		Grouped Based on Risk Factor Categories	
Min. Transportation PA per Week	Percentage of Population	Min. Transportation PA per Week	Percentage of Population
0	40.7%	0	40.7%
1-60	23.3%	1-149	40.8%
61-120	14.5%	1-149	40.8%
121-140	2.1%	1-149	40.8%
141-160	1.8%	1-149	40.8%
161+	17.6%	150+	18.5%

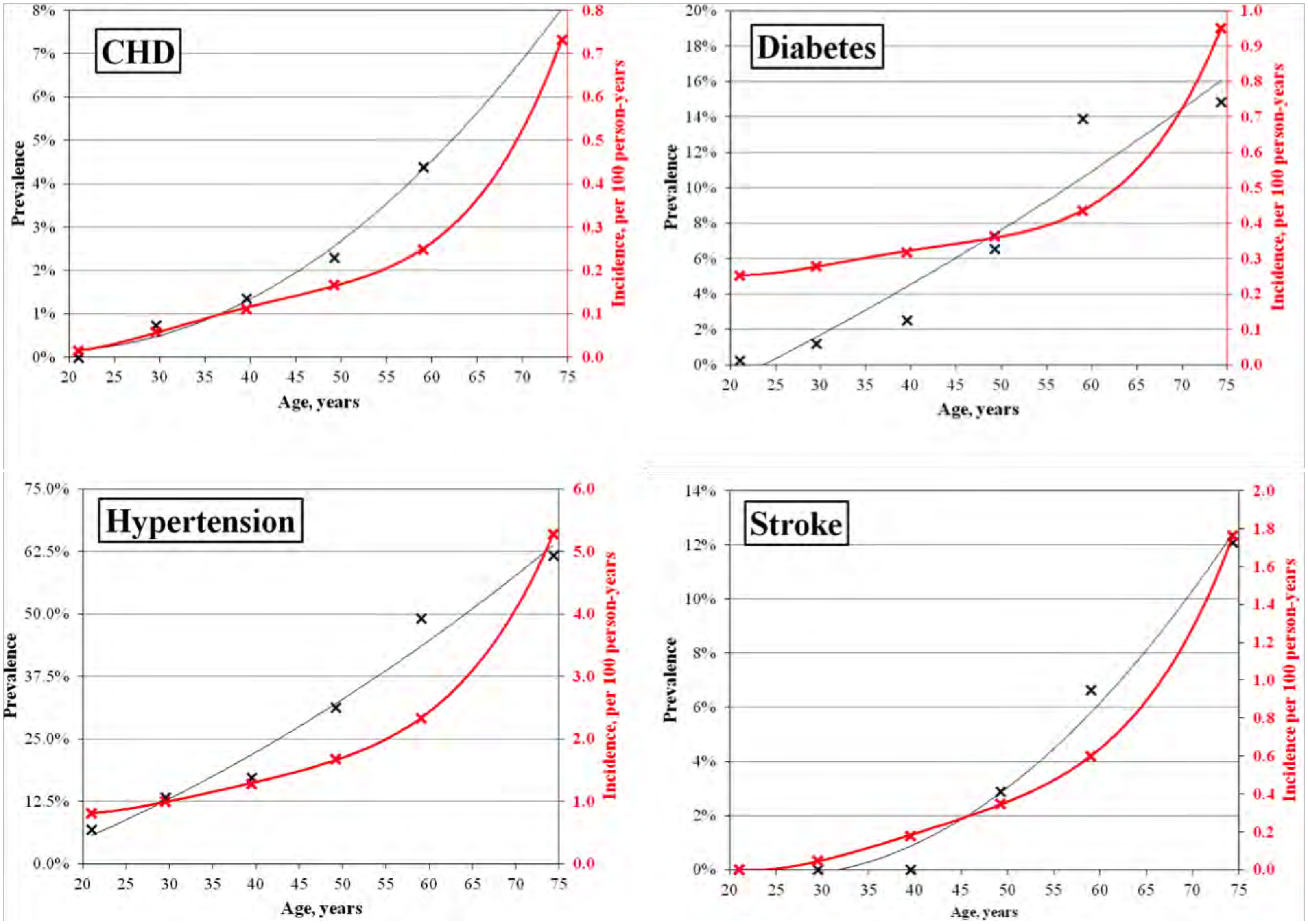

Figure 8. BRRC 2009 Disease Prevalence and Incidence, by Age

Baseline Data: Sparta

Baseline data for the Sparta study area are summarized below. Figure 9 shows the 2009 population distribution by age and sex. The study area contains a total of 1,770 residents. The study area contains a more equal distribution of males to females than Winterville and the BRRC, with 882 female residents and 888 male residents. Sparta is also relatively older than both other study areas, with population distributed fairly evenly up to 75 years of age. Baseline disease prevalence and estimated incidence by age for CHD, Diabetes, Hypertension, and Stroke for the Sparta study area are summarized in Figure 10.

Baseline active transportation behavior for the Sparta study area, taken from the 2009 BRFSS survey is presented in Table 10, in both raw form and aggregated based on our physical activity risk factor classifications.

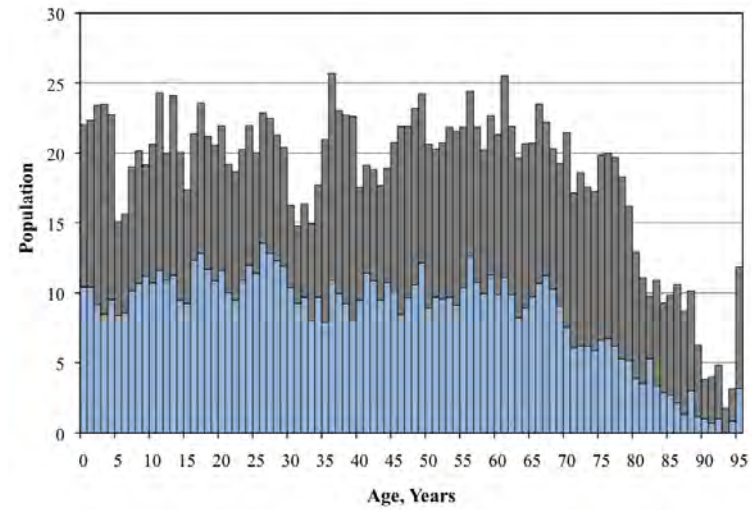

Figure 9. Sparta 2009 Population Distribution by Age

Table 10. Baseline Walking for Transportation, Sparta

2009 BRFSS Survey Results		Grouped Based on Risk Factor Categories	
Min. Transportation PA per Week	Percentage of Population	Min. Transportation PA per Week	Percentage of Population
0	83.8%	0	83.8%
1-29	4.4%	1-149	13.5%
30-59	3.3%	1-149	13.5%
60-119	3.0%	1-149	13.5%
120+	5.5%	150+	2.8%

9.4

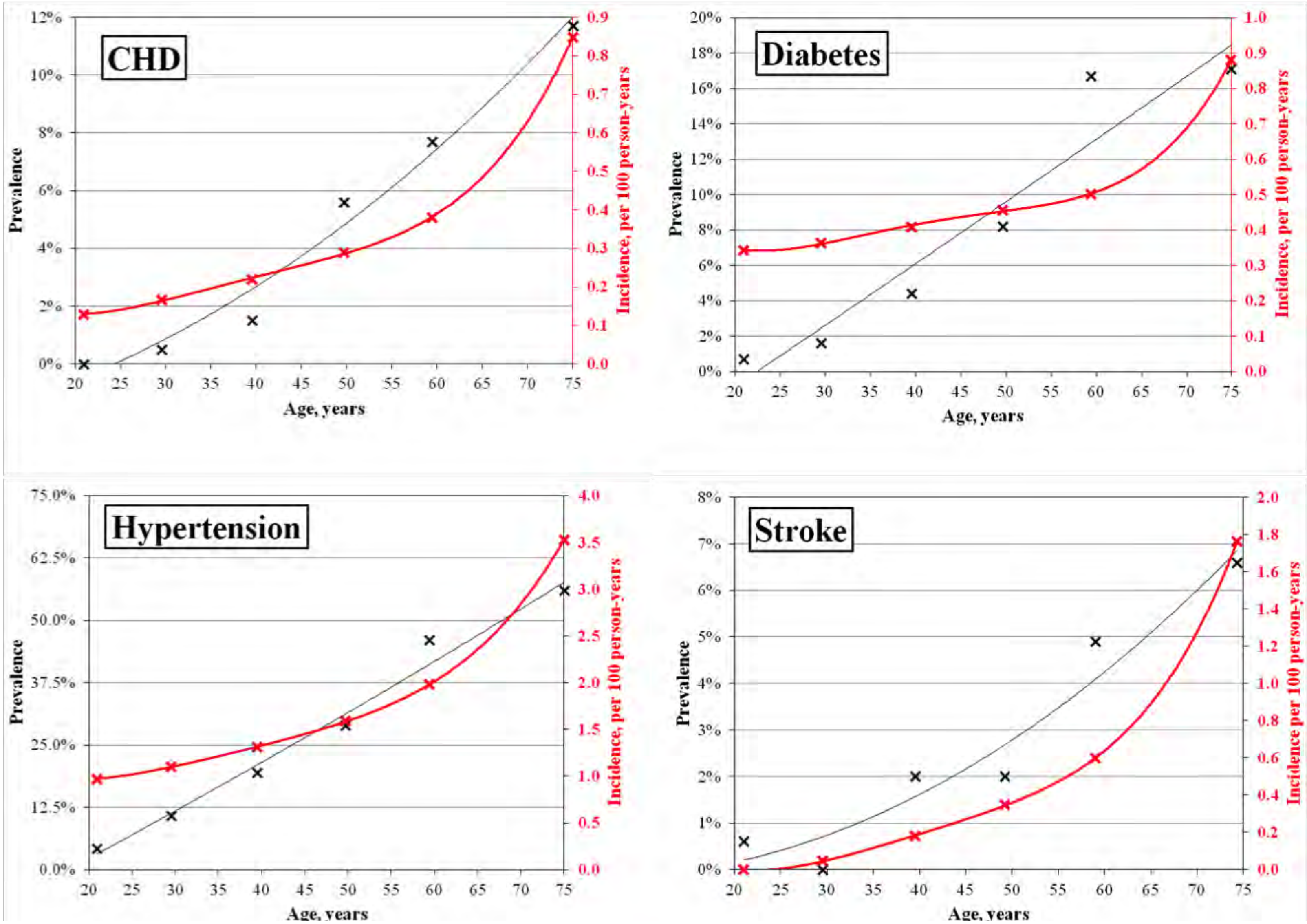

Figure 10. Sparta 2009 Disease Prevalence and Incidence, by Age

Assessment: Results

We constructed separate models to estimate the health impacts of active transportation infrastructure improvements in each community. In each model, we considered five health outcomes, disaggregated by gender: 1) avoided all-cause mortality; 2) avoided cases of CHD; 3) avoided bases of diabetes; 4) avoided cases of hypertension; and 5) avoided cases of stroke. Each model compares two scenarios, a baseline scenario and an intervention scenario, through time. We assumed that active transportation behavior would stay constant in the baseline scenario and would increase due to changes in the built environment in the intervention scenario. Thus, the health impacts of changes in the built environment are captured by the differences in health estimated outcomes over time between the two scenarios. We ran each model for 50 years, starting in 2009. The starting date of the simulation is somewhat arbitrary. We used 2009 because data for walking for transportation are only available in the 2009 BRFSS; however, we interpreted model outputs in terms of "years from the present," assuming that in some future year the project will be implemented and health impacts will grow through time from that future date.

The baseline and intervention scenarios are identical aside from one aspect: the percentage of the population in each risk factor category. Differences in health status between the two scenarios emerge through time as the population ages, distributed differently into higher and lower risk groups. All cohorts in the intervention scenario born in 2009 and thereafter spend all of their lives with a greater chance of being in a lower risk group due to increased physical activity from active transportation while population cohorts born prior to 2009 spend relatively smaller percentages of their lives with a greater chance of being in a lower risk group. Therefore, younger populations and those born in 2009 and later have a greater chance of being at reduced risk for adverse health outcomes throughout their lives due to the built environment interventions considered. Thus, improved health outcomes in the intervention scenario become more pronounced over time as individuals spend a greater portion of their total lives in lower risk factor categories resulting from transportation physical activity.

Intervention Data: Walking for Transportation

For each study area, we calculate pre- and post-project built environment variables and use these data to estimate changes in active transportation behavior in the community. For Winterville and the BRRC, we focus on the construction of new sidewalks and greenways while in Sparta we consider improvements to existing sidewalks. We calculate pre- and post-project sidewalk length, measured in miles, and sidewalk density, measured in miles of sidewalk per square mile of land. Sidewalks on two sides of the same street are both counted (i.e., a one mile length of road with sidewalks on both sides is considered two miles of sidewalks) and greenways are included in sidewalk length totals. We translate pre- and post-project built environment to estimate changes in physical activity from transportation using behavioral evidence in three ways: 1) increased average walking time due to increases in the extent of the sidewalk network; 2) increased odds of making a walking trip due to increases in the density of the sidewalk network; and 3) increased per capita walking distance in neighborhoods with a higher Pedestrian

Environment Factor (PEF). While the travel behavior literature is generally consistent in its findings,[17] it is difficult to generalize findings across cities and regions; however, we used methods consistent with the best evidence in the literature today. Methods are described in greater detail in Appendix 3.

Previous research conducted using built environment variables and travel survey data in the Raleigh-Durham-Chapel Hill Metropolitan Statistical Area found that a 1% increase in total sidewalk network length results in a 0.12% increase in average walking time per person. Additionally, every additional mile of sidewalk per square mile increases the odds of an individual having taken a walking trip by 1.4%.[17,28] Thus, we use total sidewalk length to estimate the increased walking time for existing walkers and sidewalk density to estimate the number of new walkers. The time spent walking by new walkers is assumed to be distributed in a similar manner as for existing walkers and new walkers are added to each category appropriately. For Sparta, we consider improvements to the quality of the pedestrian environment using the PEF developed in Portland, Oregon.[29-30] We estimate the pre- and post- PEF for the downtown area, considering sidewalk quality, ease of street crossings, topography, and local street network configuration. We assume that a transition from the lowest third of PEF to the middle third of PEF results in an average increase of 0.71 miles walked per person per week and from the lowest third to the highest results in an increase of 1.32 miles walked per person per week.[30] We assume a conservative average walking speed of 2.5 miles per hour to convert to time.[31]

Intervention Data: Winterville

Pre- and post-project built environment variables of interest, as well as predicted effects on walking behavior consistent with the behavioral literature reviewed, are presented in Table 11. Implementing all projects included in the Pitt County Pedestrian and Bicycle Master Plan, as well as other currently proposed sidewalks, would increase the length of sidewalk in Winterville from 14.3 to 65.7 miles. This results in an increased walking time amongst existing walkers of 43.2%. These new sidewalks would also increase sidewalk coverage, measured in sidewalk density, from 1.3 miles of sidewalk per square mile of land area to 4.8 miles of sidewalk per square mile of land area. This results in an increase in the odds of someone taking a walking trip during the week by 6.8%, meaning that some individuals who do not walk for transportation before the construction of the sidewalks will do so after the construction of the sidewalks.

Table 11. Pre- and Post-project Built Environment Variables, Winterville

	Pre-project	Post-project	Change	Behavioral Response
Sidewalk Length	*14.3 mi*	*65.7 mi*	*+360%*	*Increase in average walking time:* ***43.2%***
Sidewalk Density	*1.3 mi/mi^2*	*6.1 mi/mi^2*	*+4.8 mi/mi^2*	*Increase in odds of taking a walk trip:* ***6.8%***

Predicted active transportation behavior after the proposed built environment change, as well as the difference relative to the baseline, are presented in Table 12. A small shift from the non-walking category into a walking category is predicted. Additionally, a larger shift from the lower walking category to the upper walking category is predicted, with a large increase in the percentage of the population walking greater than 150 minutes per week and a related decline in the percentage of the population walking less than 150 minutes.

Based on these predicted changes in physical activity from walking for transportation, we predict significant positive health impacts. Fifty years after the construction of the project, 2 lives will be saved, and a modest percentage of future cases of each disease considered will be avoided. Modeled health impacts through time for both genders are shown in Figure 11, with lives saved plotted on the left axis and percentage of disease cases avoided on the right axis. These results are disaggregated by gender and displayed in Table 18 with numbers of disease cases rather than percentage of disease cases avoided to ease comparisons across projects for three time periods.

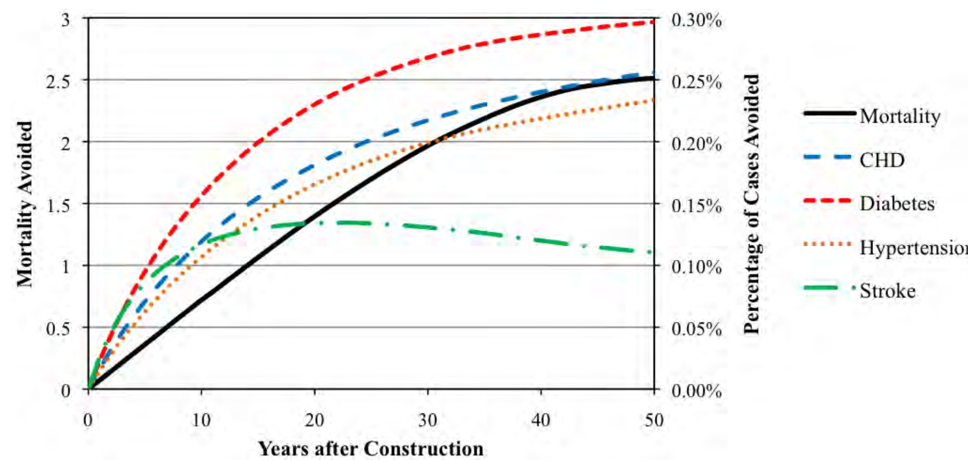

Figure 11. Winterville Predicted Health Outcomes

Table 12. Post-Intervention Walking for Transportation, Winterville

Estimated Intervention Active Transportation Behavior		Grouped Based on Risk Factor Categories		
Min. Transportation PA per Week	Percentage of Population	Min. Transportation PA per Week	Percentage of Population	Change, Relative to Baseline
0	83.4%	0	83.4%	**-0.9%**
1-29	3.6%	1-149	10.9%	**-1.4%**
30-59	2.6%	1-149	10.9%	**-1.4%**
60-119	3.1%	1-149	10.9%	**-1.4%**
120+	7.3%	150+	5.7%	**+2.3%**

Intervention Data: BRRC

Pre- and post-project built environment variables of interest, as well as predicted effects on walking behavior consistent with the behavioral literature reviewed, are presented in Table 13. Predicted active transportation behavior, as well as the difference relative to the baseline, are presented in Table 14.

Table 13. Pre- and Post-project Built Environment Variables, BRRC

	Pre-project	Post-project	Change	Behavioral Response
Sidewalk Length	5.0 mi	24.2 mi	+388%	Increase in average walking time: **46.6%**
Sidewalk Density	2.0 mi/mi²	9.9 mi/mi²	+7.9 mi/mi²	Increase in odds of taking a walk trip: **11.2%**

Table 14. Post-Intervention Walking for Transportation, BRRC

BRRC Survey Results		Grouped Based on Risk Factor Categories		
Min. Transportation PA per Week	Percentage of Population	Min. Transportation PA per Week	Percentage of Population	Change, Relative to Baseline
0	38.1%	0	38.1%	**-2.5%**
1-84	24.3%	1-149	36.2%	**-4.6%**
85-116	10.3%	1-149	36.2%	**-4.6%**
117-140	5.7%	1-149	36.2%	**-4.6%**
141-168	4.9%	150+	25.7%	**+7.1%**
169+	22.4%	150+	25.7%	**+7.1%**

Based on these predicted changes in physical activity from walking for transportation, we predict significant positive health impacts. Fifty years after the construction of the project, 7 lives will be saved and approximately 1% of future cases of both diabetes and CHD will be avoided, along with around 0.7% of future cases of hypertension and 0.4% of future cases of stroke. These health impacts are shown though time for both genders in Figure 12. Lives saved are plotted on the left axis while the percentage of cases avoided for each health outcomes are plotted on the right axis. Health outcomes are disaggregated by gender for three time periods – 10, 20, and 40 years in the future – in Table 19.

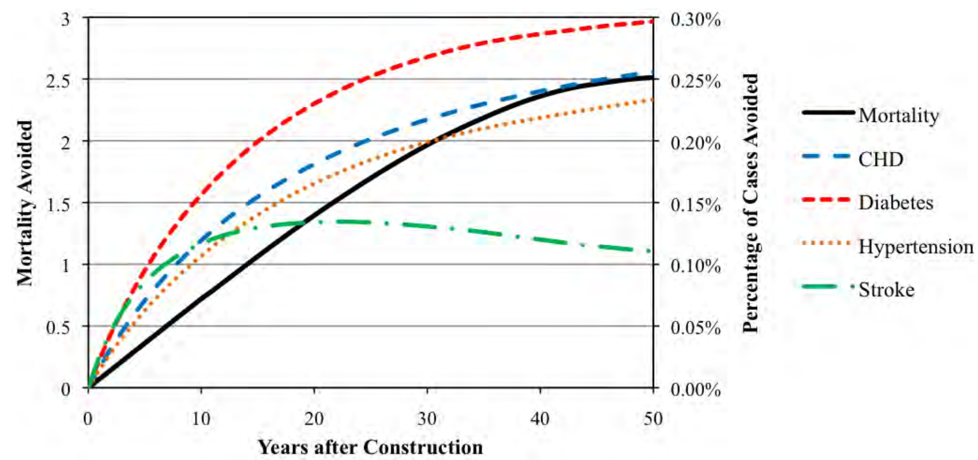

Figure 12. BRRC Predicted Health Outcomes

Intervention Data: Sparta

Pre- and post-project built environment variables of interest, as well as predicted effects on walking behavior consistent with the behavioral literature reviewed, are presented in Table 15. We assume that implementing all sidewalk improvements and street crossings as detailed in the Sparta Downtown Street Strategy will improve the PEF score from the lowest category to the middle category. Additionally, the construction of a new greenway segment would increase the total length of sidewalks and greenways in Sparta from 2.8 miles to 3.1 miles, resulting in an increased walking time amongst existing walkers of 43.2%, and would increase coverage from 1.2 miles of sidewalk per square mile of land area to 1.3 miles of sidewalk per square mile of land area, resulting in a negligible increase in the odds of someone taking a walking trip.

Predicted active transportation behavior after the proposed built environment change, as well as the difference relative to the baseline, are presented in Table 16. A large shift from the non-walking category into a walking category is predicted, as well as a moderate shift from the 1-150 minutes per week category into the greater than 150 minutes per week category.

Table 15. Pre- and Post-project Built Environment Variables, Sparta

	Pre-project	Post-project	Change	Behavioral Response
Downtown PEF	*Range: 4 to 8*	*Range: 8 to 12*	*+4*	*Increase in weekly walking distance:* ***0.57 miles per week***

Table 16. Post-Intervention Walking for Transportation, Sparta

Estimated Intervention Active Transportation Behavior		Grouped Based on Risk Factor Categories		
Min. Transportation PA per Week	*Percentage of Population*	*Min. Transportation PA per Week*	*Percentage of Population*	*Change, Relative to Baseline*
0	*75.0%*	*0*	*75.0%*	***-8.8%***
1-43	*13.2%*	*1-149*	*20.8%*	***+7.4%***
44-74	*3.3%*	*1-149*	*20.8%*	***+7.4%***
75-134	*3.0%*	*1-149*	*20.8%*	***+7.4%***
135+	*5.5%*	*150+*	*4.2%*	***+1.4%***

Based on these predicted changes in physical activity from walking for transportation, we predict significant positive health impacts. Fifty years after the construction of the project, 2 lives will be saved, and significant percentages of cases of CHD, Diabetes, Hypertension, and Stroke will be avoided. Modeled health impacts through time for both genders are shown in Figure 13. Lives saved are plotted on the left axis while the percentage of cases avoided for each health outcome are plotted on the right axis. Additionally, health outcomes are disaggregated by gender for three time periods – 10, 20, and 40 years in the future – in Table 20.

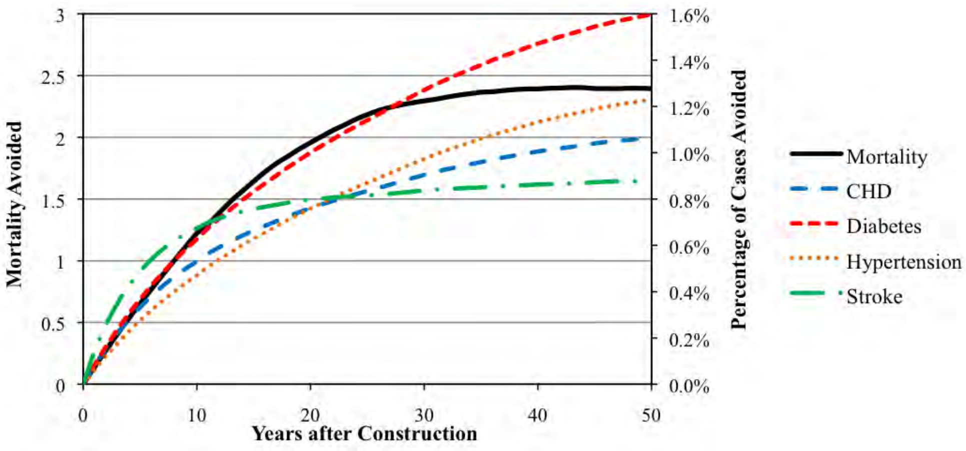

Figure 13. Sparta Predicted Health Outcomes

Economic Implications

While health outcomes are important in and of themselves, it is difficult to compare health to other outcomes without a consistent frame of reference. This is especially critical for the allocation of funds for transportation projects, wherein a large number of projects compete for funds that are limited relative to funding needs. In order to demonstrate the economic value of improved health outcomes attributable to active transportation infrastructure, we used established values for an individual's life and yearly disease cost to estimate total economic benefits to society resulting from improved health outcomes.[32-33] Health outcome valuations are detailed in Table 17. To account for reduced present value of health outcomes predicted to occur in the future, we used a traditional discounting procedure, in which the present value (PV) of a future income stream, C, received over k years in the future is adjusted based on a discount rate, d:

$$PV = \sum_{k=1}^{n} C(1+d)^{-k}$$

Selecting an appropriate discount rate is a contentious issue when monetizing health outcomes. Some argue that the future value of life should not be discounted, supporting a 0% discount rate, while others argue for a more traditional discounting approach. However, some recent work supports a discount rate between 3% and 4%.[34-35] We estimated the present value of health impacts using three discount rates to account for this uncertainty: 3.5%, 5%, and 7%. The Office of Management and Budget (OMB) requires federal agencies to use a 7% discount rate;[36] however, USDOT suggests a lower discount rate (5%) when considering the value of statistical life.[33] We consider the OMB recommended discount rate of 7%, a low case (3.5%) to match assumptions elsewhere in WalkBikeNC and to be consistent with recent literature,[35] and one intermediate case. We summarize the estimates at three points in the future that are useful from a decision-making perspective: 10, 20, and 40 years. Additionally, we estimate project costs, using either costs provided in the project documentation or new estimates based on per unit construction costs and compare them to projected benefits. While this simple cost-benefit analysis (CBA) is rather crude, it illustrates a manner in which these results can be included in decision-making processes. A benefit-cost ratio equal to 1 suggests that the project would have no net financial benefit to society, a ratio less than 1 suggests the project would be a net financial loss, and a ratio greater than 1 suggests that the project would be a net gain.

Table 17. Health Outcome Monetization Sources

Health Outcome	Monetary Value (2009 USD)	Source
CHD	$9,048 per case per year[a]	An Unhealthy America: The Economic Burden of Chronic Disease[32]
Diabetes	$9,844 per case per year[a]	An Unhealthy America: The Economic Burden of Chronic Disease[32]
Hypertension	$8,831 per case per year[a]	An Unhealthy America: The Economic Burden of Chronic Disease[32]
Stroke	$15,573 per case per year[a]	An Unhealthy America: The Economic Burden of Chronic Disease[32]
Mortality	$8,600,000 per statistical life[b]	Guidance on Treatment of the Economic Value of a Statistical Life in USDOT Analyses[33]

[a]Monetary value for North Carolina [b]Monetary value for the United States

Economic Valuation: Winterville

The estimated present value, in 2012 dollars and for each discount rate assumed, for the health impacts of the Winterville projects in the Pitt County Bicycle and Pedestrian Master Plan are shown in Figure 14. Full results are summarized in Table 18 for 10, 20, and 40 years post project construction, assuming a 3.5% discount rate and including project costs. We estimate the value of reduced mortality and reduced incidence of CHD, diabetes, hypertension, and stroke attributable to build-out of the Greenville MPO Bicycle and Pedestrian Master Plan to reach nearly $9,000,000 20 years after construction and exceed $12,500,000 within 40 years of construction. These projected economic benefits exceed estimated project cost by a factor of 0.5 to slightly above 1.0, increasing over time.

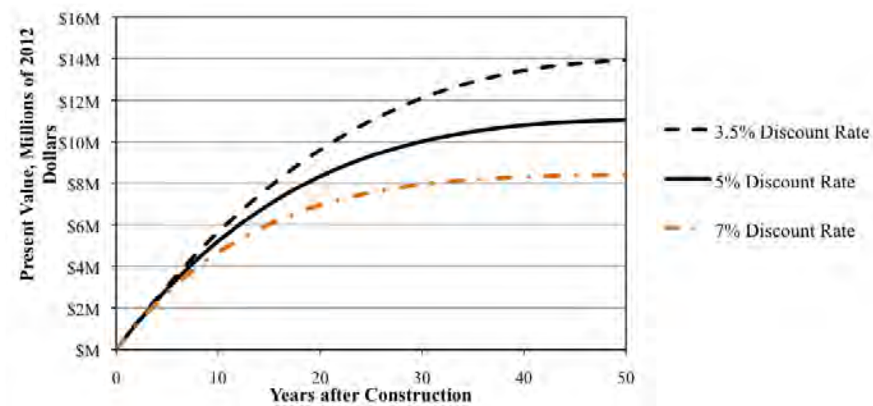

Figure 14. Winterville Economic Valuations

Table 18. Complete Winterville Results

	10 Years Post Construction			20 Years Post Construction			40 Years Post Construction		
Avoided Cases of:	Men	Women	Total	Men	Women	Total	Men	Women	Total
Mortality	0.4	0.4	0.7	0.7	0.7	1.4	1.2	1.2	2.4
CHD	0	0.3	0.3	0	0.5	0.5	0	0.7	0.7
Diabetes	0.4	0.6	1.0	0.7	1.0	1.7	1.1	1.5	2.6
Hypertension	1.1	1.4	2.5	2.0	2.4	4.4	2.9	3.6	6.5
Stroke	0.2	0.2	0.4	0.3	0.3	0.6	0.3	0.4	0.7
Economic Value	**$5,290,000**			**$8,980,000**			**$12,550,000**		
Cost Estimate	**$11,088,000**			**$11,088,000**			**$11,088,000**		
Benefit-Cost Ratio	**0.48**			**0.81**			**1.1**		

Economic Valuation: BRRC

The estimated present value, in 2012 dollars and for each discount rate assumed, for the health impacts of the BRRC small area plan are shown in Figure 15. Full results are summarized in Table 19 for 10, 20, and 40 years post project construction, assuming a 3.5% discount rate and including project costs. We estimate that the health impact of build-out of the BRRC small area plan will eclipse $25,000,000 within 20 years of construction and continue to rise above $36,000,000 40 years post-construction. Thus, we estimate that the benefits of active transportation infrastructure components of the BRRC plan will exceed the costs of construction by a factor of 4 to 9, once again increasing over time.

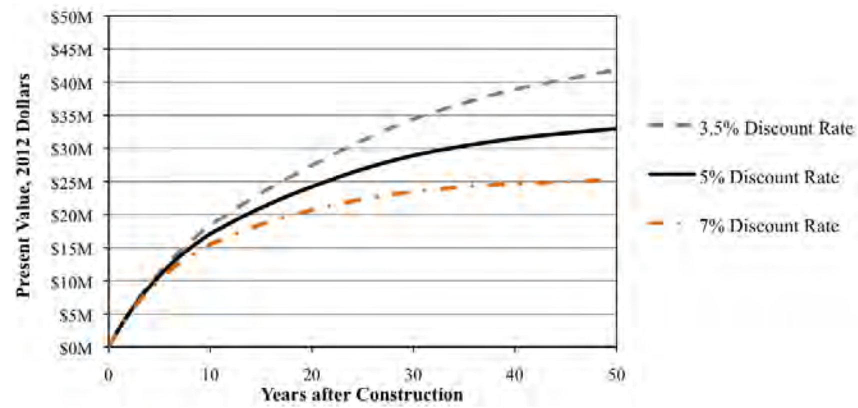

Figure 15. BRRC Economic Valuations

Table 19. Complete BRRC Results

	10 Years Post Construction			20 Years Post Construction			40 Years Post Construction		
Avoided Cases of:	Men	Women	Total	Men	Women	Total	Men	Women	Total
Mortality	1.0	1.3	2.3	1.8	1.8	3.7	3.3	3.1	6.4
CHD	0	1.4	1.4	0	2.7	2.7	0	4.5	4.5
Diabetes	1.6	2.1	3.7	3.0	3.9	6.9	5.0	6.5	11.5
Hypertension	5.2	4.2	9.4	7.5	9.5	17.0	11	14.3	25.3
Stroke	0.7	0.9	1.6	1.2	1.7	2.9	1.8	2.5	4.3
Economic Value	**$17,180,000**			**$25,610,000**			**$36,300,000**		
Cost Estimate	**$4,055,040**			**$4,055,040**			**$4,055,040**		
Benefit-Cost Ratio	**4.2**			**6.3**			**9.0**		

Economic Valuation: Sparta

The estimated present value, in 2012 dollars and for each discount rate assumed, for the health impacts of the Downtown Sparta Streetscape Strategy are shown in Figure 16. Full results are summarized in Table 20 for 10, 20, and 40 years post project construction, assuming a 3.5% discount rate. Given a typical project lifespan of 20 to 40 years, we predict that the health outcomes associated with implementation of the Downtown Sparta Streetscape Strategy will exceed the costs by a factor in the range of 13 to 22.

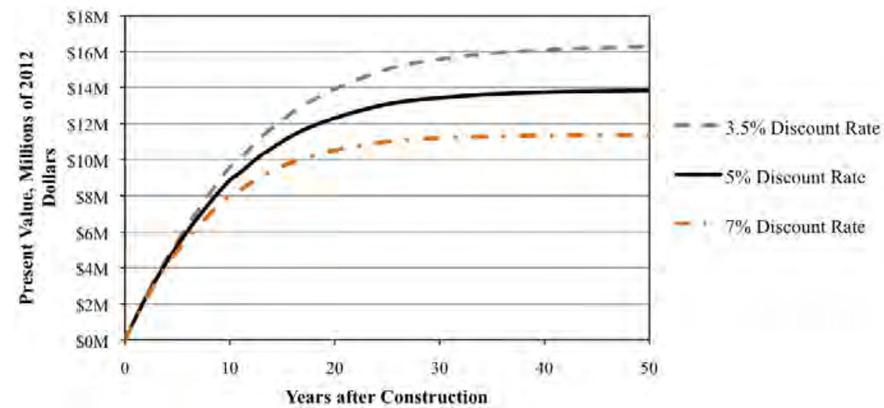

Figure 16. Sparta Economic Valuations

Table 20. Complete Sparta Results

	10 Years Post Construction			20 Years Post Construction			40 Years Post Construction		
Avoided Cases of:	Men	Women	Total	Men	Women	Total	Men	Women	Total
Mortality	0.6	0.6	1.2	1.0	1.0	2.0	1.3	1.1	2.4
CHD	0.1	0.5	0.6	0.1	0.7	0.8	0.2	0.8	1.0
Diabetes	0.4	0.6	1.0	0.7	1.0	1.7	1.0	1.3	2.3
Hypertension	1.0	1.3	2.3	1.7	2.0	3.7	2.3	2.6	4.9
Stroke	0.2	0.4	0.6	0.3	0.5	0.8	0.3	0.6	0.9
Economic Value	**$8,960,000**			**$13,010,000**			**$15,040,000**		
Cost Estimate	**$686,257**			**$686,257**			**$686,257**		
Benefit-Cost Ratio	**13.1**			**19.0**			**22.0**		

Assessment: Limitations

While the quantitative methods applied in this study represent the state of the art in HIA, several limitations should be addressed. First, our model does not explicitly consider obesity due to a lack of relative risk data linking walking for transportation to overweight/obesity. However, this may represent the lack of a direct causal linkage between non-vigorous physical activity and overweight/obesity when controlling for confounding factors such as diet. Further, the uncontrolled RR values selected linking the disease in our model to walking for transportation do not control for obesity, thereby implicitly assuming a similar prevalence of overweight and obesity in the study population used in the epidemiological study and the populations in our three study areas. Regardless, the inability of our model to explicitly consider obesity likely results in more conservative model results. Similarly, data limitations at the county level for cancer prevalence and incidence by age and sex prevent the inclusion of these health outcomes in our model. However, the prevalence of cancer is small; thus, the change in prevalence relative to the baseline would likely be limited in this assessment should we have been able to include cancer outcomes. Finally, Chronic Obstructive Pulmonary Disease (COPD) is not considered due to limited epidemiological evidence linking non-vigorous physical activity to the prevalence or incidence of COPD, although evidence does recommend physical activity as a means to reduce mortality in those already diagnosed with COPD.[37] This likely does not bias our results because changes in mortality in individuals diagnosed with COPD would be included in a population-level all-cause mortality relative risk for physical activity, assuming prevalence of COPD is roughly similar across populations. In sum, diseases not included in this assessment likely result in a small, conservative under-estimate of total health benefits.

A second limitation arises from the nature of the Behavioral Risk Factor Surveillance System (BRFSS) data used to estimate population prevalence and incidence. The BRFSS question listed in Table 7 asks whether respondents have ever been told that they have a given disease; thus, the prevalence of reversible diseases (e.g. hypertension) is likely over-estimated. While the incidence estimation results in its own uncertainty, this is compounded for reversible disease with potentially unreliable prevalence estimates. However, the data used for this HIA are the most accurate publicly available data sources for disease prevalence.

A third significant limitation is the uncertainty associated with transportation behavior estimates. While the estimates are generally feasible and supported by a growing body of literature, the majority of travel behavior studies focus on trip numbers or mode choice – which are important for transportation planners but less so for public health practitioners – rather than trip duration or distance. Therefore, estimates in this report are based on single studies and subject to uncertainties when applied to other geographic areas. Additionally, in the Sparta study area, the built environment variable used is based on subjective criteria (sidewalk and crossing quality) and is not statistically significant in the model used by Boarnet et al. However, we use the lowest model coefficient and assume a modest change in Pedestrian Environment Factor to be conservative. We also assume that only 25% of the Town of Sparta – the area of the town within a 0.25 mile buffer of the proposed street improvements – is affected by this built environment change.

Finally, we consider only walking for transportation and do not consider cycling for transportation or purely recreational physical activity (i.e., from recreationally using a greenway). Behavioral studies linking built environment characteristics to cycling behavior and purely recreational physical activity from transportation are limited. These limitations result in conservative estimates of post-intervention physical activity from transportation, particularly in Winterville and the BRRC where topographical constraints do not present a barrier to cycling. While not considered in this assessment, these domains of physical activity may be included in future iterations of this model as behavioral studies improve.

The complexity of DYNAMO-HIA presents a significant limitation for wider use of the methods performed in the assessment. However, the depth and quantitative nature of the findings warrant a significant effort to adapt DYNAMO-HIA model components into a more user-friendly package. Further, the DYNAMO-HIA model was applied despite significant data limitations; thus, a similar model with a more user-friendly interface would likely be extremely useful to researchers and practitioners alike interested in quantitative HIA methods.

Recommendations

From the findings of this report, we developed three broad sets of recommendations: 1) Project-specific recommendations; 2) Recommendations from WalkBikeNC that are directly supported by this analysis; and 3) Recommendations for practice. These are summarized below:

Project-specific recommendations: Winterville

1. Build out sidewalk network in Winterville as proposed in the Greenville Bicycle and Pedestrian Master Plan
2. Use modeled health impacts to help advocate for funding from potential funding sources, as identified in the Greenville Bicycle and Pedestrian Master Plan
3. Investigate programs to counteract negative perceptions (both stigmas and elitist perception) of active transportation behavior in the community
4. Coordinate with local institutions to include active transportation-related questions in future local surveys

Project-specific recommendations: BRRC

1. Coordinate with NCDOT to ensure that reconstruction of all state owned right-of-way in the project area is accompanied by construction of sidewalks on both sides of the street
2. Ensure that all new roads in the study area are initially built with sidewalks on both sides of the street
3. Coordinate with local partners (state of North Carolina, Art Museum, etc.) to explore creative funding options for sidewalks infrastructure

4. Coordinate with local institutions to include active transportation-related questions in future local surveys

Project-specific recommendations: Sparta

1. Build out the pedestrian improvements as proposed in the Sparta Downtown Streetscape Strategy
2. Leverage the results of this report to advocate for funding from a variety of potential partners
3. Coordinate with local institutions to include active transportation-related questions in future local surveys

Supported WalkBikeNC recommendations:

Mobility

1. Expand community-oriented pedestrian facilities
2. Provide pedestrian and bicycle access to transit

Safety

1. Create a strategic, consistent, and connected pedestrian and bicycle network

Public Health

1. Increase active living environments
2. Increase the safety, connectivity, and accessibility of the bicycle and pedestrian network
3. Improve public health outcomes

Economic Competitiveness

1. Increase attractiveness and quality-of-life through walkable and bikeable communities
2. Measure return on investment of active transportation investments
3. Use return on investment analyses to inform transportation decision-making

Recommendations for research and practice:

1. Develop improved data infrastructure for the following:

   a. Sidewalk and bicycle networks

   b. More refined prevalence data for cancer (by type), CHD, diabetes, hypertension, and stroke.

2. Ensure that future studies of the built environment and travel behavior report active travel in units relevant to epidemiological studies (i.e., minutes of physical activity rather than mode choice, number of trips, or reductions in vehicle miles travelled)
3. Using optional state-specific questions, include active transportation as a regularly asked question in the BRFSS (e.g., 2009 North Carolina BRFSS)
4. Develop local capacity to conduct HIAs by providing training, technical assistance, and other resources.
5. Advance HIA methods to focus on methods that help inform decisions on proposed policies, plans, and development from a quantitative perspective, including the use of monetization of health impacts.
6. Develop a practitioner-focused tool that combines a Marko Chain approach with a more user-friendly interface and linked to publicly available data sources.

Reporting

The findings of this report will be disseminated in three ways: 1) inclusion in WalkBikeNC; 2) presentation of results to local leaders and decision-makers in each HIA community; 3) presentation at appropriate public meetings and venues; and 4) publication in academic literature and presentation at appropriate academic conferences.

This report is included in its entirety as a technical appendix in the North Carolina Statewide Bicycle and Pedestrian Master Plan, known as WalkBikeNC. Further, a brief summary and key HIA findings appear within the main text of the plan.

Post-project meetings will be held in each community to present results and obtain feedback from local leaders and decision-makers in each community.

A brief presentation highlighting the findings of this analysis, as well as broad lessons learned, will be presented as appropriate meetings as part of the post-WalkBikeNC period. Meetings that will be targeted include outreach meetings with WalkBikeNC stakeholders, community transformation grant meetings, and Municipal Planning Organization (MPO) and/or Rural Planning Organization (RPO) meetings in each project region.

The results of this analysis will also be translated into an academic paper to be submitted to an appropriate journal and will be submitted for presentation at academic conferences such as the National Health Impact Assessment (HIA) Meeting. These publications will focus on the technical methods, limitations, and implications for future work – with the aim of developing a user-friendly, practitioner-ready quantitative HIA tool in the future.

Monitoring and Evaluation

Looking to the future, monitoring and evaluation should focus on the build-out of the projects as analyzed in this report as well as changes in active transportation behavior in each community. While health outcomes are measured over time, the predicted magnitude of change and the large number of external factors that may affect health outcomes prevent a significant barrier to using health outcomes for evaluation. Active transportation behavior, however, is a more sensitive intermediary and can be used as a proxy for health outcomes with proven links to physical activity from transportation. Build-out of projects provides a more tangible measure and is a suitable proxy for the efficacy of local institutions in providing funding for active transportation infrastructure in their community. Along with these measures, efforts should be made to capture perceptions of active transportation in each community and document changes over time that may be attributable to infrastructure changes, active transportation programs, and/or demographic or cultural shifts. These data could be collected opportunistically as potential partners administer related surveys in each community over time.

Acknowledgements

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Appendix 1: Health Advisory Team

Participant	Organization
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Julie Hunkins	NC Department of Transportation
Helen Chaney	NC Department of Transportation
Lori Rhew	NC Department of Health and Human Services
Ruth Petersen	NC Department of Health and Human Services
Monique Bethell	NC Department of Health and Human Services
Chuck Flink	Alta/Greenways
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Jackie Epping	Centers for Disease Control and Prevention
Candace Rutt	Centers for Disease Control and Prevention
Jennifer MacDougall	Blue Cross Blue Shield of NC Foundation
Jackie MacDonald-Gibson	UNC Environmental Sciences and Engineering
Ted Mansfield	UNC Environmental Sciences and Engineering
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Appendix 2: Community Meeting Documentation

Winterville

Participant	Organization
Jo Morgan	*Pitt County*
James Rhodes	*Pitt County*
Daryl Vreeland	*Greenville MPO*
Jennifer Smith	*Vidant Health*
Alan Lilley	*Town of Winterville*

The meeting began with a broad scoping exercise designed to identify a wide range of factors that may have negative health impacts in the community. Broadly, the participants identified several built environment factors that may negatively affect health outcomes in Winterville, including non-walkable development scales, car-oriented development, segregated land uses, lack of services and employment within Winterville proper, and school siting. Participants also identified demographic and cultural factors, including poverty and a high prevalence of risk factors, as negative influences on the health of their community. Specific to physical infrastructure in Winterville, participants identified the lack of sidewalks, poor sidewalk connectivity between developments that do contain sidewalks, road widening projects undertaken without supplementary improvements such as the addition of sidewalks and bike lanes, and physical barriers presented by NC11 and the railroad tracks that bisect Winterville as having a potentially negative effect on public health. Considering services, participants identified the lack of public transit and poor access to facilities that offer affordable healthcare as potential detriments to public health. The participants also noted that Winterville has successfully employed joint-use agreements in many schools to provide recreational facilities outside of school hours; however, the positive health impacts of these agreements may be limited due to poor school siting and poor bicycle and pedestrian infrastructure around schools. Considering social and/or economic conditions that may impact health, the participants noted concern over the stigmatized perception of walking and biking as a mode of transportation (rather than recreationally) in Winterville. They also stressed the importance of correctly framing the message to encourage active transportation as a normative rather than elitist behavior. Participants also identified concerns over poor awareness of drivers, cyclists, and pedestrian of the “rules of the road” in multi-modal situations. Finally, the participants expressed concerns over the degree to which NC11 degrades the natural environment and, in turn, public health, due to noise and air pollution. The overall aesthetic quality of many streetscapes, including NC11, was also identified as negatively influencing public health ("there are sidewalks on NC11, but who would want to walk on them?") Overall, three themes emerged in discussing determinants of health in broad terms: 1) Underlying socio-demographic characteristics and cultural norms, 2) Inadequacies in physical infrastructure, and 3) Land use patterns.

Upon concluding the broad scoping exercise, a more focused exercise was conducted to gain further insight relevant to the Bicycle and Pedestrian Master Plan. Focusing specifically on physical inactivity as a determinant of health, the participants identified the lack of physical infrastructure, specifically outside of downtown and outside of newer subdivisions built in the wake of subdivision regulations requiring the construction of sidewalks, as the primary barrier to increasing physical activity. Participants noted that lack of physical activity is a risk factor for a range of health outcomes including overweight/obesity, heart disease, mental health, etc. Susceptible populations were identified primarily based on geography rather than socio-demographic characteristics; that is, the workshop participants felt that neighborhood quality was a more important than individual characteristics in explaining the propensity to use physically active transportation modes. A final point that was made during discussion is that it is important to "make infrastructure a part of your day," reinforcing the need to frame active transportation in a way that helps develop a positive cultural norm for its use, rather than an elite activity for the "lycra crowd." The two-phased scoping exercise conducted in Winterville provided the project team with invaluable information regarding the broad contextual drivers of health outcomes in the community as well as specific concerns relevant to the Pedestrian and Bicycle Master Plan. Further, a brief discussion of framing the message encouraged the use of economic development, quality of life, and social equity as frames to discuss active transportation. However, it was also noted that it is difficult to get chronic disease on the public agenda because of historic emphasis on communicable disease as well as the view that "health is only important until you don't have it" – providing support for frames other than public health to discuss active transportation.

An informal discussion followed on a variety of issues, including other relevant projects that may be included in the analysis and potential sources for more granular health data. The participants encouraged the project team to consider several of the broader infrastructure recommendations included in the Bicycle and Pedestrian Master Plan, including improvements to Old Tar Road and NC11. In response to this request, the project team will likely prepare two implementation scenarios – one including only projects identified as "Priority Projects" in the plan and one including these projects as well as several additional projects high-profile identified in the plan – in addition to the "do-nothing" scenario. Regarding data, participants stressed that Pitt County is a Behavioral Risk Factor Surveillance System (BRFSS) oversampled county, so risk factor data are more robust than in many other geographies.

Sparta

Participant	Organization
Jennifer Greene	*Appalachian Health District*
Kevin Dowell	*Town of Sparta*
Bryan Edwards	*Sparta Town Manager*
Jane Wyatt	*Town of Sparta*
Eric Woolridge	*Destination by Design*
Teresa Buckwalter	*Destination by Design*
Beth Fornadley	*Appalachian Health District*
Rachel Miller	*Appalachian Health District*

The meeting began with a broad scoping exercise designed to identify a wide range of factors that may have negative health impacts in the community. Broadly, the participants identified several built environment factors that may negatively affect health outcomes in Sparta, including: 1) incomplete sidewalk network, 2) heavy traffic along key routes, 3) segregated land uses, and 4) rural school siting. Participants also identified demographic and cultural factors including: 1) poverty, 2) age (older population), 3) high proportion of population lacking health insurance, 4) a cultural bias towards the car due in part due to Sparta's rural setting, 5) poor nutrition/ access to healthy foods, and 6) cultural norms regarding tobacco use. Specific to physical infrastructure in Sparta, participants identified the lack of sidewalks, the width and quality of existing sidewalks (an example of a sidewalk with an electrical pole in the middle was given), the lack of passing zones (to pass cyclists) on rural roads, and the large lane widths on roads throughout Sparta (encouraging high travel speeds) as having a potentially negative effect on public health. However, the participants also identified several new trails that have been completed recently in Sparta and anecdotally characterized the use of these trails as fairly significant. Considering services, participants identified the lack of public transit and the fragmentation of government services downtown (i.e., previously, residents would "park once" in downtown and walk to use government services, but now that services are offered in different buildings, individuals seem more likely to drive to each building) as negatively affecting health. Considering social and/or economic conditions that may impact health, the participants noted that walking is stigmatized in the community and that several economic conditions, including a large parentage of the population of fixed incomes and a large number of seasonal workers, may have a negative influence on public health. However, the participants did note that Sparta has a strong sense of community and that there are generally a large number of active volunteers in the community, which may improve well-being directly and may be leveraged to counteract the negative walking stigma in the future. Participants also identified concerns over proper education of drivers and cyclists and inconsiderate behaviors of drivers towards pedestrians in general. Finally, the participants noted that, while the natural environment of Sparta is largely pristine, the aesthetics of downtown are not conducive to walking. Further, the extreme elevation changes in the community make cycling very difficult and thus more of a recreational activity. Additionally, participants noted that Sparta does have a great deal of open space, but lacks programmed open space (i.e., sports fields, playground equipment, etc.) which may reduce the effectiveness of open space as a recreational resource. Overall, three central themes emerged in our broad discussions of health determinants in Sparta: 1) the real and perceived safety of pedestrians, including the perception of pedestrians from the drivers' point of view, 2) inadequacies in physical infrastructure, and 3) difficulties associated with high prevalence of poverty and a high number of seasonal workers/population. Similar to the meeting in Winterville, framing the message was stressed at several points during the scoping exercise. Participants in Sparta suggested framing active transportation as an issue of personal choice: expanding infrastructure that is supportive of physically active transportation expands personal choice and gives individuals a new opportunity to choose to be physically active as part of their daily routine.

A more focused scoping exercise was also conducted to gain additional information relevant to the Downtown Sparta Streetscape Strategy. Focusing specifically on physical inactivity as a determinant of health, the participants identified the lack of safe opportunities to cross the street, high traffic speed, and traffic signaling that is unsafe for pedestrians (e.g., right turn green arrows and protected right turn lanes) as primary barriers to increased walking due to negative effects (real and perceived) on pedestrian safety. Participants did not consider bicycling due to natural environment factors (e.g., steep slopes) that present significant barriers to cycling. Participants also identified several sub-populations that may be impacted by targeted improvements, including students who are unable to walk to school due to gaps in the sidewalk network, seasonal workers who do not have a car and must walk to work since there is no public transit, and carless households that also must rely on walking as a primary mode of transportation. The scoping exercises conducted in Sparta provided some insight into cultural, social, and economic drivers of health outcomes in the community in addition to specific health concerns relevant to the Downtown Streetscape Strategy and specific sub-populations that may be more affected than others by the plan.

After completing the discussion on scoping, a brief discussion on data sources and complementary projects in Sparta was conducted. A number of projects were identified, including a greenway plan and a pedestrian plan that may be used to develop an additional implementation scenario at the discretion of the project team. It was stressed that, while Census data for Sparta are not geographically specific, several additional sources of data are available that may be useful, including physical activity survey data from a recent county recreational plan.

Blue Ridge Road Corridor

A discussion guide was developed to guide focus group participants through a discussion of the breadth of health concerns, real, potential and/or perceived, that are known to people who live, work and visit the BRRC. During 1.5 hours of facilitated discussion, focus group participants were asked to provide thoughts and comments on the following three general topics:

1. What elements of the BRRC neighborhood and environment, as it currently exists, do stakeholders identify as a concern to public health?
2. What health effects, both positive and negative, can be identified in the BRRC that might be affected through planning, design, and change to infrastructure?
3. How can existing plans or conceptual designs for the BRRC address specific health concerns?

Facilitators began each session by briefly introducing the City of Raleigh's Blue Ridge Road District Study and outlined HIA methods and the objectives of the Blue Ridge Road Corridor Health Impact Assessment Project. A discussion then followed based on the outline of the discussion guide with details and examples provided by the facilitator to ensure discussion of all relevant topic areas and contribution by all focus group participants.

Focus group participants were recruited from citizens and officials who had attended the City of Raleigh's February 9, 2012 Blue Ridge Road Corridor design charrette and from contacts provided by the Blue Ridge Road Corridor Health Impact Assessment Project advisory committee. Focus group meeting times and locations were selected to provide opportunities for a broad range of stakeholders to participate. Evening meetings were held to allow residents from neighborhoods both north and south of Wade Avenue to attend and lunch time meetings were scheduled to allow business owners, those employed in the BRRC, and government officials to attend.

The group of 40 participants was primarily composed of people employed within the BRRC (14), residents of neighborhoods adjacent to the BRRC (12) or officials from the City of Raleigh, Wake County or state agencies (11). Two people with business interests along the corridor and one planning student also participated. All focus group participants were familiar with at least some portion of the BRRC from personal and/or professional experiences.

Focus group participants raised over 70 concerns about threats to public health in the BRRC. 17 of these concerns were raised in more than one focus group and 11 concerns were raised the majority of focus group meetings. Only one concern, the lack of adequate sidewalks in the BRRC area, was identified as a public health concern in all five focus groups.

Focus group meetings are summarized below:

Location	Date	Attendees	Notes
Private residence in the Westover community, adjacent to the State Fairgrounds	*February 28th 2012*	*6*	*Stakeholders present were all neighbors of the BRRC (6)*
Urban Design Center, downtown Raleigh	*March 1st 2012*	*9*	*Stakeholders present were state and local officials, also were members of the BRRC HIA Advisory Council (9)*
Wake Internal Medicine Building, 3100 Blue Ridge Road	*March 6th 2012*	*7*	*Stakeholders present were primarily neighbors of the BRRC north of Wade Avenue (6) and one member who was a business owner with property interest along the BRRC (1).*
North Carolina Museum of Art, 2110 Blue Ridge Road	*March 8th 2012*	*12*	*Stakeholders present all employees or volunteers of the NC Museum of Art (12).*
NCSU Vet School	*March 20th 2012*	*6*	*Participants in this focus group were a mix of stakeholder types including local officials (2), employees working within the BRRC (2), a local business owner (1) and a student of urban design (1).*

Eight concerns to public health that were raised by a majority of focus groups and that were described as having relatively high weight as a concern to public health:

- Lack of adequate sidewalks/crosswalks
- Intersections and roads designed primarily for cars
- Lack of public transportation
- Drunk/distracted drivers
- Lack of efficient road system
- Lack of clear trail indicators (signs, maps, etc.)
- Large gaps between pedestrian destinations
- Not all pedestrian facilities open at night

Focus group participants identified 19 health impacts related to development of the BRRC. Five of these health impacts were raised in more than one focus group and two health impacts, stress and safety from injury, were identified as a public health concern in all five focus groups. Safety from injury was the one health impact identified by all focus groups and weighted as relatively important compared to other health impacts.

Focus group participants identified 27 potential changes to the BRRC that could positively impact public health. Twelve of these ideas were raised in more than one focus group and one idea, improving the aesthetics of the BRRC environment was raised at every focus group meeting.

Seven ideas to improve public health that were raised by a majority of focus groups:

1. Make BRRC more aesthetically pleasing
2. Sidewalks/crosswalks on major roads
3. Build more things to walk to (coffee shops, restaurants, etc.)
4. Bike lanes/bike racks
5. Improved connections to and between modes of public transit
6. Educational opportunities
7. Better publicity, signage, maps, etc.

Broadly, the major themes expressed by focus group participants are as follows:

- A lack of sidewalks and crosswalks is a serious threat to public health.
- Design of the BRRC roads at present does not well serve non-vehicular transportation.
- The BRRC is perceived as a dangerous area due to the potential for injury on streets.
- A lack of convenient public transportation is perceived as a deterrent to public health.
- The environment of the BRRC is perceived as stressful.
- Environmental degradation and/or improvements from development activities were perceived as important, but not clearly linked to public health in the BRRC.
- Noise and light pollution were perceived as important, but not strongly linked to public health in the BRRC.
- Limited signage and wayfinding materials limit pedestrian and bicycle travel.
- Lack of bicycle lanes and bicycle parking identified as limits to bicycle transportation to and within the BRRC.
- Large gaps exist between existing destinations along the corridor, limiting pedestrian and bicycle travel.
- Efforts to increase the density of service and recreational destinations along the BRRC perceived as a positive effort to support public health.
- Efforts to improve the aesthetic feel of the BRRC perceived an important role in public health.

Appendix 3: Technical Methods

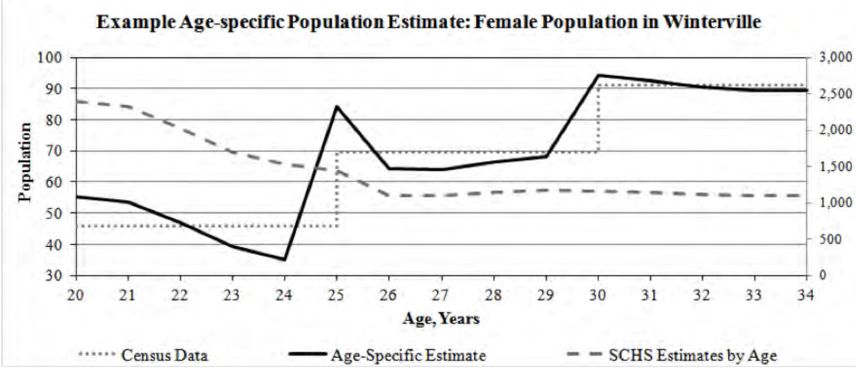
Population Age Distribution Estimation

The DYNAMO-HIA requires baseline population estimates for all ages ranging from 0-95; however, census data are given in larger age groups. The NC SCHS provides county-level population estimates by sex and age. We use the distribution of the SCHS population by age to estimate the distribution of population by age within each census age group, holding the total population in each census age group constant. To do this, we do the following for each sex:

1. Calculate the percentage of SCHS population at each age as a percentage of total population in the associated census age group
2. Multiply census data grouped populations by the appropriate SCHS population percentage

An example calculation and graphical representation of the process are presented to the right:

	County-Wide Data						**Study Area Data**					
	NC SCHS Estiamtes			Percentage, by Census group			Census Data			Age-Specifc Estimates		
	Gender		**Total**	*Gender*		**Total**	*Gender*		**Total**	*Gender*		**Total**
Age	Female	Male		Female	Male		Female	Male		Female	Male	
↑												
20	2,401	2,020	4,421	24.1%	22.0%	23.1%	230	186	416	**55**	**41**	**96**
21	2,314	2,062	4,376	23.2%	22.5%	22.9%	↓	↓	↓	**53**	**42**	**95**
22	2,029	1,922	3,951	20.4%	21.0%	20.6%				**47**	**39**	**86**
23	1,697	1,693	3,390	17.0%	18.5%	17.7%				**39**	**34**	**74**
24	1,526	1,474	3,000	15.3%	16.1%	15.7%				**35**	**30**	**65**
25	1,439	1,446	2,885	24.2%	22.9%	23.6%	347	230	577	**84**	**53**	**136**
26	1,103	1,398	2,501	18.6%	22.2%	20.4%	↓	↓	↓	**64**	**51**	**118**
27	1,098	1,318	2,416	18.5%	20.9%	19.7%				**64**	**48**	**114**
28	1,135	1,073	2,208	19.1%	17.0%	18.0%				**66**	**39**	**104**
29	1,167	1,071	2,238	19.6%	17.0%	18.3%				**68**	**39**	**105**
30	1,162	1,033	2,195	20.7%	20.8%	20.7%	456	384	840	**94**	**80**	**174**
31	1,141	1,005	2,146	20.3%	20.2%	20.3%	↓	↓	↓	**93**	**78**	**170**
32	1,114	985	2,099	19.8%	19.8%	19.8%				**90**	**76**	**166**
33	1,100	971	2,071	19.6%	19.5%	19.6%				**89**	**75**	**164**
34	1,101	978	2,079	19.6%	19.7%	19.6%				**89**	**76**	**165**
↓												



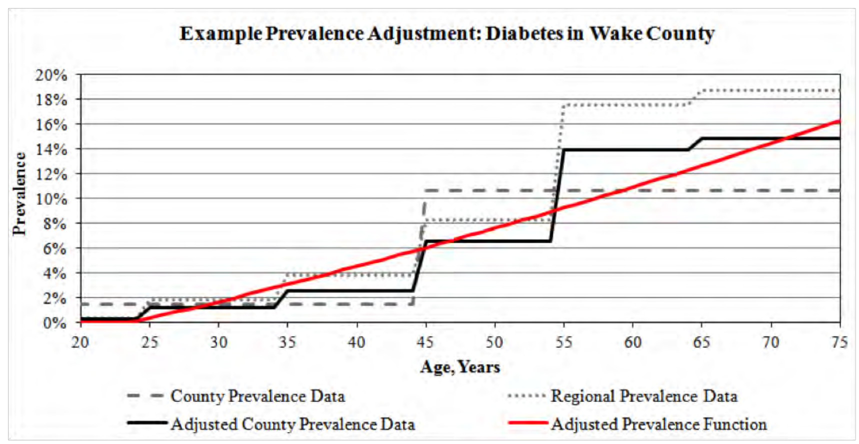
Population Disease Prevalence Estimation

Like population data, the DYNAMO-HIA requires age-specific baseline prevalence estimates for each disease specified. We use 2009 BRFSS data to estimate these values; however, these data are reported in two age groups at the county level and six age groups at the regional level. We follow a conceptually similar process as for population data as described previously. We use the finer-grained regional disease prevalence rates to estimate prevalence rates in the same age ranges at the county level constrained to given disease prevalence in the larger age ranges at the county level. To do this, we do the following for each disease:

1. Calculate the number of individuals in each county-level age group with each disease using 2009 NC SCHS population estimates and county-level prevalence estimates
2. Calculate the number of individuals in each regional age group with each disease using 2009 NC SCHS population estimates and regional prevalence estimates
3. Sum the total number of individuals with the disease from the regional prevalence estimates applied to county population (i.e., sum values from #2 into county-level age groups)
4. Calculate an adjustment factor, equal to the sum from #3 divided by the total from #1
5. Adjust the county-specific prevalence estimates using the six regional age groups by the adjustment factor calculated in #4
6. Use the six age group prevalence estimates to fit a second-order continuous prevalence function, assuming each prevalence value occurs at the population-weighted age midpoint of the six age groups
7. Use the continuous function above to estimate disease prevalence at 1-year intervals (i.e., 0, 1, 2, 3, etc.); subject to the following:
   - Disease prevalence below age 18 is always zero;
   - Disease prevalence is always positive;
   - Disease prevalence always increases with age (if a portion of the prevalence curve had a negative slope, values prior to the low point of the function were replaced with the low point so that the slope was equal to zero); and
   - Prevalence is constant after age 75.

An example calculation and graphical representation are presented below, for Diabetes prevalence in Wake County:

County Prevalence Data				Regional Prevalence Data				Estimated Prevalence Data	
Age Group	Prevalence	County Population	Individuals with Disease	Age Group	Prevalence	County Population	Individuals with Disease	Adjusted Number of individuals	Adjusted Prevalence
18-44	1.5%	386,848	**5,803**	18-24	0.4%	93,774	375	250	**0.3%**
				25-34	1.8%	140,898	2,536	1,693	**1.2%**
				35-44	3.8%	152,176	5,783	3,860	**2.5%**
						SUM:	***8,694***	**5,803 ✓**	
						ADJUSTMENT FACTOR:	***0.667***		
45+	10.7%	286,403	**30,645**	45-54	8.3%	133,472	11,078	8,745	**6.6%**
				55-64	17.6%	84,177	14,815	11,696	**13.9%**
				65+	18.8%	68,754	12,926	10,204	**14.8%**
						SUM:	***38,819***	**30,645 ✓**	
						ADJUSTMENT FACTOR:	***0.789***		



Population Disease Instance Estimation

Using a differential equation-based method developed by Ralph Brinks, age-specific incidence rates are derived for each study area population.[6] While this method is only applicable to chronic disease with no remission, the prevalence data on which incidence data are estimated are generally stated in the form of "Has your doctor every told you have [disease]?" or similar;[5] thus, the data available implicitly ignore the possibility of remission into a healthy state. While this may lead to overestimates of prevalence in the population for disease such as hypertension, it also ensures the validity of the incidence estimation procedure employed. To perform incidence rate estimations, the following steps were conducted for each study area (see Figure A1 for an example of this process):

1. Fit a second-order function, $s(a)$ to given prevalence data
2. Take the derivative of the prevalence function, ds/da
3. Define the function $c=((ds/da))/((1-s))$
4. Estimate age-specific incidence using the following function; only used to predict incidence at ages for which prevalence is known $i(a)=c(a)+m(a)\times(1-(s(a)\times (R(a)-1)+1)^{-1})$
5. Fit a fourth-order function to the estimated incidence data between points. Assume incidence is zero below age 18 and constant above age 75.

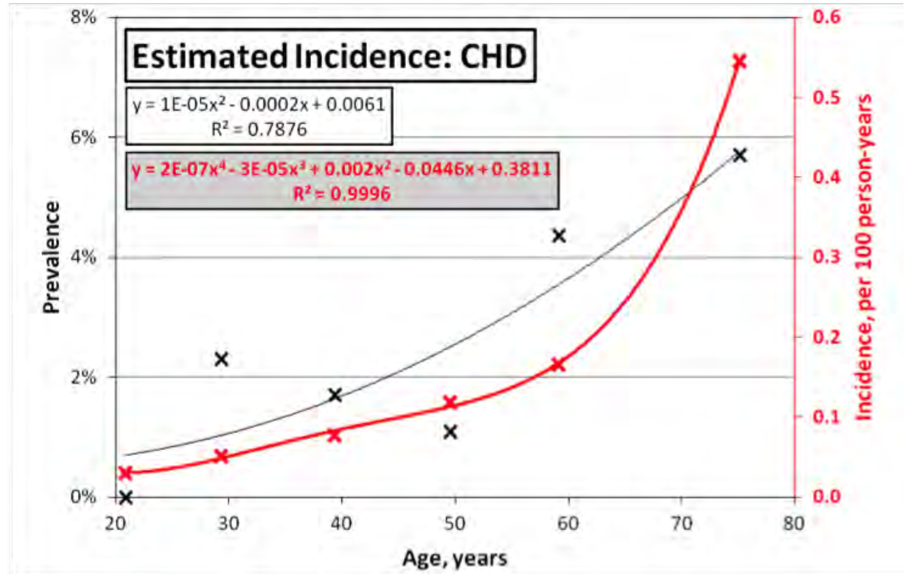


Figure A1. Estimated Incidence of CHD, Winterville Study Area

Transportation Behavior Estimation

We estimate increased physical activity from walking for transportation using behavioral evidence from studies of the built environment and transportation behavior. For the Winterville and BRRC study areas, we are interested in the total length and density of the sidewalk network because the plans we investigate include the construction of new sidewalks. In the Sparta study area, we are interested in the quality of the pedestrian environment because the Downtown Streetscape Strategy includes pedestrian improvements but no new sidewalk construction.

Considering sidewalk length and density, we focus on a dissertation exploring transportation behavior in the Raleigh-Durham-Chapel Hill Metropolitan Statistical Area completed by Yingling Fan, now an assistant professor at the University of Minnesota. The study considers transportation from three different perspectives and develops several predictive models linking built environment variables to transportation behaviors. Specifically, the study estimates that a 1% increase in total sidewalk length is associated with a 0.12% increase in average walking time. The study also estimates that a 1 mile per square mile increase in sidewalk density increases the odds of an individual having reported walking by 1.4%. We consider these two effects to be distinct effects that influence two different populations: average walking time influencing existing walkers and increases in the odds of walking influencing existing non-walkers. We estimate that the average increase in walking time applies evenly to each walking time category; thus, we multiply the average walking time of each walking time category by the predicted change and hold the percentage of the population in each walking time category constant. We then calculate the observed odds of walking, apply the predicted increase in odds, and multiply the total number of walkers by a factor so that the new odds equal the predicted increased odds. We assume that new walkers are distributed proportionally across all walking time categories based on the existing distribution. Conceptually, we increase the mean walking time of each walking time category ("expanding" each walking time category) using changes in total sidewalk length and move a portion of non-walkers into the walking time categories using changes in sidewalk density.

Considering improvements to sidewalk quality, we use the concept of a Pedestrian Environment Factor (PEF) first developed in the LUTRAQ project in Portland, Oregon. The PEF is a 12-point index that assesses the quality of the pedestrian environment based on four variables: 1) sidewalk quality; 2) ease of street crossings; 3) topography; and 4) local street network configuration. Each characteristic is assessed on a 3-point scale (1, 2, or 3) and the values are summed to derive the PEF; thus, the PEF can range from 4-12. As applied in research, PEF scores are divided into thirds; thus, the absolute PEF value in a given geography is less important that the relative value of the PEF compared to other geographies in the study area. For our purposes, we assume that topography and local street network characteristics remain constant pre- and post-project; however, both sidewalk quality and ease of street crossings increase in a subjective rating from 1 to 3. This results in a predicted increase in PEF of 4 points for the areas in the vicinity of the downtown streetscape improvements. We conservatively assume that this is analogous to a move from the lowest PEF third to the middle PEF third. Using a study by Boarnet et al. from 2008, we thus assume that this results in an increase of 0.71 miles per week per person living in the vicinity of the downtown streetscape project. We translate this value into a 13.6 minute increase in minutes walked per person per week living within 0.25 miles of the streetscape improvements and apply this increased walking time to both existing walkers and to non-walkers. Using GIS, we calculate that 25% of the total land area of the Town of Sparta is within 0.25 miles of the proposed improvements, thus we assume that only 25% of the population in each walking time category increases his or her walking time by this amount per week.

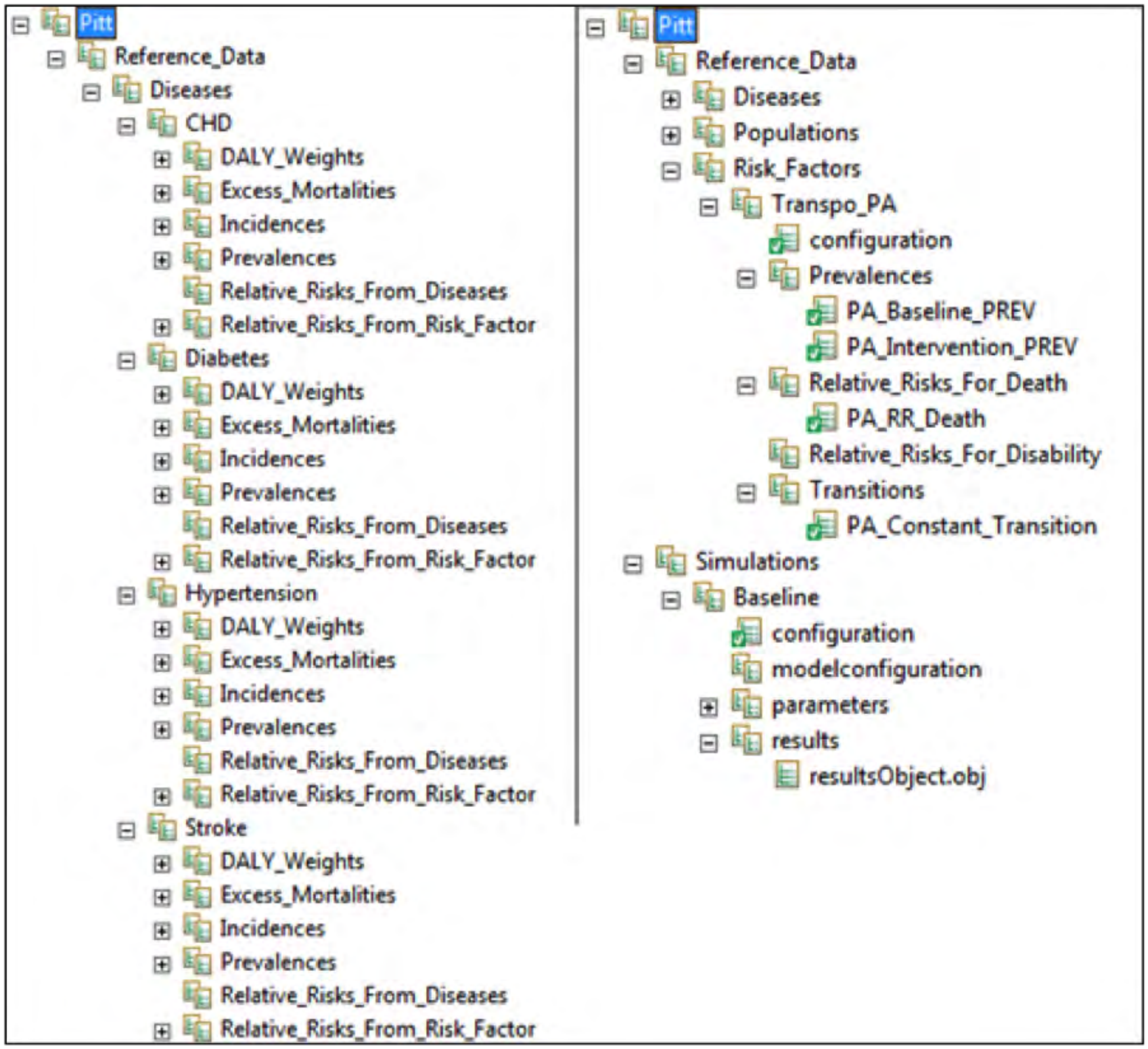
Appendix 4: DYNAMO-HIA Technical Documentation

DYNAMO-HIA Data Requirements

	Data	Source
Population	**Newborns:** *number of projected newborns for the given population*	*Unidentified*
	Overall DALY Weights: *percentage of disability*	*National Surveys*
	Overall Mortality: *observed mortality rate by age and sex*	*NC SCHS*
	Size: *population size by age and sex*	*Census/ACS*
Diseases	**Excess Mortality:** *additional mortality when having the disease*	*Epidemiological studies*
	Incidence: *number of cases per person-years, by age and sex*	*NC SCHS*
	Prevalence: *age and sex specific prevalence of the population*	*NC SCHS*
	Relative Risks from Diseases: *relative risk of contracting the disease when having another disease, by age and sex*	*Epidemiological studies*
	Relative Risks from Risk Factor: *Information on how the underlying risk factor affects the risk of contracting the given disease; differs slightly based on risk factor*	*Epidemiological studies*
	DALY Weights: *percentage of disability caused by disease*	*Unidentified*
Risk Factors	**Prevalance Data for Lack of Physical Activity:** *percentage in each exposure category for each age and gender (e.g., percent of population that is physically inactive*	*BRFSS or local surveys*
	Relative Risk for Death (optional): *relvative risk of the risk factor on total mortality; age and sex specific*	*Epidemiological studies*
	Relative Risk for Disability (optional): *relative risk of the risk factor on total disability; age and sex specific*	*Epidemiological studies*
	Transitions: *age and sex specific probability of switching from one risk factor category to another (key model component for our purposes)*	*Elasticities from literature on behavioral change due to changes in the built environment*

Data Preparation

For inclusion in the DYNAMO-HIA model architecture, data must be converted into .xml files with specific structures, depending on the type of data. This is accomplished using Excel Macros provided to the user during the DYNAMO-HIA model installation. Model files are entered into a folder with the following form:



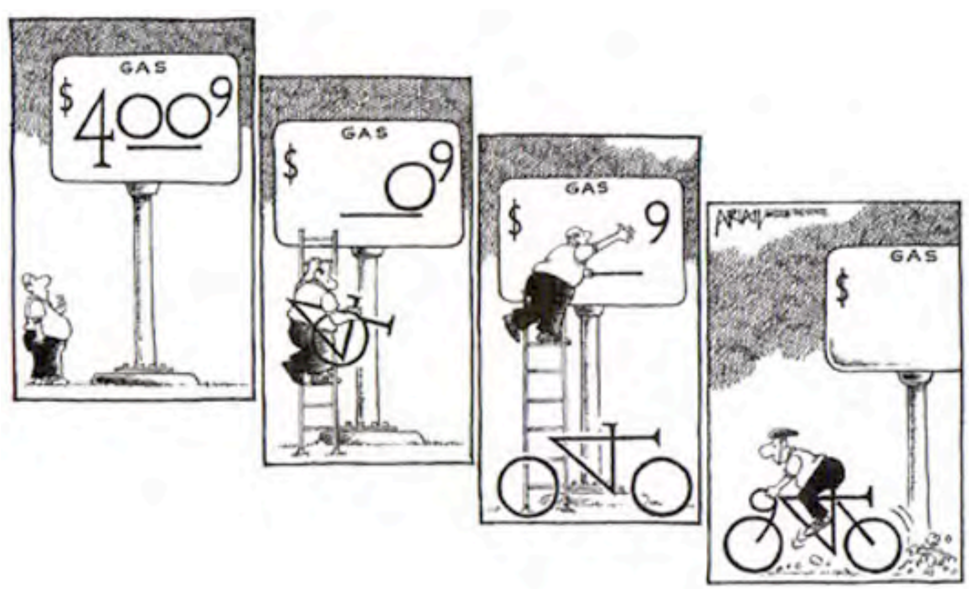
9.5 Economics

Duck, NC

Introduction

Bicycling and walking are important forms of transportation that hold substantial benefits over other modes in terms of cost, environmental sustainability, health impacts, and safety. The state of North Carolina (referred to henceforth as "the state") and the state of North Carolina Department of Transportation (NCDOT) recognize that creating a state that is more bicycle and pedestrian friendly is beneficial not just to individual residents, but to local communities and to the state as a whole as well.

Accordingly, NCDOT recently changed its mission statement to "Connecting people and places safely and efficiently, with accountability and environmental sensitivity to enhance the economy, health and well-being of North Carolina." By including health and well-being in its mission statement, NCDOT is recognizing that transportation is more than just getting from one place to another, but also has a measurable effect on quality of life.



Source: Robert Ariail (2009)

In this Chapter

In this spirit, NCDOT has commissioned a Pedestrian and Bicycle Master Plan ("the Master Plan") for the state. The document will include both plans for improving current greenways and other bicycle and pedestrian infrastructure, and for creating and maintaining new bicycle and pedestrian facilities.

An important component of its Master Plan is the promotion of policies and investments that have a positive economic impact on the state. This appendix considers the following categories of economic impact:

1. The economic impact of upfront construction of the bicycle and pedestrian infrastructure, which translates into a one-time stimulus of economic activity and job creation during the construction period;
2. The economic impact of ongoing use of the bicycle and pedestrian infrastructure. This impact comes largely in the form of tourism that is attracted to the state by the existence of the infrastructure. Tourism attractions bring in purchasing power from outside the state to support economic activity and employment within it;
3. The direct use value enjoyed by users of the bicycle and pedestrian infrastructure;
4. The health care cost reduction from increased active living resulting from the newfound access to a recreational amenity;
5. The commuting gains that will occur as commuters opt for biking or walking to and from work or school, thereby reducing road congestion, including the safety impact of additional dedicated pathways that remove bicyclists and pedestrians from shared roads, thus lowering automobile accidents; and the personal cost savings from cheaper alternative transportation modes.

CASE STUDY

The Swamp Rabbit Trail

The Greenville Hospital System Swamp Rabbit Trail (SRT) is a 17.5 mile recreational trail running along the Reedy River in Greenville, South Carolina. The SRT, which opened in 2009, was created to provide residents with active recreation opportunities, offer a non-motorized commuting option, and promote economic activity.

An estimated 359,000 people use the SRT annually. Businesses near the trail reported increases in sales ranging from 30% to 85% as a result of increased business from visitors to the trail. One business decided to open as a result of the trail's construction, and another relocated to the site and saw a 30% increase in sales as a result. A third business reported that 75% of Saturday business and 40% of weekday business could be attributed to the trail (Reed 2012).

State of North Carolina Mode Shares for Walking and Bicycling as Compared to Top Five States and Neighboring States

Rank	State	Walk Commute Mode Share	Rank	State	Bike Commute Mode Share
1	Alaska	8.2%	1	Oregon	2.1%
2	New York	6.3%	2	Montana	1.3%
3	Vermont	6.2%	3	Colorado	1.2%
4	Montana	5.1%	4	Idaho	1.2%
5	Hawaii	4.7%	5	Wyoming	1.1%
-	United States	2.9%	-	United States	0.5%
32	Virginia	2.4%	34	Virginia	0.3%
42	South Carolina	1.9%	37	South Carolina	0.3%
44	North Carolina	1.8%	40	North Carolina	0.2%
49	Tennessee	1.4%	48	Tennessee	0.1%

Source: US Census Bureau (2011)

6. The property value impact associated with people's willingness to pay a premium to be located near such an outdoor amenity, which translates into wealth gains for property owners and increased property tax revenues for local governments.

The scale of these economic impacts can be estimated using a variety of industry standard techniques. As this approach is prospective rather than retrospective in nature, and as a number of impacts are difficult to quantify in precise terms, a number of predicted economic benefits must be made and results should be considered rough approximations. All predicted economic benefits are designed to be conservative so as not to overstate impacts.

For the purposes of this report, it is assumed that plans for the expansion of bicycle and pedestrian infrastructure will result in the construction of 300 miles of new greenway trails. Should plans result in more or less expansion,

The Virginia Creeper Trail

The Virginia Creeper Trail (VCT) is a 34.3 mile recreational trail in southwestern Virginia. The rail-to-trail project, completed in 1984, was developed through a public-private partnership and is maintained by federal, state, and local government agencies, as well as volunteers and private organizations.

One study found the individual net economic value for recreational use of the VCT to be between $23 to $38 per person per trip. All local and nonlocal visitors spend approximately $2.5 million in the region in per year.

Of this spending, tourists visiting the VCT from outside the study region (Washington and Greyson counties) spend about $1.2 million annually in direct spending, generating $1.6 million in total spending (Bowker 2004, Bowker 2007). An estimated 10,305 overnight visitors and 40,034 day visitors per¬ year come for the primary purpose of using the trail. Nonlocal users traveled an average of 260 miles.

When asked to rank the benefits they receive from using the VCT, users ranked "health and fitness" as the most important, followed by "opportunity

Economics

impact estimates should be sized upward or downward accordingly.

We believe this is a reasonable estimate based on plans already in place, through which anticipated spending on bicycle and pedestrian infrastructure is far exceeding any previous investment levels.

Furthermore, as of the 2010 Census, the state ranks 40th among all states for bicycle commute share and 44th for walking mode share. Simply meeting national averages would mean more than a doubling of bicycle commuters and over a 50 percent increase in the number of walking commuters. In fact, over the long range, it is suggested that the state aspire to a walk mode share of 3 percent and a bicycle mode share of 2 percent. Meeting this goal would represent a significant increase in the amount of walking and bicycling taking place within the state, in excess of the example increases assumed throughout this report.

Suggested Future Goal Ranges for State of North Carolina Mode Shares for Walking and Bicycling

Commute Mode Share	Current (2010)	Low / Short-Term Goal	Med / Medium-Term Goal	High / Long-Term Goal
Walk	*1.8%*	*2.0%*	*2.5%*	*3.0%*
Bicycle	*0.2%*	*0.5%*	*1.0%*	*2.0%*

▲ *Source for current mode share: US Census Bureau (2010)*

Economic Impact from Upfront Construction of Bicycle and Pedestrian Infrastructure

Overview

There is a growing realization and appreciation of the significant economic stimulus that results from large-scale physical improvement projects such as the construction of pedestrian and bicycle infrastructure. These projects create immediate construction employment opportunities, resulting in large amounts of initial expenditures whose economic impact ripples through entire local and regional economies, creating jobs within a region and generating tax revenues for the local jurisdictions within that region. This is particularly helpful at a time of slack construction demand, high unemployment, and distressed fiscal conditions.

Predicted Economic Benefits

Project costs for the initial construction and renovation of greenways are not known at this juncture, since decisions have not yet been made as to how much and where such amenities will be built, and to what level of quality. Therefore, two sets of predicted economic benefits must be made:

1. How many new greenway miles will be built? It is assumed that this Plan will result in the construction of 300 new miles of trails.

2. How much will construction cost? Per mile construction costs were assumed to approximate those of other, similar projects. Based on a review of other trails, a cost estimate of approximately $280,000 per mile was used.[1]

Economic Impact

Three hundred miles of new greenways in the state, at $280,000 in construction costs per mile, results in about $84 million in new construction. To estimate the total economic impact associated with this amount of upfront construction, a standard input-output model was developed. Multiplier data provided by the US Department of Commerce were used to calculate the composition and scale of total expenditures, employment, and earnings resulting from the aggregate direct expenditures from trail construction.[2]

Based on this model, it appears that economic impact from construction within the state will be significant. It is estimated that construction spending will generate about $174 million in total expenditures, supporting about 1,600 jobs within the state and jobs and generating about $2 million in tax revenues for the state.[3]

Estimated Total One-Time Upfront Economic Impact Resulting from Construction of New Bicycle and Pedestrian Infrastructure within the State of North Carolina

	State of North Carolina
Direct Expenditures ($M)	*$84*
Indirect Expenditures ($M)	*$89*
Total Expenditures ($M)	*$174*
Total Employees	*1,600*
Total Earnings ($M)	*$55*
Total Tax Revenues ($M)	*$1.7*

Source: US Department of Commerce (2011), Econsult Corporation (2012)

Economic Impact from Ongoing Use of Bicycle and Pedestrian Infrastructure

Overview

In addition to upfront construction impacts, bicycle and pedestrian infrastructure will also create annual economic impacts through its continued operations, particularly as it draws in tourists to the state. Tourism is an important engine of economic growth: visitors spend money on hotels, transportation, dining, and entertainment, and therefore represent the use of outside purchasing power to support local businesses and governments. Therefore, it is important to consider the tourism impact of a major recreational amenity such as bicycle and pedestrian greenways.

Predicted Economic Benefits

Literature shows that additions and improvements to bicycle and pedestrian infrastructure will increase the number of outside tourists visiting a region. However, it is unknown at this time how much additional tourism activity will result from the additions to the state's inventory of bicycle and pedestrian infrastructure. For now, it is assumed that current tourism associated specifically with bicycle and pedestrian activity will increase by 40 percent: 20 percent from the addition of more greenways, and 20 percent from increased connectivity, improved activities, and enhanced promotion of existing greenways. Should actual tourism activity vary from this estimate, the results reported here can be adjusted upward or downward.

New Visitor Spending

A literature review was conducted in order to better understand the impact of bicycle and pedestrian infrastructure on tourism.[4] Of the approximately 23 million overnight visitors who came to the state in 2011[5], many participated in activities relating to biking or walking. Thus, biking and walking-related tourism represent an important sector of the state's tourism industry.

Estimated Number of Out-of-State Overnight Visitors Who Participated in Bicycle or Pedestrian Activities within the State of North Carolina in 2011

Activity	% of Out-of-State Tourists	# of Out-of-State Tourists (in M)
Rural sightseeing	12.9%	3.01
State/national park	8.6%	2.00
Urban sightseeing	7.4%	1.72
Wildlife viewing	5.8%	1.35
Hiking/ backpacking	3.9%	0.91
Bird watching	2.9%	0.68
Nature travel/ ecotouring	2.7%	0.63
Biking	2.0%	0.47

Source: VisitNC.com (2011), Econsult Corporation (2012); Bottom row: Considered in Estimating Aggregate Tourism Activity on Bicycle and Pedestrian Infrastructure.

To be conservative, and because it is difficult to determine which of the pedestrian-related activities occur as a result of specific pedestrian and bicycle infrastructure, it is assumed that 12 % of all out-of-state tourists participated in bicycle and pedestrian activities. This is lower than the sum of all pedestrian and bicycle activities. However, because survey respondents were permitted to select multiple activities, there is likely to be some overlap. Six percent of all out-of-state overnight visitors is equivalent to 2.76 million people.

How much new out-of-state visitor spending is generated by investment in pedestrian and bicycle infrastructure is a function of two additional variables, for which conservative predicted economic benefits are used to arrive at a preliminary estimate. First, it is assumed that investment in bicycle and pedestrian infrastructure increases the number of pedestrian and bicycle tourists by 40 percent, as stated above. Second, it is assumed that these tourists represent $60 per day in spending, based on data from prior studies.[6] This yields an additional $68 million in out-of-state visitor spending as a result of investment in bicycle and pedestrian infrastructure.

These estimates could very well end up being far too conservative. In 2011, the state saw 37 million overnight visitors, who spent an aggregate $17 billion. A $68 million increase in visitor spending therefore represents an increase of only 0.4 percent. As new bicycle and pedestrian infrastructure comes into existence, the state may have a better understanding of the new purchasing power it is able to attract as a result.

Estimated Increase in Out-of-State Spending Resulting from Investment in Bicycle and Pedestrian Infrastructure within the State of North Carolina

# Current Bicycle/ Pedestrian Tourists	% Increase in # Bicycle/ Pedestrian Tourists	# New Bicycle/ Pedestrian Tourists	Avg. Spending per Bicycle/ Pedestrian Tourist	Aggregate Spending by New Bicycle/ Pedestrian Tourists
2.8 million	*40%*	*1,120,000*	*$60*	*$68 million*

Source: North Carolina Division of Tourism, Film, and Sports Development (2011), Econsult Corporation (2012)

Economic Impact

The economic impact of this level of new spending can be modeled using the same methodology and model described in the previous section. Based on the predicted economic benefits used above, it is estimated that investment in pedestrian and bicycle infrastructure will result in about $128 million in new expenditures each year, supporting about 1,600 new jobs within the state and generating about $1 million in tax revenues for the state.

Additional Considerations

This estimate of tourism spending conservatively analyzes only out-of-state visitors. However, bicycle and pedestrian facilities will also attract in-state visitors who would otherwise have left the state for bicycling and walking activities. Additionally, pedestrian and bicycle facilities can cause economic activity to concentrate in certain areas rather than being distributed around the state, resulting in additional gains from agglomeration.

This analysis is also conservative in that it only considers net new expenditures from leisure visitors. This neglects the potential economic impact from new business activity that is attracted by bicycle and pedestrian infrastructure. Such

Estimated Annual Economic Impact Resulting from Increased Out-of-State Bicycle/Pedestrian Tourism within the State of North Carolina

	State of North Carolina
Direct Expenditures ($M)	*$68*
Indirect Expenditures ($M)	*$60*
Total Expenditures ($M)	*$128*
Total Employees	*1600*
Total Earnings ($M)	*$36*
Total Tax Revenues ($M)	*$1.1*

Source: US Department of Commerce (2011), Econsult Corporation (2012)

outdoor amenities are increasingly considered by both employers and employees in their locational decisions, so investment in bicycle and pedestrian infrastructure could very well yield additional business attraction, retention, and expansion within the state. [7] Studies have also shown that bicycle and pedestrian infrastructure is economically beneficial to commercial corridors and retail centers, by increasing foot traffic and accessibility and by improving the aesthetics of a location. [8]

Economic Impact of Direct Use Value of Bicycle and Pedestrian Infrastructure

Overview

Recreational amenities like pedestrian and bicycle infrastructure are designed to facilitate enjoyable activities such as jogging, hiking, and bicycling. Little or no money exchanges hands when a person uses a greenway for recreation, but this person still derives significant personal benefits, which economists call "consumer utility" and which can be quantified using "willingness to pay" surveys. These surveys ask respondents how much they would be willing to pay to participate in an activity, thereby allowing an average direct use value to be assigned to that activity[9].

The most accepted "willingness to pay" estimates of direct use value are based on surveys conducted by the US Army Corps of Engineers, which publishes "Unit Day Values" of a variety of recreational activities. The implementation of pedestrian and bicycle infrastructure within the state is likely to lead to a significant increase in the number of recreational users and recreational uses, and therefore confers benefit to those users, on which an estimated aggregate value of their consumer utility can be placed.

Predicted Economic Benefits

It is unknown how much new recreational activity will be generated by investment in bicycle and pedestrian infrastructure, since decisions about how much and where to build have not yet been made. For now, it is assumed that recreational activity will increase by 40 percent. This is not inconsistent with increases in recreational use seen when other greenways were constructed[10].

Base Amount of Recreational Activity

Literature shows that an increase in bicycle and pedestrian infrastructure will lead to an increase in users in bicycle and pedestrian activities. It is unknown at this time how much additional recreational activity will result from the implementation of the bicycle and pedestrian facilities, but one way to forecast this amount is to estimate the current base of recreational activity, and then to assign some percentage increase in that recreational activity that results from the implementation of the trail.

Bicycle and walking activities are already popular among residents of the state, with 82 percent of the population reporting that they walk for pleasure. Multiplying through by the average number of uses per year and by Unit Day Values yields a very high aggregate amount of direct use value derived from various outdoor recreational activities: 2.65 billion uses per year, totaling $4.5 billion.

Of course, not all outdoor recreation activities involve walking or bicycling, and not all walking and bicycling occurs on pedestrian and bicycle infrastructure. It is assumed that walking for pleasure, bicycling, day hiking, and running or jogging are the only four activities that will increase with the addition of the state's improved bicycle and pedestrian infrastructure. Furthermore, it is estimated that of the total amount of these activities, only 25 percent of the total uses occur on pedestrian and bicycle infrastructure. Based on these predicted economic benefits, it is estimated that pedestrian and bicycle infrastructure is responsible for about 250 million uses and about $570 million in direct use value per year.

Estimated Aggregate Value Derived by Residents of the State of North Carolina per Year from Participation in Selected Outdoor Recreation Activities

Activity	% of Population that Participates	Total # Users (M)	Avg. # Uses/Yr	Total # Uses (M)	Unit Day Value	Total Unit Day Value ($M)
Walk for pleasure	82%	7.9	68.4	542	$1.47	$796
View/photo natural scenery	57%	5.5	45.9	253	$1.32	$334
Visit nature centers, etc.	53%	5.1	45.9	234	$1.47	$345
Sightseeing	53%	5.1	45.9	234	$1.32	$310
Visit historic Sites	43%	4.2	45.9	191	$1.32	$252
View/photo other wildlife	43%	4.2	45.9	191	$1.32	$252
View/photo wildflowers, trees	41%	4.0	45.9	182	$1.32	$240
View/photograph birds	34%	3.3	45.9	151	$1.32	$199
Bicycling	31%	3.0	35.3	106	$3.16	$334
Visit a primitive area	30%	2.9	45.9	132	$1.32	$174
Day hiking	30%	2.9	45.9	132	$3.16	$416
Running or jogging	28%	2.7	81.7	223	$3.25	$726
Visit archeological sites	18%	1.7	45.9	80	$1.32	$105
Total				**2,650**		**$4,482**

Source: North Carolina Division of Parks and Recreation (2009), Ohio Department of Natural Resources (2001), US Army Corps of Engineers (2010), Econsult Corporation (2012)

Economic Impact

Given this set of predicted economic benefits concerning base use of existing bicycle and pedestrian infrastructure, it is estimated that further investment will yield significant additional activity and therefore recreational benefit. A 40 percent increase in recreational activity would mean 100 million more uses and $230 million more in direct use value per year.

Health Care Cost Reduction from Increased Activity from Bicycle and Pedestrian Infrastructure

Overview

Walking and bicycling – whether for commuting or leisure – are physical activities that can have positive health effects on the bicyclists and pedestrians. This can in turn reduce the amount of money that is spent on health care by bicyclists and pedestrians, and by the health care pools of which they are a part. Health problems due to inactivity

Estimated Aggregate Value Derived by Residents of the State of North Carolina per Year from Participation in Selected Outdoor Recreation Activities Taking Place on Bicycle and Pedestrian Infrastructure

Source: North Carolina Division of Parks and Recreation (2009), Ohio Department of Natural Resources (2001), US Army Corps of Engineers (2010), Econsult Corporation (2012)

Activity	Total # Uses (M)	Total # Uses (M) Bicycle/ Pedestrian Infrastructure Only	Total Direct Use Value ($M)	Total Direct Use Value ($M) Bicycle/ Pedestrian Infrastructure Only
Walk for pleasure	*542*	*135*	*$796*	*$199*
Bicycling	*106*	*26*	*$334*	*$83*
Day hiking	*132*	*33*	*$416*	*$104*
Running or jogging	*223*	*56*	*$726*	*$181*
Total	***1,002***	***251***	***$2,272***	***$568***

Increase in Estimated Aggregate Value Derived by Residents of the State of North Carolina per Year from Participation in Selected Outdoor Recreation Activities as a Result of Investment in Bicycle and Pedestrian Infrastructure

Activity	Current # Uses (M)	Increase in # Uses (M)	Current Direct Use Value ($M)	Increase in Direct Use Value ($M)
Walk for pleasure	*135*	*54*	*$199*	*$80*
Bicycling	*26*	*10*	*$83*	*$34*
Day hiking	*33*	*14*	*$104*	*$42*
Running or jogging	*56*	*22*	*$181*	*$72*
Total	***251***	***100***	***$568***	***$228***

Source: North Carolina Division of Parks and Recreation (2009), Ohio Department of Natural Resources (2001), US Army Corps of Engineers (2010), Econsult Corporation (2012) are a common and growing problem in the US, and health care costs are expanding significantly. Outdoor amenities are helpful in promoting moderate physical activity. Even minor changes in daily habits can make a difference in health outcomes, with significant impacts on health care cost burdens. Preventative active living results in lower rates of hospital visits due to lower rates of obesity, chronic disease, and asthma.

Existing Literature

There is a substantial body of literature connecting access to recreational amenities to increased active living, and increased active living to improved health outcomes and to lower health care costs[11]. Health care cost reductions take place in at least five categories:

1. Direct health care costs – The amount spent immediately as a result of short-term health care needs.
2. Indirect health care costs – The amount spent over a lifetime as a result of reduced risk of chronic illness.
3. Direct worker's compensation costs – The direct amount spent on worker's compensation claims.
4. Indirect worker's compensation costs – The indirect administrative amount spent on worker's compensation claims.
5. Worker productivity – The cost of absenteeism (unhealthy and not at work) and "presenteeism" (unhealthy and present at work but not fully functioning).

A conservative aggregation of the existing literature on this issue suggests that the per person cost reduction associated with active living is about $3,000, when considering all of these health care cost reduction categories.

Predicted Economic Benefits

New pedestrian and bicycle infrastructure is particularly impactful in generating new exercisers from the population of people who live near the new infrastructure, since their barriers to active recreation have been lowered so dramatically as a result of the new amenities. However, since it is currently unknown how much new investment in pedestrian and bicycle infrastructure is being planned and where it will be located, it is difficult to predict the number of new exercisers that will result from such investments.

For now, one can make a preliminary assumption and then revise these results once actual increases in recreational activity can be measured. Consider first that 82 percent of residents of the state currently walk for pleasure. If one assumes that of the remaining 18 percent who do not, investment in bicycle and pedestrian infrastructure will result in just two percent of them taking up active recreation, this represents 26,000 new exercisers out of the state's adult population of 7.4 million people.

Conservative Estimate of Health Care Cost Savings Each Year within the State of North Carolina As a Result of Physical Activity

Health Care Cost Category	Per Person Health Care Cost Savings
Direct Health Care Cost Reductions	*$308*
Indirect Health Care Cost Reductions	*$924*
Direct Worker Compensation Cost Reductions	*$9*
Indirect Worker Compensation Cost Reductions	*$24*
Total	***$2,895***

▲ *Source: Pratt et al (2000), SMART BRFSS (2010), Chenoweth (2005), Chenoweth and Bortz (2005), Census Bureau (2009), Econsult Corporation (2012)*

Economic Impact

Multiplying this number by the low-end estimates of cost impacts for each of the five health care cost reduction categories conservatively yields an estimated health care cost reduction impact of about $76 million per year as a result of the expansion of North Carolina bicycle and pedestrian infrastructure. Should investment in bicycle and pedestrian infrastructure induce additional exercisers, or should health care costs rise higher, the health care cost reduction impacts would be even greater.

Commuting Gains from Bicycle and Pedestrian Infrastructure

Overview

Several studies have shown that the introduction of bicycle or pedestrian infrastructure can influence the commuting mode choice of local residents; this has also been shown to be effective for school-related trips, when safety is a particular priority[12]. There are many economic benefits, such as those achieved through environmental and personal health improvements, associated with replacing short car trips with other modes of transportation. More than 80 percent of North Carolina residents currently drive to work alone. Most others carpool or work from home. Only 1.8 percent of residents report walking to work, and less than 0.2 percent bicycle to work[13]. This equates to a total of approximately 81,000 residents who currently walk or bike to work, out of an adult worker population of 4.2 million.

The change to active commuting results in various benefits for those switching to the new mode of commuting, including improved health and safety. Additionally, this change leads to reduced fuel and automobile maintenance spending and can even aid other commuters by reducing road congestion.

Estimated Number of New Exercisers within the State of North Carolina as a Result of Investment in Bicycle and Pedestrian Infrastructure

Adult Population in the State of North Carolina	% Who Do Not Walk for Pleasure	% Who Begin to Exercise as a Result of Bicycle/ Pedestrian Infrastructure	# New Exercisers as a Result of Bicycle/Pedestrian Infrastructure
7.4 Million	18%	2%	26,000

Source: US Census Bureau (2012), North Carolina Division of Parks and Recreation (2009), Econsult Corporation (2012)

Estimated Number of New Exercisers within the State of North Carolina as a Result of Investment in Bicycle and Pedestrian Infrastructure

# New Exercisers as a Result of Bicycle/ Pedestrian Infrastructure	Per Person Health Care Cost Savings	Aggregate Health Care Cost Savings as a Result of Bicycle/Pedestrian Infrastructure
26,000	$2,895	$76 million

Source: US Census Bureau (2012), North Carolina Division of Parks and Recreation (2009), Econsult Corporation (2012)

Predicted Economic Benefits

This analysis assumes that statewide investments in bicycle and pedestrian facilities will result in a 40 percent increase in the number of residents walking or biking to work through improved accessibility and connectivity. This 40 percent increase is equivalent to roughly 32,000 people[14].

These mode shifts result in fewer car miles driven. It is assumed that half of these commuters would switch from driving (i.e. switching results in less car miles driven), while the other half would switch from some form of public transportation or else from carpooling (i.e. switching does not result in less car miles driven).

It is further assumed that the average new bicycle commuter is traveling 3.5 miles each way, and that the average new pedestrian commuter is traveling 0.7 miles each way, as per the state's current average distances traveled by mode of transportation. This equates to an aggregate 4.9 million fewer car miles not driven.

Economic Impacts – Lower Emissions, Decreased Gasoline Consumption, Reduced Congestion

There are three immediate positive economic impacts that result from reducing car miles driven[15]. First, reducing car miles driven reduces harmful emissions by cars. According to industry averages for emissions per car mile driven and externality costs per pollutant, reducing car miles driven by 4.9 million results in about $150,000 in total benefits per year.

Second, reducing car miles driven reduces the amount of gasoline consumed. According to industry averages, reducing car miles driven by 4.9 million results in about $800,000 less in gasoline purchased and about 12,000 fewer barrels of oil consumed.

Average Distance Traveled to Work within the State of North Carolina, by Mode of Transportation

Mode of Transportation	Distance from Home to Work
Automobile	*17.2*
Bus	*19.8*
Train/subway/trolley	*11.4*
Bicycle	*3.5*
Walk	*0.7*

Source: National Household Travel Survey (2009), Econsult Corporation (2012)

Third, reducing car miles driven reduces congestion for all other drivers. According to the Texas Transportation Institute, the Raleigh-Durham urban area, where about 6.3 billion car miles are driven each year, experienced 19 million hours of travel delay in 2011, wasting 6.6 million gallons of gasoline and resulting in $418 million in congestion costs. Applying these proportions to the state as a whole yields a total congestion costs avoided per year of about $325,000[16].

A reduction in car miles can also lead to economic benefits through reducing the amount of wear and tear on roads and thereby reducing government infrastructure repair spending, allowing these funds to be spent elsewhere. However, these gains are deemed too insubstantial to be included in this analysis. Road deterioration is caused primarily by weather patterns (i.e. the freeze-thaw cycle of seasons) and by heavy trucks, not passenger vehicles, which would not be affected by bicycle and pedestrian infrastructure expansion.

Estimated Reduction in Car Miles Driven as a Result of Increased Bicycle and Pedestrian Commuting in Response to Investment in Bicycle and Pedestrian Infrastructure within the State of North Carolina

	Bicycle Commuters	Pedestrian Commuters	Total
Current # Commuters	9,000	72,000	81,000
% Increase as a Result of Bicycle/Pedestrian Infrastructure	40%	40%	40%
New # Commuters	3,600	28,800	32,400
Avg Distance Traveled (miles)	3.5	0.7	
Aggregate Distance Traveled per Day by New Commuters	25,200	40,320	65,520
Work Days/Year	150	150	
Total Aggregate Distance Traveled per Year by New Commuters	3,780,000	6,048,000	9,828,000
% New Commuters Shifting from Driving	50%	50%	
Reduction in Car Miles Driven	**1.9 Million**	**3 Million**	**4.9 Million**

Source: National Household Travel Survey (2009), Econsult Corporation (2012), US Census Bureau (2011)

Economic Impacts – Increased Safety, Reduced Accidents

Investment in pedestrian and bicycle infrastructure has a threefold effect on commuter safety. First, current pedestrian and bicycle commuters will be safer using dedicated pedestrian and bicycle roadways: studies have shown that marked bike lanes can reduce crash rates by 50 percent when compared to unmarked roads[17], while separated walking infrastructure can also reduce the rate of non-intersection pedestrian accidents by 88 percent[18]. Second, current car commuters who switch to walking and bicycling will avoid the possibility of getting into car accidents. Third, the increased number of pedestrian and bicycle commuters will lead to greater awareness of pedestrians and bicyclists by car drivers on shared roadways.

A recent study found that each mile shifted from motorized transportation to non-motorized transportation resulted in 4 cents in safety benefits[19]. This means that 4.9 million miles shifted from car driving to bicycling or walking generates about $200,000 in annual safety benefits.

Estimated Externality Cost Avoided from Pollutants Not Emitted as a Result of Fewer Car Miles Driven Due to Increased Bicycle and Pedestrian Commuting in Response to Investment in Bicycle and Pedestrian Infrastructure within the State of North Carolina

Pollutant	Grams per Car Mile Driven	Total Pollution Avoided (Tons)	Externality Cost per Ton	Total Externality Cost ($000)
CO_2	365	1,977	$21	$42
SO_2	0.02	0.1	$2,370	$0
CO	9.5	51.5	$1,280	$66
NOX	0.8	4.3	$9,685	$42
VOC	0.28	1.5	$9,040	$14
PM10	0.11	0.6	$6,460	$4
Total				**$167**

Source: Bureau of Transportation Statistics (2009), Energy Information Agency (2010), University of California at Berkeley (2008), Air Pollution Modeling and Its Application XII (1998), Econsult Corporation (2012)

Estimated Gasoline and Oil Not Consumed as a Result of Fewer Car Miles Driven Due to Increased Bicycle and Pedestrian Commuting in Response to Investment in Bicycle and Pedestrian Infrastructure

Car Miles Not Driven	**4.9 Million**
Average Fuel Efficiency (miles per gallon)	22.5
Gallons of Gasoline Not Used	**220,000**
Average Price of Gasoline (per gallon)	$3.71
Total Amount Not Spent on Gasoline ($M)	**$800,000**
Gallons of Gasoline Produced per Barrel of Oil	18.56
Total Barrels of Oils Not Consumed	**11,750**

Source: Bureau of Transportation Statistics (2009), Energy Information Agency (2010), University of California at Berkeley (2008), Air Pollution Modeling and Its Application XII (1998), Econsult Corporation (2012)

Property Value Impact from Bicycle and Pedestrian Infrastructure

Overview

Pedestrian and bicycle infrastructure represents a desirable recreational amenity. Proximity to such infrastructure is increasingly characterized by increasing house values, as people are willing to pay a premium to be near such amenities, regardless of whether they plan to use them. Thus, recreational amenities such as bicycle and pedestrian infrastructure are seen as value-enhancing to nearby properties.

The economic benefit of investing in bicycle and pedestrian infrastructure, from a property value standpoint, is twofold. First, such investments tend to increase nearby property values, therefore generating household wealth. Second, to the extent that these increased property values are properly accounted for in property assessments, they then result in additional annual property tax revenues to municipalities and school districts.

Existing Literature

A more extensive and direct calculation of the property value impact of the introduction of the North Carolina bicycle and pedestrian infrastructure system on its immediate surroundings is beyond the scope of this report, especially since the exact location of new investments are not yet known. However, there is a growing body of literature, including numerous studies conducted by Econsult, that provides some guidance as to the magnitude of property value impact associated with investment in bicycle and pedestrian infrastructure, and off-street greenways in particular. The literature suggests that the property value impact of new greenways on nearby residential properties is something on the order of an additional 4 to 7 percent.

In contrast, investment in roadways for cars is often associated with lower property values, although one must be careful to necessarily assign causality, since the larger rights-of-way needed for roads for cars often means they are sited in lower-valued areas. At the very least, a subset of the studies that have looked at the property value impact of greenways in urban areas have accounted for situations in which bicycle and pedestrian infrastructure has come at the expense of reducing roadway space for cars. In other words, in such cases, any loss associated with decreased car mobility has been more than offset by the gains associated with increased bicycle and pedestrian mobility.

Predicted Economic Benefits

Since it is yet uncertain as to the existence and distribution of new greenway infrastructure such as access points, vista points, and other amenities that may have an influence on property values, we are only able to make a rough estimate of property value impact at this time. To be conservative, it is assumed that the implementation of the new state's bicycle and pedestrian facilities will result in a one-time 4 percent increase in the value of properties located within a ¼-mile of the new infrastructure[20].

To arrive at an estimate of the number of homes that will fall within a ¼-mile of new greenways, a number of conservative estimates were made. First, the statewide housing density of 80 houses per square mile was assumed[21]. Second, the smallest possible area within a ¼-mile radius of the assumed 300 miles of new greenways was assumed, which is an area of about 150 square miles[22]. This yields about 12,000 houses. At an average house value of about $130,000, there is about $1.6 billion in aggregate house value within a ¼-mile radius of the assumed 300 miles of new greenways.

Economic Impact

Investment in new bicycle and pedestrian infrastructure is likely to have a significant impact on property values and on property tax revenues. Based on the conservative predicted economic benefits above, and assuming a one-time 4 percent increase in the value of properties located within a ¼-mile of the new greenways proposed in this plan, the estimated one-time increase in property value would be on the order of about $64 million. Conservatively

Summary of Relevant Studies on the Property Value Impact of Trails, Parks, and Other Green Space[1]

See resources at the end of this appendix for a more detailed version of this table

Source	Estimated Property Value Impact
"A Dynamic Approach to Estimating Hedonic Prices for Environmental Goods: An Application to Open Space Purchase," Riddel (2001)	*+3.75%*
"Quantifying the Economic Value of Protected Open Space in Southeastern Pennsylvania," Econsult Corporation (2010)	*+7%*
"The Economic Impact of the Catawba Regional Trail," Campbell and Monroe (2004)	*+4%*
"The Potential Economic Impacts of the Proposed Carolina Thread Trail," Econsult Corporation (2007)	*+4%*
"Valuing the Conversion of Urban Green Space," Econsult Corporation (2010)	*+7.2%*

▲ *Source: See above*

assuming a real property tax rate of 1 percent, and assuming that property value increases are properly accounted for in property tax assessments, that magnitude of property value increase would generate about $640,000 per year in new property tax revenues to various municipalities and school districts.

Estimated Aggregate House Value within the State of North Carolina That Will Be within a Quarter-Mile of New Greenways

Houses/ Sq. Mi.	Sq. Mi. within ¼-Mile	# Houses within ¼-Mile	Average House Value	Aggregate House Value within ¼-Mile
80	*150*	*12,000*	*$133,000*	*$1.6 Billion*

▲ *Source: US Census Bureau (2010), Zillow.com (2012), Econsult Corporation (2012)*

Conclusion

This report has discussed the many forms of economic impact that may result from an increase in the rate of bicycling and walking activity across the state and associated new investments in bicycle and pedestrian infrastructure. Specific quantifications of economic impact from investment in bicycle and pedestrian infrastructure await the actual decisions on whether, where, and to what degree such infrastructure will be implemented throughout the state of North Carolina, and how people and organizations will respond to the existence of these amenities. Nevertheless, this first approximation of the type and magnitude of economic impact suggests that there are a number of ways in which investment in bicycle and pedestrian infrastructure generates very real and very large economic returns, to the state and to its residents and businesses.

Estimated Aggregate Increase in Property Value and in Property Tax Revenue within the State of North Carolina as a Result of Investment in Bicycle and Pedestrian Infrastructure

Aggregate House Value within ¼-Mile	One-Time % Increase in Property Value	Aggregate One-Time Increase in Property Value	Real Property Tax Rate	Aggregate Annual Increase in Property Tax Revenues
$3.2 Billion	4%	$124 Million	1%	$1,240,000

Source: US Census Bureau (2010), Zillow.com (2012), Econsult Corporation (2012)

Summation of Estimated Economic Impacts Associated with Investment in Bicycle and Pedestrian Infrastructure within the State of North Carolina

Economic Impact Category	Estimated Economic Impact	Beneficiaries
Economic stimulus from upfront construction	$174M supporting 1,600 jobs	The entire state economy
Economic stimulus from increased tourism activity	$128M supporting 1,600 jobs	The entire state economy
Direct use value from usage of bicycle and pedestrian infrastructure	$228M in new direct use value	State residents who use the new bicycle and pedestrian infrastructure
Health care cost reduction from usage of bicycle and pedestrian infrastructure	$76M in health care cost reduction	State residents who use the new bicycle and pedestrian infrastructure, and the health care cost pools they are a part of
Commuting gains from increased usage of bicycle and pedestrian infrastructure	4.9M fewer car miles driven, $167,000 in emissions cost avoidance, $800,000 not spent on gasoline, $325,000 in congestion cost avoidance	Drivers within the state, as well as the state as a whole
Property value gains from proximity to bicycle and pedestrian infrastructure	$64M one-time increase in property value, $640,000 annual increase in property tax revenues	Property owners, municipalities and school districts

Source: Econsult Corporation (2012)

Resources for Further Information

Additional Detail on Construction Costs Per Mile for Other, Similar Bicycle and Pedestrian Infrastructure Projects

Source: North Carolina Division of Parks and Recreation (2009), Ohio Department of Natural Resources (2001), US Army Corps of Engineers (2010), Econsult Corporation (2012)

Construction Costs per Mile for Other Similar Bicycle and Pedestrian Infrastructure Projects

Study	Author	Location	Year	# Miles	Construction Cost	Cost per Mile
Ecusta Rail-to-Trail Economic Impact Analysis	*Econsult Corporation*	*Hendersonville, NC*	*2012*	*20.3*	*$13,000,000*	*$640,394*
The Economic Impact of Investments in Bicycle Facilities: A Case Study of the Northern Outer Banks	*Institute for Transportation Research and Education North Carolina State University*	*Outer Banks, NC*	*2004*	*55.75*	*$6,727,303*	*$120,669*
The Potential Economic Impacts of the Proposed Catawba Thread Trail	*Econsult Corporation*	*North Carolina*	*2007*	*500*	*$100,000,000*	*$200,000*
Coastal Georgia Greenway Market Study and Projected Economic Impact	*Armstrong Atlantic State University*	*Georgia*	*2003*	*150*	*$28,800,000*	*$192,000*
The Piedmont Greenway	*The Piedmont Land Conservancy*	*Greensboro, NC*	*2007*	*28*	*$7,200,000*	*$257,143*
Average					***$31,145,461***	***$282,041***

Economic and Fiscal Impact Model Theory

History

The theory behind input-output modeling stretches as far back as the mid 17th century, when Sir William Petty described the interconnectedness of "production, distribution, and wealth disposal." While Perry can be credited with noticing links between economies, input-output modeling did not begin to take true form until the mid 18th century, when French physician François Quesnay created the Tableau Économique. His work detailed how a landowner spends his earnings on goods from farms and merchants, who in turn spend their money on a host of goods and services. Over the course of the century, an algebraic framework was added by Achille-Nicholas Isnard. Robert Torrens and Léon Walras refined the model by establishing the connections between profits and production.

The modern input-output system can be attributed to Wassily Leontief. In his thesis, "The Economy as a Circular Flow" (1928), he outlined the economy as an integrated system of linear equations relating inputs and outputs. This framework soon gained popularity, and became a widely accepted analytical tool. In 1936, Leontief produced the first input-output analysis of the US. Leontief's work became the US Department of Commerce's Bureau of Economic Analysis's (BEA) standard benchmark for US production in the 1950s. Leontief received a Nobel Prize for his work in 1973.

By the 1970s, the BEA had developed regional multipliers that could benchmark regional production throughout the US. Through extensive surveying, the impacts of each industry could be determined at the individual county level. These multipliers later became known as the Regional Input-Output Modeling System, RIMS. These multipliers would later be improved in the 1980s and reclassified as RIMS II multipliers. This new system soon became a trusted standard in economic impact studies. The updated RIMS II multipliers show the effect on the local economy that localized expenditures have in terms of employment, output, and earnings.

Application

The use and application of multipliers are fairly basic and intuitive. Multipliers, in their most basic form, are the result of an algebraic analysis expressing how two inputs are interconnected in the production of an output. The result of the equation generates a multiplier that is broken down into direct, indirect, and induced effects. In a generalized example: if the multiplier for good "X" to good "Y" is 3, then the direct of good "X" on "Y" is 1, with indirect and induced effects of 2. Essentially, every unit of good "X" supports 2 units of good "Y".

When implemented on a large complex scale, such as that of the US economy or any subsection of it, multiplier effects across industries can be complicated. However, the same general concept comes into play. Each industry has largely different and varied inputs into other industries. The quantity of the output is largely decided by the scale and efficiency of the industries involved. As a result, the sum of those inputs equates to an output product plus a value added/component. By arranging these inputs and outputs by industry in a matrix, and performing some algebra to find the Leontief inverse matrix, each industry's effect on final demand can be estimated. Additionally, the direct, indirect, and induced effects can also be determined. Direct effects include direct purchases for production, indirect effects include expenses during production, and induced effects concern the expenditures of employees directly involved with production. Using building construction as an example, the direct effects would include materials, brick, steel, and mortar, the indirect effects would involve the steel fabrication, concrete mixing, and the induced effects would consider the construction workers purchases from their wages. While impacts vary in size, each industry has rippling effects throughout the economy. By using an input-output model, these effects can be more accurately quantified and explained.

RIMS II is one of several popular choices for regional input-output modeling. Each system has its own nuances in establishing proper location coefficients. RIMS II uses a location quotient to determine its regional purchase coefficient (RPC). This represents the proportion of demand for a good that is filled locally; this assessment helps determine the multiplier for the localized region. RIMS II takes the multipliers and divides them into over 500 industry categories in accordance to the North American Industrial Classification System (NAICS) codes. A comprehensive breakdown of a region's multipliers by industry can be shown.

Despite the usefulness of input-output modeling, there are some shortcomings to the system. Notably, input-output models ignore economies of scale. Input-output models assume that costs and inputs remain proportionate through different levels of production. Further, multipliers are not generally updated on a timely basis; most multipliers are prone to be outdated with the current economy. If the multipliers are sourced from a year of a recession economy, the multipliers may not accurately represent the flows from an economic boom period. Additionally, the multipliers may not capture sudden legal or technological changes which may improve or decrease efficiency in the production process. Regardless, I-O models still serve as the standard in the estimation of local and regional impacts.

Economic Impact Model

The methodology and input-output model used in this economic impact analysis are considered standard for estimating such expenditure impacts, and the results are typically recognized as reasonable and plausible effects, based on the predicted economic benefits (including data) used to generate the impacts. In general, one can say that any economic activity can be described in terms of the total output generated from every dollar of direct expenditures. If an industry in a given region sells $1 million of its goods, there is a direct infusion of $1 million into the region. These are referred to as direct expenditures.

However, the economic impact on the region does not stop with that initial direct expenditure. Regional suppliers to that industry have also been called upon to increase their production to meet the needs of the industry to produce the $1 million in goods sold. Further, suppliers of these same suppliers must also increase production to meet their increased needs as well. These are referred to as indirect expenditures. In addition, these direct and indirect expenditures require workers, and these workers must be paid for their labor. These wages and salaries will, in turn, be spent in part on goods and services produced locally, engendering another round of impacts. These are referred to as induced expenditures.

Direct expenditures are fed into a model constructed by Econsult Corporation and based on RIMS II data. The model then produces a calculation of the total expenditure effect on the regional economy. This total effect includes the initial direct expenditure effect, as well as the ripple effects described, the indirect and induced expenditure effects.

Part of the total expenditure effect is actually the increase in total wages and salaries (usually referred to as earnings), which the model can separate from the expenditure estimates. Direct payroll estimates are fed into the "household' industry of the input-output model. Impacts of this industry are estimated using the personal consumption expenditure breakdown of the national input-output table and are adjusted to account for regional consumption spending and leakages from personal taxes and savings. The direct, indirect, and induced earnings represent a component of the total economic impact attributable to wages and salaries. Finally, the model calculates the total expenditures affecting the various industries and translates this estimate into an estimate of the total labor (or jobs) required to produce this output.

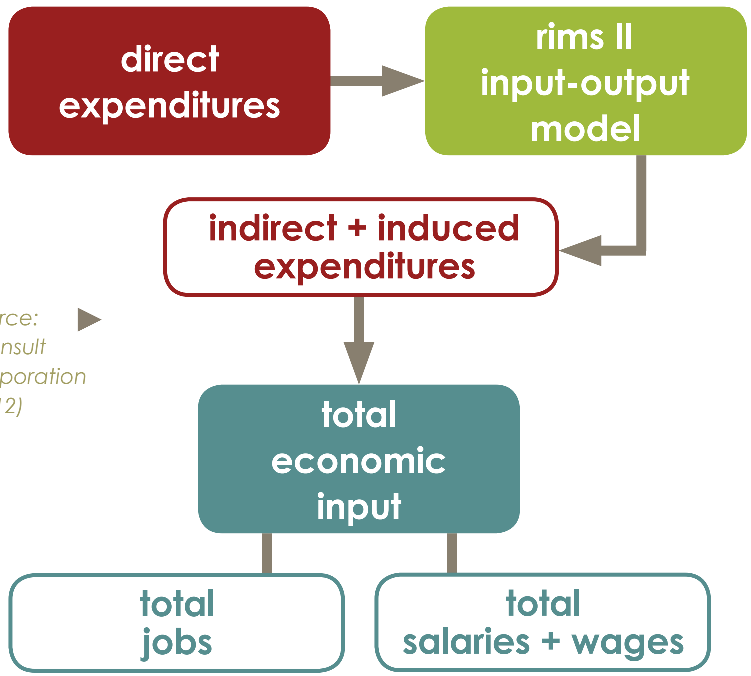
In short, the input-output model estimates the total economic activity in a region that can be attributed to the direct demand for the goods or services of various industries. This type of approach is used to estimate the total economic activity attributable to the expenditures associated with various types of spending in the region.

Fiscal Impact Model

The RIMS II model provides estimates of the economic impact of a new project or program on the regional economy. It does not, however, estimate the fiscal impact of the increased economic activity on state and local governments. Econsult has constructed a model that takes the output from the RIMS II model and generates detailed estimates of the increases in state and local tax collections that arise from the new project. Those revenues are in fact a part of the total economic impact of a new project that is often ignored in conventional economic impact analyses.

The RIMS II model provides estimates of direct, indirect, and induced expenditures, earnings, and employment within the defined region. The Econsult fiscal impact model combines the RIMS II output with the relevant tax types and tax bases associated with the jurisdiction or jurisdictions for which fiscal impact is being modeled. Specifically, the estimated earnings supported by the direct, indirect, and induced expenditures generated by the model are used to apportion the net increase in the relevant tax bases and therefore in those tax revenue categories. The resulting estimates represent the projected tax revenue gains to the jurisdiction or jurisdictions as a result of the increased business activity and its attendant indirect and induced effects.

Flowchart of Input-Output Methodology for Estimating Economic Impact



Source: Econsult Corporation (2012)

9.5

Sources

Miller, Ronald E., and Peter D. Blair. Input-output Analysis Foundations and Extensions. Cambridge, UK: Cambridge UP, 2009. Print.

Bess, Rebecca & Ambargis Zoë. "Input-Output models for Impact Analysis: Suggestions for Practitioners Using RIMS II Multipliers" Conference Proceeding, Southern Regional Science Association Conference March 2011

Lahr, Michael. "Input-Output Analysis: Technical Description and Application." Rutgers University Edward J. Bloustein School of Planning and Public Policy, 2010.

Additional Detail on Estimated Tourism Impacts from Other, Similar Bicycle, and Pedestrian Infrastructure Projects

Estimated Outside Users per Mile per Year for Other, Similar Bicycle and Pedestrian Infrastructure Projects

Name	State	Length (mi)	Est. Outside Users/ Year	Est. Outside Users/ Mile/ Year	Source	Total Unit Day Value ($M)
Virginia Creeper	*Virginia*	*33.4*	*50,339*	*1,507*	*The University of Georgia*	*$796*
New River Trail	*Virginia*	*39*	*66,331*	*1,701*	*The University of Georgia*	*$334*
Little Miami Scenic Trail	*Ohio*	*72*	*150,000*	*2,083*	*OH/KY/IN Regional COG*	*$345*
Catawba	*North Carolina*	*150*	*62,000*	*143*	*Campbell & Munroe*	*$310*
The Great Allegheny Passage	*Maryland-Pennsylvania*	*141*	*500,000*	*3,546*	*Treadly. net*	*$252*

Source: various, Econsult Corporation (2012)

Literature Estimated Tourism Impacts From Other, Similar Bicycle and Pedestrian Infrastructure Projects

Title	Published By	Year	Findings
Bikeways to Prosperity: Assessing the Economic Impact of Bicycle Facilities	*NCDOT*	*2006*	*4 million tourists visit the Outer Banks annually; 17% do some bicycling on their trip. This translates to approximately 680,000 annual visitors who bicycle, leading to an annual economic impact of $60 million and 1,407 jobs supported.*
Economic Impact of Bicycling and Walking in Vermont	*Vermont Agency of Transportation; Resource Systems Group, Inc.*	*2012*	*Visitor expenditures were obtained for over 40 major running and bicycling events in Vermont in 2009. These attracted over 16,000 participants, which supported 160 workers with $4.7 million in labor earnings.*
Coastal Georgia Greenway Market Study and Projected Economic Impact	*Armstrong Atlantic State University*	*2003*	*With the completion of the Georgia component of the East Coast Greenway, the Coastal Georgia Greenway (CGG), the CGG will annually add between $5 and $6.9 million to business revenue in 2015, rising to between $10.2 and $15 million in 2020.*
Great Allegheny Passage Economic Impact Study	*Allegheny Trail Alliance*	*2008*	*An estimated 800,000 trips are taken annually to the Passage, where the direct spending from trail users is estimated to be over $40 million, leading to $7.5 million in wages for 93 net new jobs, and a net gain of 47 new trail-related businesses.*
The Outdoor Recreation Economy: Technical Report on Methods and Findings	*Southwick Associates*	*2012*	*Active outdoor recreation (bicycling, trail activities, paddling, snow sports, camping, fishing, hunting, and wildlife viewing) contributes a total of $788 billion annually to the U.S. economy, supports 12.0 million jobs, and generates $197.4 billion in annual state, local, and national tax revenue.*
Bicycling Means Business: The Economic Benefits of Bicycle Infrastructure	*Advocacy Advance*	*2012*	*Maine's bicycle infrastructure has generated an estimated $66 million a year in tourism impacts since 2001.*
Jackson Hole Trails Project Economic Impact Study	*University of Wyoming*	*2011*	*Of a total of $18.1 million in economic activity generated in 2010 from the Teton County trail system, approximately $16.9 million was generated by non-local trail users.*

Source: Various, Econsult Corporation (2012)

9.5

Glossary of Terms for Input-Output Models

Source: Econsult Corporation (2012)

Multiplier Effect the notion that initial outlays have a ripple effect on a local economy, to the extent that direct expenditures lead to indirect and induced expenditures.

Economic Impacts total expenditures, employment, and earnings generated.

Fiscal Impacts local and/or state tax revenues generated.

Direct Expenditures initial outlays usually associated with the project or activity being modeled; examples: one-time upfront construction and related expenditures associated with a new or renovated facility, annual expenditures associated with ongoing facility maintenance and/or operating activity.

Direct Employment the full time equivalent jobs associated with the direct expenditures.

Direct Earnings the salaries and wages earned by employees and contractors as part of the direct expenditures.

Indirect Expenditures indirect and induced outlays resulting from the direct expenditures; examples: vendors increasing production to meet new demand associated with the direct expenditures, workers spending direct earnings on various purchases within the local economy.

Indirect Employment the full time equivalent jobs associated with the indirect expenditures.

Indirect Earnings the salaries and wages earned by employees and contractors as part of the indirect expenditures.

Total Expenditures the sum total of direct expenditures and indirect expenditures.

Total Employment the sum total of direct employment and indirect employment.

Total Earnings the sum total of direct earnings and indirect earnings.

Partial Bibliography of Studies on the Connection Between Recreational Amenities, Increased Exercise, Improved Health, and Reduced Health Care Costs

"A Cost-Benefit Analysis of Physical Activity Using Bike/Pedestrian Trails." Health Promotion Practice (2005).

"Active Commuting and Cardiovascular Disease Risk," Archives of Internal Medicine (2009).

"Cost Effectiveness of Community-Based Physical Activity Interventions," American Journal of Preventative Medicine (2008).

"Does the Outdoor Environment Matter for Psychological Restoration Gained through Running?" Psychology of Sports and Exercise (2003); "Restorative Effects of Natural Environment Experiences," Environment & Behavior (1991).

"Higher Direct Medical Costs Associated with Physical Inactivity," The Physician and Sportsmedicine (2000).

"Leisure-time Physical Activity Levels and Changes in Relation to Risk of Hip Fracture in Men and Women," American Journal of Epidemiology (2001).

"NCHS Data on Obesity," National Center for Health Statistics (2009).

"Occupational, Leisure Time, and Commuting Physical Activity in Relation to Cardiovascular Mortality among Finnish Subjects with Hypertension," American Journal of Hypertension (2007).

"Outdoor Recreation, Health, and Wellness: Understanding and Enhancing the Relationship," Resources for the Future (2009).

"Physical Inactivity Cost Calculator: How the Physical Inactivity Cost Calculator was Developed," College of Health and Human Performance (2005).

"Reduced Risk of Myocardial Infarction Related to Active Commuting: Inflammatory and Haemostatic Effects Are Potential Major Mediating Mechanisms," European Journal of Cardiovascular Prevention and Rehabilitation (2010).

"The Relative Influence of, and Interaction between, Environmental and Individual Determinants of Recreational Physical Activity in Sedentary Workers and Home Makers," University of Western Australia (1998).

"The Significance of Parks to Physical Activity and Public Health," American Journal of Preventive Medicine (2005).

"Transport and health: en route to a healthier Australia," Medical Journal of Australia (2000).

Additional Detail on the Impact of Other, Similar Bicycle and Pedestrian Infrastructure Projects on Commuting Mode Choice (following pages)

Recent Studies on the Property Value Impact of Recreational Facilities (following pages)

The Impact of Other, Similar Bicycle and Pedestrian Infrastructure Projects on Commuting Mode Choice

Title	Published By	Year	Findings
A Longitudinal Analysis of the Effect of Bicycle Facilities on Commute Mode Share	University of Minnesota	2005	Areas with facilities often already have very high bicycle commute shares compared to the other areas of Minneapolis-St. Paul. The construction of facilities led to a mode share increase from 1.7% to 2% while the rest of the region remained constant at .2%. All individual facilities studied were associated with a significant increase in bicycle mode share.
Active Transportation for America: The Case for Increased Federal Investment in Bicycling and Walking	Rails to Trails Conservancy	2008	Value of anticipated fuel savings from replacing short car trips alone = $3.5 billion under the status quo...The overall amount that could be saved on gasoline expenditure is in the range of $10 to $35 billion annually. Gives cost of bike lanes, bike racks, and sidewalks. During the course of a year, regular bicycle commuters that ride five miles to work, can save about $500 on fuel and more than $1,000 on other expenses related to driving.
If You Build Them, Commuters Will Use Them: Association between Bicycle Facilities and Bicycle Commuting	Transportation Research Record	1997	The study found that there is a positive association between miles of bicycle pathway per resident and percentage of population commuting by bicycle in 18 US cities.
Physically Active Commuting to Work – Testing Its Potential for Exercise Promotion"	Medicine and Science in Sports and Exercise	1994	The study found that people can be induced to actively commute to work. 10% of people who actively commute regularly are willing to increase their amount of active commuting, 6% of people who actively commute occasionally are willing to increase their amount of active commuting, 7% of people who do not active commute but for whom it is possible to actively commute (19% of total population) are willing to increase their level of active commuting. Programs to encourage active commuting were well received in the workplace test setting. Significant proportions of commuters were willing to switch to active commuting if provided safe passages for doing so.

▲ Source: Various, Econsult Corporation (2012)

Title	Published By	Year	Findings
The Impact of Bicycling Facilities on Commute Mode Share	*Minnesota DOT*	*2008*	*This study determines that several factors, including level of publicity, suitability of routes for commute purposes, and overall connectivity to the bicycle network, determine whether or not the creation of bicycle facilities leads to an increase in bicycle commuting.*
Barriers to Municipal Planning for Pedestrians and Bicyclists in North Carolina	*NCMJ- North Carolina Institute of Medicine and The Duke Endowment*	*2011*	*In 2009, 17% of North Carolina adults reported any walking or bicycling for transportation, and 26% reported no leisure activities or exercises during the past month, similar to the 2009 national average of 24%. North Carolina was 43rd among states for the percentage of adults who walked or bicycled for transportation, compared with the rest of the nation.*
Economic and Health Benefits of Bicycling in Iowa	*University of Northern Iowa, Iowa Bicycle Coalition*	*2011*	*There are an estimated 25,000 bicycle commuters in Iowa, who spend on average $1,160 per year for bicycle related activities. Commuter cyclist spending generates $51.9 million in direct and indirect impacts to Iowa and save Iowa $13.3 million in health care costs.*
The Social and Economic Benefits and Transportation Enhancements	*National Transportation Enhancements Clearinghouse*	*2005*	*The Marin County Bicycle Coalition began the Safe Routes to School program in 2000. In its first year, walking and biking trips to participating schools increased by 57%. In 2004, single student trips dropped by 13% among participating schools. This translates into more than 3,500 one-way trips saved every day, and an annual savings of nearly 2 million vehicle miles.*

Recent Studies on the Property Value Impact of Recreational Facilities

Amenity Being Analyzed	Estimated Effect	Source
Public greenbelt in Boulder CO	*3.75 percent increase in mean house prices resulting from preservation of open space.*	*"A Dynamic Approach to Estimating Hedonic Prices for Environmental Goods: An Application to Open Space Purchase," Riddel (2001).*
Protected open space larger than 5 acres in Philadelphia	*Homes within a quarter-mile of sites have a 7 percent premium in value, declining to 0 percent within 1 mile*	*"Quantifying the Economic Value of Protected Open Space in Southeastern Pennsylvania," Econsult Corporation (August 2010).*
Various trailways across the US	*Apex, NC: The Shepard's Vineyard housing development added $5,000 to the price of 40 homes adjacent to the regional greenway – and those homes were still the first to sell.* *Salem, OR: land adjacent to a greenbelt was found to be worth about $1,200 an acre more than land only 1000 feet away.* *Seattle, WA: Homes bordering the 12-mile Burke-Gilman trail sold for 6 percent more than other houses of comparable size.* *Brown County, WI: Lots adjacent to the Mountain Bay Trail sold faster for an average of 9 percent more than similar property not located next to the trail.* *Dayton, OH: Five percent of the selling price of homes near the Cox Arboretum and park was attributable to the proximity of that open space.*	*"The Economic Benefits of Parks and Open Space," The Trust for Public Land (2005) and "Economic Benefits of Trails and Greenways," The Rails-to-Trails Conservancy (2005).*

▲ *Source: Various, Econsult Corporation (2012)*

Amenity Being Analyzed	Estimated Effect	Source
Catawba Regional Trail in NC	Being located within a quarter-mile of the trail conferred a 4 percent increase.	"The Economic Impact of the Catawba Regional Trail," Campbell and Monroe (2004).
Pennypack Park in Philadelphia	In the vicinity of Philadelphia's 1,300-acre Pennypack Park, property values correlate significantly with proximity to the park. In 1974, the park accounted for 33 percent of the value of land 40 feet away from the park, nine percent when located 1,000 feet away, and 4.2 percent at a distance of 2,500 feet.	"The Effect of a Large Urban Park on Real Estate Value," American Institute of Planning Journal (July 1974).
Abandoned or vacant industrial sites that were converted to green space in Philadelphia	Prior to conversion, homes within ¼ mile of an abandoned/vacant site were valued at 19.7 percent less than comparable homes that were not within a quarter-mile of an abandoned/vacant site. As a result of the announcement of conversion but prior to conversion, house prices near future converted sites had an appreciation rate that was 0.70 percent per year higher than the citywide average. Immediately following conversion to green space, homes within a ¼ mile increased in value by 7.2 percent on average, relative to comparable homes that were not proximate to such sites. In the years following conversion, homes within a ¼ mile of the site experienced an additional annual appreciation rate of 5.2 percent per year, relative to comparable homes that are not near such sites.	"Valuing the Conversion of Urban Green Space," Econsult Corporation (June 2010). (For Pennsylvania Horticultural Society.)

Endnotes

1. See resources at the end of this appendix for additional detail on average construction costs per mile.
2. The economic impact model takes multiplier data from the US Department of Commerce's Regional Input-Output Modeling Systems (RIMS II) to produce estimates of the distribution of economic impact at the county and state level. See resources at the end of this appendix for a summary of Econsult's economic and fiscal impact methodology.
3. Since construction activity has a finite time period, these impacts are one-time and not ongoing in nature. This is contrasted against impacts from ongoing activities, which continue on into the future and therefore generate impacts that are ongoing and not one-time in nature.
4. See resources at the end of this appendix for additional detail on tourism impacts from other, similar bicycle and pedestrian infrastructure projects.
5. The North Carolina Department of Commerce reported 37 million visitors to the state in 2011, of which 63 percent came from outside the state.
6. "Ecusta Rail-to-Trail Economic Impact Analysis."Econsult Corporation (2012). By way of comparison, the 37 million overnight visitors to the state in 2011 represented an aggregate $17 billion in visitor spending, for a per-visitor average of $459. The lower estimate of $60 per day is used to account for the fact that many of the new out-of-state visitors generated by investment in bicycle and pedestrian infrastructure are not brand new to the state, but rather represent existing visitors spending additional time and making additional expenditures within the state as a result of the investment in bicycle and pedestrian infrastructure. Consider, for example, a family spending an extra night in order to enjoy a leisurely bicycle ride (and therefore incurring one more hotel night, one or two more meals, etc.), or a businessman staying in town a few extra hours in order to enjoy a run (and therefore spending additional amounts on food or souvenirs as a result of their longer stay).
7. "Active Transportation Beyond Urban Centers: Walking and Bicycling in Small Towns and Rural America," Rails to Trails Conservancy (2012).
8. "Bike Corrals: Local Business Impacts, Benefits, and Attitudes," Portland State University (2011).
9. While no money is changing hands when people use bicycle and pedestrian infrastructure, this direct use benefit is real and significant. And, in a sense, there are monetary consequences to this activity. People may choose from a variety of recreational options, and using the trail for free may substitute for other options that cost money, thus saving households money that can be diverted to other preferred uses.
10. For example, the addition of open space as a part of the Atlanta BeltLine greenway project was found to increase by 50 percent the likelihood of outdoor recreation among residents of neighborhoods within a half-mile of the open space parts of the BeltLine: "Atlanta BeltLine Health Impact Assessment," Georgia Institute of Technology (June 2007).
11. See resources at the end of this appendix for a detailed bibliography of studies on the connection between recreational

amenities, increased active living, improved health benefits, and reduced health care costs.

12. See resources at the end of this appendix for additional detail on the impact of other, similar bicycle and pedestrian infrastructure projects on commuting mode choice.

13. "American Community Survey." US Census Bureau (2010).

14. This may be too conservative. By way of comparison, in the City of Philadelphia, the introduction of a set of wider bicycle-only lanes (as opposed to just regular bicycle lanes) in the downtown area doubled bicycle ridership on those streets.

15. Over the long term, there are additional positive economic impacts from reducing car miles driven, as cities and regions adjust their land use patterns and transportation infrastructure investments to become more environmentally sustainable and economically efficient.

16. $418 million in congestion costs out of 6.3 billion car miles driven = 6.6 cents in congestion costs per mile driven multiplied by the 4.9 million car miles not driven, resulting in $325,000 in congestion costs avoided.

17. "The impact of transportation infrastructure on bicycling injuries and crashes: a review of the literature." Environmental Health (2009).

18. "Safety Benefits of Walkways, Sidewalks, and Paved Shoulders" Federal Highway Administration (2010).

19. "Evaluating Non-Motorized Transportation Benefits and Costs." Victoria Transport Policy Institute (2012).

20. What is meant by this assumption is that, all else equal, properties located within a quarter-mile of the new facilities will increase in value by 4 percent more than other, similar properties not located within a quarter-mile of the trail. Thus, if properties in the area increase in value by 3 percent, then properties located within a quarter-mile of the trail will increase by 7 percent (3 percent + 4 percent), while if properties in the area decrease in value by 3 percent, then properties located within a quarter-mile of the trail will increase by 1 percent (-3 percent + 4 percent). This may turn out to be conservative on one or more of three fronts. First, the one-time property value increase may be larger than 4 percent, as is suggested by the body of literature. Second, there may be a difference in the ongoing appreciation rate over time between properties located within a quarter-mile of the infrastructure and properties not located within a quarter-mile of the trail, such that the property value increase resulting from the implementation of the trail is not just the upfront 4 percent difference but also some ongoing difference that grows over time. Third, some upfront and/or ongoing difference in property value may apply to properties that are not located within a quarter-mile of the infrastructure but are still reasonably close to the trail; for example, properties located between a quarter-mile and a half-mile of the trail may sell for a premium, since such a distance from the trail may still be considered easily covered on foot.

21. There are about 4.3 million housing units within the state. The state's land area is about 54,000 square miles. Therefore, there are about 80 houses per square mile. This may be too conservative an estimate, since it is likely that new bicycle and pedestrian infrastructure will be located in areas that are more densely populated than the state as a whole, which contains significant proportions of rural and parkland space.

22. The smallest possible area within a ¼-mile radius of the assumed 300 miles of new bicycle and pedestrian infrastructure would be a single straight 300-mile segment of new bicycle and pedestrian infrastructure. This would have an area within a ¼-mile radius of 150 miles (a ¼-mile on each side of the straight line, plus a ¼-mile radius at both ends). If, more realistically, the new bicycle and pedestrian infrastructure was broken up into multiple segments throughout the state, the area within a ¼-mile radius would be larger.

9.6 Environment

Wake Forest, NC

Introduction

North Carolina enjoys a wealth of natural resources and scenic landscapes that have attracted tourists for generations, and helped support in-migration and business development for more than two centuries. From the sand dunes at Jockey's Ridge State Park, Outer Banks, coastal maritime forests, Tryon Palace at New Bern state historic site, to Bentonville Civil War Battlefields, Umstead State Park near Raleigh, the Piedmont Uwharrie National Forest, Longleaf Pine forest at Sandhills gameland near Pinehurst and Fort Bragg, Lake Norman near Charlotte, NC Zoological Park in Asheboro, to iconic mountain features such as Grandfather Mountain and Chimney Rock state park. People from throughout the world recognize our state's rich and diverse ecosystems, distinct physiographic regions and mild climate as the foundation for a quality lifestyle. It is incumbent upon all North Carolinians to steward these natural assets so that future generations can enjoy and prosper from these resources. The high quality lifestyle enjoyed by North Carolinians today is sustained by our clean air, clean water, stable soil and groundwater, and an ample supply of locally grown food and natural resources.

State of the Environment in North Carolina

A potential threat to the current and future lifestyle is our rapidly growing population and its accompanying land use development. North Carolina currently ranks tenth in the most populated states, with 9.5 million people. In the next 20 years, our population will increase to more than 12 million.[1] It is vitally important that North Carolinians use sound judgment in accommodating such growth, and balance the opportunity of future land development with land and water conservation principles and practices. As our population grows, there will be demand and need for more grey infrastructure (roads, potable water, sewer services, trash disposal, energy, public schools, shopping and office centers, etc.).

The need for grey infrastructure must be balanced with the needs to conserve and steward our green infrastructure (streams, lakes, native vegetation, soil, groundwater, wetlands, etc.). Green Infrastructure is the interconnected green space network (including natural areas and

In this Chapter

features, public and private conservation lands, working lands with conservation values and other protected open space) that is managed for its natural resource values and for the associated benefits it confers to human populations.

If we can accommodate growth and development in a way that does not compromise the ability to conserve and steward our natural resources, North Carolina will continue to be an attractive state that supports manufacturing, increased tourism, progressive agriculture, active military base operations and sustained economic growth. These values are intertwined and must be achieved simultaneously as we manage future challenges and opportunities.

Stewardship responsibility

At the statewide level, stewardship of natural resources has been actively managed by agencies within North Carolina state government, in partnership with federal, local government, non-governmental organizations, and private-sector businesses. North Carolina has established an excellent record of achievement when it comes to balancing the needs of environmental stewardship in association with progressive growth and development.

NC Department of Environment and Natural Resources (DENR)

As the lead environmental stewardship agency for North Carolina, the Department of Environment and Natural Resources (DENR) has helped preserve and protect natural resources within the state for more than 100 years. Known in the early 1900s as the N.C. Geological and Economic Survey, its original mission was to protect watersheds, prevent and control wildfires, and manage the state's geologic and mineral resources.[2] Today, the Department works across multiple divisions to accomplish the following:

- Administer regulatory programs designed to protect air quality, water quality, and public health
- Offer technical assistance to businesses, farmers, local governments, and the public
- Offer educational programs encouraging responsible environmental stewardship behavior at DENR facilities and through the state's school system
- Through its natural resource divisions, work to protect fish, wildlife and wilderness areas
- Work with state parks and forests to ensure safe and enjoyable outdoor recreation experiences

NC Division of Parks and Recreation (DPR)

There are several ways in which the purposes and mission of the North Carolina Division of Parks and Recreation (DPR) can contribute to the achievement of the state's bicycle and pedestrian goals. Although the division's focus is recreation rather than transportation, they can be an important partner in advocating, planning, funding and implementing bicycle and pedestrian projects because walking and biking often encompass both recreation and transportation purposes.

DPR is responsible for preparation of the NC Statewide Comprehensive Outdoor Recreation Plan (SCORP), which provides guidance on recreational trends and needs for the federal Land and Water Conservation Fund and other grant programs. This report identifies walking and cycling as important recreational needs that should be met. This is consistent with the recognition that walking and cycling are important transportation needs. The next SCORP update will be in 2014.

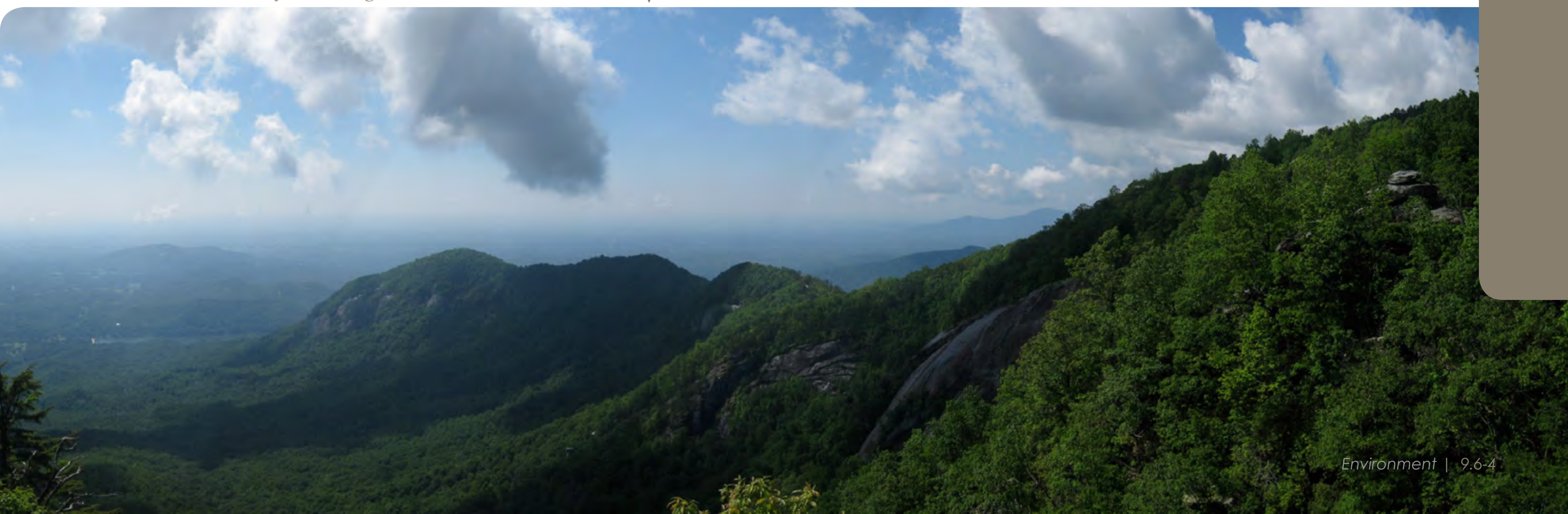
In addition to preparing the SCORP, DPR operates the State Parks System, consisting of more than 218,000 acres, with 41 state parks and recreation areas as well as 33 undeveloped conservation areas, including state natural areas, state rivers, state trails, and state lakes. Park resources can help mitigate climate, air, and water pollution, which contribute to impacts on public health. The state parks are also important destinations for local and regional trails and greenways and for NCDOT's statewide bicycle routes. NCDOT should coordinate with DPR to establish safe, appropriate, and environmentally sustainable walking and biking access to state parks.

The State Parks System includes four State Trails, one of which is the Mountains-to-Sea State Trail (MST). The State Trails are multi-jurisdictional partnerships to provide connected, long-distance hiking and paddle trails. The focus of these trails is recreational, but they can serve transportation purposes as well. The Mountains-to-Sea State Trail is a partnership among state and federal land managing agencies, counties and municipalities, and volunteer groups such as the Friends of the Mountains-to-Sea Trail.

The Mountains-to-Sea State Trail will be a continuous, off-road trail from the Great Smoky Mountains National Park in western North Carolina to Jockeys Ridge State Park on the Outer Banks. The distance is approximately 1,000 miles, but only 530 miles have been completed. The NC Division of Parks and Recreation is working with multiple partners to complete the trail. NCDOT has assisted with planning and implementation of some segments of the Mountains-to-Sea State Trail because the trail is an important component of a walk/bike strategy for many communities along the route of the trail.

The NC Parks and Recreation Trust Fund (PARTF) was established in 1994 to fund improvements to the state parks system, to fund grants for local government park and recreation projects, and to improve public access to the state's beaches and estuarine shorelines. The PARTF local grant program is administered by DPR, and through this program, hundreds of grants have been awarded for

Hickory Nut Gorge in western North Carolina ▼



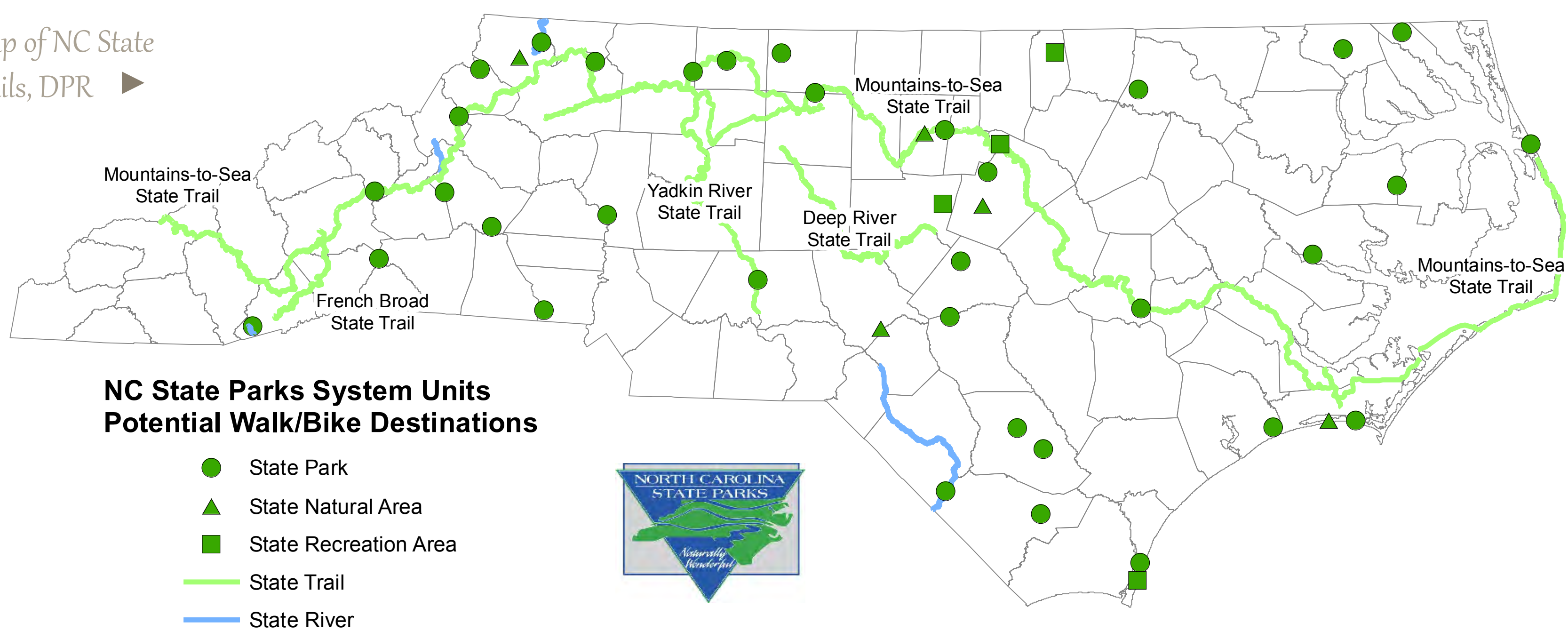
trail and greenway projects, including bicycle and walking paths that are primarily used for recreation. The purpose of PARTF is focused on recreation, but many of these projects may also serve transportation needs. PARTF is an important partner in providing bicycle and pedestrian opportunities in North Carolina.

DPR also administers the North Carolina Trails System (GS 113A-83). By statute, the NC Trails System is focused on scenic and recreational trails to serve the outdoor recreation needs of an expanded population and to promote public access and enjoyment of outdoor, natural and remote areas. The DPR State Trails Program also administers federal Recreational Trail Program grants and state Adopt-a-Trail grants to provide funding to government agencies and non-profit organizations for trail and greenway projects.

NCDOT should work closely with DPR to explore ways to coordinate and enhance the role that recreational trails and greenways can play in implementing bicycle and pedestrian transportation projects. The interface between recreation and transportation purposes can help to advance statewide goals for walking and biking.

The mission of the state parks system is to conserve and protect representative examples of the natural beauty, ecological features and recreational resources of statewide significance; to provide outdoor recreational opportunities in a safe and healthy environment; and to provide environmental education opportunities that promote environmental stewardship of the state's natural heritage.

Map of NC State Trails, DPR ▶



Federal and Local Partners

North Carolina benefits in land and water stewardship efforts from its strong working relations and partnership with federal agencies, including (but not limited to) the U. S. Fish and Wildlife Service, U. S. Forest Service, National Park Service, and the U. S. Army Corps of Engineers. These agencies all play a vital and important role in managing land and water resources, and determining for how land and water is used in a manner that is consistent with state and federal programs and laws. Federally owned land accounts for approximately 8% of all land in North Carolina, or roughly 2.3 million acres. (Source: U.S. General Services Administration, 2010)

North Carolina's local governments are among the most valued partners in land and water conservation. The vast majority of land use development is controlled by decision makers in local governments. Local governments also enforce sustainable land development activity, are responsible for making sure that sediment and erosion control occurs, that urban forests are established and that sidewalks and trails are planned and constructed.

Non-governmental organizations play a vital role in stewardship of our natural resources. A wide range of NGOs collaborate with state and local governments every day to promote and carry out stewardship work. In order to continuing the promotion of environmental stewardship, environmental literacy, and strategic transportation choice throughout North Carolina, collaboration will be required among state agencies, local governments and NGOs.

Stewardship is the responsibility of each and every North Carolinian, and is easily achieved by, among many other endeavors, maintaining sound vegetation practices on privately owned land, participating in local waste recycling programs, by composting organic material, conserving potable water and participating in alternative transportation programs like bike-to-work and safe-routes-to-school.

◄ Nantahala River with paddle trails and greenway trail

Transportation Impacts to the Environment

In order to consider the value that biking and walking may have for the environment, it is important to first examine the adverse effects that continued automobile use has on the environment. Motor vehicles and the roadway infrastructure they require contribute to several issues of environmental quality, energy consumption, and conservation that could be mitigated by substituting some automobile trips with walking and bicycling.

Development Impacts and Encouragement of Walking and Bicycling

Developing communities that are more conducive to biking and walking leads to their use of walking and biking as an alternative to motorized transportation. Designing communities and developments to provide better connectivity for pedestrians and bicyclists encourages more walking and biking. Incentivizing land use patterns that are conducive to connectivity for pedestrians and bicyclists facilitates walking and biking as a viable choice in transportation. Land development patterns should encourage block size limits that are conducive to walking. By encouraging the appropriate location of key community destinations, connectivity for pedestrians and bicyclists can be increased.

In order to effectively increase the desired for walking and bicycling, North Carolina communities must encourage density and more compact development patterns. National transportation studies conclude that 1-3 mile distances are the predominant distances walkers and bikers will travel to work or to shop. The development pattern in urbanized communities provides more opportunity to encourage and promote active adoption of a bicycling and walking. Community planners, developers and public officials play a role in selecting and approving development patterns that can lead to or facilitate bike and pedestrian patterns. The denser development and redevelopment within urban areas discourages development in the rural green spaces, farm fields and forests.

Land Use and Road Space Requirements

Roads and surface parking lots require a substantial amount of land area to accommodate large volumes of motor vehicles. In urban areas, making space for greater numbers of motor vehicles requires expropriating valuable urban property to construct new roads, widen existing roads, or construct or expand parking lots. As a result, development becomes more spread out throughout a municipality or region, leading to a loss of open space and conversion of farmland. Increases to impervious surface area also compromise water and flood drainage, putting areas at greater risk of flooding and reducing water and soil quality.

▲ *Roadways and parking areas require significant amounts of land.*

Energy and Environmental Benefits of Bicycling and Walking

Providing environments for safe and efficient walking and biking can encourage people to replace some driving trips with these human-powered modes. Such efforts can help to improve the environment in North Carolina by lowering vehicle emissions resulting in cleaner air, healthier communities and by preserving valuable natural resources.

Overview of Air Quality and Water Quality Mandates

Air quality in North Carolina has been steadily improving since the early 1980's as a result of efforts throughout the state to reduce ozone and particle pollution. Collectively, cars, trucks and other vehicles are the largest source of air pollution in North Carolina. Highway and off-road vehicles account for three-fourths (76%) of the statewide emissions of nitrogen oxides (as of 2010), the main cause of ozone, which is the state's most widespread air quality problem. As new and more stringent federal air quality standards are achieved, air quality throughout the state will continue to improve.

North Carolina's streams, rivers and lakes generally have good water quality. Approximately 30 percent of the state's waters have impaired water quality, due to high levels of mercury, bacteria and large amounts of sediment. Significant progress has been made across North Carolina addressing nutrient pollution through nutrient management strategies for the Neuse and Tar-Pamlico river basins.

As North Carolina grows, both in terms of population and land use development, future impacts to air quality and water quality will occur.

▲ *A slight increase in bicycling and walking would reduce emissions in NC.*

Air Quality

As of 2003, 27 percent of U.S. greenhouse gas emissions were attributed to the transportation sector. Personal vehicles account for almost two-thirds (62 percent) of all transportation emissions.[4] Primary emissions that pose potential risks are carbon dioxide, carbon monoxide, volatile organic compounds, (VOCs), nitrous oxides (NOx), benzene and airborne particulates. Children and senior citizens are particularly sensitive to the harmful affects of air pollution, as are individuals with heart or other respiratory illnesses. Increased health risks such as asthma and heart problems are associated with vehicle emissions.[5] The most pollutants are released during the first few minutes of starting an engine, known as a "cold start". Therefore a longer vehicle trip produces fewer pollutants per mile than a shorter one.

According to the Bureau of Transportation Statistics, 40% of daily trips in the US are two miles or less and 25% are less than one mile, a distance that can easily be covered by walking or bicycling.[6] Transitioning some of these trips to walking and biking rather than driving would greatly reduce cold starts and resulting pollution.

Older car and truck air-conditioning units also contribute significantly to reduced air quality due to their use of chloro-fluorocarbons (CFCs). Approximately 25 percent of all CFCs are emitted by motor vehicle air-conditioning units.[7] CFCs are the third-greatest contributor to the greenhouse effect (14%), behind carbon dioxide (50%) and methane (18%). CFCs are also known contributors to the degradation of the stratospheric ozone layer. As the ozone layer degrades, greater levels of ultraviolet radiation pass through the atmosphere to the earth's surface, increasing the likelihood and severity of sunburns and skin cancers.

Reduction in Vehicle Emissions and Congestion

The reduction in vehicle emissions as a result of decreased automobile dependency can be viewed as a benefit to North Carolina residents and their surrounding environment. Decreasing the dependency on daily motor vehicle trips and increasing the number of alternative travel methods such as bicycling and walking can reduce emissions and assist in improving air quality. Replacing two miles of driving each day with walking or bicycling will, in one year, prevent 730 pounds of carbon dioxide from entering the atmosphere.[8]

A research study on active transportation and air quality found that a five percent increase in the walkability of a neighborhood is associated with a per capita 32.1% increase in active travel, 6.5% fewer miles driven, 5.6% fewer grams of nitrous oxides (NOx) emitted, and 5.5% fewer grams of volatile organic compounds (VOCs) emitted.[9] These reductions can have considerable positive health effects. A study in Minneapolis-St. Paul, Minnesota found that if bicycles were used for half of the short trips made on good weather days, the Twin Cities could prevent 300 deaths and save $57 million in annual medical costs due to reduced air pollution and increased physical activity. Collectively, 11 major Midwest cities would save $7 billion in medical costs each year and prevent 1,100 deaths.[10]

Walking and bicycling help to improve roadway efficiency, mitigate congestion and noise pollution, and reduce stress. Replacing motor vehicle trips with walking and bicycling helps to reduce the number of vehicles on the road and adds minimally to road congestion.[11] As quieter forms of transportation, walking and biking are also more desirable modes of travel in dense areas and in residential neighborhoods.

Traffic congestion carries a number of costs, including wasted time, excess fuel consumption, wasted productivity, and stress. According to the Texas Transportation Institute, congestion in the Raleigh-Durham area alone creates 19.2 million hours of travel delay and results in 6.5 million gallons of wasted fuel each year.[12] These inefficiencies contribute to an estimated annual congestion cost of $418 million. Traffic congestion in Charlotte leads to similar costs; 17.7 million hours are lost to travel delay and 5.2 million gallons of excess fuel are consumed as a result. The estimated annual congestion cost for Charlotte is $378 million. Congestion and noise pollution also carry stress costs that may interfere with individuals' physical health and quality of life.

Water Quality

Motor oil and other contaminants that leak onto the roadway end up in road runoff, polluting waterways and groundwater. Fuel that is stored in tanks underground may also seep into the surrounding soil over time and into aquifers and other water sources.

The extraction, shipping, and storing of oil has also led to widespread environmental pollution. Major oil spills, such as the 1989 Exxon Valdez oil spill off the coast of Alaska and the 2006 Deepwater Horizon oil spill in the Gulf of Mexico, create long-lasting contamination of marine habitats.[13] At a local level, oil and gasoline commonly leak from motor vehicles, fuel pumps, or other sources into road runoff or are poured down drains or into sewers. All of these contaminants then seep into surrounding waterways and groundwater.

Another source of water pollution is from the everyday use and wear and tear of motor vehicles. Brake lining wear, leaked fluids, and the release of lead and rare earth metals from batteries and other auto parts all leach into the surrounding environment and accumulate over time.[14]

Salts that are used to de-ice roadways during the winter months also accumulate in stormwater runoff and pollute the environment.

Energy Conservation and Independence

According to the National Association of Realtors and Transportation for America, 89% of Americans believe that transportation investments should support the goal of reducing energy use.[15] Providing alternative modes of travel has the potential to shift dependency on foreign oil and promote sustainable transportation choices in communities. With better walking and bicycling facilities, many people would be able to make short trips of three miles or less – which currently account for 50 percent of all motor vehicle trips – by foot or bike without the need to use a car.

▲ *Congestion is a growing problem in a number of areas, including NC.*

The transportation sector accounts for 71 percent of all petroleum use in the US. Fuel consumption could be drastically reduced by replacing some driving trips with walking and bicycling trips, particularly short trips of three miles or less. Approximately 25% of all driving trips are less than one mile, 40% of daily trips are within two miles or less, and approximately 50% of trips are three miles or less. Reducing the percentage of short trips made by motor vehicle by taking advantage of walking and biking would help to reduce state and national fuel consumption and the environmental costs associated with it.

Solid Waste

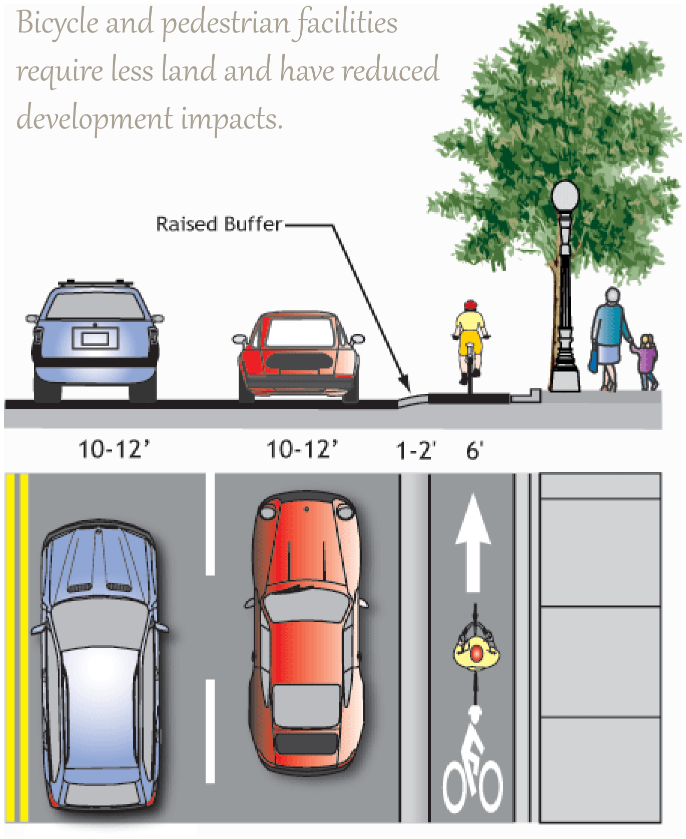
Every year in the United States, an estimated 10 million motor vehicle chassis and 250 million used tires are dumped into landfills and scrap yards.[16] Much of this waste is not recycled and is left to rust and decay, leaching harmful chemicals and materials. By contrast, the primary sources of waste from walking and bicycling are worn-out shoes and bicycle tires and parts, much of which can be recycled. The amount of waste produced from walking and bicycling that cannot be recycled is an order of magnitude less than that produced from discarded motor vehicles and parts.

▲ *Much of the waste generated from automobile manufacturing is not recycled.*

Roadway Development Impacts

Transitioning to a multimodal transportation network that provides adequate facilities for walking and biking would require less infrastructure development than an auto-dependent transportation system. Walking and biking produce much less wear and tear on roads and require much less impervious surface to operate. With reduced motor vehicle use, roadways would not need to be maintained, expanded, or built as frequently or intensively. This would help to mitigate the associated loss of open space, conversion of farmland, use of valuable urban property, and compromise to water and flood drainage that results from building, expanding, and maintaining paved surfaces.[17]

▼ *Bicycle and pedestrian facilities require less land and have reduced development impacts.*



Wildlife Habitat

Large road projects have deleterious effects on surrounding wildlife habitat. Not only can sprawling roads and development limit the extent of unique North Carolina habitats, but they can also create a barrier within habitats, known as habitat fragmentation. This segmentation of ecosystems and habitat ranges for North Carolina species interferes with the ability of wildlife to sustain their populations and can lead to a loss of biodiversity.

Trails and Greenways Benefit Community Conservation

Trails are an integral part of our natural environment and can be used as a tool for conservation. Trails assist with preserving important natural landscapes, providing necessary links between fragmented habitats and providing tremendous opportunities for protecting plant and animal species. Increased development has contributed to the creation of habitat islands—isolating wildlife, reducing their natural habitats and survival. Trails provide that important link between these island populations and habitats and increase the available land to many wildlife species.

Greenways provide numerous direct and indirect ecological benefits to the communities in which they are located. They function as protectors and preservers of our natural resources by preserving vital habitat corridors and promoting plant and animal diversity. They cleanse and replenish the air, buffer the negative effects of development while mitigating noise, water, thermal and air pollution.

Greenways are community connectors. They create linkages and corridors for the human and natural community alike. Depending upon the location, some greenways are the only wooded areas around, sheltering birds and other species along the tree buffers. In other cases greenways provide open areas for species that prefer the edge of the greenway corridor. But some greenways serve greater purpose, particularly if they contain sufficient buffers that provide corridors wide enough for particular species to move within. Greenways can be utilized to link protected open spaces, community parks and waterways, which serve as human transportation corridors and effectively link certain habitats and animal communities. Take for example a wooded river walkway or greenway. If sufficiently buffered, it serves the purpose of buffering the river's floodplain and sheltering a significant habitat community, while providing a human transportation or recreation linkage.

▲ *Greenway corridors provide many benefits to wildlife habitat if properly constructed.*

It is important to consider the natural landscape in the design and implementation of a greenway. Some habitats and species are particularly sensitive to impervious surfaces or to light infiltration. The shaded woodland along the greenway can provide a different climate for the user or the animal inhabitant. Greenways need not be only narrow linear pathways. Well-known greenways, like the Mountains-to-Sea Trail, are developed by linkages of park and conservation nodes that provide activity areas along a larger greenway. Few users utilize the entire length of longer systems like the 900-mile MST. Instead many communities have developed loop systems that allow the public to access the trunk line for the larger greenway system while incorporating smaller linkages as part of a community system.

Some greenways are developed for environmental restoration. Wetland and stream mitigation or preservation projects sometimes provide an excellent opportunity to develop trails or greenways that can make an area accessible to pedestrians and bicyclists. These situations maximize the public benefit of the property's conservation by water quality improvements and public accessibility.

Greenways and trails are more than functional pedestrian and bicycle thoroughfares. Communities and organizations utilize conservation and recreation tools to obtain goals that benefit transportation while upholding important natural resource objectives. The Carolina Thread Trail and the Neuse River Greenway are excellent examples of larger community greenway transportation projects with equally important water quality and habitat conservation objectives. The Neuse River Greenway is both a Raleigh greenway and part of the much larger Mountains-to-Sea Trail. These same greenways systems support public health and recreation objectives. Planning for greenways does often not just meet the objectives of one agency or planning entity. Greenways and trails provide an excellent opportunity for different partners with different objectives to make a proposed project more successful. These same partners are able to bring different matching resources as well as expertise to the table for successful implementation.

Enhancing Cultural Awareness and Community Identity

Trails, greenways, and open space can serve as connections to local heritage by preserving historic places and by providing access to them. They provide a sense of place and an understanding of past events by drawing greater public attention to historic and cultural locations and events. Trails often provide access to historic sites such as battlegrounds, bridges, buildings, and canals that otherwise would be difficult to access or interpret. Each community and region has its own unique history, its own features and destinations, and its own landscapes. By recognizing, honoring, and connecting these features, the combined results serve to enhance cultural awareness and community identity, potentially attracting tourism. Being aware of the historical and cultural context when naming parks and trails and designing features will further enhance the overall trail- and park-user experience. An important link to our future is through our past. Greenways can serve to elevate the special history and culture of towns, cities and villages by providing accessibility to historic and architectural significant buildings, educational interpretation and special community assets.

Improved Water Quality and Wildlife Habitat

Greenway corridors often become off-road transportation facilities with simultaneous benefits. They help link fragmented tracts of land and protect sensitive natural features, natural processes, and ecological integrity.

Greenways also contribute to cleaner air by preserving stands of plants 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 and roadway runoff.[18]

> *"The protection of open spaces associated with trail and greenway development often also protects natural floodplains along rivers and streams. According to the Federal Emergency Management Agency (FEMA), the implementation of floodplain ordinances is estimated to prevent $1.1 billion in flood damages annually. By restoring developed floodplains to their natural state and protecting them as greenways, many riverside communities are preventing potential flood damages and related costs."*

Federal Emergency Management Agency. (2005) Building Stronger: State and Local Mitigation Planning.

Promoting Environmental Stewardship in North Carolina

The choices that we make every day are what ultimately drive the strength of our economy, resource base, and the quality of the environment. The State of North Carolina is fortunate to have policies and programs underway that promote and encourage environmental stewardship through low impact development and the conservation of natural resources. Both NCDOT and NCDENR support stewardship efforts at the state level, and their continued partnership will provide the leadership that is necessary to offer sustainable transportation choices to North Carolinians. The following programs, recognition and leadership programs, environmental education, information sharing, and collaborative problem solving opportunities will enhance and promote environmental stewardship in the state for generations.

Current Policies and Programs

EPA Building Blocks for Sustainable Communities

The purpose of delivering this program is to stimulate a discussion about growth and development and strengthen local capacity to implement sustainable approaches to community development. The program provides quick, targeted technical assistance to selected local and/ or tribal governments in helping them achieve desired development goals, improve quality of life, and become more economically and environmentally sustainable.

http://www.epa.gov/smartgrowth/buildingblocks.htm

The Evolution of Environmental Stewardship

Source: EPA Environmental Stewardship Staff Committee

Bike-share systems to create alternative commuting options

Bike-share systems are designed to make it economical and convenient to use bicycles for trips that are too far to walk but too short to drive in creating a balanced and dynamic transit system. Charlotte launched the largest bike sharing system in North Carolina in 2012 with over 200 bikes and 20 stations strategically located throughout the city.

http://charlotte.bcycle.com/About/WhatisCharlotteBcycle.aspx

NC Environmental Stewardship Initiative (ESI)

DENR's Environmental Stewardship Initiative is designed to promote and encourage superior environmental performance by North Carolina's regulated community. This voluntary program provides benefits and technical assistance to stimulate the development and implementation of programs that use pollution prevention and innovative approaches to meet and go beyond regulatory requirements. This program seeks to reduce the impact on the environment beyond measures required by any permit or rule, producing a better environment, conserving natural resources and resulting in long-term economic benefits.

http://portal.ncdenr.org/web/deao/outreach/esi

North Carolina Natural Heritage Program (NCNHP)

The North Carolina Natural Heritage Program (NCNHP), within DENR, works in partnership with a variety of state and federal agencies, private organizations, individuals, and corporations to identify the most significant natural areas of North Carolina and share this information, enabling future generations to enjoy the full diversity of North Carolina's natural heritage.

The NCNHP maintains the state's most extensive database for information on rare plants and animals, natural communities, outstanding natural areas, and land managed for conservation across the state. This scientific evidence is used to consider the ecological significance of various sites, and to evaluate the likelihood and nature of ecological impacts. Analysis of the data facilitates the establishment of priorities for the protection of North Carolina's most significant natural areas. NCNHP consolidates the information collected about rare species, high quality natural communities, and significant natural areas and makes it available for a variety of uses, including conservation and development planning throughout North Carolina.

North Carolina Conservation Planning Tool

The North Carolina Conservation Planning Tool (CPT) compiles this data into maps that communities can use to visualize how natural resources add value, and apply this information to put conservation opportunities in order of priority. This can support development planning that meets the needs of both people and the natural world upon which we depend, such as greenways alongside streams. The Biodiversity/Wildlife Habitat Assessment of the CPT is being integrated into the Wildlife Resources Commission's Green Growth Toolbox, which is shared with local governments and regional planning groups that want to address natural resources as part of their planning process.

Green Growth Toolbox

The NC Wildlife Resources Commission partners with the NC Conservation Planning Tool and other organizations to implement the Green Growth Toolbox. The Green Growth Toolbox is a non-regulatory tool for local governments, planners, communities and developers interested in conserving priority wildlife and habitat through their local land use planning methods. The GGT consists of a handbook that details community benefits, how to interpret NC conservation data sources for habitat mapping and how to achieve Green Growth through community plans, incentives, ordinances, development review and site design. NCWRC and partners provide training workshops to planners and communities with free follow-up technical assistance on planning projects. The Green Growth Toolbox can be used to minimize transportation impacts to wildlife and habitats because it details land use planning techniques that conserve priority wildlife habitats and travel corridors. It also provides specific wildlife science-based guidance on how much habitat priority wildlife need in order to remain in developing landscapes.

http://www.ncwildlife.org/greengrowth

Complete Streets Policy

Complete Streets is North Carolina's approach to interdependent, multi-modal transportation networks that safely accommodate access and travel for all users. The policy requires planners and designers to consider and incorporate multimodal alternatives in the design and improvement of all transportation projects within a growth area of a municipality unless certain circumstances exist.

http://www.ncdot.gov/bikeped/lawspolicies/policies/

National Trails Day

National Trails Day is a celebration of trails that involve a broad array of activities including hiking, dog walking, bike riding, trail maintenance, birding, wildlife photography, geocaching, paddle trips, trail running, trail dedications, health-focused programs, and children's activities. 29 events were officially registered in North Carolina in 2012, and National Trails Day took place June 1 in 2013.

http://www.americanhiking.org/national-trails-day/

North Carolina Safe Routes Action Plan

As part of the Safe Routes to School National Partnership, the mission of this program is to advocate for safe walking and bicycling to and from schools, and in daily life, to improve health and well-being of America's students and to foster the creation of livable, sustainable communities.

http://www.saferoutespartnership.org/sites/default/files/pdf/NCActionPlan11-2012.pdf

Active Living By Design

Active Living By Design (ALBD) creates community-led change by working with local and national partners to build a culture of active living and healthy eating. Established by the Robert Wood Johnson Foundation, ALBD is part of the North Carolina Institute for Public Health at the UNC Gillings School of Global Public Health in Chapel Hill, North Carolina. ALBD's mission is to create community-led change by working with local and national partners to build a culture of active living and healthy eating.

http://www.activelivingbydesign.org/

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9.7 Lane Width Research

Broad Street, Durham, NC

Introduction

This appendix presents design considerations for lane widths on state-owned roads in North Carolina. NCDOT's Complete Streets Policy emphasizes that the agency is committed to "providing an efficient multi-modal transportation network in North Carolina such that the access, mobility, and safety needs of motorists, transit users, bicyclists, and pedestrians of all ages and abilities are safely accommodated." The width of travel lanes is an important consideration as the agency seeks to balance the safety needs of all roadway users while at the same time ensuring that public rights-of-way in North Carolina are used to the utmost efficiency. To inform this discussion, a review of current lane width guidance and research is provided below.

Overview of Policy Guidance

National highway design policy allows a flexible approach to selecting lane widths. The AASHTO *Policy on Geometric Design of Highways and Streets* recommends that lane widths on major roads should range from 10-12 feet.[1] The selection of the appropriate lane width is a context-based decision. For example, 12-foot lanes are generally more appropriate on higher speed, free flowing, principal arterials. On roads with signals operating at lower speeds (45 mph or less), narrower lane widths are normally adequate and have some advantages. The determination of lane widths should incorporate factors such as a road's crash history, speed limit, the volume of heavy trucks, and whether a shoulder is provided.

The Federal Highway Administration allows flexibility and notes that while wider lane widths may be attainable on new construction, projects that seek to retrofit the built environment should consider minimum values where appropriate.[2] Flexibility in lane widths is particularly important in cities and towns, where there is often a concentration of multiple modes in constrained conditions. In recognition of the needs of cities, the Institute of Transportation Engineers (ITE) published the *Urban Street Geometric Design Handbook*.[3]

In this Chapter

The *Geometric Design Handbook* addresses the importance of context when selecting travel lane width and provides specific lane width recommendations based on roadway type and cross section. For example, it provides minimum recommended lane width dimensions for urban collector streets, which take into account context-based factors such as motor vehicle volumes, speed, and whether there is existing on-street parking and/or bike lanes.

Overview of Research

Traditionally, 12 feet was the desired standard for motor vehicle travel lanes. Narrower lane widths have been avoided in the past due to concerns about vehicle occupant safety and congestion, especially on arterial roadways. New research, however, has shown that 12 feet is not always needed for safety and capacity and lane widths between 10 feet and 11 feet on arterials and collectors do not negatively impact overall motor vehicle safety or operations. A summary of safety and capacity-related research is provided below.

Safety

A study by the Midwest Research Institute entitled *Relationship of Lane Width to Safety for Urban and Suburban Arterials*[4] concluded "That there is no indication that crash frequencies increase as lane width decreases for arterial roadway segments or arterial intersection approaches." The study compared 408 miles of urban and suburban arterials under state and local jurisdictions in two states. The types of roads in the analysis included the following arterial roadway types:

- Two-lane undivided arterials
- Three-lane arterials (one lane each direction + center turn lane)
- Four-lane undivided arterials
- Four-lane divided arterials
- Five-lane arterials (two lanes each direction + center turn lane).

According to the study, "A safety evaluation of lane widths for arterial roadway segments found no indication, except in limited cases, that the use of narrower lanes increases crash frequencies." Further, the study found that, "The lane width effects in the analyses conducted were generally either not statistically significant or indicated that narrower lanes were associated with lower rather than higher crash frequencies." Similarly, the study found no indication, except in limited cases, that the use of narrower lanes for arterial intersection approaches increases crash frequencies.

It is important to note that this study highlighted three situations in which the observed lane width effect was inconsistent including: lane widths of 10 feet or less on four-lane undivided arterials; lane widths of 9 feet or less on four-lane divided arterials; and lane widths of 10 feet or less on approaches to four-leg STOP-controlled arterial intersections. According to the study, these inconsistent findings do not mean that the use of narrower lanes must be avoided in these situations, but rather that, "It is recommended that narrower lane widths be used cautiously in these situations unless local experience indicates otherwise." The study also provides a caveat that "Lane widths less than 12 feet should be used cautiously where substantial volumes of bicyclists share the road with motor vehicles, unless an alternative facility for bicycles such as a wider curb lane or paved shoulder is provided."

The safety study described above included roads with buses and heavy vehicles. However, it bears mentioning that these vehicles are wider than single-occupancy vehicles (10.5 feet compared to 8 feet). Providing a bike lane or paved shoulder adjacent to a lane that carries higher volumes of heavy vehicles is beneficial to both users.

Finally, a report of the National Cooperative Highway Research Program report titled *Effective Utilization of Street Width on Urban Arterials* reached a similar conclusion.[5] This report considered the effectiveness of various strategies to re-allocate widths on urban arterials. The report surveys a wide range of crash data and finds no consistent relationship between 10 foot lanes and increased crash rates. The report recommends that narrower lanes should be considered as a strategy to implement other geometric improvements.

Capacity

Research has also been done to determine the effect of reducing lane widths on motor vehicle capacity. NCHRP Project 3-72 entitled *Lane Widths, Channelized Right Turns, and Right-turn Deceleration Lanes in Urban and Suburban Areas*[6] studied saturation flow rates for various lane widths, and found only a negligible difference (less than 5%) between the saturation flow rate of a 12' travel lane versus a 9.5' travel lane. Therefore, reducing a travel lane width from 12' to 10' has been found to have little adverse effects on motor vehicle capacity in urban and suburban locations.

The *Highway Capacity Manual* (HCM) is the standard reference document for determining the capacity of roadways and intersections. It was updated in 2010 and reflects the research findings discussed above.[7]

Rural Travel Lane and Shoulder Width Characteristics

There are thousands of miles of rural state-owned roads in North Carolina. Determining the appropriate land widths on these roads should incorporate the context-based factors discussed above, including crash history, speed limit, the volume of heavy trucks, and whether a shoulder is provided. Additional considerations for rural roads are provided below.

- According to FHWA, more than 42,000 fatalities occur annually on roadways in the United States. Nearly 60 percent of these fatalities are related to roadway departure crashes, 50 percent of which occur on rural, two-lane roads.[8]

- One option for addressing roadway departure crashes without adjusting the total paved width is to reconfigure the combination of lane and shoulder width to provide wider shoulders.

- It is important to consider the combined width of a roadway's travel lanes and paved shoulders to address safety issues on rural roads.

- Research performed for the *Interactive Highway Safety Design Model* (IHSDM) and the *Highway Safety Manual* (HSM) indicates that there is fairly substantial evidence of the benefits of adding shoulders to nearly all lane widths.[9]

- An important safety feature of paved shoulders is the prevention of head-on motor vehicle crashes. These crashes often occur when a motorist's wheels catch on the pavement lip (when there is no paved shoulder) and motorists' overcorrect as they attempt to get their motor vehicle back on the pavement, often launching them into the opposing lane. These crashes tend to be very costly and are often fatal.

- Shoulders provide additional motorist recovery area, a break-down area, and reduce pavement maintenance over time.

- Paved shoulders (at least 4') provide space for bicyclists and in many rural areas, they also serve as the only place for pedestrians to walk.

- Narrow lanes are not desirable on rural roads with high volumes of truck traffic. This is due to issues related to off-tracking, where the rear wheels of trucks generally track inside the front wheels on horizontal curves. Therefore, the design vehicle should be considered when identifying potential lane-shoulder configurations. This consideration is relevant for all roads; however, it is especially pertinent for rural roads without paved shoulders because in these cases there is no refuge space for pedestrians and bicyclists and the roads are often winding and hilly.

Other State DOT Practices

- The Florida DOT issued a *Roadway Design Bulletin* that directs staff to consider narrowing lanes to provide bike facilities as part of road projects that are not going to result in widening the road. It notes that the reduction of lane widths should be to no less than 11 feet lanes for design speeds greater than or equal to 40mph and no less than 10 feet for design speeds less than or equal to 35mph. The bulletin is available at: http://www.dot.state.fl.us/rddesign/updates/files/RDB09-03.pdf. This design bulletin is consistent with FDOT's *Roadway Design Manual.*

- The New Jersey Department of Transportation considers 11 feet to be an appropriate lane width on urban arterials; however, the agency allows 10 foot lanes where needed because of right-of-way or development constraints.

Conclusion

Lane width standards are critical to the overall cost and environmental impact of future roadway projects in North Carolina. A complete streets approach does not always mean a wider footprint for roadways, rather in some cases it means a more efficient utilization of the existing right-of-way. This is a critical issue with respect to the Department's ability to retrofit roadways to accommodate pedestrians and bicyclists, particularly during resurfacing projects and capacity improvement projects. Modifications to existing policies regarding standard lane widths deserve careful consideration as the Complete Streets policy is implemented in the future.

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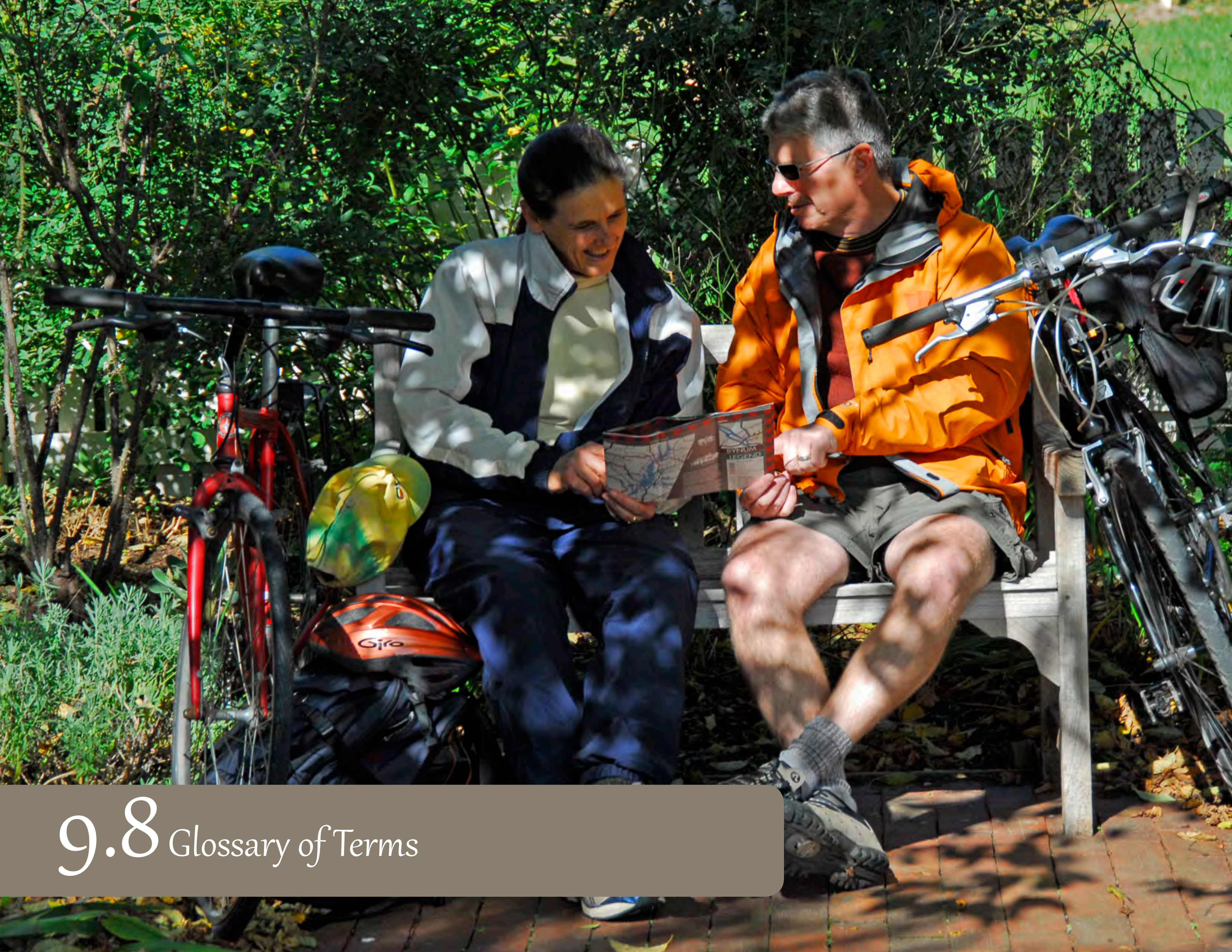

9.8 Glossary of Terms

Terms & definitions

2040 Plan: Statewide long-range plan, which serves as a blueprint for transportation planning and investment over the next 30 years

AAA: American Automobile Association

AASHTO: American Association of State Highway and Transportation Officials; nonprofit, nonpartisan association representing highway and transportation departments in all states in all modes to foster an integrated national transportation system.

ACA: Adventure Cycling Association

ACS: American Community Survey

ADA: Americans with Disabilities Act; civil rights law that prohibit discrimination based on disability, in this context, regarding the access and use of public accommodations

ADT: Average Daily Traffic

Alternative transportation: modes of travel other than private cars, such as walking, bicycling, rollerblading, carpooling and transit

ALBD: Active Living by Design

APBP: Association of Pedestrian and Bicycle Professionals

Bicycle Friendly Community: A national recognition program run by the League of American Bicyclists that provides incentives, hands-on assistance, and award recognition for communities that actively support bicycling, and ranks states annually based on their level of bike-friendliness.

BRFSS: Behavioral Risk Factor Surveillance System

CAPAG: Climate Action Plan Advisory Group

In this Chapter

CDC: Center for Disease Control and Prevention; one of the major operating components of the Department of Health and Human Services working to create the expertise, information, and tools that people and communities need to protect their health – through health promotion, prevention of disease, injury and disability, and preparedness for new health threats.

CIPs: Capital Improvement Programs

CMF: Crash Modification Factor

COG: Council of Governments

Complete Streets (CS): are streets designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. By adopting a Complete Streets policy, communities direct their transportation planners and engineers to routinely design and operate the entire right of way to enable safe access for all users, regardless of age, ability, or mode of transportation.

CPT: Conservation Planning Tool

CTNC: Conservation Trust for North Carolina

CTP: Comprehensive Transportation Plan

DBPT: Division of Bicycle and Pedestrian Transportation, under the North Carolina Department of Transportation

DHHS: Department of Health and Human Services

DENR: Department of Environment and Natural Resources

DWM: Davis Wealth Management Foundation

ECG: East Coast Greenway

ESI: Environmental Stewardship Initiative

ESMM: Eat Smart Move More

FDM: Facilities Development Manual

FEP: Fundamental Engineering Principles

FHWA: Federal Highway Administration; an agency within the U.S. Department of Transportation that supports state and local governments in the design, construction, and maintenance of the Nation's highway system (Federal Aid Highway Program) and various federally and tribal owned lands

FTA: Federal Transportation Administration

GGT: Green Growth Toolbox

GIS: Geographic Information Systems; integrates hardware, software and data for capturing, managing, analyzing and displaying all forms of geographically referenced information

HEC: Healthy Environments Collaborative

HEC: Highway Engineering Concepts

HIA: Health Impact Assessment

HSIP: Highway Safety Improvement Program

HSRC: The Highway Safety Research Center run out of the University of North Carolina that conducts interdisciplinary research aimed at reducing deaths, injuries and related societal costs of roadway crashes.

ITE: Institute of Transportation Engineers

ITRE: Institute for Transportation Research and the Education; an inter:institutional research center administered by North Carolina State University that conducts surface, water, and air transportation research, while providing professional training and educational opportunities

LCIs: League Cycling Instructor; qualified through a course run through the League of American Bicyclists, these individuals teach courses to suit the needs of any cyclist

LOS: Level of Service; a measure used by traffic engineers to determine the effectiveness of elements of transportation infrastructure

LPI: Leading Pedestrian Interval

LRTP: Long-Range Transportation Plan; completed by the MPO/RPO every 5 years, looking at the vision for transportation 25 years in the future

LWCF: Land and Water Conservation Fund

MAP-21: Moving Ahead for Progress in the 21st Century Act; the funding and authorization bill signed by Obama in July 2012.

Mode Share: The percentage of travelers (or trips made) using a particular type of transportation (e.g., walk, bicycle, private car)

MPO: Municipal Planning Organization

MTIP: Metropolitan Transportation Improvement Program

MUTCD: Manual on Uniform Traffic Control Devices

NACTO: National Association of City Transportation Officials; published the Urban Bikeway Design Guide

NCATA: North Carolina Active Transportation Alliance

NCBOT: North Carolina Board of Transportation

NCDOT: North Carolina Department of Transportation

NHTSA: National Highway Traffic Safety Administration; established by the Highway Safety Act of 1970 to directs the highway safety and consumer programs

PBIC: Pedestrian Bicycle Information Center

PHB: Pedestrian Hybrid Beacons

PROWAG: Public Rights-of-Way Accessibility Guidelines

RDM: Roadway Design Manual

RIMS: Regional Input-Output Modeling System

RPO: Regional Planning Organization

RRFB: Rectangular Rapid Flashing Beacons

RTOR: Right Turn on Red

SAFETEA:LU: Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users; the funding and authorization bill that governed federal surface transportation spending from 2005, until MAP:21 replaced it in 2012

SCORP: Statewide Comprehensive Outdoor Recreation Plan

SCHS: State Center for Health Statistics

SRTS: Safe Routes to School

STIP: Statewide Transportation Improvement Program

TAP: Transportation Alternative Program

TND: Traditional Neighborhood Development; helps to create vibrant mixed-use neighborhoods with higher densities and a range of complementary uses

Walk to School Day: a global event led by the National Center for Safe Routes to School where communities from over 40 countries walk and bike to school on a single day in October

VMT: Vehicle miles traveled

Walk Friendly Community: A national recognition program run out of the Pedestrian and Bicycle Information Center developed to encourage towns and cities across the U.S. to establish or recommit to a high priority for supporting safer walking environments.

Watch for Me NC: a comprehensive campaign aimed at reducing the number of pedestrians hit and injured in crashes with vehicles. The program is a collaborative effort with state and local transportation agencies.

WHO: World Health Organization

9.9 North Carolina Crash and Mode Share Data

Downtown Raleigh, NC

Overview

This appendix presents multiple tables that contain North Carolina city and county population data, crash totals, and commuting data. Population numbers are from 2010 US Census data. Commuting data is drawn from the 2007-2011 5-year American Community Survey(ACS). Crash data was provided from NCDOT Division of Bicycle and Pedestrian Transportation and includes a full year's worth of data from 2010.

These tables serve as starting points for future benchmarking and evaluation. As recommended in this Plan, crash data collection should continue and be improved through more consistent and comprehensive, on-site recording and inventory. Commuting data is always available from the US Census American Community Survey.

In many states and cities, there is an inverse relationship between pedestrian/bicycle mode share and pedestrian/bicycle crashes. In other words, the more pedestrians and bicyclists in the environment, the lower the per capita rate of crashes.

In this Chapter

Table 9.9.1 County Pedestrian Crash Data and Commuter Data

County	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Alamance	151131	27	0.000179	0.18	981	0.006491	6.49
Alexander	37198	3	0.000081	0.08	235	0.006318	6.32
Alleghany	11155	3	0.000269	0.27	14	0.001255	1.26
Anson	26948	6	0.000223	0.22	73	0.002709	2.71
Ashe	27281	3	0.000110	0.11	49	0.001796	1.80
Avery	17797	0	0.000000	0.00	193	0.010845	10.84
Beaufort	47759	9	0.000188	0.19	426	0.008920	8.92
Bertie	21282	4	0.000188	0.19	249	0.011700	11.70
Bladen	35190	13	0.000369	0.37	233	0.006621	6.62
Brunswick	107431	22	0.000205	0.20	492	0.004580	4.58
Buncombe	238318	89	0.000373	0.37	2,348	0.009852	9.85
Burke	90912	9	0.000099	0.10	508	0.005588	5.59
Cabarrus	178011	40	0.000225	0.22	726	0.004078	4.08
Caldwell	83029	16	0.000193	0.19	414	0.004986	4.99
Camden	9980	2	0.000200	0.20	1	0.000100	0.10
Carteret	66469	16	0.000241	0.24	613	0.009222	9.22
Caswell	23719	2	0.000084	0.08	134	0.005649	5.65
Catawba	154358	56	0.000363	0.36	518	0.003356	3.36
Chatham	63505	9	0.000142	0.14	677	0.010661	10.66
Cherokee	27444	4	0.000146	0.15	127	0.004628	4.63
Chowan	14793	5	0.000338	0.34	151	0.010208	10.21
Clay	10587	2	0.000189	0.19	25	0.002361	2.36
Cleveland	98078	24	0.000245	0.24	690	0.007035	7.04
Columbus	58098	11	0.000189	0.19	332	0.005714	5.71
Craven	103505	12	0.000116	0.12	1,382	0.013352	13.35
Cumberland	319431	146	0.000457	0.46	4,923	0.015412	15.41
Currituck	23547	1	0.000042	0.04	41	0.001741	1.74
Dare	33920	13	0.000383	0.38	360	0.010613	10.61
Davidson	162878	24	0.000147	0.15	633	0.003886	3.89
Davie	41240	6	0.000145	0.15	292	0.007081	7.08
Duplin	58505	11	0.000188	0.19	626	0.010700	10.70

County	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Durham	267587	100	0.000374	0.37	3,249	0.012142	12.14
Edgecombe	56552	20	0.000354	0.35	314	0.005552	5.55
Forsyth	350670	61	0.000174	0.17	2,678	0.007637	7.64
Franklin	60619	6	0.000099	0.10	596	0.009832	9.83
Gaston	206086	59	0.000286	0.29	763	0.003702	3.70
Gates	12197	1	0.000082	0.08	53	0.004345	4.35
Graham	8861	2	0.000226	0.23	61	0.006884	6.88
Granville	59916	4	0.000067	0.07	350	0.005842	5.84
Greene	21362	3	0.000140	0.14	38	0.001779	1.78
Guilford	488406	215	0.000440	0.44	4,001	0.008192	8.19
Halifax	54691	27	0.000494	0.49	244	0.004461	4.46
Harnett	114678	22	0.000192	0.19	593	0.005171	5.17
Haywood	59036	7	0.000119	0.12	312	0.005285	5.28
Henderson	106740	33	0.000309	0.31	710	0.006652	6.65
Hertford	24669	2	0.000081	0.08	153	0.006202	6.20
Hoke	46952	6	0.000128	0.13	458	0.009755	9.75
Hyde	5810	0	0.000000	0.00	93	0.016007	16.01
Iredell	159437	34	0.000213	0.21	391	0.002452	2.45
Jackson	40271	2	0.000050	0.05	785	0.019493	19.49
Johnston	168878	26	0.000154	0.15	508	0.003008	3.01
Jones	10153	1	0.000098	0.10	115	0.011327	11.33
Lee	57866	9	0.000156	0.16	254	0.004389	4.39
Lenoir	59495	14	0.000235	0.24	362	0.006085	6.08
Lincoln	78265	7	0.000089	0.09	263	0.003360	3.36
Macon	44996	4	0.000089	0.09	253	0.005623	5.62
Madison	33922	1	0.000029	0.03	218	0.006427	6.43
Martin	20764	1	0.000048	0.05	218	0.010499	10.50
McDowell	24505	6	0.000245	0.24	238	0.009712	9.71
Mecklenburg	919628	392	0.000426	0.43	8,614	0.009367	9.37
Mitchell	15579	4	0.000257	0.26	47	0.003017	3.02
Montgomery	27798	2	0.000072	0.07	140	0.005036	5.04

County	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Moore	88247	22	0.000249	0.25	537	0.006085	6.09
Nash	95840	17	0.000177	0.18	462	0.004821	4.82
New Hanover	202667	75	0.000370	0.37	1,565	0.007722	7.72
Northampton	22099	1	0.000045	0.05	159	0.007195	7.19
Onslow	177772	33	0.000186	0.19	4,762	0.026787	26.79
Orange	133801	39	0.000291	0.29	3,427	0.025613	25.61
Pamlico	13144	3	0.000228	0.23	95	0.007228	7.23
Pasquotank	40661	9	0.000221	0.22	318	0.007821	7.82
Pender	52217	6	0.000115	0.11	149	0.002853	2.85
Perquimans	13453	0	0.000000	0.00	131	0.009738	9.74
Person	39464	5	0.000127	0.13	108	0.002737	2.74
Pitt	168148	40	0.000238	0.24	1,799	0.010699	10.70
Polk	20510	2	0.000098	0.10	161	0.007850	7.85
Randolph	141752	47	0.000332	0.33	743	0.005242	5.24
Richmond	46639	14	0.000300	0.30	145	0.003109	3.11
Robeson	134168	47	0.000350	0.35	824	0.006142	6.14
Rockingham	93643	17	0.000182	0.18	362	0.003866	3.87
Rowan	138428	33	0.000238	0.24	595	0.004298	4.30
Rutherford	67810	14	0.000206	0.21	371	0.005471	5.47
Sampson	63431	16	0.000252	0.25	497	0.007835	7.84
Scotland	36157	13	0.000360	0.36	141	0.003900	3.90
Stanly	60585	11	0.000182	0.18	366	0.006041	6.04
Stokes	47401	5	0.000105	0.11	199	0.004198	4.20
Surry	73673	19	0.000258	0.26	406	0.005511	5.51
Swain	13981	3	0.000215	0.21	96	0.006866	6.87
Transylvania	33090	4	0.000121	0.12	402	0.012149	12.15
Tyrrell	4407	0	0.000000	0.00	106	0.024053	24.05
Union	201292	25	0.000124	0.12	579	0.002876	2.88
Vance	45422	15	0.000330	0.33	255	0.005614	5.61
Wake	900993	266	0.000295	0.30	7,153	0.007939	7.94
Warren	20972	1	0.000048	0.05	138	0.006580	6.58

County	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Washington	13228	2	0.000151	0.15	83	0.006275	6.27
Watauga	51079	15	0.000294	0.29	1,592	0.031167	31.17
Wayne	122623	31	0.000253	0.25	683	0.005570	5.57
Wilkes	69340	9	0.000130	0.13	401	0.005783	5.78
Wilson	81234	19	0.000234	0.23	588	0.007238	7.24
Yadkin	38406	6	0.000156	0.16	98	0.002552	2.55

Table 9.9.2 County Bicycle Crash Data and Commuter Data

County	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bike Commuters	Bike Commuters per Capita	Bike Commuters per 1,000
Alamance	151131	15	0.000099	0.10	68	0.000450	0.45
Alexander	37198	1	0.000027	0.03	0	0.000000	0.00
Alleghany	11155	0	0.000000	0.00	24	0.002152	2.15
Anson	26948	1	0.000037	0.04	26	0.000965	0.96
Ashe	27281	1	0.000037	0.04	0	0.000000	0.00
Avery	17797	1	0.000056	0.06	1	0.000056	0.06
Beaufort	47759	5	0.000105	0.10	62	0.001298	1.30
Bertie	21282	2	0.000094	0.09	0	0.000000	0.00
Bladen	35190	2	0.000057	0.06	0	0.000000	0.00
Brunswick	107431	10	0.000093	0.09	55	0.000512	0.51
Buncombe	238318	28	0.000117	0.12	547	0.002295	2.30
Burke	90912	6	0.000066	0.07	115	0.001265	1.26
Cabarrus	178011	12	0.000067	0.07	65	0.000365	0.37
Caldwell	83029	4	0.000048	0.05	69	0.000831	0.83
Camden	9980	2	0.000200	0.20	0	0.000000	0.00
Carteret	66469	7	0.000105	0.11	72	0.001083	1.08
Caswell	23719	0	0.000000	0.00	0	0.000000	0.00
Catawba	154358	19	0.000123	0.12	67	0.000434	0.43
Chatham	63505	5	0.000079	0.08	30	0.000472	0.47
Cherokee	27444	3	0.000109	0.11	0	0.000000	0.00

County	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bike Commuters	Bike Commuters per Capita	Bike Commuters per 1,000
Chowan	14793	0	0.000000	0.00	14	0.000946	0.95
Clay	10587	1	0.000094	0.09	0	0.000000	0.00
Cleveland	98078	5	0.000051	0.05	17	0.000173	0.17
Columbus	58098	4	0.000069	0.07	14	0.000241	0.24
Craven	103505	7	0.000068	0.07	97	0.000937	0.94
Cumberland	319431	35	0.000110	0.11	209	0.000654	0.65
Currituck	23547	2	0.000085	0.08	17	0.000722	0.72
Dare	33920	17	0.000501	0.50	175	0.005159	5.16
Davidson	162878	8	0.000049	0.05	53	0.000325	0.33
Davie	41240	3	0.000073	0.07	0	0.000000	0.00
Duplin	58505	2	0.000034	0.03	126	0.002154	2.15
Durham	267587	40	0.000149	0.15	773	0.002889	2.89
Edgecombe	56552	8	0.000141	0.14	44	0.000778	0.78
Forsyth	350670	11	0.000031	0.03	219	0.000625	0.62
Franklin	60619	2	0.000033	0.03	4	0.000066	0.07
Gaston	206086	13	0.000063	0.06	56	0.000272	0.27
Gates	12197	1	0.000082	0.08	13	0.001066	1.07
Graham	8861	0	0.000000	0.00	0	0.000000	0.00
Granville	59916	3	0.000050	0.05	0	0.000000	0.00
Greene	21362	1	0.000047	0.05	30	0.001404	1.40
Guilford	488406	78	0.000160	0.16	450	0.000921	0.92
Halifax	54691	4	0.000073	0.07	12	0.000219	0.22
Harnett	114678	6	0.000052	0.05	43	0.000375	0.37
Haywood	59036	0	0.000000	0.00	36	0.000610	0.61
Henderson	106740	6	0.000056	0.06	29	0.000272	0.27
Hertford	24669	2	0.000081	0.08	33	0.001338	1.34
Hoke	46952	4	0.000085	0.09	84	0.001789	1.79
Hyde	5810	1	0.000172	0.17	84	0.014458	14.46
Iredell	159437	16	0.000100	0.10	22	0.000138	0.14
Jackson	40271	0	0.000000	0.00	15	0.000372	0.37
Johnston	168878	15	0.000089	0.09	45	0.000266	0.27
Jones	10153	0	0.000000	0.00	58	0.005713	5.71

County	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bike Commuters	Bike Commuters per Capita	Bike Commuters per 1,000
Lee	57866	1	0.000017	0.02	33	0.000570	0.57
Lenoir	59495	6	0.000101	0.10	32	0.000538	0.54
Lincoln	78265	3	0.000038	0.04	25	0.000319	0.32
Macon	44996	0	0.000000	0.00	20	0.000444	0.44
Madison	33922	0	0.000000	0.00	0	0.000000	0.00
Martin	20764	5	0.000241	0.24	5	0.000241	0.24
McDowell	24505	2	0.000082	0.08	14	0.000571	0.57
Mecklenburg	919628	130	0.000141	0.14	638	0.000694	0.69
Mitchell	15579	0	0.000000	0.00	0	0.000000	0.00
Montgomery	27798	0	0.000000	0.00	0	0.000000	0.00
Moore	88247	9	0.000102	0.10	38	0.000431	0.43
Nash	95840	14	0.000146	0.15	37	0.000386	0.39
New Hanover	202667	62	0.000306	0.31	853	0.004209	4.21
Northampton	22099	1	0.000045	0.05	21	0.000950	0.95
Onslow	177772	10	0.000056	0.06	534	0.003004	3.00
Orange	133801	23	0.000172	0.17	1,069	0.007989	7.99
Pamlico	13144	2	0.000152	0.15	18	0.001369	1.37
Pasquotank	40661	5	0.000123	0.12	42	0.001033	1.03
Pender	52217	2	0.000038	0.04	36	0.000689	0.69
Perquimans	13453	0	0.000000	0.00	0	0.000000	0.00
Person	39464	1	0.000025	0.03	0	0.000000	0.00
Pitt	168148	20	0.000119	0.12	272	0.001618	1.62
Polk	20510	0	0.000000	0.00	0	0.000000	0.00
Randolph	141752	5	0.000035	0.04	7	0.000049	0.05
Richmond	46639	2	0.000043	0.04	23	0.000493	0.49
Robeson	134168	23	0.000171	0.17	144	0.001073	1.07
Rockingham	93643	3	0.000032	0.03	0	0.000000	0.00
Rowan	138428	15	0.000108	0.11	119	0.000860	0.86
Rutherford	67810	5	0.000074	0.07	0	0.000000	0.00
Sampson	63431	4	0.000063	0.06	48	0.000757	0.76
Scotland	36157	6	0.000166	0.17	11	0.000304	0.30
Stanly	60585	2	0.000033	0.03	47	0.000776	0.78

County	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bike Commuters	Bike Commuters per Capita	Bike Commuters per 1,000
Stokes	47401	1	0.000021	0.02	0	0.000000	0.00
Surry	73673	3	0.000041	0.04	0	0.000000	0.00
Swain	13981	0	0.000000	0.00	0	0.000000	0.00
Transylvania	33090	1	0.000030	0.03	10	0.000302	0.30
Tyrrell	4407	0	0.000000	0.00	0	0.000000	0.00
Union	201292	8	0.000040	0.04	38	0.000189	0.19
Vance	45422	4	0.000088	0.09	0	0.000000	0.00
Wake	900993	136	0.000151	0.15	1,186	0.001316	1.32
Warren	20972	1	0.000048	0.05	0	0.000000	0.00
Washington	13228	1	0.000076	0.08	4	0.000302	0.30
Watauga	51079	9	0.000176	0.18	150	0.002937	2.94
Wayne	122623	8	0.000065	0.07	167	0.001362	1.36
Wilkes	69340	1	0.000014	0.01	29	0.000418	0.42
Wilson	81234	14	0.000172	0.17	50	0.000616	0.62
Yadkin	38406	1	0.000026	0.03	22	0.000573	0.57
Yancey	17818	0	0.000000	0.00	17	0.000954	0.95

Table 9.9.3 City Pedestrian Crash Data and Commuter Data

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Aberdeen	6350	8	0.001260	1.26	54	0.008504	8.50
Ahoskie	5039	0	0.000000	0.00	36	0.007144	7.14
Alamance	951	0	0.000000	0.00	7	0.007361	7.36
Albemarle	15903	7	0.000440	0.44	103	0.006477	6.48
Alliance	776	2	0.002577	2.58	11	0.014175	14.18
Andrews	1781	0	0.000000	0.00	0	0.000000	0.00
Angier	4350	1	0.000230	0.23	3	0.000690	0.69
Ansonville	631	0	0.000000	0.00	0	0.000000	0.00
Apex	37476	4	0.000107	0.11	185	0.004936	4.94
Arapahoe	556	0	0.000000	0.00	3	0.005396	5.40
Archdale	11415	5	0.000438	0.44	0	0.000000	0.00
Archer Lodge	4292	1	0.000233	0.23	0	0.000000	0.00

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Asheboro	25012	23	0.000920	0.92	176	0.007037	7.04
Asheville	83393	65	0.000779	0.78	1320	0.015829	15.83
Askewville	241	0	0.000000	0.00	1	0.004149	4.15
Atkinson	299	0	0.000000	0.00	2	0.006689	6.69
Atlantic Beach	1495	0	0.000000	0.00	40	0.026756	26.76
Aulander	895	0	0.000000	0.00	15	0.016760	16.76
Aurora	520	0	0.000000	0.00	2	0.003846	3.85
Autryville	196	0	0.000000	0.00	6	0.030612	30.61
Ayden	4932	0	0.000000	0.00	25	0.005069	5.07
Badin	1974	0	0.000000	0.00	8	0.004053	4.05
Bailey	569	0	0.000000	0.00	9	0.015817	15.82
Bakersville	464	0	0.000000	0.00	5	0.010776	10.78
Bald Head Island	158	0	0.000000	0.00	0	0.000000	0.00
Banner Elk	1028	0	0.000000	0.00	102	0.099222	99.22
Bath	249	0	0.000000	0.00	2	0.008032	8.03
Bayboro	1263	0	0.000000	0.00	0	0.000000	0.00
Bear Grass	73	0	0.000000	0.00	0	0.000000	0.00
Beaufort	4039	3	0.000743	0.74	193	0.047784	47.78
Beech Mountain	320	0	0.000000	0.00	5	0.015625	15.63
Belhaven	1688	0	0.000000	0.00	57	0.033768	33.77
Belmont	10076	10	0.000992	0.99	189	0.018757	18.76
Belville	1936	0	0.000000	0.00	17	0.008781	8.78
Belwood	950	0	0.000000	0.00	3	0.003158	3.16
Benson	3311	0	0.000000	0.00	32	0.009665	9.66
Bermuda Run	1725	0	0.000000	0.00	0	0.000000	0.00
Bessemer City	5340	0	0.000000	0.00	0	0.000000	0.00
Bethania	328	1	0.003049	3.05	2	0.006098	6.10
Bethel	1577	0	0.000000	0.00	24	0.015219	15.22
Beulaville	1296	1	0.000772	0.77	32	0.024691	24.69
Biltmore Forest	1343	0	0.000000	0.00	0	0.000000	0.00
Biscoe	1700	0	0.000000	0.00	0	0.000000	0.00
Black Creek	769	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Black Mountain	7848	1	0.000127	0.13	186	0.023700	23.70
Bladenboro	1750	1	0.000571	0.57	13	0.007429	7.43
Blowing Rock	1241	0	0.000000	0.00	41	0.033038	33.04
Boardman	157	0	0.000000	0.00	0	0.000000	0.00
Bogue	684	0	0.000000	0.00	4	0.005848	5.85
Boiling Spring Lakes	5372	0	0.000000	0.00	10	0.001862	1.86
Boiling Springs	4647	1	0.000215	0.22	261	0.056165	56.17
Bolivia	143	0	0.000000	0.00	14	0.097902	97.90
Bolton	691	0	0.000000	0.00	0	0.000000	0.00
Boone	17122	13	0.000759	0.76	1330	0.077678	77.68
Boonville	1222	0	0.000000	0.00	3	0.002455	2.45
Bostic	386	0	0.000000	0.00	0	0.000000	0.00
Brevard	7609	3	0.000394	0.39	131	0.017216	17.22
Bridgeton	454	0	0.000000	0.00	0	0.000000	0.00
Broadway	1229	0	0.000000	0.00	8	0.006509	6.51
Brookford	382	0	0.000000	0.00	0	0.000000	0.00
Brunswick	1119	0	0.000000	0.00	9	0.008043	8.04
Bryson City	1424	0	0.000000	0.00	12	0.008427	8.43
Bunn	344	0	0.000000	0.00	5	0.014535	14.53
Burgaw	3872	0	0.000000	0.00	0	0.000000	0.00
Burlington	49963	10	0.000200	0.20	261	0.005224	5.22
Burnsville	1693	0	0.000000	0.00	157	0.092735	92.73
Butner	7591	0	0.000000	0.00	37	0.004874	4.87
Cajah's Mountain	2823	1	0.000354	0.35	4	0.001417	1.42
Calabash	1786	0	0.000000	0.00	0	0.000000	0.00
Calypso	538	0	0.000000	0.00	0	0.000000	0.00
Cameron	285	0	0.000000	0.00	0	0.000000	0.00
Candor	840	1	0.001190	1.19	0	0.000000	0.00
Canton	4227	0	0.000000	0.00	29	0.006861	6.86
Cape Carteret	1917	0	0.000000	0.00	18	0.009390	9.39
Carolina Beach	5706	3	0.000526	0.53	65	0.011392	11.39
Carolina Shores	3048	0	0.000000	0.00	9	0.002953	2.95
Carrboro	19582	9	0.000460	0.46	360	0.018384	18.38

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Carthage	2205	1	0.000454	0.45	13	0.005896	5.90
Cary	135234	26	0.000192	0.19	941	0.006958	6.96
Casar	297	0	0.000000	0.00	3	0.010101	10.10
Castalia	268	0	0.000000	0.00	1	0.003731	3.73
Caswell Beach	398	0	0.000000	0.00	4	0.010050	10.05
Catawba	603	0	0.000000	0.00	0	0.000000	0.00
Cedar Point	1279	0	0.000000	0.00	12	0.009382	9.38
Cedar Rock	300	0	0.000000	0.00	0	0.000000	0.00
Centerville	89	0	0.000000	0.00	0	0.000000	0.00
Cerro Gordo	207	0	0.000000	0.00	0	0.000000	0.00
Chadbourn	1856	0	0.000000	0.00	3	0.001616	1.62
Chapel Hill	57233	20	0.000349	0.35	2811	0.049115	49.12
Charlotte	731424	345	0.000472	0.47	7243	0.009903	9.90
Cherryville	5760	2	0.000347	0.35	55	0.009549	9.55
Chimney Rock Village	113	0	0.000000	0.00	0	0.000000	0.00
China Grove	3563	1	0.000281	0.28	17	0.004771	4.77
Chocowinity	820	0	0.000000	0.00	3	0.003659	3.66
Claremont	1352	1	0.000740	0.74	26	0.019231	19.23
Clarkton	837	0	0.000000	0.00	7	0.008363	8.36
Clayton	16116	3	0.000186	0.19	23	0.001427	1.43
Clemmons	18627	3	0.000161	0.16	74	0.003973	3.97
Cleveland	871	0	0.000000	0.00	5	0.005741	5.74
Clinton	8639	4	0.000463	0.46	69	0.007987	7.99
Clyde	1223	0	0.000000	0.00	3	0.002453	2.45
Coats	2112	1	0.000473	0.47	0	0.000000	0.00
Cofield	413	0	0.000000	0.00	17	0.041162	41.16
Colerain	204	0	0.000000	0.00	0	0.000000	0.00
Columbia	891	0	0.000000	0.00	11	0.012346	12.35
Columbus	999	1	0.001001	1.00	9	0.009009	9.01
Como	91	0	0.000000	0.00	0	0.000000	0.00
Concord	79066	22	0.000278	0.28	318	0.004022	4.02
Conetoe	294	0	0.000000	0.00	22	0.074830	74.83
Connelly Springs	1669	0	0.000000	0.00	16	0.009587	9.59

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Conover	8165	9	0.001102	1.10	14	0.001715	1.71
Conway	836	0	0.000000	0.00	0	0.000000	0.00
Cooleemee	960	1	0.001042	1.04	0	0.000000	0.00
Cornelius	24866	1	0.000040	0.04	202	0.008124	8.12
Cove City	399	0	0.000000	0.00	0	0.000000	0.00
Cramerton	4165	0	0.000000	0.00	9	0.002161	2.16
Creedmoor	4124	0	0.000000	0.00	0	0.000000	0.00
Creswell	276	0	0.000000	0.00	2	0.007246	7.25
Crossnore	192	0	0.000000	0.00	9	0.046875	46.88
Dallas	4488	0	0.000000	0.00	93	0.020722	20.72
Danbury	189	0	0.000000	0.00	0	0.000000	0.00
Davidson	10944	1	0.000091	0.09	295	0.026955	26.96
Denton	1636	0	0.000000	0.00	22	0.013447	13.45
Dillsboro	232	0	0.000000	0.00	8	0.034483	34.48
Dobbins Heights	866	0	0.000000	0.00	4	0.004619	4.62
Dobson	1586	0	0.000000	0.00	73	0.046028	46.03
Dortches	935	0	0.000000	0.00	5	0.005348	5.35
Dover	401	0	0.000000	0.00	2	0.004988	4.99
Drexel	1858	0	0.000000	0.00	0	0.000000	0.00
Dublin	338	0	0.000000	0.00	5	0.014793	14.79
Duck	369	1	0.002710	2.71	2	0.005420	5.42
Dunn	9263	8	0.000864	0.86	85	0.009176	9.18
Durham	228330	96	0.000420	0.42	3207	0.014045	14.05
Earl	260	0	0.000000	0.00	0	0.000000	0.00
East Arcadia	487	0	0.000000	0.00	0	0.000000	0.00
East Bend	612	0	0.000000	0.00	6	0.009804	9.80
East Laurinburg	300	0	0.000000	0.00	5	0.016667	16.67
East Spencer	1534	0	0.000000	0.00	0	0.000000	0.00
Eastover	3628	1	0.000276	0.28	0	0.000000	0.00
Eden	15527	7	0.000451	0.45	119	0.007664	7.66
Edenton	5004	2	0.000400	0.40	118	0.023581	23.58
Elizabeth City	18683	5	0.000268	0.27	214	0.011454	11.45

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Elizabethtown	3583	1	0.000279	0.28	61	0.017025	17.02
Elk Park	452	0	0.000000	0.00	0	0.000000	0.00
Elkin	4001	3	0.000750	0.75	0	0.000000	0.00
Ellenboro	873	0	0.000000	0.00	0	0.000000	0.00
Ellerbe	1054	0	0.000000	0.00	31	0.029412	29.41
Elm City	1298	0	0.000000	0.00	27	0.020801	20.80
Elon	9419	2	0.000212	0.21	264	0.028028	28.03
Emerald Isle	3655	2	0.000547	0.55	16	0.004378	4.38
Enfield	2532	2	0.000790	0.79	8	0.003160	3.16
Erwin	4405	2	0.000454	0.45	4	0.000908	0.91
Eureka	197	0	0.000000	0.00	0	0.000000	0.00
Everetts	164	0	0.000000	0.00	3	0.018293	18.29
Fair Bluff	951	0	0.000000	0.00	8	0.008412	8.41
Fairmont	2663	0	0.000000	0.00	27	0.010139	10.14
Fairview	2678	0	0.000000	0.00	14	0.005228	5.23
Faison	961	0	0.000000	0.00	36	0.037461	37.46
Faith	807	1	0.001239	1.24	3	0.003717	3.72
Falcon	258	0	0.000000	0.00	3	0.011628	11.63
Falkland	96	1	0.010417	10.42	0	0.000000	0.00
Fallston	607	0	0.000000	0.00	36	0.059308	59.31
Farmville	4654	2	0.000430	0.43	111	0.023850	23.85
Fayetteville	200564	118	0.000588	0.59	4327	0.021574	21.57
Flat Rock	3114	0	0.000000	0.00	30	0.009634	9.63
Fletcher	7187	1	0.000139	0.14	12	0.001670	1.67
Fontana Dam	#N/A	0	#N/A	#N/A	#N/A	#N/A	#N/A
Forest City	7476	8	0.001070	1.07	27	0.003612	3.61
Forest Hills	365	0	0.000000	0.00	3	0.008219	8.22
Fountain	427	0	0.000000	0.00	3	0.007026	7.03
Four Oaks	1921	0	0.000000	0.00	7	0.003644	3.64
Foxfire Village	902	0	0.000000	0.00	0	0.000000	0.00
Franklin	3845	0	0.000000	0.00	42	0.010923	10.92
Franklinton	2023	0	0.000000	0.00	9	0.004449	4.45

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Franklinville	1164	1	0.000859	0.86	9	0.007732	7.73
Fremont	1255	0	0.000000	0.00	26	0.020717	20.72
Fuquay-Varina	17937	6	0.000335	0.33	38	0.002119	2.12
Gamewell	4051	0	0.000000	0.00	0	0.000000	0.00
Garland	625	0	0.000000	0.00	4	0.006400	6.40
Garner	25745	13	0.000505	0.50	192	0.007458	7.46
Garysburg	1057	0	0.000000	0.00	0	0.000000	0.00
Gaston	1152	0	0.000000	0.00	67	0.058160	58.16
Gastonia	71741	40	0.000558	0.56	209	0.002913	2.91
Gatesville	321	0	0.000000	0.00	0	0.000000	0.00
Gibson	540	0	0.000000	0.00	5	0.009259	9.26
Gibsonville	6410	1	0.000156	0.16	0	0.000000	0.00
Glen Alpine	1517	0	0.000000	0.00	4	0.002637	2.64
Godwin	139	0	0.000000	0.00	0	0.000000	0.00
Goldsboro	36437	15	0.000412	0.41	261	0.007163	7.16
Goldston	268	0	0.000000	0.00	2	0.007463	7.46
Graham	14153	2	0.000141	0.14	42	0.002968	2.97
Grandfather Village	25	0	0.000000	0.00	0	0.000000	0.00
Granite Falls	4722	0	0.000000	0.00	57	0.012071	12.07
Granite Quarry	2930	0	0.000000	0.00	0	0.000000	0.00
Grantsboro	688	1	0.001453	1.45	0	0.000000	0.00
Green Level	2100	1	0.000476	0.48	0	0.000000	0.00
Greenevers	634	1	0.001577	1.58	17	0.026814	26.81
Greensboro	269666	152	0.000564	0.56	2471	0.009163	9.16
Greenville	84554	19	0.000225	0.22	1400	0.016557	16.56
Grifton	2617	0	0.000000	0.00	0	0.000000	0.00
Grimesland	441	0	0.000000	0.00	0	0.000000	0.00
Grover	708	0	0.000000	0.00	2	0.002825	2.82
Halifax	234	0	0.000000	0.00	5	0.021368	21.37
Hamilton	408	0	0.000000	0.00	0	0.000000	0.00
Hamlet	6495	1	0.000154	0.15	0	0.000000	0.00
Harmony	531	1	0.001883	1.88	16	0.030132	30.13

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Harrells	202	0	0.000000	0.00	10	0.049505	49.50
Harrellsville	106	0	0.000000	0.00	0	0.000000	0.00
Harrisburg	11526	1	0.000087	0.09	0	0.000000	0.00
Hassell	84	0	0.000000	0.00	0	0.000000	0.00
Havelock	20735	3	0.000145	0.14	699	0.033711	33.71
Haw River	2298	1	0.000435	0.44	0	0.000000	0.00
Hayesville	311	1	0.003215	3.22	0	0.000000	0.00
Hemby Bridge	1520	0	0.000000	0.00	9	0.005921	5.92
Henderson	15368	9	0.000586	0.59	159	0.010346	10.35
Hendersonville	13137	25	0.001903	1.90	151	0.011494	11.49
Hertford	2143	0	0.000000	0.00	9	0.004200	4.20
Hickory	40010	31	0.000775	0.77	264	0.006598	6.60
High Point	104371	47	0.000450	0.45	878	0.008412	8.41
High Shoals	696	0	0.000000	0.00	5	0.007184	7.18
Highlands	924	0	0.000000	0.00	40	0.043290	43.29
Hildebran	2023	0	0.000000	0.00	18	0.008898	8.90
Hillsborough	6087	3	0.000493	0.49	67	0.011007	11.01
Hobgood	348	0	0.000000	0.00	0	0.000000	0.00
Hoffman	588	0	0.000000	0.00	6	0.010204	10.20
Holden Beach	575	0	0.000000	0.00	3	0.005217	5.22
Holly Ridge	1268	0	0.000000	0.00	8	0.006309	6.31
Holly Springs	24661	2	0.000081	0.08	0	0.000000	0.00
Hookerton	409	0	0.000000	0.00	2	0.004890	4.89
Hope Mills	15176	0	0.000000	0.00	38	0.002504	2.50
Hot Springs	560	0	0.000000	0.00	4	0.007143	7.14
Hudson	3776	3	0.000794	0.79	0	0.000000	0.00
Huntersville	46773	12	0.000257	0.26	212	0.004533	4.53
Indian Beach	112	0	0.000000	0.00	0	0.000000	0.00
Indian Trail	33518	2	0.000060	0.06	51	0.001522	1.52
Jackson	513	0	0.000000	0.00	13	0.025341	25.34
Jacksonville	70145	15	0.000214	0.21	3774	0.053803	53.80
Jamestown	3382	3	0.000887	0.89	18	0.005322	5.32

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Jamesville	491	0	0.000000	0.00	6	0.012220	12.22
Jefferson	1611	0	0.000000	0.00	0	0.000000	0.00
Jonesville	2285	1	0.000438	0.44	0	0.000000	0.00
Kannapolis	42625	17	0.000399	0.40	347	0.008141	8.14
Kelford	251	0	0.000000	0.00	0	0.000000	0.00
Kenansville	855	0	0.000000	0.00	29	0.033918	33.92
Kenly	1339	1	0.000747	0.75	5	0.003734	3.73
Kernersville	23123	8	0.000346	0.35	112	0.004844	4.84
Kill Devil Hills	6683	0	0.000000	0.00	28	0.004190	4.19
King	6904	2	0.000290	0.29	20	0.002897	2.90
Kings Mountain	10296	6	0.000583	0.58	64	0.006216	6.22
Kingstown	681	0	0.000000	0.00	3	0.004405	4.41
Kinston	21677	11	0.000507	0.51	174	0.008027	8.03
Kittrell	467	1	0.002141	2.14	2	0.004283	4.28
Kitty Hawk	3272	3	0.000917	0.92	117	0.035758	35.76
Knightdale	11401	3	0.000263	0.26	132	0.011578	11.58
Kure Beach	2012	0	0.000000	0.00	20	0.009940	9.94
La Grange	2873	0	0.000000	0.00	0	0.000000	0.00
Lake Lure	1192	0	0.000000	0.00	0	0.000000	0.00
Lake Park	3422	0	0.000000	0.00	0	0.000000	0.00
Lake Waccamaw	1480	0	0.000000	0.00	36	0.024324	24.32
Landis	3109	0	0.000000	0.00	0	0.000000	0.00
Lansing	158	0	0.000000	0.00	11	0.069620	69.62
Lasker	122	0	0.000000	0.00	1	0.008197	8.20
Lattimore	488	0	0.000000	0.00	25	0.051230	51.23
Laurel Park	2180	0	0.000000	0.00	57	0.026147	26.15
Laurinburg	15962	7	0.000439	0.44	86	0.005388	5.39
Lawndale	606	0	0.000000	0.00	0	0.000000	0.00
Leggett	60	0	0.000000	0.00	0	0.000000	0.00
Leland	13527	0	0.000000	0.00	0	0.000000	0.00
Lenoir	18228	7	0.000384	0.38	78	0.004279	4.28

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Lewiston Woodville	549	0	0.000000	0.00	21	0.038251	38.25
Lewisville	12639	0	0.000000	0.00	51	0.004035	4.04
Lexington	18931	7	0.000370	0.37	246	0.012995	12.99
Liberty	2656	0	0.000000	0.00	7	0.002636	2.64
Lilesville	536	0	0.000000	0.00	7	0.013060	13.06
Lillington	3194	1	0.000313	0.31	12	0.003757	3.76
Lincolnton	10486	2	0.000191	0.19	55	0.005245	5.25
Linden	130	0	0.000000	0.00	0	0.000000	0.00
Littleton	674	0	0.000000	0.00	21	0.031157	31.16
Locust	2930	0	0.000000	0.00	14	0.004778	4.78
Long View	4871	1	0.000205	0.21	57	0.011702	11.70
Louisburg	3359	2	0.000595	0.60	213	0.063412	63.41
Love Valley	90	0	0.000000	0.00	0	0.000000	0.00
Lowell	3526	0	0.000000	0.00	15	0.004254	4.25
Lucama	1108	0	0.000000	0.00	0	0.000000	0.00
Lumber Bridge	94	0	0.000000	0.00	0	0.000000	0.00
Lumberton	21542	21	0.000975	0.97	98	0.004549	4.55
Macclesfield	471	0	0.000000	0.00	30	0.063694	63.69
Macon	119	0	0.000000	0.00	18	0.151261	151.26
Madison	2246	3	0.001336	1.34	11	0.004898	4.90
Maggie Valley	1150	0	0.000000	0.00	20	0.017391	17.39
Magnolia	939	0	0.000000	0.00	4	0.004260	4.26
Maiden	3310	0	0.000000	0.00	0	0.000000	0.00
Manteo	1434	0	0.000000	0.00	17	0.011855	11.85
Marietta	175	0	0.000000	0.00	0	0.000000	0.00
Marion	7838	3	0.000383	0.38	116	0.014800	14.80
Mars Hill	1869	0	0.000000	0.00	109	0.058320	58.32
Marshall	872	0	0.000000	0.00	3	0.003440	3.44
Marshville	2402	0	0.000000	0.00	24	0.009992	9.99
Marvin	5579	0	0.000000	0.00	0	0.000000	0.00
Matthews	27198	5	0.000184	0.18	169	0.006214	6.21

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Maxton	2426	1	0.000412	0.41	49	0.020198	20.20
Mayodan	2478	0	0.000000	0.00	0	0.000000	0.00
Maysville	1019	1	0.000981	0.98	17	0.016683	16.68
McAdenville	651	0	0.000000	0.00	0	0.000000	0.00
McDonald	113	0	0.000000	0.00	0	0.000000	0.00
McFarlan	117	0	0.000000	0.00	0	0.000000	0.00
Mebane	11393	2	0.000176	0.18	67	0.005881	5.88
Mesic	220	0	0.000000	0.00	13	0.059091	59.09
Micro	441	0	0.000000	0.00	0	0.000000	0.00
Middleburg	133	1	0.007519	7.52	4	0.030075	30.08
Middlesex	822	0	0.000000	0.00	16	0.019465	19.46
Midland	3073	0	0.000000	0.00	0	0.000000	0.00
Midway	4679	1	0.000214	0.21	0	0.000000	0.00
Mills River	6802	0	0.000000	0.00	19	0.002793	2.79
Milton	166	0	0.000000	0.00	0	0.000000	0.00
Mineral Springs	2639	0	0.000000	0.00	0	0.000000	0.00
Minnesott Beach	440	0	0.000000	0.00	5	0.011364	11.36
Mint Hill	22722	9	0.000396	0.40	25	0.001100	1.10
Misenheimer	728	0	0.000000	0.00	72	0.098901	98.90
Mocksville	5051	1	0.000198	0.20	14	0.002772	2.77
Momeyer	224	0	0.000000	0.00	6	0.026786	26.79
Monroe	32797	12	0.000366	0.37	82	0.002500	2.50
Montreat	723	0	0.000000	0.00	83	0.114799	114.80
Mooresboro	311	0	0.000000	0.00	0	0.000000	0.00
Mooresville	32711	11	0.000336	0.34	102	0.003118	3.12
Morehead City	8661	3	0.000346	0.35	115	0.013278	13.28
Morganton	16918	4	0.000236	0.24	139	0.008216	8.22
Morrisville	18576	2	0.000108	0.11	110	0.005922	5.92
Morven	511	0	0.000000	0.00	0	0.000000	0.00
Mount Airy	10388	7	0.000674	0.67	36	0.003466	3.47
Mount Gilead	1181	0	0.000000	0.00	6	0.005080	5.08
Mount Holly	13656	0	0.000000	0.00	8	0.000586	0.59

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Mount Olive	4589	1	0.000218	0.22	73	0.015908	15.91
Mount Pleasant	1652	0	0.000000	0.00	5	0.003027	3.03
Murfreesboro	2835	0	0.000000	0.00	63	0.022222	22.22
Murphy	1627	1	0.000615	0.61	19	0.011678	11.68
Nags Head	2757	3	0.001088	1.09	20	0.007254	7.25
Nashville	5352	0	0.000000	0.00	0	0.000000	0.00
Navassa	1505	0	0.000000	0.00	17	0.011296	11.30
New Bern	29524	5	0.000169	0.17	340	0.011516	11.52
New London	600	1	0.001667	1.67	0	0.000000	0.00
Newland	698	0	0.000000	0.00	21	0.030086	30.09
Newport	4150	2	0.000482	0.48	44	0.010602	10.60
Newton	12968	7	0.000540	0.54	25	0.001928	1.93
Newton Grove	569	0	0.000000	0.00	4	0.007030	7.03
Norlina	1118	0	0.000000	0.00	15	0.013417	13.42
Norman	138	0	0.000000	0.00	2	0.014493	14.49
North Topsail Beach	743	0	0.000000	0.00	0	0.000000	0.00
North Wilkesboro	4245	2	0.000471	0.47	13	0.003062	3.06
Northwest	735	0	0.000000	0.00	0	0.000000	0.00
Norwood	2379	1	0.000420	0.42	4	0.001681	1.68
Oak City	317	0	0.000000	0.00	0	0.000000	0.00
Oak Island	6783	1	0.000147	0.15	33	0.004865	4.87
Oak Ridge	6185	0	0.000000	0.00	19	0.003072	3.07
Oakboro	1859	0	0.000000	0.00	23	0.012372	12.37
Ocean Isle Beach	550	0	0.000000	0.00	0	0.000000	0.00
Old Fort	908	0	0.000000	0.00	35	0.038546	38.55
Oriental	900	0	0.000000	0.00	17	0.018889	18.89
Orrum	91	0	0.000000	0.00	0	0.000000	0.00
Ossipee	543	0	0.000000	0.00	23	0.042357	42.36
Oxford	8461	2	0.000236	0.24	239	0.028247	28.25
Pantego	179	0	0.000000	0.00	0	0.000000	0.00
Parkton	436	0	0.000000	0.00	0	0.000000	0.00
Parmele	278	0	0.000000	0.00	0	0.000000	0.00

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Patterson Springs	622	0	0.000000	0.00	3	0.004823	4.82
Peachland	437	0	0.000000	0.00	15	0.034325	34.32
Peletier	644	0	0.000000	0.00	0	0.000000	0.00
Pembroke	2973	5	0.001682	1.68	22	0.007400	7.40
Pikeville	678	0	0.000000	0.00	12	0.017699	17.70
Pilot Mountain	1477	0	0.000000	0.00	20	0.013541	13.54
Pine Knoll Shores	1339	0	0.000000	0.00	7	0.005228	5.23
Pine Level	1700	0	0.000000	0.00	0	0.000000	0.00
Pinebluff	1337	1	0.000748	0.75	20	0.014959	14.96
Pinehurst	13124	1	0.000076	0.08	76	0.005791	5.79
Pinetops	1374	0	0.000000	0.00	34	0.024745	24.75
Pineville	7479	10	0.001337	1.34	102	0.013638	13.64
Pink Hill	552	0	0.000000	0.00	3	0.005435	5.43
Pittsboro	3743	1	0.000267	0.27	21	0.005610	5.61
Pleasant Garden	878	0	0.000000	0.00	17	0.019362	19.36
Plymouth	3878	0	0.000000	0.00	6	0.001547	1.55
Polkton	3375	2	0.000593	0.59	7	0.002074	2.07
Polkville	545	0	0.000000	0.00	0	0.000000	0.00
Pollocksville	311	0	0.000000	0.00	8	0.025723	25.72
Powellsville	276	1	0.003623	3.62	0	0.000000	0.00
Princeton	1194	0	0.000000	0.00	16	0.013400	13.40
Princeville	2082	0	0.000000	0.00	0	0.000000	0.00
Proctorville	117	0	0.000000	0.00	3	0.025641	25.64
Raeford	4611	1	0.000217	0.22	11	0.002386	2.39
Raleigh	403892	182	0.000451	0.45	4709	0.011659	11.66
Ramseur	1692	0	0.000000	0.00	3	0.001773	1.77
Randleman	4113	5	0.001216	1.22	26	0.006321	6.32
Ranlo	3434	0	0.000000	0.00	0	0.000000	0.00
Raynham	72	0	0.000000	0.00	0	0.000000	0.00
Red Cross	742	1	0.001348	1.35	3	0.004043	4.04
Red Oak	3430	0	0.000000	0.00	17	0.004956	4.96
Red Springs	3428	1	0.000292	0.29	44	0.012835	12.84

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Reidsville	14520	1	0.000069	0.07	0	0.000000	0.00
Rennert	383	1	0.002611	2.61	0	0.000000	0.00
Rhodhiss	1070	0	0.000000	0.00	0	0.000000	0.00
Rich Square	1070	0	0.000000	0.00	0	0.000000	0.00
Richfield	613	0	0.000000	0.00	2	0.003263	3.26
Richlands	1520	0	0.000000	0.00	28	0.018421	18.42
River Bend	4394	0	0.000000	0.00	0	0.000000	0.00
Roanoke Rapids	15754	13	0.000825	0.83	106	0.006728	6.73
Robbins	1097	2	0.001823	1.82	3	0.002735	2.73
Robbinsville	620	1	0.001613	1.61	0	0.000000	0.00
Robersonville	1488	0	0.000000	0.00	46	0.030914	30.91
Rockingham	9558	7	0.000732	0.73	11	0.001151	1.15
Rockwell	2108	0	0.000000	0.00	8	0.003795	3.80
Rocky Mount	1602	26	0.016230	16.23	204	0.127341	127.34
Rolesville	3786	0	0.000000	0.00	48	0.012678	12.68
Ronda	417	0	0.000000	0.00	2	0.004796	4.80
Roper	611	0	0.000000	0.00	9	0.014730	14.73
Rose Hill	1626	0	0.000000	0.00	12	0.007380	7.38
Roseboro	1191	0	0.000000	0.00	13	0.010915	10.92
Rosman	576	0	0.000000	0.00	7	0.012153	12.15
Rowland	1037	0	0.000000	0.00	3	0.002893	2.89
Roxboro	8362	3	0.000359	0.36	49	0.005860	5.86
Roxobel	240	0	0.000000	0.00	0	0.000000	0.00
Rural Hall	2937	1	0.000340	0.34	13	0.004426	4.43
Ruth	440	0	0.000000	0.00	2	0.004545	4.55
Rutherford College	1341	0	0.000000	0.00	5	0.003729	3.73
Rutherfordton	4213	0	0.000000	0.00	10	0.002374	2.37
Saint Helena	389	0	0.000000	0.00	0	0.000000	0.00
Saint James	3165	2	0.000632	0.63	48	0.015166	15.17
Saint Pauls	2035	1	0.000491	0.49	10	0.004914	4.91
Salemburg	435	2	0.004598	4.60	9	0.020690	20.69
Salisbury	33662	15	0.000446	0.45	166	0.004931	4.93

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Saluda	713	0	0.000000	0.00	0	0.000000	0.00
Sandy Creek	260	0	0.000000	0.00	0	0.000000	0.00
Sandyfield	447	0	0.000000	0.00	0	0.000000	0.00
Sanford	28094	6	0.000214	0.21	187	0.006656	6.66
Santeetlah	28094	0	0.000000	0.00	#N/A	#N/A	#N/A
Saratoga	408	1	0.002451	2.45	0	0.000000	0.00
Sawmills	5240	1	0.000191	0.19	25	0.004771	4.77
Scotland Neck	2059	0	0.000000	0.00	35	0.016999	17.00
Seaboard	632	1	0.001582	1.58	3	0.004747	4.75
Seagrove	228	0	0.000000	0.00	7	0.030702	30.70
Sedalia	623	0	0.000000	0.00	0	0.000000	0.00
Selma	6073	1	0.000165	0.16	62	0.010209	10.21
Seven Devils	192	0	0.000000	0.00	0	0.000000	0.00
Seven Springs	110	0	0.000000	0.00	0	0.000000	0.00
Severn	276	0	0.000000	0.00	0	0.000000	0.00
Shallotte	3675	2	0.000544	0.54	22	0.005986	5.99
Sharpsburg	2024	0	0.000000	0.00	0	0.000000	0.00
Shelby	20323	10	0.000492	0.49	100	0.004921	4.92
Siler City	7887	3	0.000380	0.38	45	0.005706	5.71
Simpson	416	1	0.002404	2.40	0	0.000000	0.00
Sims	282	0	0.000000	0.00	0	0.000000	0.00
Smithfield	10966	10	0.000912	0.91	37	0.003374	3.37
Snow Hill	1595	0	0.000000	0.00	5	0.003135	3.13
Southern Pines	12334	4	0.000324	0.32	104	0.008432	8.43
Southern Shores	2714	0	0.000000	0.00	5	0.001842	1.84
Southport	2833	2	0.000706	0.71	57	0.020120	20.12
Sparta	1770	1	0.000565	0.56	2	0.001130	1.13
Speed	80	0	0.000000	0.00	0	0.000000	0.00
Spencer	3267	1	0.000306	0.31	35	0.010713	10.71
Spencer Mountain	37	0	0.000000	0.00	0	0.000000	0.00
Spindale	4321	2	0.000463	0.46	16	0.003703	3.70
Spring Hope	1320	0	0.000000	0.00	22	0.016667	16.67

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Spring Lake	11964	5	0.000418	0.42	117	0.009779	9.78
Spruce Pine	2175	2	0.000920	0.92	41	0.018851	18.85
Staley	393	0	0.000000	0.00	3	0.007634	7.63
Stallings	13831	1	0.000072	0.07	34	0.002458	2.46
Stanfield	1486	0	0.000000	0.00	0	0.000000	0.00
Stanley	3556	0	0.000000	0.00	5	0.001406	1.41
Stantonsburg	784	0	0.000000	0.00	17	0.021684	21.68
Star	876	0	0.000000	0.00	9	0.010274	10.27
Statesville	24532	11	0.000448	0.45	34	0.001386	1.39
Stedman	1028	0	0.000000	0.00	0	0.000000	0.00
Stem	463	0	0.000000	0.00	0	0.000000	0.00
Stokesdale	5047	1	0.000198	0.20	9	0.001783	1.78
Stoneville	1056	0	0.000000	0.00	12	0.011364	11.36
Stonewall	281	0	0.000000	0.00	0	0.000000	0.00
Stovall	418	0	0.000000	0.00	0	0.000000	0.00
Sugar Mountain	198	0	0.000000	0.00	0	0.000000	0.00
Summerfield	10232	2	0.000195	0.20	63	0.006157	6.16
Sunset Beach	3572	1	0.000280	0.28	8	0.002240	2.24
Surf City	1853	0	0.000000	0.00	0	0.000000	0.00
Swansboro	2663	0	0.000000	0.00	45	0.016898	16.90
Swepsonville	1154	0	0.000000	0.00	11	0.009532	9.53
Sylva	2588	0	0.000000	0.00	34	0.013138	13.14
Tabor City	2511(r4469)	0	0.000000	0.00	5	#VALUE!	#VALUE!
Tar Heel	117	0	0.000000	0.00	0	0.000000	0.00
Tarboro	11415	1	0.000088	0.09	95	0.008322	8.32
Taylorsville	2098	1	0.000477	0.48	0	0.000000	0.00
Taylortown	722	0	0.000000	0.00	8	0.011080	11.08
Teachey	376	0	0.000000	0.00	8	0.021277	21.28
Thomasville	26757	2	0.000075	0.07	96	0.003588	3.59
Tobaccoville	2441	0	0.000000	0.00	11	0.004506	4.51
Topsail Beach	368	0	0.000000	0.00	3	0.008152	8.15
Trent Woods	4155	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Trenton	287	0	0.000000	0.00	11	0.038328	38.33
Trinity	6614	1	0.000151	0.15	51	0.007711	7.71
Troutman	2383	1	0.000420	0.42	15	0.006295	6.29
Troy	3189	1	0.000314	0.31	35	0.010975	10.98
Tryon	1646	0	0.000000	0.00	31	0.018834	18.83
Turkey	292	0	0.000000	0.00	0	0.000000	0.00
Unionville	5929	1	0.000169	0.17	26	0.004385	4.39
Valdese	4490	0	0.000000	0.00	141	0.031403	31.40
Vanceboro	1005	0	0.000000	0.00	16	0.015920	15.92
Vandemere	254	0	0.000000	0.00	0	0.000000	0.00
Varnamtown	541	0	0.000000	0.00	9	0.016636	16.64
Vass	720	0	0.000000	0.00	0	0.000000	0.00
Waco	321	0	0.000000	0.00	0	0.000000	0.00
Wade	556	0	0.000000	0.00	0	0.000000	0.00
Wadesboro	5813	3	0.000516	0.52	26	0.004473	4.47
Wagram	840	0	0.000000	0.00	0	0.000000	0.00
Wake Forest	30117	0	0.000000	0.00	53	0.001760	1.76
Walkertown	4675	2	0.000428	0.43	50	0.010695	10.70
Wallace	3880	1	0.000258	0.26	172	0.044330	44.33
Wallburg	3047	0	0.000000	0.00	0	0.000000	0.00
Walnut Cove	1425	0	0.000000	0.00	0	0.000000	0.00
Walnut Creek	835	0	0.000000	0.00	0	0.000000	0.00
Walstonburg	219	0	0.000000	0.00	4	0.018265	18.26
Warrenton	862	0	0.000000	0.00	25	0.029002	29.00
Warsaw	3054	1	0.000327	0.33	34	0.011133	11.13
Washington	9744	3	0.000308	0.31	122	0.012521	12.52
Washington Park	451	0	0.000000	0.00	18	0.039911	39.91
Watha	190	0	0.000000	0.00	0	0.000000	0.00
Waxhaw	9859	2	0.000203	0.20	13	0.001319	1.32
Waynesville	9869	1	0.000101	0.10	36	0.003648	3.65
Weaverville	3120	0	0.000000	0.00	17	0.005449	5.45
Webster	363	0	0.000000	0.00	2	0.005510	5.51

City/Town	Population 2010	Ped Crashes 2010	Ped Crashes per Capita	Crashes per 1,000 people	Total Pedestrian Commuters	Ped Commuters per Capita	Ped Commuters per 1,000
Weddington	9459	1	0.000106	0.11	42	0.004440	4.44
Weldon	1655	2	0.001208	1.21	0	0.000000	0.00
Wendell	5845	1	0.000171	0.17	41	0.007015	7.01
Wentworth	2807	0	0.000000	0.00	0	0.000000	0.00
Wesley Chapel	7463	0	0.000000	0.00	0	0.000000	0.00
West Jefferson	1348	1	0.000742	0.74	9	0.006677	6.68
Whispering Pines	2928	0	0.000000	0.00	6	0.002049	2.05
Whitakers	744	0	0.000000	0.00	15	0.020161	20.16
White Lake	1074	1	0.000931	0.93	4	0.003724	3.72
Whiteville	5394	4	0.000742	0.74	37	0.006859	6.86
Whitsett	590	0	0.000000	0.00	4	0.006780	6.78
Wilkesboro	3413	2	0.000586	0.59	37	0.010841	10.84
Williamston	5511	1	0.000181	0.18	61	0.011069	11.07
Wilmington	106476	57	0.000535	0.54	1183	0.011110	11.11
Wilson	49167	16	0.000325	0.33	330	0.006712	6.71
Wilson's Mills	2277	1	0.000439	0.44	7	0.003074	3.07
Windsor	3630	0	0.000000	0.00	43	0.011846	11.85
Winfall	594	0	0.000000	0.00	0	0.000000	0.00
Wingate	3491	0	0.000000	0.00	85	0.024348	24.35
Winston-Salem	229617	43	0.000187	0.19	2245	0.009777	9.78
Winterville	9269	3	0.000324	0.32	53	0.005718	5.72
Winton	769	0	0.000000	0.00	7	0.009103	9.10
Woodfin	6123	0	0.000000	0.00	31	0.005063	5.06
Woodland	809	0	0.000000	0.00	7	0.008653	8.65
Wrightsville Beach	2477	2	0.000807	0.81	4	0.001615	1.61
Yadkinville	2959	3	0.001014	1.01	0	0.000000	0.00
Yanceyville	2039	0	0.000000	0.00	29	0.014223	14.22
Youngsville	1157	0	0.000000	0.00	0	0.000000	0.00
Zebulon	4433	1	0.000226	0.23	30	0.006767	6.77

Table 9.9.4 City Bicycle Crash Data and Commuter Data

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Aberdeen	6350	1	0.000157	0.16	0	0.000000	0.00
Ahoskie	5039	0	0.000000	0.00	11	0.002183	2.18
Alamance	951	0	0.000000	0.00	0	0.000000	0.00
Albemarle	15903	0	0.000000	0.00	0	0.000000	0.00
Alliance	776	0	0.000000	0.00	0	0.000000	0.00
Andrews	1781	2	0.001123	1.12	0	0.000000	0.00
Angier	4350	1	0.000230	0.23	0	0.000000	0.00
Ansonville	631	0	0.000000	0.00	0	0.000000	0.00
Apex	37476	2	0.000053	0.05	0	0.000000	0.00
Arapahoe	556	0	0.000000	0.00	0	0.000000	0.00
Archdale	11415	0	0.000000	0.00	0	0.000000	0.00
Archer Lodge	4292	0	0.000000	0.00	0	0.000000	0.00
Asheboro	25012	3	0.000120	0.12	7	0.000280	0.28
Asheville	83393	21	0.000252	0.25	364	0.004365	4.36
Askewville	241	0	0.000000	0.00	0	0.000000	0.00
Atkinson	299	0	0.000000	0.00	0	0.000000	0.00
Atlantic Beach	1495	0	0.000000	0.00	14	0.009365	9.36
Aulander	895	0	0.000000	0.00	0	0.000000	0.00
Aurora	520	0	0.000000	0.00	0	0.000000	0.00
Autryville	196	0	0.000000	0.00	0	0.000000	0.00
Ayden	4932	1	0.000203	0.20	0	0.000000	0.00
Badin	1974	0	0.000000	0.00	0	0.000000	0.00
Bailey	569	0	0.000000	0.00	0	0.000000	0.00
Bakersville	464	0	0.000000	0.00	0	0.000000	0.00
Bald Head Island	158	0	0.000000	0.00	0	0.000000	0.00
Banner Elk	1028	0	0.000000	0.00	0	0.000000	0.00
Bath	249	0	0.000000	0.00	0	0.000000	0.00
Bayboro	1263	0	0.000000	0.00	0	0.000000	0.00
Bear Grass	73	0	0.000000	0.00	0	0.000000	0.00
Beaufort	4039	0	0.000000	0.00	20	0.004952	4.95
Beech Mountain	320	0	0.000000	0.00	0	0.000000	0.00
Belhaven	1688	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Belmont	10076	0	0.000000	0.00	0	0.000000	0.00
Belville	1936	0	0.000000	0.00	0	0.000000	0.00
Belwood	950	0	0.000000	0.00	0	0.000000	0.00
Benson	3311	0	0.000000	0.00	0	0.000000	0.00
Bermuda Run	1725	1	0.000580	0.58	0	0.000000	0.00
Bessemer City	5340	0	0.000000	0.00	0	0.000000	0.00
Bethania	328	0	0.000000	0.00	0	0.000000	0.00
Bethel	1577	0	0.000000	0.00	0	0.000000	0.00
Beulaville	1296	0	0.000000	0.00	0	0.000000	0.00
Biltmore Forest	1343	0	0.000000	0.00	0	0.000000	0.00
Biscoe	1700	0	0.000000	0.00	0	0.000000	0.00
Black Creek	769	0	0.000000	0.00	0	0.000000	0.00
Black Mountain	7848	0	0.000000	0.00	10	0.001274	1.27
Bladenboro	1750	0	0.000000	0.00	0	0.000000	0.00
Blowing Rock	1241	0	0.000000	0.00	0	0.000000	0.00
Boardman	157	0	0.000000	0.00	0	0.000000	0.00
Bogue	684	0	0.000000	0.00	4	0.005848	5.85
Boiling Spring Lakes	5372	0	0.000000	0.00	0	0.000000	0.00
Boiling Springs	4647	1	0.000215	0.22	0	0.000000	0.00
Bolivia	143	0	0.000000	0.00	0	0.000000	0.00
Bolton	691	0	0.000000	0.00	0	0.000000	0.00
Boone	17122	9	0.000526	0.53	150	0.008761	8.76
Boonville	1222	0	0.000000	0.00	0	0.000000	0.00
Bostic	386	0	0.000000	0.00	0	0.000000	0.00
Brevard	7609	1	0.000131	0.13	10	0.001314	1.31
Bridgeton	454	0	0.000000	0.00	0	0.000000	0.00
Broadway	1229	0	0.000000	0.00	0	0.000000	0.00
Brookford	382	0	0.000000	0.00	0	0.000000	0.00
Brunswick	1119	0	0.000000	0.00	2	0.001787	1.79
Bryson City	1424	0	0.000000	0.00	0	0.000000	0.00
Bunn	344	0	0.000000	0.00	4	0.011628	11.63
Burgaw	3872	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Burlington	49963	9	0.000180	0.18	14	0.000280	0.28
Burnsville	1693	0	0.000000	0.00	0	0.000000	0.00
Butner	7591	0	0.000000	0.00	0	0.000000	0.00
Cajah's Mountain	2823	0	0.000000	0.00	0	0.000000	0.00
Calabash	1786	0	0.000000	0.00	0	0.000000	0.00
Calypso	538	0	0.000000	0.00	0	0.000000	0.00
Cameron	285	0	0.000000	0.00	0	0.000000	0.00
Candor	840	0	0.000000	0.00	0	0.000000	0.00
Canton	4227	0	0.000000	0.00	0	0.000000	0.00
Cape Carteret	1917	0	0.000000	0.00	5	0.002608	2.61
Carolina Beach	5706	3	0.000526	0.53	0	0.000000	0.00
Carolina Shores	3048	0	0.000000	0.00	0	0.000000	0.00
Carrboro	19582	1	0.000051	0.05	451	0.023031	23.03
Carthage	2205	0	0.000000	0.00	0	0.000000	0.00
Cary	135234	23	0.000170	0.17	136	0.001006	1.01
Casar	297	0	0.000000	0.00	0	0.000000	0.00
Castalia	268	0	0.000000	0.00	0	0.000000	0.00
Caswell Beach	398	0	0.000000	0.00	0	0.000000	0.00
Catawba	603	0	0.000000	0.00	0	0.000000	0.00
Cedar Point	1279	0	0.000000	0.00	0	0.000000	0.00
Cedar Rock	300	0	0.000000	0.00	0	0.000000	0.00
Centerville	89	0	0.000000	0.00	0	0.000000	0.00
Cerro Gordo	207	0	0.000000	0.00	0	0.000000	0.00
Chadbourn	1856	1	0.000539	0.54	0	0.000000	0.00
Chapel Hill	57233	17	0.000297	0.30	528	0.009225	9.23
Charlotte	731424	113	0.000154	0.15	558	0.000763	0.76
Cherryville	5760	0	0.000000	0.00	19	0.003299	3.30
Chimney Rock Village	113	0	0.000000	0.00	0	0.000000	0.00
China Grove	3563	0	0.000000	0.00	0	0.000000	0.00
Chocowinity	820	0	0.000000	0.00	0	0.000000	0.00
Claremont	1352	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Clarkton	837	0	0.000000	0.00	0	0.000000	0.00
Clayton	16116	0	0.000000	0.00	0	0.000000	0.00
Clemmons	18627	0	0.000000	0.00	0	0.000000	0.00
Cleveland	871	0	0.000000	0.00	0	0.000000	0.00
Clinton	8639	1	0.000116	0.12	29	0.003357	3.36
Clyde	1223	0	0.000000	0.00	0	0.000000	0.00
Coats	2112	0	0.000000	0.00	0	0.000000	0.00
Cofield	413	0	0.000000	0.00	0	0.000000	0.00
Colerain	204	0	0.000000	0.00	0	0.000000	0.00
Columbia	891	0	0.000000	0.00	0	0.000000	0.00
Columbus	999	0	0.000000	0.00	0	0.000000	0.00
Como	91	0	0.000000	0.00	0	0.000000	0.00
Concord	79066	6	0.000076	0.08	39	0.000493	0.49
Conetoe	294	0	0.000000	0.00	0	0.000000	0.00
Connelly Springs	1669	0	0.000000	0.00	0	0.000000	0.00
Conover	8165	1	0.000122	0.12	0	0.000000	0.00
Conway	836	0	0.000000	0.00	6	0.007177	7.18
Cooleemee	960	0	0.000000	0.00	0	0.000000	0.00
Cornelius	24866	0	0.000000	0.00	0	0.000000	0.00
Cove City	399	0	0.000000	0.00	0	0.000000	0.00
Cramerton	4165	0	0.000000	0.00	0	0.000000	0.00
Creedmoor	4124	0	0.000000	0.00	0	0.000000	0.00
Creswell	276	0	0.000000	0.00	0	0.000000	0.00
Crossnore	192	0	0.000000	0.00	0	0.000000	0.00
Dallas	4488	1	0.000223	0.22	0	0.000000	0.00
Danbury	189	0	0.000000	0.00	0	0.000000	0.00
Davidson	10944	3	0.000274	0.27	42	0.003838	3.84
Denton	1636	0	0.000000	0.00	0	0.000000	0.00
Dillsboro	232	0	0.000000	0.00	0	0.000000	0.00
Dobbins Heights	866	0	0.000000	0.00	0	0.000000	0.00
Dobson	1586	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Dortches	935	0	0.000000	0.00	0	0.000000	0.00
Dover	401	0	0.000000	0.00	0	0.000000	0.00
Drexel	1858	0	0.000000	0.00	0	0.000000	0.00
Dublin	338	0	0.000000	0.00	0	0.000000	0.00
Duck	369	0	0.000000	0.00	11	0.029810	29.81
Dunn	9263	1	0.000108	0.11	3	0.000324	0.32
Durham	228330	35	0.000153	0.15	749	0.003280	3.28
Earl	260	0	0.000000	0.00	0	0.000000	0.00
East Arcadia	487	0	0.000000	0.00	0	0.000000	0.00
East Bend	612	0	0.000000	0.00	0	0.000000	0.00
East Laurinburg	300	0	0.000000	0.00	0	0.000000	0.00
East Spencer	1534	0	0.000000	0.00	0	0.000000	0.00
Eastover	3628	0	0.000000	0.00	0	0.000000	0.00
Eden	15527	2	0.000129	0.13	0	0.000000	0.00
Edenton	5004	0	0.000000	0.00	14	0.002798	2.80
Elizabeth City	18683	2	0.000107	0.11	42	0.002248	2.25
Elizabethtown	3583	0	0.000000	0.00	0	0.000000	0.00
Elk Park	452	0	0.000000	0.00	0	0.000000	0.00
Elkin	4001	0	0.000000	0.00	0	0.000000	0.00
Ellenboro	873	0	0.000000	0.00	0	0.000000	0.00
Ellerbe	1054	0	0.000000	0.00	0	0.000000	0.00
Elm City	1298	0	0.000000	0.00	0	0.000000	0.00
Elon	9419	4	0.000425	0.42	0	0.000000	0.00
Emerald Isle	3655	3	0.000821	0.82	0	0.000000	0.00
Enfield	2532	1	0.000395	0.39	0	0.000000	0.00
Erwin	4405	1	0.000227	0.23	0	0.000000	0.00
Eureka	197	0	0.000000	0.00	0	0.000000	0.00
Everetts	164	0	0.000000	0.00	0	0.000000	0.00
Fair Bluff	951	0	0.000000	0.00	0	0.000000	0.00
Fairmont	2663	0	0.000000	0.00	0	0.000000	0.00
Fairview	2678	0	0.000000	0.00	0	0.000000	0.00

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Faison	961	0	0.000000	0.00	5	0.005203	5.20
Faith	807	0	0.000000	0.00	0	0.000000	0.00
Falcon	258	0	0.000000	0.00	0	0.000000	0.00
Falkland	96	0	0.000000	0.00	0	0.000000	0.00
Fallston	607	0	0.000000	0.00	0	0.000000	0.00
Farmville	4654	1	0.000215	0.21	11	0.002364	2.36
Fayetteville	200564	27	0.000135	0.13	160	0.000798	0.80
Flat Rock	3114	0	0.000000	0.00	0	0.000000	0.00
Fletcher	7187	0	0.000000	0.00	0	0.000000	0.00
Fontana Dam	#N/A	0	#N/A	#N/A	#N/A	#N/A	#N/A
Forest City	7476	2	0.000268	0.27	0	0.000000	0.00
Forest Hills	365	0	0.000000	0.00	0	0.000000	0.00
Fountain	427	0	0.000000	0.00	0	0.000000	0.00
Four Oaks	1921	0	0.000000	0.00	18	0.009370	9.37
Foxfire Village	902	0	0.000000	0.00	0	0.000000	0.00
Franklin	3845	0	0.000000	0.00	0	0.000000	0.00
Franklinton	2023	0	0.000000	0.00	0	0.000000	0.00
Franklinville	1164	0	0.000000	0.00	0	0.000000	0.00
Fremont	1255	0	0.000000	0.00	0	0.000000	0.00
Fuquay-Varina	17937	1	0.000056	0.06	0	0.000000	0.00
Gamewell	4051	0	0.000000	0.00	0	0.000000	0.00
Garland	625	0	0.000000	0.00	1	0.001600	1.60
Garner	25745	1	0.000039	0.04	10	0.000388	0.39
Garysburg	1057	0	0.000000	0.00	0	0.000000	0.00
Gaston	1152	0	0.000000	0.00	0	0.000000	0.00
Gastonia	71741	8	0.000112	0.11	28	0.000390	0.39
Gatesville	321	0	0.000000	0.00	0	0.000000	0.00
Gibson	540	0	0.000000	0.00	0	0.000000	0.00
Gibsonville	6410	1	0.000156	0.16	0	0.000000	0.00
Glen Alpine	1517	0	0.000000	0.00	0	0.000000	0.00
Godwin	139	0	0.000000	0.00	0	0.000000	0.00

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Goldsboro	36437	4	0.000110	0.11	116	0.003184	3.18
Goldston	268	0	0.000000	0.00	0	0.000000	0.00
Graham	14153	1	0.000071	0.07	0	0.000000	0.00
Grandfather Village	25	0	0.000000	0.00	0	0.000000	0.00
Granite Falls	4722	0	0.000000	0.00	40	0.008471	8.47
Granite Quarry	2930	0	0.000000	0.00	0	0.000000	0.00
Grantsboro	688	0	0.000000	0.00	0	0.000000	0.00
Green Level	2100	0	0.000000	0.00	0	0.000000	0.00
Greenevers	634	0	0.000000	0.00	0	0.000000	0.00
Greensboro	269666	48	0.000178	0.18	313	0.001161	1.16
Greenville	84554	7	0.000083	0.08	215	0.002543	2.54
Grifton	2617	0	0.000000	0.00	0	0.000000	0.00
Grimesland	441	1	0.002268	2.27	0	0.000000	0.00
Grover	708	0	0.000000	0.00	0	0.000000	0.00
Halifax	234	0	0.000000	0.00	0	0.000000	0.00
Hamilton	408	0	0.000000	0.00	0	0.000000	0.00
Hamlet	6495	0	0.000000	0.00	11	0.001694	1.69
Harmony	531	0	0.000000	0.00	0	0.000000	0.00
Harrells	202	0	0.000000	0.00	0	0.000000	0.00
Harrellsville	106	0	0.000000	0.00	0	0.000000	0.00
Harrisburg	11526	0	0.000000	0.00	0	0.000000	0.00
Hassell	84	0	0.000000	0.00	0	0.000000	0.00
Havelock	20735	3	0.000145	0.14	65	0.003135	3.13
Haw River	2298	0	0.000000	0.00	0	0.000000	0.00
Hayesville	311	0	0.000000	0.00	0	0.000000	0.00
Hemby Bridge	1520	0	0.000000	0.00	0	0.000000	0.00
Henderson	15368	3	0.000195	0.20	0	0.000000	0.00
Hendersonville	13137	3	0.000228	0.23	0	0.000000	0.00
Hertford	2143	0	0.000000	0.00	0	0.000000	0.00
Hickory	40010	13	0.000325	0.32	44	0.001100	1.10
High Point	104371	21	0.000201	0.20	137	0.001313	1.31

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High Shoals	696	1	0.001437	1.44	0	0.000000	0.00
Highlands	924	0	0.000000	0.00	0	0.000000	0.00
Hildebran	2023	0	0.000000	0.00	0	0.000000	0.00
Hillsborough	6087	0	0.000000	0.00	0	0.000000	0.00
Hobgood	348	0	0.000000	0.00	0	0.000000	0.00
Hoffman	588	1	0.001701	1.70	0	0.000000	0.00
Holden Beach	575	0	0.000000	0.00	0	0.000000	0.00
Holly Ridge	1268	0	0.000000	0.00	0	0.000000	0.00
Holly Springs	24661	1	0.000041	0.04	0	0.000000	0.00
Hookerton	409	0	0.000000	0.00	0	0.000000	0.00
Hope Mills	15176	3	0.000198	0.20	13	0.000857	0.86
Hot Springs	560	0	0.000000	0.00	5	0.008929	8.93
Hudson	3776	0	0.000000	0.00	0	0.000000	0.00
Huntersville	46773	3	0.000064	0.06	14	0.000299	0.30
Indian Beach	112	0	0.000000	0.00	0	0.000000	0.00
Indian Trail	33518	1	0.000030	0.03	16	0.000477	0.48
Jackson	513	0	0.000000	0.00	0	0.000000	0.00
Jacksonville	70145	4	0.000057	0.06	438	0.006244	6.24
Jamestown	3382	0	0.000000	0.00	0	0.000000	0.00
Jamesville	491	0	0.000000	0.00	0	0.000000	0.00
Jefferson	1611	0	0.000000	0.00	0	0.000000	0.00
Jonesville	2285	0	0.000000	0.00	0	0.000000	0.00
Kannapolis	42625	6	0.000141	0.14	24	0.000563	0.56
Kelford	251	0	0.000000	0.00	0	0.000000	0.00
Kenansville	855	0	0.000000	0.00	0	0.000000	0.00
Kenly	1339	1	0.000747	0.75	0	0.000000	0.00
Kernersville	23123	0	0.000000	0.00	0	0.000000	0.00
Kill Devil Hills	6683	2	0.000299	0.30	26	0.003890	3.89
King	6904	0	0.000000	0.00	0	0.000000	0.00
Kings Mountain	10296	0	0.000000	0.00	0	0.000000	0.00
Kingstown	681	0	0.000000	0.00	0	0.000000	0.00

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Kinston	21677	5	0.000231	0.23	0	0.000000	0.00
Kittrell	467	0	0.000000	0.00	0	0.000000	0.00
Kitty Hawk	3272	5	0.001528	1.53	0	0.000000	0.00
Knightdale	11401	0	0.000000	0.00	0	0.000000	0.00
Kure Beach	2012	0	0.000000	0.00	42	0.020875	20.87
La Grange	2873	0	0.000000	0.00	0	0.000000	0.00
Lake Lure	1192	0	0.000000	0.00	0	0.000000	0.00
Lake Park	3422	0	0.000000	0.00	0	0.000000	0.00
Lake Waccamaw	1480	0	0.000000	0.00	0	0.000000	0.00
Landis	3109	1	0.000322	0.32	0	0.000000	0.00
Lansing	158	0	0.000000	0.00	0	0.000000	0.00
Lasker	122	0	0.000000	0.00	0	0.000000	0.00
Lattimore	488	0	0.000000	0.00	0	0.000000	0.00
Laurel Park	2180	0	0.000000	0.00	0	0.000000	0.00
Laurinburg	15962	4	0.000251	0.25	11	0.000689	0.69
Lawndale	606	0	0.000000	0.00	0	0.000000	0.00
Leggett	60	0	0.000000	0.00	0	0.000000	0.00
Leland	13527	1	0.000074	0.07	0	0.000000	0.00
Lenoir	18228	3	0.000165	0.16	29	0.001591	1.59
Lewiston Woodville	549	0	0.000000	0.00	0	0.000000	0.00
Lewisville	12639	1	0.000079	0.08	0	0.000000	0.00
Lexington	18931	0	0.000000	0.00	0	0.000000	0.00
Liberty	2656	0	0.000000	0.00	0	0.000000	0.00
Lilesville	536	0	0.000000	0.00	0	0.000000	0.00
Lillington	3194	0	0.000000	0.00	3	0.000939	0.94
Lincolnton	10486	1	0.000095	0.10	0	0.000000	0.00
Linden	130	0	0.000000	0.00	0	0.000000	0.00
Littleton	674	0	0.000000	0.00	0	0.000000	0.00
Locust	2930	0	0.000000	0.00	0	0.000000	0.00
Long View	4871	0	0.000000	0.00	40	0.008212	8.21
Louisburg	3359	0	0.000000	0.00	0	0.000000	0.00
Love Valley	90	0	0.000000	0.00	0	0.000000	0.00

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Lowell	3526	0	0.000000	0.00	0	0.000000	0.00
Lucama	1108	0	0.000000	0.00	0	0.000000	0.00
Lumber Bridge	94	0	0.000000	0.00	0	0.000000	0.00
Lumberton	21542	8	0.000371	0.37	33	0.001532	1.53
Macclesfield	471	0	0.000000	0.00	0	0.000000	0.00
Macon	119	0	0.000000	0.00	0	0.000000	0.00
Madison	2246	0	0.000000	0.00	0	0.000000	0.00
Maggie Valley	1150	0	0.000000	0.00	0	0.000000	0.00
Magnolia	939	0	0.000000	0.00	0	0.000000	0.00
Maiden	3310	0	0.000000	0.00	0	0.000000	0.00
Manteo	1434	0	0.000000	0.00	13	0.009066	9.07
Marietta	175	1	0.005714	5.71	0	0.000000	0.00
Marion	7838	1	0.000128	0.13	0	0.000000	0.00
Mars Hill	1869	0	0.000000	0.00	0	0.000000	0.00
Marshall	872	0	0.000000	0.00	0	0.000000	0.00
Marshville	2402	0	0.000000	0.00	0	0.000000	0.00
Marvin	5579	0	0.000000	0.00	0	0.000000	0.00
Matthews	27198	0	0.000000	0.00	0	0.000000	0.00
Maxton	2426	1	0.000412	0.41	0	0.000000	0.00
Mayodan	2478	0	0.000000	0.00	0	0.000000	0.00
Maysville	1019	0	0.000000	0.00	0	0.000000	0.00
McAdenville	651	0	0.000000	0.00	0	0.000000	0.00
McDonald	113	0	0.000000	0.00	0	0.000000	0.00
McFarlan	117	0	0.000000	0.00	0	0.000000	0.00
Mebane	11393	0	0.000000	0.00	0	0.000000	0.00
Mesic	220	0	0.000000	0.00	0	0.000000	0.00
Micro	441	0	0.000000	0.00	0	0.000000	0.00
Middleburg	133	0	0.000000	0.00	0	0.000000	0.00
Middlesex	822	0	0.000000	0.00	10	0.012165	12.17
Midland	3073	1	0.000325	0.33	0	0.000000	0.00
Midway	4679	0	0.000000	0.00	0	0.000000	0.00
Mills River	6802	0	0.000000	0.00	0	0.000000	0.00

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Milton	166	0	0.000000	0.00	0	0.000000	0.00
Mineral Springs	2639	0	0.000000	0.00	0	0.000000	0.00
Minnesott Beach	440	0	0.000000	0.00	0	0.000000	0.00
Mint Hill	22722	0	0.000000	0.00	24	0.001056	1.06
Misenheimer	728	0	0.000000	0.00	0	0.000000	0.00
Mocksville	5051	0	0.000000	0.00	0	0.000000	0.00
Momeyer	224	0	0.000000	0.00	0	0.000000	0.00
Monroe	32797	2	0.000061	0.06	22	0.000671	0.67
Montreat	723	0	0.000000	0.00	0	0.000000	0.00
Mooresboro	311	0	0.000000	0.00	0	0.000000	0.00
Mooresville	32711	5	0.000153	0.15	13	0.000397	0.40
Morehead City	8661	1	0.000115	0.12	29	0.003348	3.35
Morganton	16918	1	0.000059	0.06	67	0.003960	3.96
Morrisville	18576	0	0.000000	0.00	48	0.002584	2.58
Morven	511	0	0.000000	0.00	0	0.000000	0.00
Mount Airy	10388	1	0.000096	0.10	0	0.000000	0.00
Mount Gilead	1181	0	0.000000	0.00	0	0.000000	0.00
Mount Holly	13656	0	0.000000	0.00	0	0.000000	0.00
Mount Olive	4589	0	0.000000	0.00	48	0.010460	10.46
Mount Pleasant	1652	0	0.000000	0.00	0	0.000000	0.00
Murfreesboro	2835	0	0.000000	0.00	0	0.000000	0.00
Murphy	1627	0	0.000000	0.00	0	0.000000	0.00
Nags Head	2757	3	0.001088	1.09	43	0.015597	15.60
Nashville	5352	0	0.000000	0.00	0	0.000000	0.00
Navassa	1505	0	0.000000	0.00	0	0.000000	0.00
New Bern	29524	2	0.000068	0.07	32	0.001084	1.08
New London	600	0	0.000000	0.00	0	0.000000	0.00
Newland	698	0	0.000000	0.00	0	0.000000	0.00
Newport	4150	1	0.000241	0.24	0	0.000000	0.00
Newton	12968	1	0.000077	0.08	23	0.001774	1.77
Newton Grove	569	0	0.000000	0.00	0	0.000000	0.00
Norlina	1118	0	0.000000	0.00	0	0.000000	0.00
Norman	138	0	0.000000	0.00	0	0.000000	0.00

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North Topsail Beach	743	0	0.000000	0.00	0	0.000000	0.00
North Wilkesboro	4245	0	0.000000	0.00	29	0.006832	6.83
Northwest	735	0	0.000000	0.00	0	0.000000	0.00
Norwood	2379	1	0.000420	0.42	0	0.000000	0.00
Oak City	317	0	0.000000	0.00	0	0.000000	0.00
Oak Island	6783	2	0.000295	0.29	0	0.000000	0.00
Oak Ridge	6185	0	0.000000	0.00	0	0.000000	0.00
Oakboro	1859	0	0.000000	0.00	0	0.000000	0.00
Ocean Isle Beach	550	1	0.001818	1.82	3	0.005455	5.45
Old Fort	908	0	0.000000	0.00	0	0.000000	0.00
Oriental	900	0	0.000000	0.00	7	0.007778	7.78
Orrum	91	0	0.000000	0.00	0	0.000000	0.00
Ossipee	543	0	0.000000	0.00	0	0.000000	0.00
Oxford	8461	0	0.000000	0.00	0	0.000000	0.00
Pantego	179	0	0.000000	0.00	0	0.000000	0.00
Parkton	436	0	0.000000	0.00	0	0.000000	0.00
Parmele	278	0	0.000000	0.00	0	0.000000	0.00
Patterson Springs	622	0	0.000000	0.00	0	0.000000	0.00
Peachland	437	0	0.000000	0.00	0	0.000000	0.00
Peletier	644	0	0.000000	0.00	0	0.000000	0.00
Pembroke	2973	2	0.000673	0.67	19	0.006391	6.39
Pikeville	678	0	0.000000	0.00	0	0.000000	0.00
Pilot Mountain	1477	0	0.000000	0.00	0	0.000000	0.00
Pine Knoll Shores	1339	0	0.000000	0.00	0	0.000000	0.00
Pine Level	1700	0	0.000000	0.00	0	0.000000	0.00
Pinebluff	1337	0	0.000000	0.00	0	0.000000	0.00
Pinehurst	13124	0	0.000000	0.00	0	0.000000	0.00
Pinetops	1374	0	0.000000	0.00	0	0.000000	0.00
Pineville	7479	5	0.000669	0.67	0	0.000000	0.00
Pink Hill	552	0	0.000000	0.00	0	0.000000	0.00
Pittsboro	3743	1	0.000267	0.27	0	0.000000	0.00
Pleasant Garden	878	0	0.000000	0.00	0	0.000000	0.00
Plymouth	3878	1	0.000258	0.26	0	0.000000	0.00

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Polkton	3375	0	0.000000	0.00	0	0.000000	0.00
Polkville	545	0	0.000000	0.00	0	0.000000	0.00
Pollocksville	311	0	0.000000	0.00	2	0.006431	6.43
Powellsville	276	0	0.000000	0.00	0	0.000000	0.00
Princeton	1194	0	0.000000	0.00	0	0.000000	0.00
Princeville	2082	0	0.000000	0.00	0	0.000000	0.00
Proctorville	117	0	0.000000	0.00	0	0.000000	0.00
Raeford	4611	0	0.000000	0.00	0	0.000000	0.00
Raleigh	403892	87	0.000215	0.22	890	0.002204	2.20
Ramseur	1692	0	0.000000	0.00	0	0.000000	0.00
Randleman	4113	0	0.000000	0.00	0	0.000000	0.00
Ranlo	3434	0	0.000000	0.00	0	0.000000	0.00
Raynham	72	0	0.000000	0.00	0	0.000000	0.00
Red Cross	742	0	0.000000	0.00	0	0.000000	0.00
Red Oak	3430	0	0.000000	0.00	0	0.000000	0.00
Red Springs	3428	0	0.000000	0.00	0	0.000000	0.00
Reidsville	14520	1	0.000069	0.07	0	0.000000	0.00
Rennert	383	0	0.000000	0.00	0	0.000000	0.00
Rhodhiss	1070	0	0.000000	0.00	0	0.000000	0.00
Rich Square	1070	0	0.000000	0.00	0	0.000000	0.00
Richfield	613	0	0.000000	0.00	0	0.000000	0.00
Richlands	1520	0	0.000000	0.00	0	0.000000	0.00
River Bend	4394	0	0.000000	0.00	0	0.000000	0.00
Roanoke Rapids	15754	0	0.000000	0.00	0	0.000000	0.00
Robbins	1097	0	0.000000	0.00	0	0.000000	0.00
Robbinsville	620	0	0.000000	0.00	0	0.000000	0.00
Robersonville	1488	0	0.000000	0.00	0	0.000000	0.00
Rockingham	9558	0	0.000000	0.00	0	0.000000	0.00
Rockwell	2108	1	0.000474	0.47	0	0.000000	0.00
Rocky Mount	1602	14	0.008739	8.74	28	0.017478	17.48
Rolesville	3786	0	0.000000	0.00	0	0.000000	0.00
Ronda	417	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Roper	611	0	0.000000	0.00	4	0.006547	6.55
Rose Hill	1626	0	0.000000	0.00	0	0.000000	0.00
Roseboro	1191	0	0.000000	0.00	18	0.015113	15.11
Rosman	576	0	0.000000	0.00	0	0.000000	0.00
Rowland	1037	0	0.000000	0.00	0	0.000000	0.00
Roxboro	8362	1	0.000120	0.12	0	0.000000	0.00
Roxobel	240	0	0.000000	0.00	0	0.000000	0.00
Rural Hall	2937	0	0.000000	0.00	0	0.000000	0.00
Ruth	440	0	0.000000	0.00	0	0.000000	0.00
Rutherford College	1341	0	0.000000	0.00	0	0.000000	0.00
Rutherfordton	4213	0	0.000000	0.00	0	0.000000	0.00
Saint Helena	389	0	0.000000	0.00	3	0.007712	7.71
Saint James	3165	1	0.000316	0.32	0	0.000000	0.00
Saint Pauls	2035	0	0.000000	0.00	0	0.000000	0.00
Salemburg	435	0	0.000000	0.00	0	0.000000	0.00
Salisbury	33662	7	0.000208	0.21	108	0.003208	3.21
Saluda	713	0	0.000000	0.00	0	0.000000	0.00
Sandy Creek	260	0	0.000000	0.00	0	0.000000	0.00
Sandyfield	447	0	0.000000	0.00	0	0.000000	0.00
Sanford	28094	1	0.000036	0.04	33	0.001175	1.17
Santeetlah	28094	0	0.000000	0.00	#N/A	#N/A	#N/A
Saratoga	408	0	0.000000	0.00	0	0.000000	0.00
Sawmills	5240	0	0.000000	0.00	0	0.000000	0.00
Scotland Neck	2059	0	0.000000	0.00	12	0.005828	5.83
Seaboard	632	0	0.000000	0.00	0	0.000000	0.00
Seagrove	228	0	0.000000	0.00	0	0.000000	0.00
Sedalia	623	0	0.000000	0.00	0	0.000000	0.00
Selma	6073	1	0.000165	0.16	21	0.003458	3.46
Seven Devils	192	0	0.000000	0.00	0	0.000000	0.00
Seven Springs	110	0	0.000000	0.00	0	0.000000	0.00
Severn	276	0	0.000000	0.00	0	0.000000	0.00
Shallotte	3675	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Sharpsburg	2024	0	0.000000	0.00	0	0.000000	0.00
Shelby	20323	2	0.000098	0.10	17	0.000836	0.84
Siler City	7887	1	0.000127	0.13	15	0.001902	1.90
Simpson	416	0	0.000000	0.00	0	0.000000	0.00
Sims	282	0	0.000000	0.00	0	0.000000	0.00
Smithfield	10966	4	0.000365	0.36	0	0.000000	0.00
Snow Hill	1595	0	0.000000	0.00	0	0.000000	0.00
Southern Pines	12334	6	0.000486	0.49	38	0.003081	3.08
Southern Shores	2714	0	0.000000	0.00	7	0.002579	2.58
Southport	2833	0	0.000000	0.00	40	0.014119	14.12
Sparta	1770	0	0.000000	0.00	0	0.000000	0.00
Speed	80	1	0.012500	12.50	0	0.000000	0.00
Spencer	3267	0	0.000000	0.00	0	0.000000	0.00
Spencer Mountain	37	0	0.000000	0.00	0	0.000000	0.00
Spindale	4321	0	0.000000	0.00	0	0.000000	0.00
Spring Hope	1320	0	0.000000	0.00	0	0.000000	0.00
Spring Lake	11964	1	0.000084	0.08	10	0.000836	0.84
Spruce Pine	2175	0	0.000000	0.00	0	0.000000	0.00
Staley	393	0	0.000000	0.00	0	0.000000	0.00
Stallings	13831	0	0.000000	0.00	0	0.000000	0.00
Stanfield	1486	0	0.000000	0.00	0	0.000000	0.00
Stanley	3556	1	0.000281	0.28	0	0.000000	0.00
Stantonsburg	784	0	0.000000	0.00	0	0.000000	0.00
Star	876	0	0.000000	0.00	0	0.000000	0.00
Statesville	24532	7	0.000285	0.29	0	0.000000	0.00
Stedman	1028	0	0.000000	0.00	0	0.000000	0.00
Stem	463	0	0.000000	0.00	0	0.000000	0.00
Stokesdale	5047	0	0.000000	0.00	0	0.000000	0.00
Stoneville	1056	0	0.000000	0.00	0	0.000000	0.00
Stonewall	281	0	0.000000	0.00	0	0.000000	0.00
Stovall	418	0	0.000000	0.00	0	0.000000	0.00
Sugar Mountain	198	0	0.000000	0.00	1	0.005051	5.05

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Summerfield	10232	0	0.000000	0.00	0	0.000000	0.00
Sunset Beach	3572	1	0.000280	0.28	0	0.000000	0.00
Surf City	1853	0	0.000000	0.00	20	0.010793	10.79
Swansboro	2663	1	0.000376	0.38	25	0.009388	9.39
Swepsonville	1154	0	0.000000	0.00	0	0.000000	0.00
Sylva	2588	0	0.000000	0.00	0	0.000000	0.00
Tabor City	2511(r4469)	0	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!
Tar Heel	117	0	0.000000	0.00	0	0.000000	0.00
Tarboro	11415	1	0.000088	0.09	16	0.001402	1.40
Taylorsville	2098	0	0.000000	0.00	0	0.000000	0.00
Taylortown	722	0	0.000000	0.00	0	0.000000	0.00
Teachey	376	0	0.000000	0.00	0	0.000000	0.00
Thomasville	26757	3	0.000112	0.11	17	0.000635	0.64
Tobaccoville	2441	0	0.000000	0.00	0	0.000000	0.00
Topsail Beach	368	0	0.000000	0.00	13	0.035326	35.33
Trent Woods	4155	0	0.000000	0.00	0	0.000000	0.00
Trenton	287	0	0.000000	0.00	0	0.000000	0.00
Trinity	6614	0	0.000000	0.00	0	0.000000	0.00
Troutman	2383	1	0.000420	0.42	0	0.000000	0.00
Troy	3189	0	0.000000	0.00	0	0.000000	0.00
Tryon	1646	0	0.000000	0.00	0	0.000000	0.00
Turkey	292	0	0.000000	0.00	0	0.000000	0.00
Unionville	5929	2	0.000337	0.34	0	0.000000	0.00
Valdese	4490	0	0.000000	0.00	0	0.000000	0.00
Vanceboro	1005	0	0.000000	0.00	0	0.000000	0.00
Vandemere	254	0	0.000000	0.00	0	0.000000	0.00
Varnamtown	541	0	0.000000	0.00	0	0.000000	0.00
Vass	720	0	0.000000	0.00	0	0.000000	0.00
Waco	321	0	0.000000	0.00	0	0.000000	0.00
Wade	556	0	0.000000	0.00	0	0.000000	0.00
Wadesboro	5813	1	0.000172	0.17	26	0.004473	4.47
Wagram	840	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Wake Forest	30117	0	0.000000	0.00	20	0.000664	0.66
Walkertown	4675	0	0.000000	0.00	0	0.000000	0.00
Wallace	3880	0	0.000000	0.00	0	0.000000	0.00
Wallburg	3047	0	0.000000	0.00	17	0.005579	5.58
Walnut Cove	1425	0	0.000000	0.00	0	0.000000	0.00
Walnut Creek	835	0	0.000000	0.00	0	0.000000	0.00
Walstonburg	219	0	0.000000	0.00	0	0.000000	0.00
Warrenton	862	0	0.000000	0.00	0	0.000000	0.00
Warsaw	3054	1	0.000327	0.33	4	0.001310	1.31
Washington	9744	2	0.000205	0.21	29	0.002976	2.98
Washington Park	451	0	0.000000	0.00	6	0.013304	13.30
Watha	190	0	0.000000	0.00	0	0.000000	0.00
Waxhaw	9859	0	0.000000	0.00	0	0.000000	0.00
Waynesville	9869	0	0.000000	0.00	20	0.002027	2.03
Weaverville	3120	0	0.000000	0.00	0	0.000000	0.00
Webster	363	0	0.000000	0.00	0	0.000000	0.00
Weddington	9459	1	0.000106	0.11	0	0.000000	0.00
Weldon	1655	1	0.000604	0.60	0	0.000000	0.00
Wendell	5845	0	0.000000	0.00	0	0.000000	0.00
Wentworth	2807	0	0.000000	0.00	0	0.000000	0.00
Wesley Chapel	7463	0	0.000000	0.00	0	0.000000	0.00
West Jefferson	1348	0	0.000000	0.00	0	0.000000	0.00
Whispering Pines	2928	0	0.000000	0.00	0	0.000000	0.00
Whitakers	744	0	0.000000	0.00	0	0.000000	0.00
White Lake	1074	0	0.000000	0.00	0	0.000000	0.00
Whiteville	5394	2	0.000371	0.37	0	0.000000	0.00
Whitsett	590	0	0.000000	0.00	0	0.000000	0.00
Wilkesboro	3413	0	0.000000	0.00	0	0.000000	0.00
Williamston	5511	3	0.000544	0.54	0	0.000000	0.00
Wilmington	106476	47	0.000441	0.44	634	0.005954	5.95
Wilson	49167	13	0.000264	0.26	50	0.001017	1.02
Wilson's Mills	2277	0	0.000000	0.00	0	0.000000	0.00
Windsor	3630	0	0.000000	0.00	0	0.000000	0.00

City/Town	Population 2010	Bike Crashes 2010	Bike Crashes per Capita	Crashes per 1,000 people	Total Bicycle Commuters	Bicycle Commuters per Capita	Bicycle Commuters per 1,000
Winfall	594	0	0.000000	0.00	0	0.000000	0.00
Wingate	3491	0	0.000000	0.00	0	0.000000	0.00
Winston-Salem	229617	8	0.000035	0.03	219	0.000954	0.95
Winterville	9269	2	0.000216	0.22	0	0.000000	0.00
Winton	769	0	0.000000	0.00	0	0.000000	0.00
Woodfin	6123	1	0.000163	0.16	20	0.003266	3.27
Woodland	809	0	0.000000	0.00	0	0.000000	0.00
Wrightsville Beach	2477	1	0.000404	0.40	73	0.029471	29.47
Yadkinville	2959	0	0.000000	0.00	0	0.000000	0.00
Yanceyville	2039	0	0.000000	0.00	0	0.000000	0.00
Youngsville	1157	0	0.000000	0.00	0	0.000000	0.00
Zebulon	4433	2	0.000451	0.45	8	0.001805	1.80

Table 9.9.5 County Bicycle/Pedestrian Combined Crash Data and Commuter Data

County	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Alamance	151131	42	0.000278	0.28	1049	0.006941	6.94
Alexander	37198	4	0.000108	0.11	235	0.006318	6.32
Alleghany	11155	3	0.000269	0.27	38	0.003407	3.41
Anson	26948	7	0.000260	0.26	99	0.003674	3.67
Ashe	27281	4	0.000147	0.15	49	0.001796	1.80
Avery	17797	1	0.000056	0.06	194	0.010901	10.90
Beaufort	47759	14	0.000293	0.29	488	0.010218	10.22
Bertie	21282	6	0.000282	0.28	249	0.011700	11.70
Bladen	35190	15	0.000426	0.43	233	0.006621	6.62
Brunswick	107431	32	0.000298	0.30	547	0.005092	5.09
Buncombe	238318	117	0.000491	0.49	2895	0.012148	12.15
Burke	90912	15	0.000165	0.16	623	0.006853	6.85
Cabarrus	178011	52	0.000292	0.29	791	0.004444	4.44
Caldwell	83029	20	0.000241	0.24	483	0.005817	5.82
Camden	9980	4	0.000401	0.40	1	0.000100	0.10

County	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Carteret	66469	23	0.000346	0.35	685	0.010306	10.31
Caswell	23719	2	0.000084	0.08	134	0.005649	5.65
Catawba	154358	75	0.000486	0.49	585	0.003790	3.79
Chatham	63505	14	0.000220	0.22	707	0.011133	11.13
Cherokee	27444	7	0.000255	0.26	127	0.004628	4.63
Chowan	14793	5	0.000338	0.34	165	0.011154	11.15
Clay	10587	3	0.000283	0.28	25	0.002361	2.36
Cleveland	98078	29	0.000296	0.30	707	0.007209	7.21
Columbus	58098	15	0.000258	0.26	346	0.005955	5.96
Craven	103505	19	0.000184	0.18	1479	0.014289	14.29
Cumberland	319431	181	0.000567	0.57	5132	0.016066	16.07
Currituck	23547	3	0.000127	0.13	58	0.002463	2.46
Dare	33920	30	0.000884	0.88	535	0.015772	15.77
Davidson	162878	32	0.000196	0.20	686	0.004212	4.21
Davie	41240	9	0.000218	0.22	292	0.007081	7.08
Duplin	58505	13	0.000222	0.22	752	0.012854	12.85
Durham	267587	140	0.000523	0.52	4022	0.015031	15.03
Edgecombe	56552	28	0.000495	0.50	358	0.006330	6.33
Forsyth	350670	72	0.000205	0.21	2897	0.008261	8.26
Franklin	60619	8	0.000132	0.13	600	0.009898	9.90
Gaston	206086	72	0.000349	0.35	819	0.003974	3.97
Gates	12197	2	0.000164	0.16	66	0.005411	5.41
Graham	8861	2	0.000226	0.23	61	0.006884	6.88
Granville	59916	7	0.000117	0.12	350	0.005842	5.84
Greene	21362	4	0.000187	0.19	68	0.003183	3.18
Guilford	488406	293	0.000600	0.60	4451	0.009113	9.11
Halifax	54691	31	0.000567	0.57	256	0.004681	4.68
Harnett	114678	28	0.000244	0.24	636	0.005546	5.55
Haywood	59036	7	0.000119	0.12	348	0.005895	5.89
Henderson	106740	39	0.000365	0.37	739	0.006923	6.92
Hertford	24669	4	0.000162	0.16	186	0.007540	7.54

County	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Hoke	46952	10	0.000213	0.21	542	0.011544	11.54
Hyde	5810	1	0.000172	0.17	177	0.030465	30.46
Iredell	159437	50	0.000314	0.31	413	0.002590	2.59
Jackson	40271	2	0.000050	0.05	800	0.019865	19.87
Johnston	168878	41	0.000243	0.24	553	0.003275	3.27
Jones	10153	1	0.000098	0.10	173	0.017039	17.04
Lee	57866	10	0.000173	0.17	287	0.004960	4.96
Lenoir	59495	20	0.000336	0.34	394	0.006622	6.62
Lincoln	78265	10	0.000128	0.13	288	0.003680	3.68
Macon	44996	4	0.000089	0.09	273	0.006067	6.07
Madison	33922	1	0.000029	0.03	218	0.006427	6.43
Martin	20764	6	0.000289	0.29	223	0.010740	10.74
McDowell	24505	8	0.000326	0.33	252	0.010284	10.28
Mecklenburg	919628	522	0.000568	0.57	9252	0.010061	10.06
Mitchell	15579	4	0.000257	0.26	47	0.003017	3.02
Montgomery	27798	2	0.000072	0.07	140	0.005036	5.04
Moore	88247	31	0.000351	0.35	575	0.006516	6.52
Nash	95840	31	0.000323	0.32	499	0.005207	5.21
New Hanover	202667	137	0.000676	0.68	2418	0.011931	11.93
Northampton	22099	2	0.000091	0.09	180	0.008145	8.15
Onslow	177772	43	0.000242	0.24	5296	0.029791	29.79
Orange	133801	62	0.000463	0.46	4496	0.033602	33.60
Pamlico	13144	5	0.000380	0.38	113	0.008597	8.60
Pasquotank	40661	14	0.000344	0.34	360	0.008854	8.85
Pender	52217	8	0.000153	0.15	185	0.003543	3.54
Perquimans	13453	0	0.000000	0.00	131	0.009738	9.74
Person	39464	6	0.000152	0.15	108	0.002737	2.74
Pitt	168148	60	0.000357	0.36	2071	0.012317	12.32
Polk	20510	2	0.000098	0.10	161	0.007850	7.85
Randolph	141752	52	0.000367	0.37	750	0.005291	5.29
Richmond	46639	16	0.000343	0.34	168	0.003602	3.60

County	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Robeson	134168	70	0.000522	0.52	968	0.007215	7.21
Rockingham	93643	20	0.000214	0.21	362	0.003866	3.87
Rowan	138428	48	0.000347	0.35	714	0.005158	5.16
Rutherford	67810	19	0.000280	0.28	371	0.005471	5.47
Sampson	63431	20	0.000315	0.32	545	0.008592	8.59
Scotland	36157	19	0.000525	0.53	152	0.004204	4.20
Stanly	60585	13	0.000215	0.21	413	0.006817	6.82
Stokes	47401	6	0.000127	0.13	199	0.004198	4.20
Surry	73673	22	0.000299	0.30	406	0.005511	5.51
Swain	13981	3	0.000215	0.21	96	0.006866	6.87
Transylvania	33090	5	0.000151	0.15	412	0.012451	12.45
Tyrrell	4407	0	0.000000	0.00	106	0.024053	24.05
Union	201292	33	0.000164	0.16	617	0.003065	3.07
Vance	45422	19	0.000418	0.42	255	0.005614	5.61
Wake	900993	402	0.000446	0.45	8339	0.009255	9.26
Warren	20972	2	0.000095	0.10	138	0.006580	6.58
Washington	13228	3	0.000227	0.23	87	0.006577	6.58
Watauga	51079	24	0.000470	0.47	1742	0.034104	34.10
Wayne	122623	39	0.000318	0.32	850	0.006932	6.93
Wilkes	69340	10	0.000144	0.14	430	0.006201	6.20
Wilson	81234	33	0.000406	0.41	638	0.007854	7.85
Yadkin	38406	7	0.000182	0.18	120	0.003125	3.12
Yancey	17818	1	0.000056	0.06	407	0.022842	22.84

Table 9.9.6 City Bicycle/Pedestrian Combined Crash Data and Commuter Data

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Aberdeen	6350	9	0.001417	1.42	54	0.008504	8.50
Ahoskie	5039	0	0.000000	0.00	47	0.009327	9.33
Alamance	951	0	0.000000	0.00	7	0.007361	7.36
Albemarle	15903	7	0.000440	0.44	103	0.006477	6.48
Alliance	776	2	0.002577	2.58	11	0.014175	14.18
Andrews	1781	2	0.001123	1.12	0	0.000000	0.00
Angier	4350	2	0.000460	0.46	3	0.000690	0.69
Ansonville	631	0	0.000000	0.00	0	0.000000	0.00
Apex	37476	6	0.000160	0.16	185	0.004936	4.94
Arapahoe	556	0	0.000000	0.00	3	0.005396	5.40
Archdale	11415	5	0.000438	0.44	0	0.000000	0.00
Archer Lodge	4292	1	0.000233	0.23	0	0.000000	0.00
Asheboro	25012	26	0.001040	1.04	183	0.007316	7.32
Asheville	83393	86	0.001031	1.03	1684	0.020194	20.19
Askewville	241	0	0.000000	0.00	1	0.004149	4.15
Atkinson	299	0	0.000000	0.00	2	0.006689	6.69
Atlantic Beach	1495	0	0.000000	0.00	54	0.036120	36.12
Aulander	895	0	0.000000	0.00	15	0.016760	16.76
Aurora	520	0	0.000000	0.00	2	0.003846	3.85
Autryville	196	0	0.000000	0.00	6	0.030612	30.61
Ayden	4932	1	0.000203	0.20	25	0.005069	5.07
Badin	1974	0	0.000000	0.00	8	0.004053	4.05
Bailey	569	0	0.000000	0.00	9	0.015817	15.82
Bakersville	464	0	0.000000	0.00	5	0.010776	10.78
Bald Head Island	158	0	0.000000	0.00	0	0.000000	0.00
Banner Elk	1028	0	0.000000	0.00	102	0.099222	99.22
Bath	249	0	0.000000	0.00	2	0.008032	8.03
Bayboro	1263	0	0.000000	0.00	0	0.000000	0.00
Bear Grass	73	0	0.000000	0.00	0	0.000000	0.00
Beaufort	4039	3	0.000743	0.74	213	0.052736	52.74

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Beech Mountain	320	0	0.000000	0.00	5	0.015625	15.63
Belhaven	1688	0	0.000000	0.00	57	0.033768	33.77
Belmont	10076	10	0.000992	0.99	189	0.018757	18.76
Belville	1936	0	0.000000	0.00	17	0.008781	8.78
Belwood	950	0	0.000000	0.00	3	0.003158	3.16
Benson	3311	0	0.000000	0.00	32	0.009665	9.66
Bermuda Run	1725	1	0.000580	0.58	0	0.000000	0.00
Bessemer City	5340	0	0.000000	0.00	0	0.000000	0.00
Bethania	328	1	0.003049	3.05	2	0.006098	6.10
Bethel	1577	0	0.000000	0.00	24	0.015219	15.22
Beulaville	1296	1	0.000772	0.77	32	0.024691	24.69
Biltmore Forest	1343	0	0.000000	0.00	0	0.000000	0.00
Biscoe	1700	0	0.000000	0.00	0	0.000000	0.00
Black Creek	769	0	0.000000	0.00	0	0.000000	0.00
Black Mountain	7848	1	0.000127	0.13	196	0.024975	24.97
Bladenboro	1750	1	0.000571	0.57	13	0.007429	7.43
Blowing Rock	1241	0	0.000000	0.00	41	0.033038	33.04
Boardman	157	0	0.000000	0.00	0	0.000000	0.00
Bogue	684	0	0.000000	0.00	8	0.011696	11.70
Boiling Spring Lakes	5372	0	0.000000	0.00	10	0.001862	1.86
Boiling Springs	4647	2	0.000430	0.43	261	0.056165	56.17
Bolivia	143	0	0.000000	0.00	14	0.097902	97.90
Bolton	691	0	0.000000	0.00	0	0.000000	0.00
Boone	17122	22	0.001285	1.28	1480	0.086439	86.44
Boonville	1222	0	0.000000	0.00	3	0.002455	2.45
Bostic	386	0	0.000000	0.00	0	0.000000	0.00
Brevard	7609	4	0.000526	0.53	141	0.018531	18.53
Bridgeton	454	0	0.000000	0.00	0	0.000000	0.00
Broadway	1229	0	0.000000	0.00	8	0.006509	6.51
Brookford	382	0	0.000000	0.00	0	0.000000	0.00
Brunswick	1119	0	0.000000	0.00	11	0.009830	9.83
Bryson City	1424	0	0.000000	0.00	12	0.008427	8.43

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Bunn	344	0	0.000000	0.00	9	0.026163	26.16
Burgaw	3872	0	0.000000	0.00	0	0.000000	0.00
Burlington	49963	19	0.000380	0.38	275	0.005504	5.50
Burnsville	1693	0	0.000000	0.00	157	0.092735	92.73
Butner	7591	0	0.000000	0.00	37	0.004874	4.87
Cajah's Mountain	2823	1	0.000354	0.35	4	0.001417	1.42
Calabash	1786	0	0.000000	0.00	0	0.000000	0.00
Calypso	538	0	0.000000	0.00	0	0.000000	0.00
Cameron	285	0	0.000000	0.00	0	0.000000	0.00
Candor	840	1	0.001190	1.19	0	0.000000	0.00
Canton	4227	0	0.000000	0.00	29	0.006861	6.86
Cape Carteret	1917	0	0.000000	0.00	23	0.011998	12.00
Carolina Beach	5706	6	0.001052	1.05	65	0.011392	11.39
Carolina Shores	3048	0	0.000000	0.00	9	0.002953	2.95
Carrboro	19582	10	0.000511	0.51	811	0.041416	41.42
Carthage	2205	1	0.000454	0.45	13	0.005896	5.90
Cary	135234	49	0.000362	0.36	1077	0.007964	7.96
Casar	297	0	0.000000	0.00	3	0.010101	10.10
Castalia	268	0	0.000000	0.00	1	0.003731	3.73
Caswell Beach	398	0	0.000000	0.00	4	0.010050	10.05
Catawba	603	0	0.000000	0.00	0	0.000000	0.00
Cedar Point	1279	0	0.000000	0.00	12	0.009382	9.38
Cedar Rock	300	0	0.000000	0.00	0	0.000000	0.00
Centerville	89	0	0.000000	0.00	0	0.000000	0.00
Cerro Gordo	207	0	0.000000	0.00	0	0.000000	0.00
Chadbourn	1856	1	0.000539	0.54	3	0.001616	1.62
Chapel Hill	57233	37	0.000646	0.65	3339	0.058340	58.34
Charlotte	731424	458	0.000626	0.63	7801	0.010665	10.67
Cherryville	5760	2	0.000347	0.35	74	0.012847	12.85
Chimney Rock Village	113	0	0.000000	0.00	0	0.000000	0.00
China Grove	3563	1	0.000281	0.28	17	0.004771	4.77

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Chocowinity	820	0	0.000000	0.00	3	0.003659	3.66
Claremont	1352	1	0.000740	0.74	26	0.019231	19.23
Clarkton	837	0	0.000000	0.00	7	0.008363	8.36
Clayton	16116	3	0.000186	0.19	23	0.001427	1.43
Clemmons	18627	3	0.000161	0.16	74	0.003973	3.97
Cleveland	871	0	0.000000	0.00	5	0.005741	5.74
Clinton	8639	5	0.000579	0.58	98	0.011344	11.34
Clyde	1223	0	0.000000	0.00	3	0.002453	2.45
Coats	2112	1	0.000473	0.47	0	0.000000	0.00
Cofield	413	0	0.000000	0.00	17	0.041162	41.16
Colerain	204	0	0.000000	0.00	0	0.000000	0.00
Columbia	891	0	0.000000	0.00	11	0.012346	12.35
Columbus	999	1	0.001001	1.00	9	0.009009	9.01
Como	91	0	0.000000	0.00	0	0.000000	0.00
Concord	79066	28	0.000354	0.35	357	0.004515	4.52
Conetoe	294	0	0.000000	0.00	22	0.074830	74.83
Connelly Springs	1669	0	0.000000	0.00	16	0.009587	9.59
Conover	8165	10	0.001225	1.22	14	0.001715	1.71
Conway	836	0	0.000000	0.00	6	0.007177	7.18
Cooleemee	960	1	0.001042	1.04	0	0.000000	0.00
Cornelius	24866	1	0.000040	0.04	202	0.008124	8.12
Cove City	399	0	0.000000	0.00	0	0.000000	0.00
Cramerton	4165	0	0.000000	0.00	9	0.002161	2.16
Creedmoor	4124	0	0.000000	0.00	0	0.000000	0.00
Creswell	276	0	0.000000	0.00	2	0.007246	7.25
Crossnore	192	0	0.000000	0.00	9	0.046875	46.88
Dallas	4488	1	0.000223	0.22	93	0.020722	20.72
Danbury	189	0	0.000000	0.00	0	0.000000	0.00
Davidson	10944	4	0.000365	0.37	337	0.030793	30.79
Denton	1636	0	0.000000	0.00	22	0.013447	13.45
Dillsboro	232	0	0.000000	0.00	8	0.034483	34.48
Dobbins Heights	866	0	0.000000	0.00	4	0.004619	4.62

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Dobson	1586	0	0.000000	0.00	73	0.046028	46.03
Dortches	935	0	0.000000	0.00	5	0.005348	5.35
Dover	401	0	0.000000	0.00	2	0.004988	4.99
Drexel	1858	0	0.000000	0.00	0	0.000000	0.00
Dublin	338	0	0.000000	0.00	5	0.014793	14.79
Duck	369	1	0.002710	2.71	13	0.035230	35.23
Dunn	9263	9	0.000972	0.97	88	0.009500	9.50
Durham	228330	131	0.000574	0.57	3956	0.017326	17.33
Earl	260	0	0.000000	0.00	0	0.000000	0.00
East Arcadia	487	0	0.000000	0.00	0	0.000000	0.00
East Bend	612	0	0.000000	0.00	6	0.009804	9.80
East Laurinburg	300	0	0.000000	0.00	5	0.016667	16.67
East Spencer	1534	0	0.000000	0.00	0	0.000000	0.00
Eastover	3628	1	0.000276	0.28	0	0.000000	0.00
Eden	15527	9	0.000580	0.58	119	0.007664	7.66
Edenton	5004	2	0.000400	0.40	132	0.026379	26.38
Elizabeth City	18683	7	0.000375	0.37	256	0.013702	13.70
Elizabethtown	3583	1	0.000279	0.28	61	0.017025	17.02
Elk Park	452	0	0.000000	0.00	0	0.000000	0.00
Elkin	4001	3	0.000750	0.75	0	0.000000	0.00
Ellenboro	873	0	0.000000	0.00	0	0.000000	0.00
Ellerbe	1054	0	0.000000	0.00	31	0.029412	29.41
Elm City	1298	0	0.000000	0.00	27	0.020801	20.80
Elon	9419	6	0.000637	0.64	264	0.028028	28.03
Emerald Isle	3655	5	0.001368	1.37	16	0.004378	4.38
Enfield	2532	3	0.001185	1.18	8	0.003160	3.16
Erwin	4405	3	0.000681	0.68	4	0.000908	0.91
Eureka	197	0	0.000000	0.00	0	0.000000	0.00
Everetts	164	0	0.000000	0.00	3	0.018293	18.29
Fair Bluff	951	0	0.000000	0.00	8	0.008412	8.41
Fairmont	2663	0	0.000000	0.00	27	0.010139	10.14
Fairview	2678	0	0.000000	0.00	14	0.005228	5.23

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Faison	961	0	0.000000	0.00	41	0.042664	42.66
Faith	807	1	0.001239	1.24	3	0.003717	3.72
Falcon	258	0	0.000000	0.00	3	0.011628	11.63
Falkland	96	1	0.010417	10.42	0	0.000000	0.00
Fallston	607	0	0.000000	0.00	36	0.059308	59.31
Farmville	4654	3	0.000645	0.64	122	0.026214	26.21
Fayetteville	200564	145	0.000723	0.72	4487	0.022372	22.37
Flat Rock	3114	0	0.000000	0.00	30	0.009634	9.63
Fletcher	7187	1	0.000139	0.14	12	0.001670	1.67
Fontana Dam	#N/A	0	#N/A	#N/A	#N/A	#N/A	#N/A
Forest City	7476	10	0.001338	1.34	27	0.003612	3.61
Forest Hills	365	0	0.000000	0.00	3	0.008219	8.22
Fountain	427	0	0.000000	0.00	3	0.007026	7.03
Four Oaks	1921	0	0.000000	0.00	25	0.013014	13.01
Foxfire Village	902	0	0.000000	0.00	0	0.000000	0.00
Franklin	3845	0	0.000000	0.00	42	0.010923	10.92
Franklinton	2023	0	0.000000	0.00	9	0.004449	4.45
Franklinville	1164	1	0.000859	0.86	9	0.007732	7.73
Fremont	1255	0	0.000000	0.00	26	0.020717	20.72
Fuquay-Varina	17937	7	0.000390	0.39	38	0.002119	2.12
Gamewell	4051	0	0.000000	0.00	0	0.000000	0.00
Garland	625	0	0.000000	0.00	5	0.008000	8.00
Garner	25745	14	0.000544	0.54	202	0.007846	7.85
Garysburg	1057	0	0.000000	0.00	0	0.000000	0.00
Gaston	1152	0	0.000000	0.00	67	0.058160	58.16
Gastonia	71741	48	0.000669	0.67	237	0.003304	3.30
Gatesville	321	0	0.000000	0.00	0	0.000000	0.00
Gibson	540	0	0.000000	0.00	5	0.009259	9.26
Gibsonville	6410	2	0.000312	0.31	0	0.000000	0.00
Glen Alpine	1517	0	0.000000	0.00	4	0.002637	2.64
Godwin	139	0	0.000000	0.00	0	0.000000	0.00
Goldsboro	36437	19	0.000521	0.52	377	0.010347	10.35

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Goldston	268	0	0.000000	0.00	2	0.007463	7.46
Graham	14153	3	0.000212	0.21	42	0.002968	2.97
Grandfather Village	25	0	0.000000	0.00	0	0.000000	0.00
Granite Falls	4722	0	0.000000	0.00	97	0.020542	20.54
Granite Quarry	2930	0	0.000000	0.00	0	0.000000	0.00
Grantsboro	688	1	0.001453	1.45	0	0.000000	0.00
Green Level	2100	1	0.000476	0.48	0	0.000000	0.00
Greenevers	634	1	0.001577	1.58	17	0.026814	26.81
Greensboro	269666	200	0.000742	0.74	2784	0.010324	10.32
Greenville	84554	26	0.000307	0.31	1615	0.019100	19.10
Grifton	2617	0	0.000000	0.00	0	0.000000	0.00
Grimesland	441	1	0.002268	2.27	0	0.000000	0.00
Grover	708	0	0.000000	0.00	2	0.002825	2.82
Halifax	234	0	0.000000	0.00	5	0.021368	21.37
Hamilton	408	0	0.000000	0.00	0	0.000000	0.00
Hamlet	6495	1	0.000154	0.15	11	0.001694	1.69
Harmony	531	1	0.001883	1.88	16	0.030132	30.13
Harrells	202	0	0.000000	0.00	10	0.049505	49.50
Harrellsville	106	0	0.000000	0.00	0	0.000000	0.00
Harrisburg	11526	1	0.000087	0.09	0	0.000000	0.00
Hassell	84	0	0.000000	0.00	0	0.000000	0.00
Havelock	20735	6	0.000289	0.29	764	0.036846	36.85
Haw River	2298	1	0.000435	0.44	0	0.000000	0.00
Hayesville	311	1	0.003215	3.22	0	0.000000	0.00
Hemby Bridge	1520	0	0.000000	0.00	9	0.005921	5.92
Henderson	15368	12	0.000781	0.78	159	0.010346	10.35
Hendersonville	13137	28	0.002131	2.13	151	0.011494	11.49
Hertford	2143	0	0.000000	0.00	9	0.004200	4.20
Hickory	40010	44	0.001100	1.10	308	0.007698	7.70
High Point	104371	68	0.000652	0.65	1015	0.009725	9.72
High Shoals	696	1	0.001437	1.44	5	0.007184	7.18
Highlands	924	0	0.000000	0.00	40	0.043290	43.29

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Hildebran	2023	0	0.000000	0.00	18	0.008898	8.90
Hillsborough	6087	3	0.000493	0.49	67	0.011007	11.01
Hobgood	348	0	0.000000	0.00	0	0.000000	0.00
Hoffman	588	1	0.001701	1.70	6	0.010204	10.20
Holden Beach	575	0	0.000000	0.00	3	0.005217	5.22
Holly Ridge	1268	0	0.000000	0.00	8	0.006309	6.31
Holly Springs	24661	3	0.000122	0.12	0	0.000000	0.00
Hookerton	409	0	0.000000	0.00	2	0.004890	4.89
Hope Mills	15176	3	0.000198	0.20	51	0.003361	3.36
Hot Springs	560	0	0.000000	0.00	9	0.016071	16.07
Hudson	3776	3	0.000794	0.79	0	0.000000	0.00
Huntersville	46773	15	0.000321	0.32	226	0.004832	4.83
Indian Beach	112	0	0.000000	0.00	0	0.000000	0.00
Indian Trail	33518	3	0.000090	0.09	67	0.001999	2.00
Jackson	513	0	0.000000	0.00	13	0.025341	25.34
Jacksonville	70145	19	0.000271	0.27	4212	0.060047	60.05
Jamestown	3382	3	0.000887	0.89	18	0.005322	5.32
Jamesville	491	0	0.000000	0.00	6	0.012220	12.22
Jefferson	1611	0	0.000000	0.00	0	0.000000	0.00
Jonesville	2285	1	0.000438	0.44	0	0.000000	0.00
Kannapolis	42625	23	0.000540	0.54	371	0.008704	8.70
Kelford	251	0	0.000000	0.00	0	0.000000	0.00
Kenansville	855	0	0.000000	0.00	29	0.033918	33.92
Kenly	1339	2	0.001494	1.49	5	0.003734	3.73
Kernersville	23123	8	0.000346	0.35	112	0.004844	4.84
Kill Devil Hills	6683	2	0.000299	0.30	54	0.008080	8.08
King	6904	2	0.000290	0.29	20	0.002897	2.90
Kings Mountain	10296	6	0.000583	0.58	64	0.006216	6.22
Kingstown	681	0	0.000000	0.00	3	0.004405	4.41
Kinston	21677	16	0.000738	0.74	174	0.008027	8.03
Kittrell	467	1	0.002141	2.14	2	0.004283	4.28
Kitty Hawk	3272	8	0.002445	2.44	117	0.035758	35.76

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Knightdale	11401	3	0.000263	0.26	132	0.011578	11.58
Kure Beach	2012	0	0.000000	0.00	62	0.030815	30.82
La Grange	2873	0	0.000000	0.00	0	0.000000	0.00
Lake Lure	1192	0	0.000000	0.00	0	0.000000	0.00
Lake Park	3422	0	0.000000	0.00	0	0.000000	0.00
Lake Waccamaw	1480	0	0.000000	0.00	36	0.024324	24.32
Landis	3109	1	0.000322	0.32	0	0.000000	0.00
Lansing	158	0	0.000000	0.00	11	0.069620	69.62
Lasker	122	0	0.000000	0.00	1	0.008197	8.20
Lattimore	488	0	0.000000	0.00	25	0.051230	51.23
Laurel Park	2180	0	0.000000	0.00	57	0.026147	26.15
Laurinburg	15962	11	0.000689	0.69	97	0.006077	6.08
Lawndale	606	0	0.000000	0.00	0	0.000000	0.00
Leggett	60	0	0.000000	0.00	0	0.000000	0.00
Leland	13527	1	0.000074	0.07	0	0.000000	0.00
Lenoir	18228	10	0.000549	0.55	107	0.005870	5.87
Lewiston Woodville	549	0	0.000000	0.00	21	0.038251	38.25
Lewisville	12639	1	0.000079	0.08	51	0.004035	4.04
Lexington	18931	7	0.000370	0.37	246	0.012995	12.99
Liberty	2656	0	0.000000	0.00	7	0.002636	2.64
Lilesville	536	0	0.000000	0.00	7	0.013060	13.06
Lillington	3194	1	0.000313	0.31	15	0.004696	4.70
Lincolnton	10486	3	0.000286	0.29	55	0.005245	5.25
Linden	130	0	0.000000	0.00	0	0.000000	0.00
Littleton	674	0	0.000000	0.00	21	0.031157	31.16
Locust	2930	0	0.000000	0.00	14	0.004778	4.78
Long View	4871	1	0.000205	0.21	97	0.019914	19.91
Louisburg	3359	2	0.000595	0.60	213	0.063412	63.41
Love Valley	90	0	0.000000	0.00	0	0.000000	0.00
Lowell	3526	0	0.000000	0.00	15	0.004254	4.25
Lucama	1108	0	0.000000	0.00	0	0.000000	0.00
Lumber Bridge	94	0	0.000000	0.00	0	0.000000	0.00

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Lumberton	21542	29	0.001346	1.35	131	0.006081	6.08
Macclesfield	471	0	0.000000	0.00	30	0.063694	63.69
Macon	119	0	0.000000	0.00	18	0.151261	151.26
Madison	2246	3	0.001336	1.34	11	0.004898	4.90
Maggie Valley	1150	0	0.000000	0.00	20	0.017391	17.39
Magnolia	939	0	0.000000	0.00	4	0.004260	4.26
Maiden	3310	0	0.000000	0.00	0	0.000000	0.00
Manteo	1434	0	0.000000	0.00	30	0.020921	20.92
Marietta	175	1	0.005714	5.71	0	0.000000	0.00
Marion	7838	4	0.000510	0.51	116	0.014800	14.80
Mars Hill	1869	0	0.000000	0.00	109	0.058320	58.32
Marshall	872	0	0.000000	0.00	3	0.003440	3.44
Marshville	2402	0	0.000000	0.00	24	0.009992	9.99
Marvin	5579	0	0.000000	0.00	0	0.000000	0.00
Matthews	27198	5	0.000184	0.18	169	0.006214	6.21
Maxton	2426	2	0.000824	0.82	49	0.020198	20.20
Mayodan	2478	0	0.000000	0.00	0	0.000000	0.00
Maysville	1019	1	0.000981	0.98	17	0.016683	16.68
McAdenville	651	0	0.000000	0.00	0	0.000000	0.00
McDonald	113	0	0.000000	0.00	0	0.000000	0.00
McFarlan	117	0	0.000000	0.00	0	0.000000	0.00
Mebane	11393	2	0.000176	0.18	67	0.005881	5.88
Mesic	220	0	0.000000	0.00	13	0.059091	59.09
Micro	441	0	0.000000	0.00	0	0.000000	0.00
Middleburg	133	1	0.007519	7.52	4	0.030075	30.08
Middlesex	822	0	0.000000	0.00	26	0.031630	31.63
Midland	3073	1	0.000325	0.33	0	0.000000	0.00
Midway	4679	1	0.000214	0.21	0	0.000000	0.00
Mills River	6802	0	0.000000	0.00	19	0.002793	2.79
Milton	166	0	0.000000	0.00	0	0.000000	0.00
Mineral Springs	2639	0	0.000000	0.00	0	0.000000	0.00
Minnesott Beach	440	0	0.000000	0.00	5	0.011364	11.36

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Mint Hill	22722	9	0.000396	0.40	49	0.002157	2.16
Misenheimer	728	0	0.000000	0.00	72	0.098901	98.90
Mocksville	5051	1	0.000198	0.20	14	0.002772	2.77
Momeyer	224	0	0.000000	0.00	6	0.026786	26.79
Monroe	32797	14	0.000427	0.43	104	0.003171	3.17
Montreat	723	0	0.000000	0.00	83	0.114799	114.80
Mooresboro	311	0	0.000000	0.00	0	0.000000	0.00
Mooresville	32711	16	0.000489	0.49	115	0.003516	3.52
Morehead City	8661	4	0.000462	0.46	144	0.016626	16.63
Morganton	16918	5	0.000296	0.30	206	0.012176	12.18
Morrisville	18576	2	0.000108	0.11	158	0.008506	8.51
Morven	511	0	0.000000	0.00	0	0.000000	0.00
Mount Airy	10388	8	0.000770	0.77	36	0.003466	3.47
Mount Gilead	1181	0	0.000000	0.00	6	0.005080	5.08
Mount Holly	13656	0	0.000000	0.00	8	0.000586	0.59
Mount Olive	4589	1	0.000218	0.22	121	0.026367	26.37
Mount Pleasant	1652	0	0.000000	0.00	5	0.003027	3.03
Murfreesboro	2835	0	0.000000	0.00	63	0.022222	22.22
Murphy	1627	1	0.000615	0.61	19	0.011678	11.68
Nags Head	2757	6	0.002176	2.18	63	0.022851	22.85
Nashville	5352	0	0.000000	0.00	0	0.000000	0.00
Navassa	1505	0	0.000000	0.00	17	0.011296	11.30
New Bern	29524	7	0.000237	0.24	372	0.012600	12.60
New London	600	1	0.001667	1.67	0	0.000000	0.00
Newland	698	0	0.000000	0.00	21	0.030086	30.09
Newport	4150	3	0.000723	0.72	44	0.010602	10.60
Newton	12968	8	0.000617	0.62	48	0.003701	3.70
Newton Grove	569	0	0.000000	0.00	4	0.007030	7.03
Norlina	1118	0	0.000000	0.00	15	0.013417	13.42
Norman	138	0	0.000000	0.00	2	0.014493	14.49
North Topsail Beach	743	0	0.000000	0.00	0	0.000000	0.00
North Wilkesboro	4245	2	0.000471	0.47	42	0.009894	9.89

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Northwest	735	0	0.000000	0.00	0	0.000000	0.00
Norwood	2379	2	0.000841	0.84	4	0.001681	1.68
Oak City	317	0	0.000000	0.00	0	0.000000	0.00
Oak Island	6783	3	0.000442	0.44	33	0.004865	4.87
Oak Ridge	6185	0	0.000000	0.00	19	0.003072	3.07
Oakboro	1859	0	0.000000	0.00	23	0.012372	12.37
Ocean Isle Beach	550	1	0.001818	1.82	3	0.005455	5.45
Old Fort	908	0	0.000000	0.00	35	0.038546	38.55
Oriental	900	0	0.000000	0.00	24	0.026667	26.67
Orrum	91	0	0.000000	0.00	0	0.000000	0.00
Ossipee	543	0	0.000000	0.00	23	0.042357	42.36
Oxford	8461	2	0.000236	0.24	239	0.028247	28.25
Pantego	179	0	0.000000	0.00	0	0.000000	0.00
Parkton	436	0	0.000000	0.00	0	0.000000	0.00
Parmele	278	0	0.000000	0.00	0	0.000000	0.00
Patterson Springs	622	0	0.000000	0.00	3	0.004823	4.82
Peachland	437	0	0.000000	0.00	15	0.034325	34.32
Peletier	644	0	0.000000	0.00	0	0.000000	0.00
Pembroke	2973	7	0.002355	2.35	41	0.013791	13.79
Pikeville	678	0	0.000000	0.00	12	0.017699	17.70
Pilot Mountain	1477	0	0.000000	0.00	20	0.013541	13.54
Pine Knoll Shores	1339	0	0.000000	0.00	7	0.005228	5.23
Pine Level	1700	0	0.000000	0.00	0	0.000000	0.00
Pinebluff	1337	1	0.000748	0.75	20	0.014959	14.96
Pinehurst	13124	1	0.000076	0.08	76	0.005791	5.79
Pinetops	1374	0	0.000000	0.00	34	0.024745	24.75
Pineville	7479	15	0.002006	2.01	102	0.013638	13.64
Pink Hill	552	0	0.000000	0.00	3	0.005435	5.43
Pittsboro	3743	2	0.000534	0.53	21	0.005610	5.61
Pleasant Garden	878	0	0.000000	0.00	17	0.019362	19.36
Plymouth	3878	1	0.000258	0.26	6	0.001547	1.55
Polkton	3375	2	0.000593	0.59	7	0.002074	2.07

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Polkville	545	0	0.000000	0.00	0	0.000000	0.00
Pollocksville	311	0	0.000000	0.00	10	0.032154	32.15
Powellsville	276	1	0.003623	3.62	0	0.000000	0.00
Princeton	1194	0	0.000000	0.00	16	0.013400	13.40
Princeville	2082	0	0.000000	0.00	0	0.000000	0.00
Proctorville	117	0	0.000000	0.00	3	0.025641	25.64
Raeford	4611	1	0.000217	0.22	11	0.002386	2.39
Raleigh	403892	269	0.000666	0.67	5599	0.013863	13.86
Ramseur	1692	0	0.000000	0.00	3	0.001773	1.77
Randleman	4113	5	0.001216	1.22	26	0.006321	6.32
Ranlo	3434	0	0.000000	0.00	0	0.000000	0.00
Raynham	72	0	0.000000	0.00	0	0.000000	0.00
Red Cross	742	1	0.001348	1.35	3	0.004043	4.04
Red Oak	3430	0	0.000000	0.00	17	0.004956	4.96
Red Springs	3428	1	0.000292	0.29	44	0.012835	12.84
Reidsville	14520	2	0.000138	0.14	0	0.000000	0.00
Rennert	383	1	0.002611	2.61	0	0.000000	0.00
Rhodhiss	1070	0	0.000000	0.00	0	0.000000	0.00
Rich Square	1070	0	0.000000	0.00	0	0.000000	0.00
Richfield	613	0	0.000000	0.00	2	0.003263	3.26
Richlands	1520	0	0.000000	0.00	28	0.018421	18.42
River Bend	4394	0	0.000000	0.00	0	0.000000	0.00
Roanoke Rapids	15754	13	0.000825	0.83	106	0.006728	6.73
Robbins	1097	2	0.001823	1.82	3	0.002735	2.73
Robbinsville	620	1	0.001613	1.61	0	0.000000	0.00
Robersonville	1488	0	0.000000	0.00	46	0.030914	30.91
Rockingham	9558	7	0.000732	0.73	11	0.001151	1.15
Rockwell	2108	1	0.000474	0.47	8	0.003795	3.80
Rocky Mount	1602	40	0.024969	24.97	232	0.144819	144.82
Rolesville	3786	0	0.000000	0.00	48	0.012678	12.68
Ronda	417	0	0.000000	0.00	2	0.004796	4.80
Roper	611	0	0.000000	0.00	13	0.021277	21.28

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Rose Hill	1626	0	0.000000	0.00	12	0.007380	7.38
Roseboro	1191	0	0.000000	0.00	31	0.026029	26.03
Rosman	576	0	0.000000	0.00	7	0.012153	12.15
Rowland	1037	0	0.000000	0.00	3	0.002893	2.89
Roxboro	8362	4	0.000478	0.48	49	0.005860	5.86
Roxobel	240	0	0.000000	0.00	0	0.000000	0.00
Rural Hall	2937	1	0.000340	0.34	13	0.004426	4.43
Ruth	440	0	0.000000	0.00	2	0.004545	4.55
Rutherford College	1341	0	0.000000	0.00	5	0.003729	3.73
Rutherfordton	4213	0	0.000000	0.00	10	0.002374	2.37
Saint Helena	389	0	0.000000	0.00	3	0.007712	7.71
Saint James	3165	3	0.000948	0.95	48	0.015166	15.17
Saint Pauls	2035	1	0.000491	0.49	10	0.004914	4.91
Salemburg	435	2	0.004598	4.60	9	0.020690	20.69
Salisbury	33662	22	0.000654	0.65	274	0.008140	8.14
Saluda	713	0	0.000000	0.00	0	0.000000	0.00
Sandy Creek	260	0	0.000000	0.00	0	0.000000	0.00
Sandyfield	447	0	0.000000	0.00	0	0.000000	0.00
Sanford	28094	7	0.000249	0.25	220	0.007831	7.83
Santeetlah	28094	0	0.000000	0.00	#N/A	#N/A	#N/A
Saratoga	408	1	0.002451	2.45	0	0.000000	0.00
Sawmills	5240	1	0.000191	0.19	25	0.004771	4.77
Scotland Neck	2059	0	0.000000	0.00	47	0.022827	22.83
Seaboard	632	1	0.001582	1.58	3	0.004747	4.75
Seagrove	228	0	0.000000	0.00	7	0.030702	30.70
Sedalia	623	0	0.000000	0.00	0	0.000000	0.00
Selma	6073	2	0.000329	0.33	83	0.013667	13.67
Seven Devils	192	0	0.000000	0.00	0	0.000000	0.00
Seven Springs	110	0	0.000000	0.00	0	0.000000	0.00
Severn	276	0	0.000000	0.00	0	0.000000	0.00
Shallotte	3675	2	0.000544	0.54	22	0.005986	5.99

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Sharpsburg	2024	0	0.000000	0.00	0	0.000000	0.00
Shelby	20323	12	0.000590	0.59	117	0.005757	5.76
Siler City	7887	4	0.000507	0.51	60	0.007607	7.61
Simpson	416	1	0.002404	2.40	0	0.000000	0.00
Sims	282	0	0.000000	0.00	0	0.000000	0.00
Smithfield	10966	14	0.001277	1.28	37	0.003374	3.37
Snow Hill	1595	0	0.000000	0.00	5	0.003135	3.13
Southern Pines	12334	10	0.000811	0.81	142	0.011513	11.51
Southern Shores	2714	0	0.000000	0.00	12	0.004422	4.42
Southport	2833	2	0.000706	0.71	97	0.034239	34.24
Sparta	1770	1	0.000565	0.56	2	0.001130	1.13
Speed	80	1	0.012500	12.50	0	0.000000	0.00
Spencer	3267	1	0.000306	0.31	35	0.010713	10.71
Spencer Mountain	37	0	0.000000	0.00	0	0.000000	0.00
Spindale	4321	2	0.000463	0.46	16	0.003703	3.70
Spring Hope	1320	0	0.000000	0.00	22	0.016667	16.67
Spring Lake	11964	6	0.000502	0.50	127	0.010615	10.62
Spruce Pine	2175	2	0.000920	0.92	41	0.018851	18.85
Staley	393	0	0.000000	0.00	3	0.007634	7.63
Stallings	13831	1	0.000072	0.07	34	0.002458	2.46
Stanfield	1486	0	0.000000	0.00	0	0.000000	0.00
Stanley	3556	1	0.000281	0.28	5	0.001406	1.41
Stantonsburg	784	0	0.000000	0.00	17	0.021684	21.68
Star	876	0	0.000000	0.00	9	0.010274	10.27
Statesville	24532	18	0.000734	0.73	34	0.001386	1.39
Stedman	1028	0	0.000000	0.00	0	0.000000	0.00
Stem	463	0	0.000000	0.00	0	0.000000	0.00
Stokesdale	5047	1	0.000198	0.20	9	0.001783	1.78
Stoneville	1056	0	0.000000	0.00	12	0.011364	11.36
Stonewall	281	0	0.000000	0.00	0	0.000000	0.00
Stovall	418	0	0.000000	0.00	0	0.000000	0.00

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Sugar Mountain	198	0	0.000000	0.00	1	0.005051	5.05
Summerfield	10232	2	0.000195	0.20	63	0.006157	6.16
Sunset Beach	3572	2	0.000560	0.56	8	0.002240	2.24
Surf City	1853	0	0.000000	0.00	20	0.010793	10.79
Swansboro	2663	1	0.000376	0.38	70	0.026286	26.29
Swepsonville	1154	0	0.000000	0.00	11	0.009532	9.53
Sylva	2588	0	0.000000	0.00	34	0.013138	13.14
Tabor City	2511(r4469)	0	0.000000	0.00	5	#VALUE!	#VALUE!
Tar Heel	117	0	0.000000	0.00	0	0.000000	0.00
Tarboro	11415	2	0.000175	0.18	111	0.009724	9.72
Taylorsville	2098	1	0.000477	0.48	0	0.000000	0.00
Taylortown	722	0	0.000000	0.00	8	0.011080	11.08
Teachey	376	0	0.000000	0.00	8	0.021277	21.28
Thomasville	26757	5	0.000187	0.19	113	0.004223	4.22
Tobaccoville	2441	0	0.000000	0.00	11	0.004506	4.51
Topsail Beach	368	0	0.000000	0.00	16	0.043478	43.48
Trent Woods	4155	0	0.000000	0.00	0	0.000000	0.00
Trenton	287	0	0.000000	0.00	11	0.038328	38.33
Trinity	6614	1	0.000151	0.15	51	0.007711	7.71
Troutman	2383	2	0.000839	0.84	15	0.006295	6.29
Troy	3189	1	0.000314	0.31	35	0.010975	10.98
Tryon	1646	0	0.000000	0.00	31	0.018834	18.83
Turkey	292	0	0.000000	0.00	0	0.000000	0.00
Unionville	5929	3	0.000506	0.51	26	0.004385	4.39
Valdese	4490	0	0.000000	0.00	141	0.031403	31.40
Vanceboro	1005	0	0.000000	0.00	16	0.015920	15.92
Vandemere	254	0	0.000000	0.00	0	0.000000	0.00
Varnamtown	541	0	0.000000	0.00	9	0.016636	16.64
Vass	720	0	0.000000	0.00	0	0.000000	0.00

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Waco	321	0	0.000000	0.00	0	0.000000	0.00
Wade	556	0	0.000000	0.00	0	0.000000	0.00
Wadesboro	5813	4	0.000688	0.69	52	0.008945	8.95
Wagram	840	0	0.000000	0.00	0	0.000000	0.00
Wake Forest	30117	0	0.000000	0.00	73	0.002424	2.42
Walkertown	4675	2	0.000428	0.43	50	0.010695	10.70
Wallace	3880	1	0.000258	0.26	172	0.044330	44.33
Wallburg	3047	0	0.000000	0.00	17	0.005579	5.58
Walnut Cove	1425	0	0.000000	0.00	0	0.000000	0.00
Walnut Creek	835	0	0.000000	0.00	0	0.000000	0.00
Walstonburg	219	0	0.000000	0.00	4	0.018265	18.26
Warrenton	862	0	0.000000	0.00	25	0.029002	29.00
Warsaw	3054	2	0.000655	0.65	38	0.012443	12.44
Washington	9744	5	0.000513	0.51	151	0.015497	15.50
Washington Park	451	0	0.000000	0.00	24	0.053215	53.22
Watha	190	0	0.000000	0.00	0	0.000000	0.00
Waxhaw	9859	2	0.000203	0.20	13	0.001319	1.32
Waynesville	9869	1	0.000101	0.10	56	0.005674	5.67
Weaverville	3120	0	0.000000	0.00	17	0.005449	5.45
Webster	363	0	0.000000	0.00	2	0.005510	5.51
Weddington	9459	2	0.000211	0.21	42	0.004440	4.44
Weldon	1655	3	0.001813	1.81	0	0.000000	0.00
Wendell	5845	1	0.000171	0.17	41	0.007015	7.01
Wentworth	2807	0	0.000000	0.00	0	0.000000	0.00
Wesley Chapel	7463	0	0.000000	0.00	0	0.000000	0.00
West Jefferson	1348	1	0.000742	0.74	9	0.006677	6.68
Whispering Pines	2928	0	0.000000	0.00	6	0.002049	2.05
Whitakers	744	0	0.000000	0.00	15	0.020161	20.16
White Lake	1074	1	0.000931	0.93	4	0.003724	3.72

City/Town	Population 2010	Bike/Ped Crashes 2010	Bike/Ped Crashes per Capita	Crashes per 1,000 people	Total Bike/Ped Commuters	Bike/Ped Commuters per Capita	Bike/Ped Commuters per 1,000
Whiteville	5394	6	0.001112	1.11	37	0.006859	6.86
Whitsett	590	0	0.000000	0.00	4	0.006780	6.78
Wilkesboro	3413	2	0.000586	0.59	37	0.010841	10.84
Williamston	5511	4	0.000726	0.73	61	0.011069	11.07
Wilmington	106476	104	0.000977	0.98	1817	0.017065	17.06
Wilson	49167	29	0.000590	0.59	380	0.007729	7.73
Wilson's Mills	2277	1	0.000439	0.44	7	0.003074	3.07
Windsor	3630	0	0.000000	0.00	43	0.011846	11.85
Winfall	594	0	0.000000	0.00	0	0.000000	0.00
Wingate	3491	0	0.000000	0.00	85	0.024348	24.35
Winston-Salem	229617	51	0.000222	0.22	2464	0.010731	10.73
Winterville	9269	5	0.000539	0.54	53	0.005718	5.72
Winton	769	0	0.000000	0.00	7	0.009103	9.10
Woodfin	6123	1	0.000163	0.16	51	0.008329	8.33
Woodland	809	0	0.000000	0.00	7	0.008653	8.65
Wrightsville Beach	2477	3	0.001211	1.21	77	0.031086	31.09
Yadkinville	2959	3	0.001014	1.01	0	0.000000	0.00
Yanceyville	2039	0	0.000000	0.00	29	0.014223	14.22

9.10 Recommendation Ideas Tables

Pitt County, NC

Overview

The recommendation ideas found in this appendix are a comprehensive collection of input from hundreds of stakeholders, professionals, and citizens of North Carolina. The highest priority action steps are pulled from this table and described within the pillar strategies in the Implementation chapter. This table should be used as a compiled resource, especially for the medium-term and long-term timeframes. The recommendation ideas deserve further study and consideration but are not hardfast. Each recommendation idea would advance North Carolina closer to being the best state for walking and bicycling. This table should be referenced by practitioners, government bodies, and advocacy groups. The table includes key information such as responsible agencies and a reference to the location in this Plan. The table is organized by the five pillars.

In this Chapter

RECOMMENDATION IDEA TABLES

These action step ideas are organized by the five framework goals established for this Plan. Lead agencies and partner agencies are defined for each action step idea. Action step ideas have been established for NCDOT, as well as other state partners, agencies, and advocacy groups.

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
Mo	**Mobility: Improve transportation efficiency and mobility strategically with greater investment in walking and biking infrastructure (through a Complete Streets approach), improved transportation equity and choice, connectivity between transportation modes, and through better coordination between land use and transportation planning.**			
	Mobility: Financing			
M1	Seek innovative funding opportunities such as public-private partnerships, regional projects, multi-agency/multi-objective collaboration.	NCDOT		5
M2	Revisit policies that require local sponsors to cost-share for pedestrian and bicycle improvements that were incidental to roadway projects.	NCDOT		5
M3	Encourage local government funding participation to advance pedestrian/bicycle projects.	NCDOT	Municipalities	
M4	Develop better tracking of pedestrian and bicycle facility costs and revenues (especially for incidental/Complete Streets projects).	NCDOT		5
M5	Document the process by which infrastructure recommendations in local and regional pedestrian and bicycle plans will be incorporated into the funding process at the state level.	NCDOT		5
M6	Revisit scoring models for the Highway Safety Improvement Program to allow for more bicycle and pedestrian project funding.	NCDOT		5
M7	Maximze funds recevied by NCDOT for the MAP-21 Transportation Alternatives Program to be directed toward bicycle and pedestrian projects.	NCDOT		5
M8	Consider ways roadway maintenance programs can more efficiently include bicycle accommodations.	NCDOT		5,8
M9	Consider sidewalk retrofit and shoulder retrofit programs.	NCDOT		5,8
M10	Work with municipalities to develop process of identifying and establishing "shovel-ready" pedestrian and bicycle projects.	NCDOT	Municipalities	5,8

9.10

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
M11	Ensure that planning is conducted at the statewide, regional, and local scales so that a vision and recommendations are articulated. The best way to capitalize on a pedestrian or bicycle plan is to develop engineering documents for priority projects so that good information about land acquisition and cost estimates are available.	NCDOT, Municipalities, MPOs/RPOs		5
M12	Consider changes to policies affecting the inclusion, funding, and preparation for planned pedestrian and bicycle facilities. At the State level, the NCDOT Complete Streets policy will make pedestrian and bicycle projects more affordable as part of roadway projects. Locally, governments can adopt policies for dedication of rights-of-way for future on-road and greenway corridors for pedestrians and bicyclists. In addition, local policies such as Capital Improvement Programs, can set aside dollars to match outside funding sources for pedestrian and bicycle projects.	NCDOT, Municipalities, MPOs/RPOs		5
M13	Compete for state, federal, and other funding sources through open calls and prioritization methodologies. Having preliminary engineering work complete, land acquired, and a local match can make the project more competitive. Projects should serve a strong local transportation purpose but also serve the community or region as a whole by drawing economic development and health benefits.	NCDOT, Municipalities, MPOs/RPOs		5
M14	Maintain pedestrian and bicycle facilities once they are built. This is largely a local government responsibility. Well planned maintenance maximizes the original investment and lessens the time for replacement.	NCDOT, Municipalities		5
	Mobility: Planning			
M15	Update DBPT pedestrian and bicycle planning grant program to address more urban needs such as access to transit, ADA transition, corridor plans, and economic development. Also update the planning program to cover all counties with regional bicycle plans.	NCDOT-DBPT		5

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
M16	Provide consistency between recommendations in pedestrian and bicycle portions of Comprehensive Transportation Plans (CTPs) with locally-adopted pedestrian and bicycle plans.	NCDOT-DBPT	NCDOT - Transportation Planning Branch	5
M17	Align DBPT staffing with nature of planning program.	NCDOT-DBPT		
M18	Work closely with NCDOT division offices during the development of bicycle and pedestrian plans to understand the constructability of projects included in the plans.	NCDOT		5
	Mobility: GIS Data Standardization			
M19	Promote and improve the framework developed for bicycle and pedestrian plan GIS geodatabase development.	NCDOT-DBPT		3,4
M20	Actively work to collect GIS files of bicycle and pedestrian facilities for the NCDOT database.	NCDOT-DBPT	MPOs/ RPOs/local governments	3,4
M21	Once finalized, train Bicycle & Pedestrian Division staff on this framework and direct them to ensure its use during each planning process.	NCDOT-DBPT		3,4
M22	Distribute the framework to municipalities around the state and encourage them to generate and maintain data in this format going forward.	NCDOT-DBPT	MPOs/ RPOs/local governments	3,4
M23	Re-evaluate attributes and nomenclature bi-annually and update to incorporate new facilities as they are developed.	NCDOT-DBPT	MPOs/ RPOs/local governments	3,4
M24	Provide online mapping application for viewing pedestrian and bicycle routes and facilities for officials and public.	NCDOT-DBPT	MPOs/ RPOs/local governments	3

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
	Mobility: GIS Data Transfer and Data Maintenance			
M25	Consider assigning staff resources to manage and maintain the comprehensive pedestrian & bicycle database.	NCDOT-DBPT		3,4
M26	Set up process by which the database is updated regularly.	NCDOT-DBPT	MPOs/ RPOs/local governments	3,4
M27	Communicate the existence and goals of the database with local GIS staff around the state.	NCDOT-DBPT	MPOs/ RPOs/local governments	3,4
M28	Modify existing datasets (from municipal plans, CTPs, and other planning efforts) to match the selected framework, leaving gaps where they exist, and merge into one master database.	NCDOT-DBPT	NCDOT -Transportation Planning Branch	3,4
M29	Make built environment/GIS data available to researchers for economic and health impact analysis.	NCDOT-DBPT	DHHS	3
	Mobility: Statewide Bicycle Routes			
M30	Develop strategic plan for transitioning from existing statewide bicycle route network to expanded network.	NCDOT-DBPT	NCDOT Divisions, MPOs/RPOs	4
M31	Consider developing state "business routes" to complement bicycle routes where they avoid cities.	NCDOT-DBPT	NCDOT Divisions, MPOs/ RPOs, local governments	4
M32	Consider upgrading signage to include wayfinding information and be maintained by each division of NCDOT.	NCDOT-DBPT	NCDOT Divisions	4

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
M33	Promote statewide and regional bicycle routes through online viewers and and smartphone applications.	NCDOT-DBPT		4
M34	Set up an online form for individuals to report missing signs and designate one point person within DBPT to field those reports and communicate them to the appropriate local division.	NCDOT-DBPT	NCDOT Divisions	4
M35	Consider prioritizing roadway improvements along state bicycle routes to provide paved shoulders. Also, state bike routes can be prioritized that provide connectivity between state parks, natural areas, and other North Carolina destinations.	NCDOT-DBPT	NCDOT Divisions	4
	Mobility: Prioritization			
M36	Establish Pedestrian and Bicycle Quality Level of Service prioritization factor, e.g., Q/LOS Model.	NCDOT	ITRE; private consultant	5
M37	Update ped/bike prioritization including the inclusion of social equity/ health prioritization factors.	NCDOT	ITRE; DHHS	5
M38	Create health factor requirements that are appropriately scaled to project or plan size.	NCDOT	ITRE; DHHS; Active Living by Design	5
M39	Prioritize roadway improvements along state bicycle routes (updated in this planning effort) to provide paved shoulder.	NCDOT-DBPT	NCDOT Divisions	4
M40	Create an economic impact prioritization factor when data and analysis is available.	NCDOT	Department of Commerce	5
	Mobility: Design			
M41	Implement Complete Streets policy from planning to construction of all eligible projects.	NCDOT		5
M42	Unify the current policies into a comprehensive, single set going forward.	NCDOT		5
M43	Clarify preferred design policies for bicycle and pedestrian facilities.	NCDOT		5
M44	Consider updating the Roadway Design Manual to contain more design details to support the Complete Streets Design Guidelines.	NCDOT		5

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
M45	Conduct audits of Complete Streets implementation and compliance with Complete Streets.	NCDOT		5
M46	Update greenway design and construction standards in consultation with all affected business units in NCDOT, local government, and NCDENR.	NCDOT	DENR	5
M47	Expand guidance to include a more thorough, detailed list for specific pedestrian and bicycle treatments (utilize Chapter 6 toolbox).	NCDOT		6
M48	Conduct a comprehensive comparative assessment of current policies and identify and correct conflicts and deficiencies.	NCDOT		5
M49	Develop a strategy and timeline for updating all other state design resources to comply with guidance provided in the Complete Streets Design Guidelines.	NCDOT		5
M50	Clarify pedestrian and bicycle needs on bridge structures in urban, rural, and transitioning areas that reflect the lifespan of bridges.	NCDOT		5
M51	Develop and publish new crosswalk marking guidelines consistent with the MUTCD.	NCDOT		5
M2	Consider requiring pedestrian and bicycle (Complete Streets) training and require eduction credits be met every two years.	NCDOT		8
M53	Continue to update the Complete Streets Planning and Design Guidelines to follow statewide and national practices and federal guidelines.	NCDOT		5
M54	Provide clear guidance regarding the inclusion of Complete Streets elements in roadway projects.	NCDOT		5
M55	Consider including official policy statements in areas such as lane widths, liability, and the preference for bike lanes over wide outside lanes.	NCDOT		5
M56	Consider a standard protocol to require a proactive review of lane widths and capacity during new construction, reconstruction and resurfacing projects with the purpose of determining if bike lanes or wider paved shoulders can be implemented as a part of the project.	NCDOT		5

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
M57	Clarify the complete streets appeals process, for example to document who can make appeals, what information is needed, how and to whom it should be submitted, and how appeals will be evaluated.	NCDOT		5
M58	Build and document the relationship between the Complete Streets policy and the Main Streets program.	NCDOT		5
	Mobility: Access to Transit			
M59	Ensure clear/breakaway zone policies allow transit amenities including signage, benches, shelters, bike racks/lockers, bike stations, and other items at transit stops that maintain safety for all roadway users.	NCDOT - Public Transportation Division	DBPT	3,4
M60	Expand access to transit planning program to include focus on high-crash areas, high-volume transit services, and major transit terminals.	NCDOT - Public Transportation Division	DBPT	3,4
M61	Clarify policies with regard to ADA-compliant transit stops to ensure the stop itself is compliant, but also to provide an accessible and safe path of travel to sidewalks and intersections in the vicinity of the stop. Policies should also address the pros and cons of nearside versus far-side transit stops, and provide methods to accommodate necessary pedestrian crossings of wide streets at controlled and uncontrolled locations to access transit stops on the other side of the street.	NCDOT - Public Transportation Division	DBPT	3
M62	Per the recommendations for the RDM (Chapter 6),consider providing detailed design guidance for the placement of benches, shelters, bike parking and bike lockers associated with longer term transit facilities such as park and ride lots.	NCDOT - Public Transportation Division	DBPT	3,4
M63	Ensure bike-on-bus and bike-on-train opportunities are available along with education and ease of use. Encourage Amtark to allow bikes on trains without being boxed (this is a significant barrier to train/bicycle travel between the state's two largest metropolitan areas).	NCDOT - Public Transportation Division	DBPT, regional and local public transportation agencies	4
	Mobility: ADA Transition Plan			
M64	Adopt the U.S. Access Boards Draft PROWAG and incorporate the guidelines into the new RDM (see previous recommendation) and all roadway design projects.	NCDOT		3

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
M65	Consider preparing a Transition Plan for State-Owned Public Right-of-Way in North Carolina, and develop a monitoring program for ongoing self-evaluation (including GIS inventory/evaluation of sidewalks, signals and crossings).	NCDOT		3
M66	Consider conducting staff training on the new PROWAG.	NCDOT		3
M67	Consider updating the Transition Plan described above on a two-year cycle.	NCDOT		3
	Mobility: Roadway Maintenance			
M68	Encourage local government and division/district staff to communicate about upcoming rehabilitation projects, and the importance of setting aside money in capital budgets to help with cost-sharing responsibilities. Establish a regular annual or biannual meeting to discuss upcoming projects.	NCDOT	Local governments	5
M69	Provide early notification to municipalities of maintenance restriping schedules (as this is the best time to incorporate pedestrian and bicycle facilities).	NCDOT	Local governments	5
M70	Develop and promulgate standard maintenance agreements and work with Division Offices to understand how they work and are applied to non-traditional partners.	NCDOT	University - land planning institute	5
M71	Develop setting guidelines for magnetic induction loop detectors that increase the range of sensitivity to cyclist presence.	NCDOT		5
M72	Improve bike lane and paved shoulder sweeping programs as collaborative effort.	NCDOT, local governments		5
M73	Market the NCDOT "Contact Us" and "DOT4YOU" system to improve online form for individuals to report missing signs. Additionally, NCDOT should designate one point person within the Bicycle and Pedestrian Transportation Division to field these reports and communicate them to the appropriate division.	NCDOT-DBPT	NCDOT Divisions	4

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
	Mobility: Legislation			
M74	Evaluate state legislation that deals with minimum passing requirements, lane positioning, and hand signaling; reconsider the contributory negligence law.	NCDOT	NC State Legislature; NCATA	5
	Mobility: Land Use Integration			
M75	Consider adopting a multi-modal transportation efficient land use policy and direction.	NCDOT, Division of Community Assistance	NC State Legislature	5
M76	Consider tools for Municipalities, Counties, and NCDOT including context and transect-based approaches, small area plans, and use of Conservation Planning Tool and Green Growth Toolbox.	NCDOT, Municipalities		5
M77	Encourage local governments to develop current land use plans and development policies in advance of CTP development.		NC State Legislature	5
M78	Research best practices and case studies in the state and surrounding states for coordinated land use and transportation planning and development efforts.	NCDOT	Healthy Environments Collaborative	5
M79	Consider providing incentives to local communities that develop land use and corridor plans with adopted codes that support multi-modal transportation efficient land use.	NCDOT	NC State Legislature	5
M80	Encoourage partnerships between local land use planners, MPOs, and NCDOT to encourage understanding of land use goals such as smart growth and transportation strategies.	NCDOT	NCCOGs	5
M81	Ensure consistency in the understanding of the terminology and definitions for land use and transportation by all stakeholders.	NCDOT	MPOs/ RPOs/local governments	5
M82	Research best practices for including bicycle and pedestrian issues and mitigation options within local Traffic Impact Studies.	NCDOT		5

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
M83	Consider providing on-going support to surrounding communities during planning, design and implementation of the multi-modal transportation efficient land use plans (new transportation planner in each division).	NCDOT		5
Sa	**Safety - Improve safety for all roadway users through strategic, consistent, and connected pedestrian and bicycle facility improvement, education, and enforcement strategies.**			
Sa1	Implement "Complete Streets" approach consistently with all roadway projects to ensure connected, accessible, and safe pedestrian and bicycle network.	NCDOT		3, 4
Sa2	Develop strategy to advertise and educate NCDOT Division staff, MPOs/RPOs, cities, counties, advocates, and law enforcement staff across the state about HSRC crash analysis and data and trends in North Carolina.	NCDOT	HSRC, ITRE	3, 4
Sa3	Work with law enforcement and other agencies to improve the quality and completeness of pedestrian and bicycle crash data.	NCDOT	Law enforcement, Hospitals, HSRC, MPOs/ RPOs, local governments	3, 4
Sa4	Consider establishing Statewide Pedestrian and Bicycle Safety Consortium to develop consistent, thorough recording of crashes.	NCDOT	Law enforcement, Hospitals, HSRC, MPOs/ RPOs, local governments, NCATA	3, 4
Sa5	Evaluate facilities and programs for their capability to improve motorist/pedestrian/bicyclist compliance and safety. Utilize national studies and FHWA crash reduction factors shown in following table to support design solutions for safety improvement (see Chapter 6 - Pedestrian & Bicycle Toolbox).	NCDOT		3, 4

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
Sa6	Evaluate the existing HSIP prioritization and project programming process and adjust as needed to allow for more bicycle and pedestrian project success.	NCDOT	HSRC	3, 4
Sa7	Develop an injury minimization approach for setting speed limits on new roadways and major roadway reconstruction projects.	NCDOT		3, 4
Sa8	Adopt high-priority performance measures described in Chapter 8.	NCDOT		9.11
Sa9	Maintain the Safety & Mobility safety audit team to review roadway improvement plans in high crash locations. Encourage additional study.	NCDOT DBPT, Traffic Safety Unit		3, 4
Sa10	Implement education, encouragement, and enforcement programs as detailed in Chapter 7.	NCDOT	NCATA, advocacy groups, MPOs/RPOs, municipalities	
Sa11	Remain current with research regarding bicycle safety as bicycle planning and design is evolving rapidly in the United States.	NCDOT	HSRC	4
Sa12	Address safety needs of different types/experience levels of bicyclists.	NCDOT		4
Sa13	Consider continuing successful pedestrian/bicycle safety reviews conducted by the Traffic Safety Unit (examples: Fayetteville and the Outer Banks (US 158) in areas of safety concern.	NCDOT DBPT, Traffic Safety Unit		3, 4
Sa14	Engage more stakeholders in a comprehensive approach to improving safety for pedestrians.	NCDOT	ITRE, HEC, law enforcement, hospitals, MPOs/ RPOs, local governments	3, 4
Sa15	Maintain the NCDOT Traffic Safety Unit approach to review high crash locations. This team should be proactive using pedestrian/bicycle crash data regularly.	NCDOT		3

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
Sa16	Incorporate ongoing HSRC crash typing and geocoding efforts into decision-making and prioritization.	NCDOT		3
Sa17	Conduct studies at high pedestrian and bicycle crash locations and coordinate results with the HSIP process to provide pedestrian countermeasures in these locations. The agency should explore the development of a model to estimate pedestrian and bicyclist volumes, with the purpose of developing better prioritization methods that account for crash rates in addition to crash frequency. If possible, the model should be compatible and/or coordinated with analytical models currently used by other state agencies.	NCDOT		3
	Safety: Safe Routes to School			
Sa18	Continue the Safe Routes to School program as part of DBPT following the full obligation of SAFETEA-LU funding.	NCDOT-DBPT		3
Sa19	Continue new public health collaboration with DHHS/Community Transformation Grant in order to reach more communities and schools around the state.	NCDOT-DBPT	DHHS	3
Sa20	Explore ways to simplify and streamline SRTS grant and implementation processes.	NCDOT-DBPT		3
He	**Health - Contribute to public health by providing active living environments with safe, connected, accessible facilities along with programs that encourage walking and bicycling.**			
	Health: Engagement/encouragement of non-traditional groups			
H1	Update NCDOT planning guides and/or checklists during planning processes (e.g. CTPs) to prioritize inclusion of low-income, people of color, older adults, youth, people with disabilities. Seek transportation equity for lower-income communities.	Update NCDOT planning guides and/or checklists during planning		9.4
H2	Reach out to other organizations, including non-profits, to identify appropriate ways to boost resident engagement in transportation planning.	NCDOT	NC Center for Non-Profits	9.4
H3	Convene annual pedestrian summit with broad engagement of non-traditional groups/organizations.	NCATA	Volunteers (municipal planners)	9.4

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
H4	Continue annual bicycle summit and expand broad engagement of non-traditional groups/organizations.	NCATA	Volunteers (municipal planners)	9.4
H5	Establish user on-line system and other networks to educate non-traditional groups about transportation issues.	NCDOT, DHHS	NCATA	9.4
H6	Conduct targeted social media, advertisements, marketing campaigns and/or other promotional efforts to increase active transportation.	NCDOT, DHHS	NCATA	9.4
H7	Work with non-traditional organizations, e.g. El Pueblo, NAACP, NC Alliance of Disability Advocates, to identify the most effective and appropriate messages to encourage increased active transportation among low-income, people of color, youth, older adults, people with disabilities.	NCDOT, DHHS	NCATA	9.4
H8	Develop a focused outreach approach to increase bicycling among women and girls.	NCDOT, DHHS	NCATA	9.4
	Health: Institutionalization of health professionals/advocates into transportation planning processes			
H9	Encourage health professionals to participate in the transportation planning and project scoping projects.	NCDOT		9.4
H10	Provide training and materials to local health directors and boards of health regarding transportation planning.	DHHS		9.4
	Health: Community Leader outreach			
H11	Develop educational materials for local leaders, elected officials and boards/commissions regarding the benefits of active transportation and informational materials on transportation planning and implementation.	NCDOT, DHHS		9.4

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
H12	Work through state councils and organizations to reinforce (to local leaders and officials) the importance of health considerations in local planning, e.g. NC League of Municipalities, NC Association of County Commissioners.	NCDOT		9.4
	Health: Data			
H13	Prepare health data sets and reports that can be used in transportation planning, implementation and performance evaluation.	DHHS, NC State Center for Health Statistics		9.4
H14	Develop prioritiztion criteria that can be easily and objectively rated to indicate transportation projects that are likely to serve low-income, people of color, youth, older adults, and people with disabilities.	NCDOT, DHHS		5, 9.4
H15	Include health/equity criteria in project prioritization.	NCDOT, DHHS		5, 9.4
H16	Adopt high-priority performance measures described in Chapter 8.	NCDOT, DHHS		8
H17	Identify and implement the collection of new indicators for ongoing surveillance, such as children walking to school, active commuters, etc. for measuring performance.	NCDOT, DHHS		9.4
H18	Provide funding, resources and tools for local communities to collect longitudinal data (i.e. measuring the economic and health impacts) before and after pedestrian and bicycling projects are implemented.	NCDOT, DHHS		9.4
	Health: Planning and Programs			
H19	Follow new NCDOT Public Health Policy adopted October 4, 2012.	NCDOT		9.4
H20	Create health factor requirements that are appropriately scaled to project or plan size.	NCDOT	ITRE; DHHS; Active Living by Design	5

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
H21	Create an incentives structure for comprehensive planning that includes health component and improves land use to reduce distances between important destinations.	NCDOT	Local governments, MPOs/RPOs	5, 9.4
H22	Collaborate to incorporate more local school officials into transportation planning efforts.	NCDOT, DPI		9.4
H23	Engage vast network of possible non-profit partners in North Carolina, many of which support healthy living.	NC Center for Non-Profits	NCDOT-DBPT, Healthy Environments Collaborative	
H24	Maintain and establish new education, encouragement, and enforcement programs recommended in Chapter 7.	NCDOT-DBPT	NCATA, advocacy groups, MPOs/RPOs, municipalities, Healthy Environments Collaborative	7
Ec	**Economics: Maximize economic competitiveness and return on investment by creating more attractive walkable and bikable communities through additional NCDOT, public, and private funding.**			
EC1	Promote walking and bicycling as an amenity in North Carolina by featuring such exemplary facilities as the state bicycle route system, East Coast Greenway, Mountains-to-Sea Trail, and the Carolina Thread Trail.	NC Chambers of Commerce, Visitor Bureaus	Local governments, NCDOT-DBPT	
EC2	Enhance VisitNC.com state tourism website and Dept. of Commerce website to include information about quality-of-life measures (such as access to transit, greenways, etc.).	Department of Commerce		
EC3	Adopt high-priority performance measures described in Chapter 8.	Department of Commerce	NCDOT-DBPT	8
EC4	Provide modern, innovative means of sharing information and mapping on regional trails through Internet, smartphone, etc (Good example is Carolina Thread Trail website).	NCDOT-DBPT		

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
EC5	Develop study of real estate values in walkable and bikable communities in North Carolina.	Department of Commerce		
EC6	Track jobs created or related to walking/biking projects and activity.	Department of Commerce		
EC7	Track businesses locating in NC at least partially due to quality of life, walking/biking/trail amenities.	Department of Commerce		
EC8	Track visitors coming to North Carolina at least partially to walk or bicycle.	Department of Commerce		
EC9	Track economic impact of walking and biking events.	Department of Commerce		
EC10	Track retail sales in areas where walking and biking facilities are added.	Department of Commerce		
EC11	Calculate walk/bike scores across NC and make the connection to real estate values, jobs, and tourism.	Department of Commerce		
EC12	Develop additonal walking and bicycling events such as races, fundraisers, etc.	Local governments, Chambers of Commerce	NCATA, advocacy groups	
EC13	Educate developers of the economic benefits of walkability and bikability.	NCDOT-DBPT	NCATA, advocacy groups	
EC14	Maintain database of developers/developments that incorporate walkability and bikability as key features. Highlight those developments on website (like Briar Chapel).	Department of Commerce		
EC15	Develop study of real estate values in walkable and bikable communities in North Carolina.	Department of Commerce		

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
EC16	Maintain and establish new education, encouragement, and enforcement programs recommended in Chapter 7.	NCDOT-DBPT		7
	Economics: Main Street' Program			
EC17	Establish the Main Street Program as a collaboration, involving NCDOT more thoroughly in future projects to address Complete Streets transportation elements of the project.	Department of Commerce	NCDOT-DBPT	3
EC18	The Department of Commerce should continue partnering with state agencies (through interagency collaboration) along with local health departments and walking/biking groups as part of the Main Street Program.	Department of Commerce	Healthy Environments Collaborative	3
EC19	The Department of Commerce should update their design element of the Main Street Program to include language about "Complete Streets."	Department of Commerce		3
EC20	NCDOT should communicate with and provide educational opportunities for Department of Commerce staff regarding Complete Streets and its health and economic benefits.	NCDOT-DBPT	Department of Commerce	3
	Economics: NC STEP Program			
EC21	Incorporate technical workshops and training sessions on integrating bicycle and pedestrian accommodations into a town's transportation network into the training element of STEP.			3
EC22	Incorporate an NCDOT presence in the coaching phase of STEP. This DOT partnership will educate towns about the far-reaching benefits and relatively low costs of bike/ped projects and programs, citing the striking economic benefits noted in other rural regions of North Carolina.			3
EC24	Identify grant opportunities specifically for the planning and implementation of Complete Streets to jump start the revitalization of Main Street.			3

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
En	**Environment: Advance environmental stewardship by reducing automobile dependence and connecting and protecting North Carolina's natural resources through a network of greenways.**			
EN1	Develop GIS database of trails in North Carolina. Formulate and promote the use of a consistent categorization of data for different trail types. Build upon existing efforts and resources, such as the Green Growth Toolbox. Consider housing the data as part of NC One Map, since it is already accessible to various agencies.	DENR, NC Wildlife Resources Commission	NCDOT-DBPT, East Coast Greenway Alliance, Friends of the Mountains to Sea Trail, Federal agencies, local governments, National Geographic	9.6
EN2	Calculate number of miles of existing and proposed greenway/trail facilities in North Carolina. Provide this information on a statewide/regional/subregional level.	DENR	NCDOT-DBPT, DPR, East Coast Greenway Alliance, Friends of the Mountains to Sea Trail	9.6
EN3	Utilize Conservation Planning Tool (CPT) for all comprehensive Transportation Planning Branch efforts.	NCDOT Transportation Planning Branc, NC Wildlife Resources Commission	DENR, DPR, MPOs/ RPOs, local governments	9.6
EN4	Implement land use/transportation integration recommendations in Chapter 5 of this Plan so that communities can better determine where to grow and where to protect (Include updating of zoning, subdivision, and other local ordinances to support strategic land use planning and alternative transportation choices). Build upon NCDOT's Integration Project (Linking Long Range Transportation Planning and Project Development).	MPOs, local governments	NCDOT	5

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
EN5	Develop trail design guidelines based on best practices for use by multiple agencies to include Crime Prevention through Environmental Design (CPTED), guidance for environmentally-sensitive areas, and sustainable trail construction methods and specifications. Collaborate between NCDOT and DENR to ensure one, consistent, yet flexible design guideline package.	NCDOT, DENR	Input from agencies in other states that employ national best practices for trail design guidance	9.6
EN6	Connect people and towns with a pedestrian and bicycle greenway network across the state. Connect to state parks and major destinations (stadiums, fairgrounds, museums, cultural instituitions in North Carolina). Partner with Conservation Trust for NC (24 land trusts in North Carolina) to further develop trail systems through shared goals of connecting to nature, improving health, etc.	NCDOT, DENR	Local governments, Conservation Trust for NC and its 24 land trust	9.6
EN7	Develop a Greenprint for the State of NC, mapping natural and cultural areas and connecting them through a system of trails and economic development opportunities. Build upon existing efforts and resources, such as the Green Growth Toolbox and the NC One Map.	DENR, DPR, NC Wildlife Resources Commission	Conservation Trust for NC and its 24 land trusts,Healthy Environments Collaborative, local governments in capital area, private sector	9.6
EN8	Adopt high-priority performance measures described in Chapter 8 and Appx. 9.11.	NCDOT, DENR		8, 9.11

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
EN9	Track number of people using trails in North Carolina (this action step parallels with this WalkBikeNC's performance measures). Adopt and utilize a consitent counting methodology across agencies and organizations. Utilize DHHS grants and develop a volunteer program to assist with tracking.	DENR	East Coast Greenway Alliance, Friends of the Mountains to Sea Trail, local governments, DHHS, colleges and universities, private sector	9.6
EN10	Work with school system to develop environmental education trails.	Dept. of Education, local school systems	NCDOT, DENR	9.6
EN11	Identify a working group to discuss priority open space and trails projects that will enhance environment and promote public access.	DENR, DHHS	NCDOT, NC Wildlife Resources Commission	9.6
EN12	Build an environmental stewardship benefits of walking and bicycling campaign (similar to Watch for Me NC, but with an environmental/ encouragement focus).	NCDOT	DENR	9.6
EN13	Develop a targeted data base through data sharing that identifies public lands for trails and greenways.	DENR	Conservation Trust for NC and its 24 land trust, DPR, NCDOT	9.6
EN14	Engage a more diverse network of non-traditional partners in North Carolina, many of which support environmental efforts, in a partnership summitt to collaborate on outreach and common goals, including taking action on many of these steps.	NC Center for Non-Profits	NCDOT-DBPT, Healthy Environments Collaborative	9.6

ID	Recommended Action Step Idea	Lead Agency	Agency Partner(s)	Chapter Ref.
	Environment: Regional Greenway Trails			
EN15	Build relationships and establish regular communication with trail advocates such as the East Coast Greenway Alliance, Friends of the Mountains-to-Sea Trail, Carolina Thread Trail, and DENR.	NCDOT-DBPT	DENR, East Coast Greenway Alliance, Friends of the Mountains to Sea Trail	4
EN16	Continue utilizing prioritization criteria for bike/ped projects that are a part of a regional trail or connect to a regional trail.	NCDOT-DBPT		4
EN17	Representative agencies for these regional trails should reach out to state agencies, counties, and municipalities to discuss the goals of the regional trail systems and establish partnerships for future growth and enhancement of these systems.	DENR, Department of Commerce, DHHS, East Coast Greenway Alliance, Friends of the Mountains to Sea Trail	NCDOT-DBPT	4
EN18	Consider optimizing the environmental benefits of greenway design to integrate the greenway into regional green infrastructure and provide more environmental services benefits. DENR, WRC, and local land trusts could assist in this design.	NCDOT	See list of potential stakeholders at left.	4
	Environment: Rail Trails Projects			
EN19	On a local level, involve the extensive list of stakeholders through a technical advisory committee or frequent communication via meetings, newsletters, phone calls, and e-mails, created uniquely to best fit the needs of each community and its respective stakeholders. Stakeholders may include railroad companies (including representatives of real estate, operations, maintenance, and legal departments), utility companies, law enforcement officials, other adjacent landowners, trail user groups, and North Carolina agencies including transportation, health, and parks and recreation.	See list of potential stakeholders at left.	See list of potential stakeholders at left.	4

EN20	Find a political champion who works at a state level to support efforts towards extending the trail network, specifically emphasizing the potential for rail-trail projects in the state. Have this high-level supporter launch an initiative for a connected trail system in the state—setting the tone for interagency cooperation.	High-level supporter	NCDOT-DBPT and NCDOT Rail Division	4
EN21	Formalize a task force of rail-trails stakeholders that play a role at a state-wide level, including members from NCDOT, NC Division of Parks and Recreation, NC DHHS, railroad operators, NC Rails Division and North Carolina Rail-Trails group. This task force should research, monitor, and notify communities of inactive or potential abandonment status of NC rails.	See list of potential stakeholders at left.	See list of potential stakeholders at left.	4
EN22	Host an annual North Carolina Trails Summit that brings together various stakeholders and provides a forum to discuss and define mutual roles and set a direction for creating a connected network of rail-trails in the state.	See list of potential stakeholders in EN18	See list of potential stakeholders in EN18	4
EN23	Create a North Carolina Rail-Trails Guide that establishes best practices in planning and design, based on states with impressive mileage of rail-trails; the guide should also include a description of the necessary processes and roles and responsibilities of stakeholders. This guide will streamline the process of rail acquisition for trail purposes and provide recommendations for next steps. This report can also include a vision for the state's network of trails and goals for rail-trail projects.	See list of potential stakeholders in EN18	See list of potential stakeholders in EN18	4

9.11 Benchmarking & Accountability

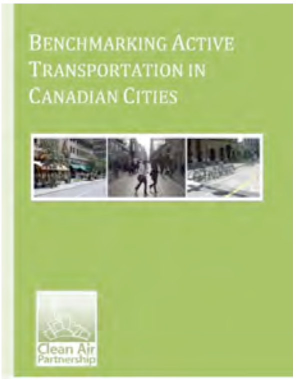
Measuring Progress

The evaluation measures in this appendix reflect best practices of the world's leading walking and bicycling communities. Higher priority performance measures, or metrics, are discussed first and listed in the Implementation chapter. A comprehensive table, inclusive of the high priority metrics, follows with each potential measure listed. An indication is given as to whether the data for such a measure in North Carolina 1) are readily available, 2) require collection and organization of existing information, or 3) require a new data collection program.

This appendix Performance Measures Table should be used as a resource by NCDOT and other agencies and organizations who wish to measure progress related to the goals of this Plan. An annual benchmarking report should be developed by NCDOT-DBPT, using at least the measures that are readily available. Each year, the report could be expanded to include other measures, with the help of other agencies and organizations. The implementation of an annual benchmarking program in North Carolina will be essential in tracking progress towards the goals of *WalkBikeNC* and it will demonstrate the benefits provided to communities throughout the state.

Measuring performance over time will allow the state to measure how it is doing in providing quality pedestrian and bicycle transportation choices. It will also provide a mechanism for making informed decisions and efficient investments. An annual benchmarking report will also be a valuable reference for project planners seeking state, federal or grant funding assistance, helping to build upon previous successes.

Example Walking and Bicycling Annual Benchmarking Reports ▼



In this Chapter

Pedestrian and bicycle metrics for the 21st century

Today, in North Carolina, pedestrians and bicyclists do not have a viable, equivalent quality transportation choice other than the use of the automobile in the current statewide transportation system. A distinct current and accruing need exists for safety, mobility, and infrastructure health across North Carolina in all three geographic tiers. There is a lack of a consistent, connected, accessible, and safe pedestrian and bicycle network across the state, region, and cities of North Carolina making walking and bicycling a difficult choice in transportation for most places across the state. In addition, pedestrians and bicyclists are more limited by distances to key destinations, a factor largely influenced by local land use decisions.

Pedestrians and bicyclists include a wide range of types, ages, capabilities, and skill levels. To effectively deliver pedestrian and bicycle transportation to North Carolinians, NCDOT must consider the range of pedestrians (See Chapter 3) and bicyclists (See Chapter 4). A customer-service approach that addresses the specific needs and requirements of the broad range of pedestrians and bicyclists is necessary for NCDOT to deliver bicycle and pedestrian transportation effectively to North Carolinians.

Each North Carolina transportation customer faces basic decisions for travel to destinations that are influenced by a number of factors. A motorist is not as influenced by distance and presence of roadway facilities because an automobile can move faster and go farther with fewer obstacles to travel, and the roadway network is interconnected and continuous, accessing destinations. A pedestrian or bicyclist is influenced by distance traveled and lack of interconnected facilities due to travel speed, capability of cyclist or pedestrian, and the fact that the network of walkways and bikeways often do not exist in many places throughout North Carolina.

A comprehensive approach that goes beyond facilities is needed to deliver to the pedestrian and bicyclist customers. In addition, as the 2040 Plan recommends, NCDOT will continue pursuing its mission of **"connecting people and places safely and efficiently, with accountability and environmental sensitivity to enhance the economy, health, and well-being of North Carolina."** Adhering to the NCDOT mission statement and delivering quality pedestrian and bicycle accommodations includes both quantitative and qualitative metrics:

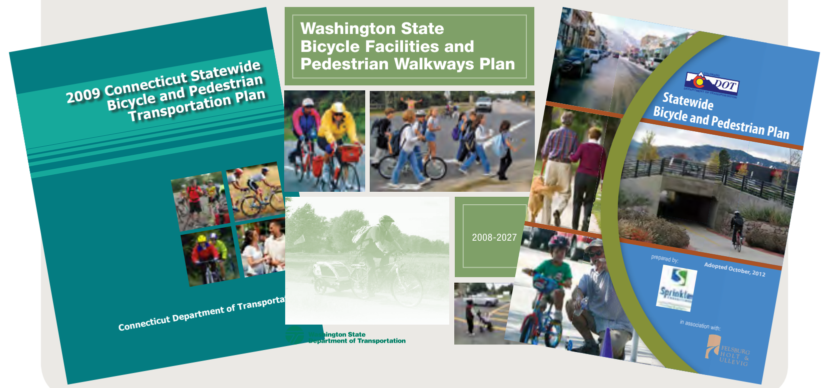
- A connected network of pedestrian and bicycle facilities, that includes crossing roadways and other landscape features
- Implementation of Complete Streets policy with a comprehensive design toolbox for each unique project needs and requirements
- Implementation of regional and local pedestrian and bicycle plans
- Land use-transportation integration
- Projects that improve safety, health of citizens, statewide economy
- Education, encouragement, and enforcement programs

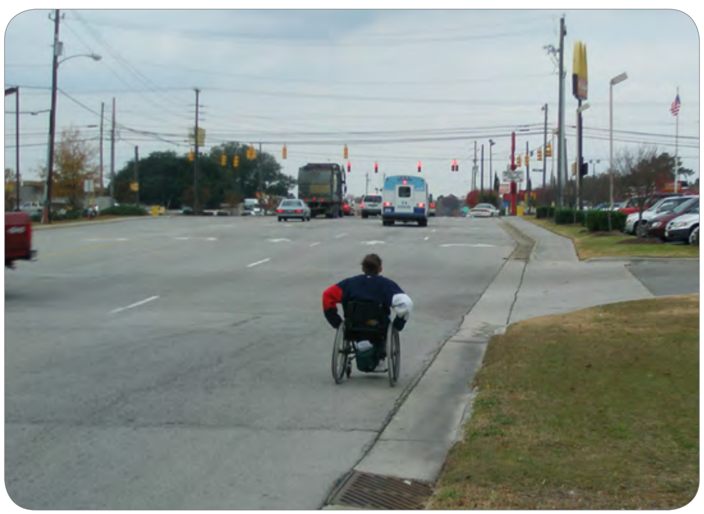
To determine if pedestrian and bicyclist needs are being met, a more comprehensive approach to metrics and performance measures is needed to build upon current LOS measurements. This approach should address the above necessities in both a system-wide (statewide/regional) level and project-specific (local) level. In many cases, this will be possible with additional data collection.

The following performance metric guides were developed utilizing precedent guidance from other states. The first two tables represent higher priority performance measures and are organized by the NCDOT Accountability Framework. The final toolbox is meant to be an exhaustive, comprehensive list of performance measures to be considered for use in the long-term.

Best Practices in Performance Metrics

States have established basic performance measures to be accountable to their customers. These measures are data-driven and have required states to allocate additional resources towards data collection. These best practices and new measures were combined to derive the pedestrian and bicycle metrics for North Carolina.





▲ Pedestrian forced to use roadway where sidewalk gap exists in Jacksonville, NC.

▲ Pedestrian crossing a roadway with poor curb ramps, no marked crosswalk, and no pedestrian signalization in Burlington, NC.

System-wide Performance Categories and Measures (Statewide/Regional Tier)

Performance Category	Performance Measure	Data	States
MOBILITY			
Mobility: Usage/health	Pedestrian and bicycle commute mode share	Readily available (already used)	LA, TN, OR, WA, MT, CO
Mobility: Usage/health	Percentage of trips made by bicycling and walking	Requires new collection	VT, MN, CO, WA
Mobility: Facilities	Percentage of state-owned, non-controlled access roadway mileage that have sidewalks	Requires new collection and organization	OR, WA, VT, AL
Mobility: Planning/ Policy	Number of regions/MPOs/RPOs/Counties/ Municipalities with bicycle/pedestrian/ greenway plans	Readily available (already used)	WA, TN, AL, CT, AZ
Mobility: Planning/ Policy	Number of regions/MPOs/RPOs/Counties/ Municipalities implementing local bike/ped policies	Requires further data collection and organization	CO, CT
Mobility: Planning/ Policy	Number of counties/cities implementing local bike/ped policies	Requires further data collection and organization	AZ
Mobility: Planning/ Policy	Compliance with Complete Streets Policy (NCDOT staff)	Requires data collection	WA (qualitative)
Mobility: Planning/ Policy	Percentage of eligible roadway projects built as Complete Streets	Requires data collection	----
Mobility: Planning/ Policy	Customer pedestrian and bicycle counts	Requires data collection	IN
Mobility: Facilities	Percentage of transit, rail, and ferry hubs with complete access amenities for bike/ped	Requires data collection	PA (goal)
Mobility: Facilities	Percentage of state-owned, non-controlled access roadway mileage that have designated and/or separated bicycle facilities (paved shoulders, bike lanes, cycle tracks)	Requires data collection and organization (already used but requires additional collection)	TN (% paved shoulder), OR, WA, AL
Mobility: Facilities	Percentage of signalized intersections with pedestrian crossing signals on state-owned roadways (within municipalities)	Requires data collection and organization	AZ (desired not obtained)
HEALTH			
Mobility: Usage/health	Physical inactivity rates/obesity rates	Readily available (already used)	IN, VT, MN, CO
Mobility: Usage/health	Percent of existing facilities brought into compliance with ADA requirements	Requires data collection	PA

Performance Category	Performance Measure	Data	States
SAFETY			
Safety	Pedestrian and bicyclist crash and fatality rates (per capita)	Readily available (already used but requires better collection)	TN, WA, VT, CO, AZ
Safety	Pedestrian and bicyclist crash and fatality rates (per capita) relative to other states	Readily available (already used but requires better collection)	TN, WA, CO, NV
Safety: Education and encouragement programs	Number of schools participating in pedestrian and bicycle safety education/encouragement events (Example: Safe Routes to School)	Requires new collection	LA (# of SRTS projects), WA, VT, CO
Safety: Education and encouragement programs	Increase in walking and bicycling to schools	Requires new collection	VT, CO
Safety: Education and encouragement programs	Cities, businesses, and universities designed as Bicycle and Walk Friendly by League of American Bicyclists and the Highway Safety Research Center	Readily available	CO (count, not list)
ECONOMIC GROWTH			
Economy	Return-on-investment measure (small business development, tourism, property values, individuals)	Requires new data collection program	IN, CO, NV, CT
ENVIRONMENT			
Environment	Percentage of planning and design efforts that utilize Conservation Planning Tool and the Green Growth Toolbox	Requires data collection	----
Environment	Reduction in transportation-related emissions due to increase in walking/bicycling trips	Requires data collection	WA, CO, CT
Mobility: Facilities	Miles of shared-use paths	Requires data collection	MA, IN, VT, AL, NV
ACCOUNTABILITY			
Mobility: Planning/ Policy	Percentage of customers satisfied with pedestrian and bicycle transportation	Requires data collection	OR (cite old sources), WA, IN, CO, NV

Project-specific Performance Categories and Measures (Sub-Regional/Local Tier)

Performance Category	Performance Measure	WalkBikeNC Plan Pillars/ Goals	Data	NCDOT Accountability Framework
Mobility: Usage/health	Quality of improvement, measured by pedestrian or bicycle LOS	Mo He En	Requires new collection	Moving People and Goods
Mobility: Usage/health	Percentage of trips made by bicycling and walking on project corridor	Mo He En	Requires new collection	Moving People and Goods
Mobility: Usage/health	Physical inactivity rates and obesity rates in county/city/locale	He	Readily available	Healthy Communities
Safety	Project would result in safety improvement as quantified by FHWA Crash Reduction Factors	Sa	Readily available	Healthy Communities
Mobility: Facilities	Project connects to an existing pedestrian and bicycle facility	Mo Sa	Requires data collection	Connectivity
Mobility: Facilities	Project located along or parallel to congested roadway	Mo Sa En	Readily available	Choices
Mobility: Facilities	Provides direct connection to transit service	Mo Sa He	Requires data collection	Connectivity
Mobility: Facilities	Project is multi-use path near larger populations	Mo En	Requires data collection	Connectivity
Mobility/Safety: Planning/Policy	Counties/cities implementing local bike/ped policies	Mo Sa He Ec En	Requires further data collection and organization	Connectivity
Mobility/Safety: Planning/Policy	Compliance with Complete Streets Policy (NCDOT staff)	Mo Sa He Ec En	Requires data collection	Choices
Safety: Education and encouragement programs	Local schools participating in pedestrian and bicycle safety education/encouragement events (Example: Safe Routes to School)	Mo Sa	Requires data collection	Healthy Communities
Safety: Education and encouragement programs	Increase in walking and bicycling to local school	Mo He En	Requires data collection	Healthy Communities
Mobility/Safety: Training	Total number of NCDOT staff and local officials participating in education/training/ enforcement for project	Mo Sa	Requires data collection	Organizational Responsibility
Economy	Project located in Downtown, "Main Street" area, and/or promotes tourism	Ec	Requires data collection	Prosperity
Environment	Project results in local emission reduction	En	Requires data collection	Resource Protection
Environment	Project connects to trail or park	En	Readily available	Resource Protection
Mobility: Planning/Policy	Customer pedestrian and bicycle counts	Mo	Requires data collection	Accountability

Case Study: National Bicycle and Pedestrian Documentation Project (www.bikepeddocumentation.org)

One of the greatest challenges facing the bicycle and pedestrian field is the lack of documentation on usage and demand. Without accurate and consistent demand and usage figures, it is difficult to measure the positive benefits of investments in these modes, especially when compared to the other transportation modes such as the private automobile. An answer to this need for data is the National Bicycle & Pedestrian Documentation Project, co-sponsored by Alta Planning and Design and the Institute of Transportation Engineers (ITE) Pedestrian and Bicycle Council. This nationwide effort provides a consistent model of data collection and ongoing data for use by planners, governments, and bicycle and pedestrian professionals.

Methodology: The basic assumptions of the methodology are that, in order to estimate existing and future bicycle and pedestrian demand and activity, agencies nationwide need to start conducting counts and surveys in a consistent manner similar to those being used by ITE and other groups for motor vehicles.

Program Forms and Materials Available Online:

1. Count and Survey Forms:
    - Data Collection Instructions
    - Forms
    - Data Entry Spreadsheet
2. Training materials for count/survey program administrators:
    - Counts Training Presentation
    - Surveys Training Presentation
3. Training materials for count/survey volunteers
    - Volunteer Training Presentation - Counts
    - Volunteer Training Presentation - Surveys

Comprehensive Performance Measures Toolbox

WalkBike NC Plan Pillars	Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organiz-ing existing information	May require new data collection program
Mobility	Output				
✦	Number of Cities/MPOs/RPOs/ Counties with existing, and new or updated bike/ped/greenway plans (Plan Inventory)	Increase in number of cities/MPOs/ RPOs/Counties with existing, and new or updated bike/ped/greenway plans			
✦	Percentage of non-controlled access roadway mileage that has planned and designated on-road bicycle facilities by facility type (bike lanes, shared-lane markings, etc.) (GIS Inventory)	Increase in percentage of roadway mileage with bicycle facilities by type statewide			
✦	Percentage of non-controlled access roadway mileage that have planned and built sidewalks (GIS Inventory)	Increase in percentage of roadway mileage with sidewalk			
✦	Percentage of signalized intersections with warranted pedestrian crossing signals (within municipalities) (GIS Inventory)	Increase in percentage of pedestrian signals			
✦	Number of Cities/MPOs/RPOs/ Counties with local bike/ped policies (see online survey results from the WalkBikeNC survey for municipalities) (Inventory of policies)	Increased or enhanced legislation for walking and bicycling			
✦	Number of transit stops and terminals with appropriate bicycle and pedestrian accommodations (GIS Inventory)	Increased transit stops and terminals with access facilities for bike/ped			

✦ *Indicates higher priority performance measure/metric to be utilized by NCDOT and its partner agencies.*

WalkBike NC Plan Pillars	Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	May require new data collection program
	Number of new laws that improve walking and bicycling (ex. three-foot passing rule, vulnerable roadway user act, etc.)	Passage of new laws improving bicycle and pedestrian conditions			
	Miles of signed and designated bicycle routes (GIS Inventory)	Increase in mileage of signed and designated bicycle routes			
	Miles of mapped NCDOT statewide and regional bicycle routes (GIS Inventory)	Increase in mileage of NCDOT regional and statewide signed and designated bicycle routes			
	Number of bike share systems, number of bikes/kiosks	Increase in number of bike share systems and number of bikes/kiosks			
	Number and percent of buses/ trains with bike racks	Increase in number and percent of buses/trains with bike racks			
	Miles of paved shoulders planned and built on non-controlled access state-owned roads	Increase in miles of paved shoulders on non-controlled access state-owned roadways			
	Number of bike racks (existing/ installed, off-street/on-street corrals, secure parking areas/bike stations, bike racks at transit)	Increase in number of local ordinances requiring bicycle parking or local initiatives installing racks			

WalkBike NC Plan Pillars	Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	May require new data collection program
Mobility	Outcome				
✦	Percentage combined pedestrian and bicycle commute mode share (from ACS)	Increase in pedestrian and bicycle mode share by type of trip (e.g., commuter, shopping, school, etc.)			
✦	Percentage of AADT represented by bicyclists and pedestrians (NC Bicycle/Pedestrian Counts Survey)	Increase in percentage of trips made by bicycling and walking			
✦	Cities, businesses and universities designated as Bicycle Friendly (LAB Bicycle Friendly Program)	Increase in cities, businesses and universities designated as Bicycle Friendly			
	Percent of customers walking or cycling to mass (high volume) passenger rail or transit services	Increase in number of bike/transit trips taken on buses/trains			
Safety	Output				
✦	Number of schools participating in pedestrian or bicycle safety education programs or events. (e.g., Safe Routes to School, Bike Smart, etc.) (International Walk/ Bike to School Day Database)	Increase in the number of schools participating			
	Number of communities participating in the "Watch for Me NC" safety campaign	Increase in number of communities participating in the "Watch for Me NC" safety campaign			
	Percent of students walking and cycling to NC schools (Database)	Increase in percent of students walking or bicycling to school			
	Number of striped crosswalks/ RRFBs/audible pedestrian signals/ other crossing treatments installed at warranted crossings (GIS Inventory)	Increase in number of crossing improvements installed			

9.11

✦ Indicates higher priority performance measure/metric to be utilized by NCDOT and its partner agencies.

WalkBike NC Plan Pillars	Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	May require new data collection program
Safety	Outcome				
✦	Per capita pedestrian and bicycle crash and fatality rates (police-reported pedestrian and bicycle crashes per unit) (PBCAT Database)	Reduction in number of crash and fatality rates			
	Number of enforcement events targeting unsafe driving, cycling and pedestrian behaviors (NCDOT Watch for Me Project Database)	Increased public awareness and compliance			
Health	Output				
	Number of physical activity education and encouragement programs focused on walking and bicycling, and number of participants	Increase in number of programs and participants			
Health	Outcome				
✦	Physical inactivity rates (BRFSS)	Reduction in rates			
✦	Obesity and diabetes rates (BRFSS)	Reduction in rates			
	Percent of asthma case rates per capita	Reduction in rates			
	Number of emergency room visits from bicycle and pedestrian crashes	Reduction in bicycle and pedestrian-related emergency room visits			
	Percentage of North Carolinians reporting walking and bicycling as form of exercise (BRFSS)	Increase in rates			
	Private bicycle ownership (% of households)	Increase percentage of ownership			

✦ *Indicates higher priority performance measure/metric to be utilized by NCDOT and its partner agencies.*

WalkBike NC Plan Pillars	Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	May require new data collection program
Economy	Output				
	Number of chambers of commerce in NC promoting walking and bicycling	Increase in number promoting			
	Number of visitors bureaus in NC promoting walking and bicycling	Increase in number promoting			
	Number of participants in major (over 100 participants) walking or bicycling events in NC	Increase in number of participants			
	Number of developers in NC promoting walkability and bikability as key features in their developments (based on home builder and realtor surveys)	Increase in number promoting			
	Number of homes and businesses located within 1/2 mile of large-scale bicycle/pedestrian corridors	Increase in new development along existing bicycle/pedestrian trails			
Economy	Outcome				
✦	Comprehensive return-on-investment measure (small business development, tourism, home prices, individuals)	Increase in return-on-investment			

✦ Indicates higher priority performance measure/metric to be utilized by NCDOT and its partner agencies.

WalkBike NC Plan Pillars	Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	May require new data collection program
	Number of articles and state rankings listing NC with regards to outdoor recreation, physical activity, quality of life or bicycle and pedestrian amenities	Increase participation by private sector in funding bicycle and pedestrian improvements			
✦	Number of pedestrians and cyclists shopping in commercial centers (NC Bicycle and Pedestrian Counts Survey)	Increased number of pedestrian and bicycle customers			
	Number of jobs directly attributed to bicycle and pedestrian project planning, construction, maintenance and programming	Increase in number of jobs attributed to bicycle and pedestrian project planning, construction, maintenance and programming			
	Percentage of visitors citing bicycling or walking as a primary activity during trip (NC Commerce - Tourism Division)	Increased percentage of visitors citing bicycling or walking as a primary activity during trip			
	Dollars invested by businesses and private organizations toward bicycle and pedestrian projects and services	Increase participation by private sector in funding bicycle and pedestrian improvements			
	Walk/bike scores	Increase in scores			
	Market value of real estate development near major new bike/ped facilities (greenways, cycle tracks etc.)	Increase in values			
Environment	Output				
✦	Miles of shared-use paths and greenways (GIS Inventory)	Increase in total miles			
✦	Percentage of planning and design efforts using Conservation Planning Tool (CPT)	Increase in percentage			

✦ Indicates higher priority performance measure/metric to be utilized by NCDOT and its partner agencies.

WalkBike NC Plan Pillars	Performance Measure	Indication of Progress Towards Desired Change or Outcome	Readily available	Requires collecting/ organizing existing information	May require new data collection program
	Number of planned miles of trails within State Parks, National Parks and National Forests (GIS Inventory)	Increase in total miles			
	Number of planned miles complete for the East Coast Greenway (GIS Inventory)	Increase in total miles			
	Number of planned miles complete for the Mountains-to-Sea State Trail (GIS Inventory)	Increase in total miles			
	Number of planned miles complete for the Carolina Thread Trail (GIS Inventory)	Increase in total miles			
	Measure of connectivity between park assets	Increase in connectivity ratio			
Environment	Outcome				
	Number of people using trails in local, state and federal parks and public properties	Increase in number of users			

✦ *Indicates higher priority performance measure/metric to be utilized by NCDOT and its partner agencies.*