A photograph of a forest at night, illuminated by numerous glowing yellow fireflies or lights. The trees are dark, and the overall scene is a mix of deep blue and green tones with bright yellow highlights. The text is overlaid on the lower-left portion of the image.

Appendix B

Natural Resources

Natural resources are all around us, even in the urban core. The air we breathe, the water we drink, the food we eat, and the places we play outside are all resource-driven. Natural resources provide clean air, water, food, habitat, opportunities for recreation and tourism, and help mitigate extreme weather events. Planning for the conservation and preservation of our natural resources is critical to Columbia’s future.

Cover photo by Brett Flashnick, courtesy of Experience Columbia SC

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Anticipating Change	B-62
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TOPICS

Access to Natural Areas,
Ecosystem Services, Conservation,
Preservation, Adaptation,
Mitigation, Clean Energy, Climate
Change, Resiliency

Introduction

Natural resources are all around us, even in the urban core. The air we breathe, the water we drink, the food we eat, and the places we play outside are all resource-driven. They provide clean air, water, food, habitat, opportunities for recreation and tourism, and help mitigate extreme weather events.

In considering natural resources, we tend to think of resources individually instead of as part of a system. The interaction between resources and their functions makes up the natural environment. Ecological functions are defined in terms of ecosystem services - for example, trees provide clean air, water, and shade. However, the value of those services to people is difficult to fully quantify. Recent studies have focused on the economic impact of natural resource-based sectors¹, such as forestry or outdoor recreation, however it is much more difficult to quantify the value of ecological functions. For example, according to the U.S. Forest Service, “every dollar spent on planting and caring for a community tree yields benefits that are two to five times that investment – benefits that include cleaner air, lower energy costs, improved water quality and stormwater control, and increased property values.”² We often forget about the valuable ecological functions our natural resources provide, and as a result tend to overlook this value when examining the costs and benefits of land use and other decisions.



Data & Maps

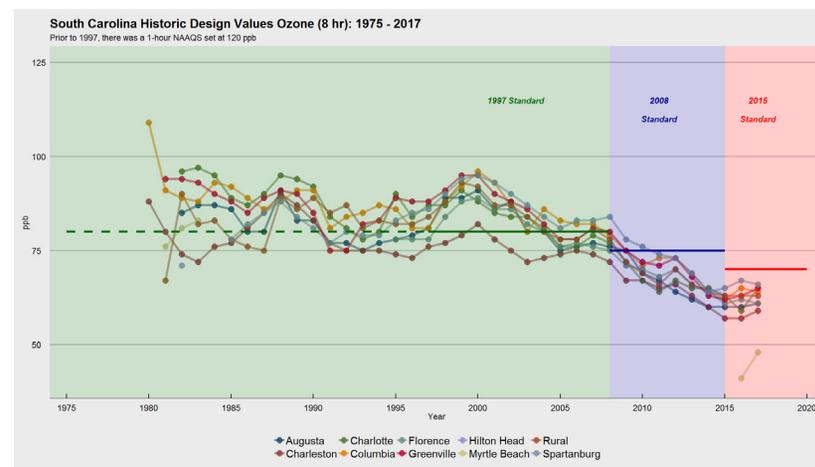
AIR QUALITY

The Clean Air Act was adopted in 1970, resulting in regulatory standards for stationary (industrial/smokestack) emitters and mobile (vehicular) emitters. As a result of the standards implemented by the Clean Air Act, industrial emissions, vehicle emissions, and fuels have become much cleaner³, leading to an overall trend of air quality improvement even as the number of passenger vehicles on the road continues to increase. Emissions standards have continued to strengthen in the years since the Act's adoption, resulting in an overall trend towards improvements in air quality both regionally and nationally. While at one time the City of Columbia's air quality did not meet the US Environmental Protection Agency's (USEPA) air quality standards (and was designated as in non-attainment), the City's air quality is currently within the standards.

The South Carolina Department of Health and Environmental Control (DHEC) monitors air quality throughout the State for compliance with the Clean Air Act. With the aforementioned reduction in smokestack emissions, air quality monitoring in the Midlands currently measures only ozone and particulate matter levels to monitor attainment. Elevated ozone levels, which tend to occur on hot sunny days, can result in a number of health problems. According to the USEPA, "ozone is a powerful oxidant that can irritate the airways."⁴ People with asthma, children, older adults, and those who work or recreate outdoors are at greatest risk for health complications due to elevated ozone exposure.

The figure to the right shows the design values (determined by the annual fourth-highest daily maximum 8-hour ozone concentration, averaged over three years) for cities throughout the State, contrasted

with the National Ambient Air Quality Standard (NAAQS) for ozone in place at the time. The chart helps to depict a nationwide trend in emissions. While emission levels show an overall downward trend, this may be tied to the linkage between human behavior and the state of the economy. During economic booms emissions tend to increase, as construction, production, vehicle miles traveled, and other sources of emissions rise. Likewise, during economic downturns, more fiscally conservative behaviors result in decreased emission-generating activities.

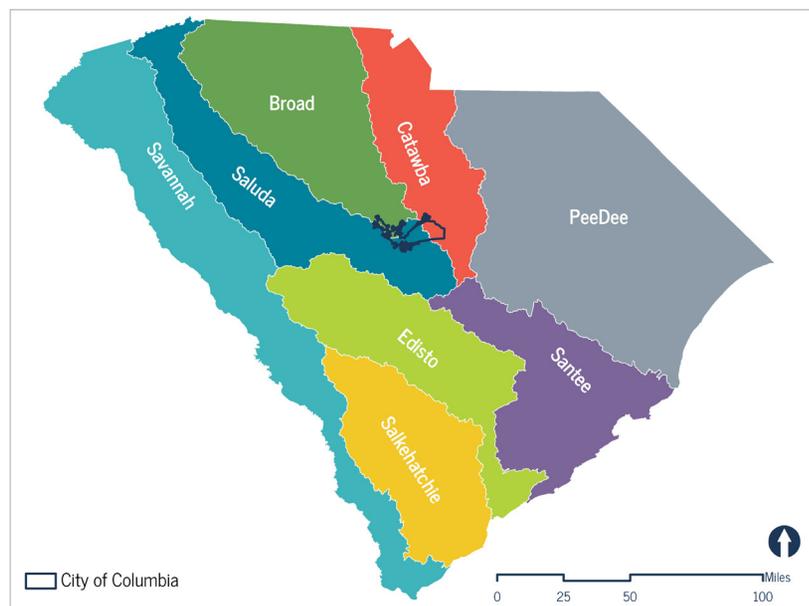


Ozone Values Over Time, Courtesy of SCDHEC, Bureau of Air Quality⁵

Data & Maps

WATERSHEDS

Located east of the Eastern Continental Divide, the water in South Carolina's rivers and streams flows towards the Atlantic Ocean by way of eight major river basins. The City of Columbia falls within six different regional watersheds and 16 different subwatersheds. These watersheds are determined by topography and natural formations, and do not adhere to municipal boundaries. Changes within these watersheds, whether they are increases in development and impervious cover, the removal of vegetative cover, or shifts in the types of land uses, can readily impact downstream areas.



Map depicting the eight major river basins in South Carolina, with the City of Columbia shown in dark blue.⁷

Watershed-level plans for water quality and protection have been developed for the following regional watersheds:

- 25-Mile Creek (SCDHEC, 2013)
- Crane Creek (Richland County, 2010)
- Gills Creek (Richland County, 2009)
- Smith Branch (City of Columbia, 2016)
- Rocky Branch (City of Columbia, 2016; in the process of being updated⁶)
- Congaree Creek (Lexington Countywide Stormwater Consortium, 2015)

The Gills Creek Middle Watershed also underwent a master planning process sponsored by the Gills Creek Watershed Association, which was completed in 2013.

Data & Maps

WATER QUALITY

Water quality issues in the Midlands have received more attention from the public and stakeholders than air quality concerns, perhaps due to both their prevalence and their visibility. Regionally, our rivers and streams suffer from a variety of sources of pollution, from nonpoint sources (runoff) to point sources (piped discharges). Pollutants from bacteria to industrial waste such as coal tar continue to affect the vitality of our regional waterways, with impacts to drinking water, recreation, and plant and animal life. Water quality issues are addressed locally by governmental and non-governmental entities, and though strides have been made, water quality issues continue to affect our local waterways.

As a provider of municipal water, stormwater management, and wastewater treatment, the City of Columbia is intricately involved in water quality issues throughout our regional watersheds. The City of Columbia is currently taking part in a number of projects which use federal grant funding⁹ to improve water quality by addressing nonpoint source pollution - the Hyatt Park Revitalization (lead organization: City of Columbia Parks & Recreation), the Earlewood Park Stream Restoration (lead organization: City of Columbia), and the Gills Creek Stream and Riparian Buffer Restoration (lead organization: Gills Creek Watershed Association). The City's stormwater program is also targeting nonpoint source pollution through watershed planning and stormwater infrastructure improvements, recently funded through the City's first "green bond" initiative. Columbia Water continues outreach to help citizens understand how they can be a part of the water quality solution, through campaigns such as "Trash the Poop" and the rain barrel program. The City is addressing point source pollution concerns through the Clean Water 2020 Program,

which is a formal response to the regulations of the Clean Water Act as they relate to the City's aging wastewater system and sanitary sewer overflows (SSOs).

Due to the shape of watersheds, water quality issues are most successfully addressed regionally. Much of the point source pollution in the Midlands is coming from outside of the City of Columbia – especially as we've seen increased development throughout the Midlands. The Congaree Riverkeeper, and regional watershed organizations continue to work to address regional point source and nonpoint source water quality issues in rivers and streams throughout the Midlands. These organizations educate the public, monitor water quality, and partner with local and state agencies to improve water quality through the reduction of both point source (discharge) and nonpoint source (runoff) pollution. Regional coalitions have also formed, including both governmental and nongovernmental agencies, to address water quality concerns.

At the State level, SCDHEC works to assure water quality compliance with the Clean Water Act, and administers the State's water quality program which includes 303(d) listings and the Total Maximum Daily Load (TMDL) program, along with a number of water quality improvement activities and grants (such as the federal grants to address water quality discussed prior). The 303(d) inventory list identifies fully supporting, impaired, and threatened waters as defined by the Clean Water Act. This list is updated every two years (submitted in the springtime of even-numbered years), through an approval process with EPA. The current¹⁰ draft 303(d) inventory is under review and comment, and may be modified as a result of

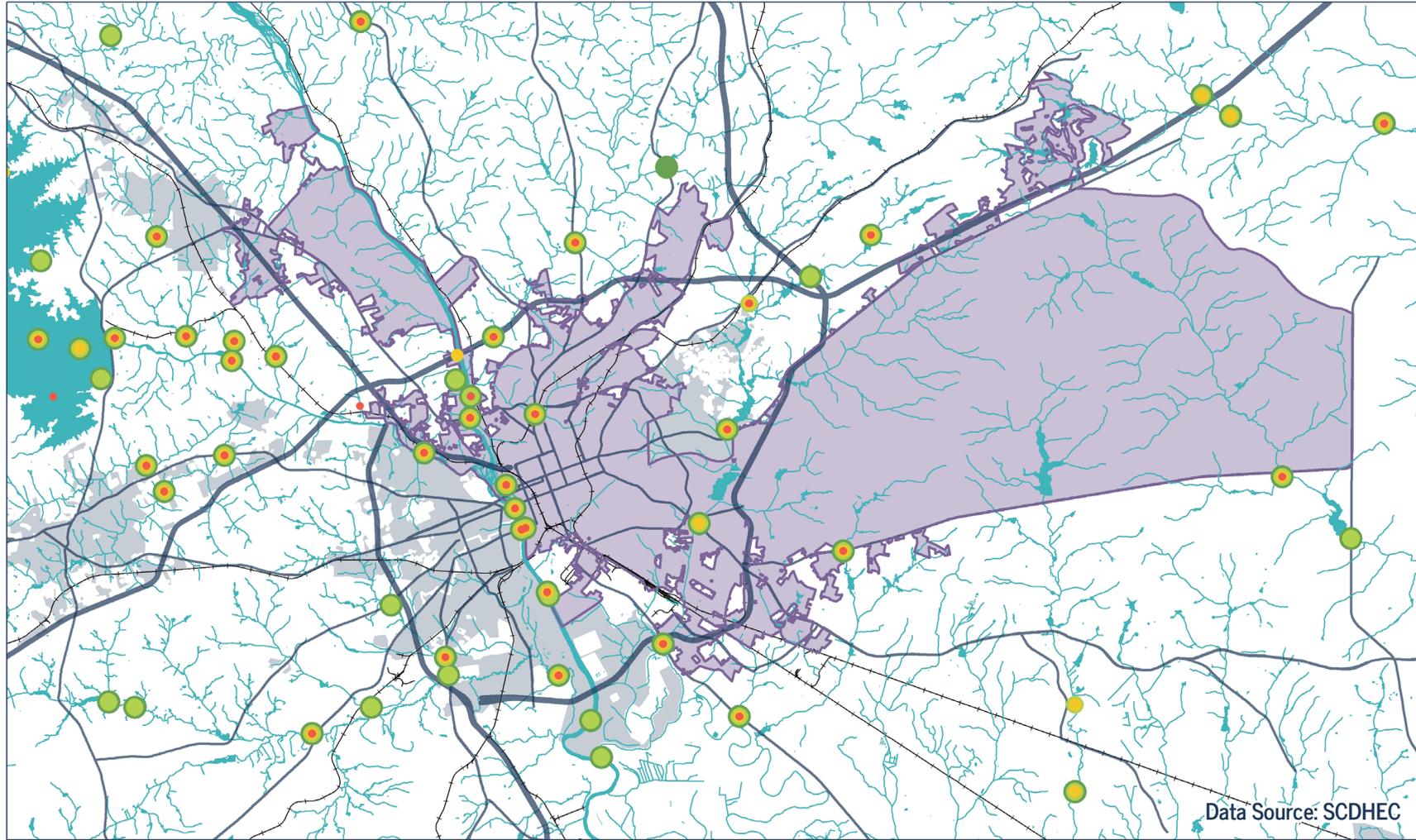
Data & Maps

WATER QUALITY, CONTINUED

the review process. The TMDL program prioritizes waters for water quality improvements which are identified as impaired on the 303(d) list, and identifies all point source and nonpoint source pollutants within a watershed. The program incorporates a watershed-based planning approach in order to identify a plan to remedy the cause(s) of impairment. Once a TMDL has been developed for an impaired water and approved by the EPA, the waterway is removed from the 303(d) list, but the waterway is still monitored until the waterway is fully restored through the prescribed plan actions.

The map on the next page utilizes SCDHEC Bureau of Water Quality data¹¹ to illustrate the monitoring points for 303(d) listed impaired waters in the Midlands Region. As noted above, once a TMDL has been developed and approved by the EPA, the waterway is removed from the 303(d) list.

Impaired Waters



Water Quality Assessments

Impaired Waters - 303(d)

- 303(d) 2016
- 303(d) 2014
- 303(d) 2012
- 303(d) 2010

- Streams & Watercourses
- Waterbodies
- City of Columbia
- Other Municipalities
- Railroad
- Interstates
- US & SC Highways



Data Source: SCDHEC

The above map shows water quality assessments of impaired waters over time, as collected at water quality monitoring locations.¹²

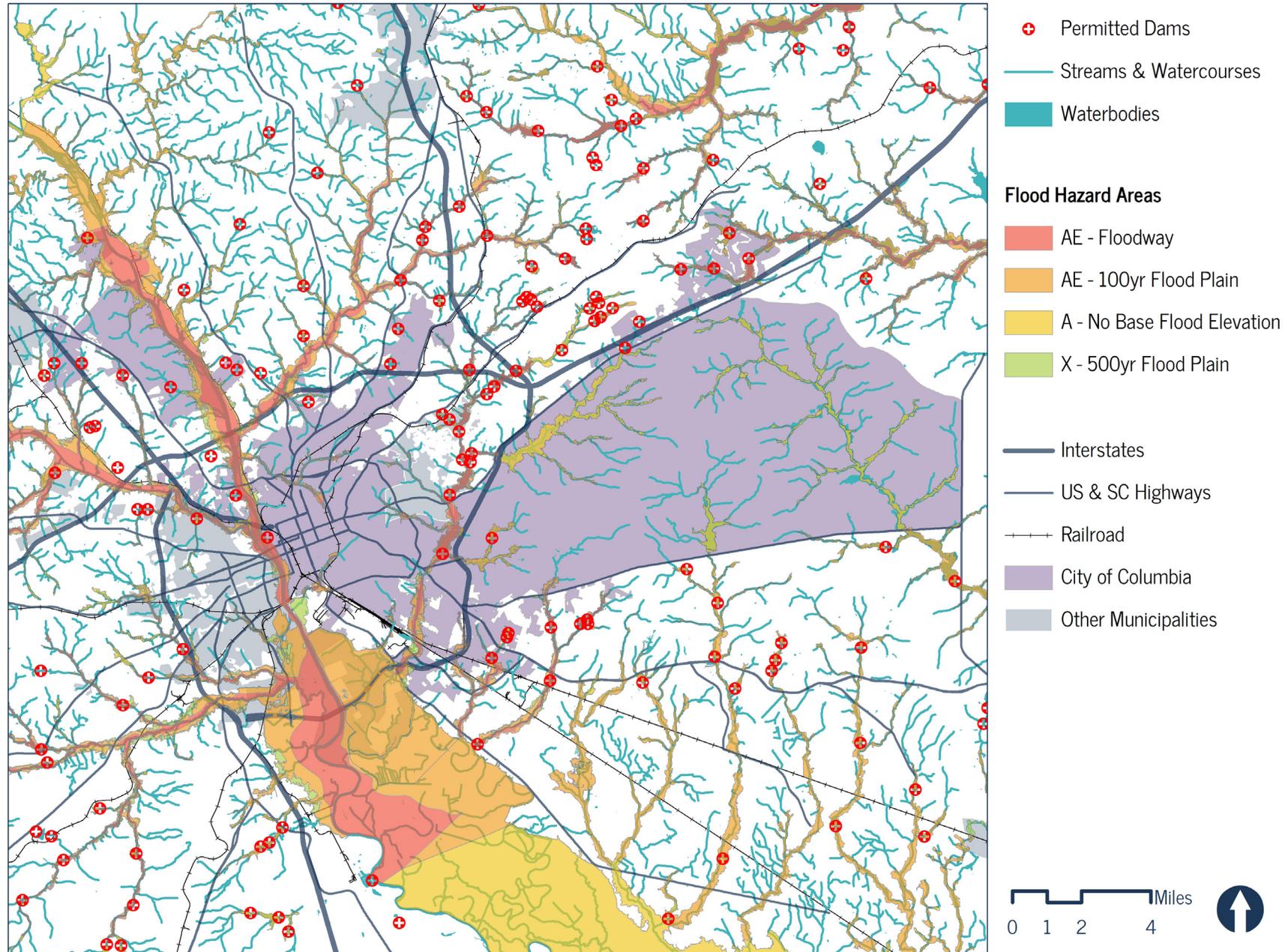
Data & Maps

FLOOD HAZARD AREAS

Located at the confluence of two major riverways, Columbia floods somewhat regularly, and many of our riparian corridors have remained in a natural state over the years due in part to these anticipated flood events. Flood hazards are dynamic and can change frequently due to a variety of factors, including weather patterns, erosion, and new development. The Federal Emergency Management Agency (FEMA) works to mitigate the effects of flooding through mapping flood hazards through the Flood Insurance Rate Map (FIRM) program, working with local governments to address flooding issues, underwriting the National Flood Insurance Program (NFIP), and providing grant funding for mitigation efforts. Updated flood maps were adopted by Richland County in 2017 and Lexington County in 2018.

Flooding impacts can be exacerbated or intensified in certain locations due to the existence of natural and man-made pinch points along waterways. Dams can act as pinch points, where dam releases and/or failures can intensify the downstream effects of flooding. As the City and the Midlands have grown in population, land development occurred hand-in-hand with dam development over the years. These dams were developed for a variety of reasons: to provide for agricultural irrigation, drinking water, transportation, recreation, electrical generation, and as amenities to development. During the 2015 floods, greater than 20" of rain fell in and around Columbia, with more than 12" of rain falling within 48 hours, stressing the already strained flood capacity of many of these dams, and resulting in dam failures and extraordinary flooding throughout the region. According to SCDHEC data¹⁵, there are currently 17 permitted dams within City of Columbia limits.

Permitted Dams & Flood Hazard Areas



As defined by FEMA⁴, the floodway is the stream channel and that portion of the adjacent floodplain which must remain open to permit passage of the base flood (the floodway is the area that will likely flood in a flood event). Zones AE and A are anticipated to have a 1% chance of flooding in a given year (hence the 100-year storm moniker) – Zone AE includes a base flood elevation, which is the elevation to which floodwater is anticipated to rise during the base flood (the base flood is the flood having a one percent chance of being equaled or exceeded in any given year, or the “100-year flood”). This elevation is then carried over to the requirement for the elevation or floodproofing of structures. Zone X is a moderate flood hazard area, and is calculated as a 0.2% annual chance of flooding in a given year (hence the 500-year storm moniker).

Data & Maps

WETLANDS

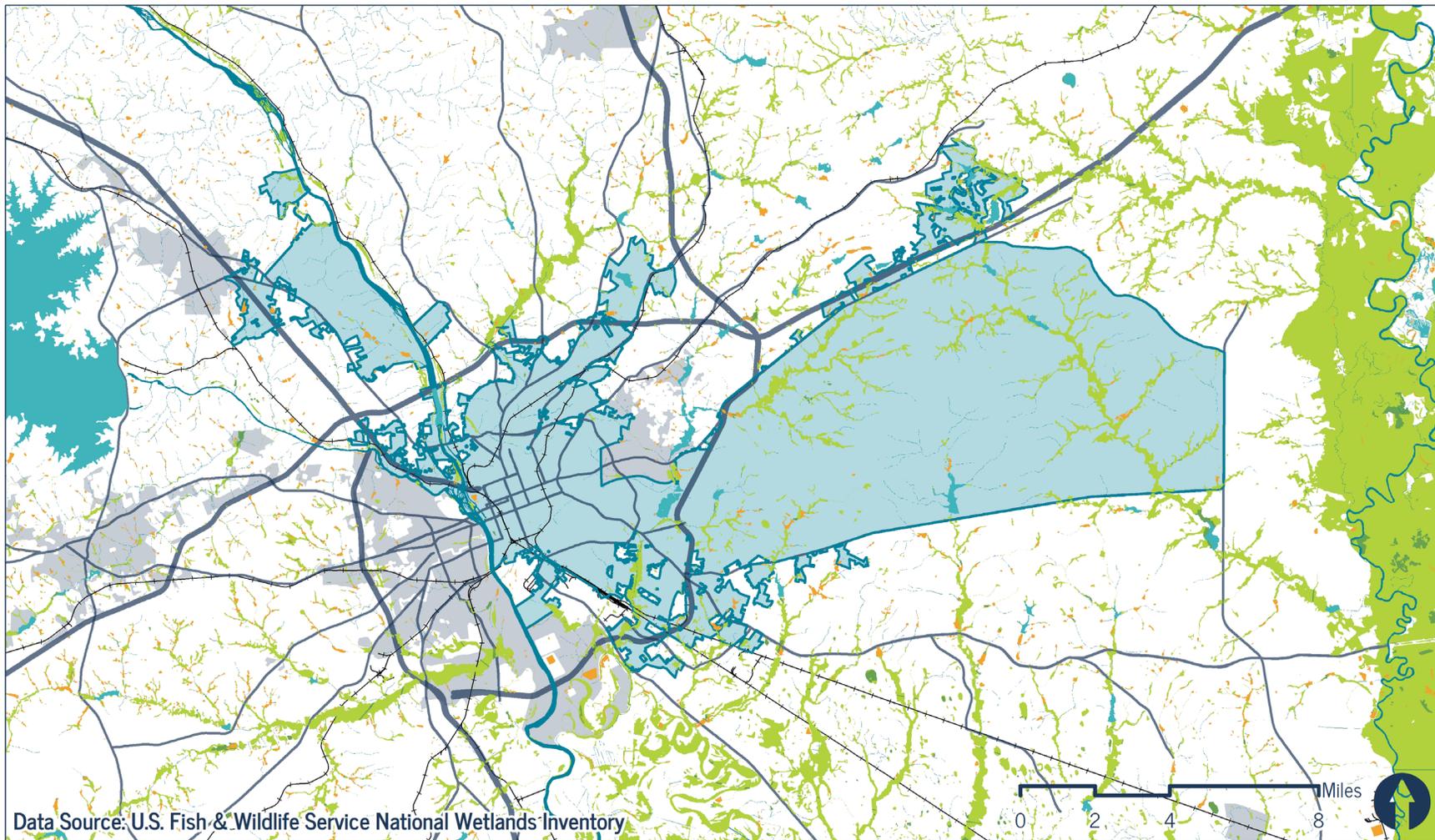
Though many may see little beauty in a swamp or soggy area, wetlands provide valuable ecosystem services and are “believed to be the most diverse ecosystems in the world.”¹⁶ Wetlands can be either permanently or seasonally saturated with moisture, and in the Midlands, wetland areas along streams and rivers help mitigate natural hazards by providing valuable flood storage, as well as habitat, water treatment, and other ecosystem services.

Protection or regulation of wetlands has changed substantially over the years, and many wetlands have already been lost (either drained or filled) due to development or agricultural practices.¹⁵ While newer federal and state laws do protect wetlands, these laws remain in flux. In the Midlands, our most famous wetland area falls within Congaree National Park, however wetlands are prevalent throughout the Midlands, as shown in the map on the following page.



Wetlands provide a variety of ecosystem services, as shown in the above graphic.

Regional Wetlands



Data Source: U.S. Fish & Wildlife Service National Wetlands Inventory

Wetland Type

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine

- City of Columbia
- Other Municipalities
- Interstates
- US & SC Highways
- Railroad

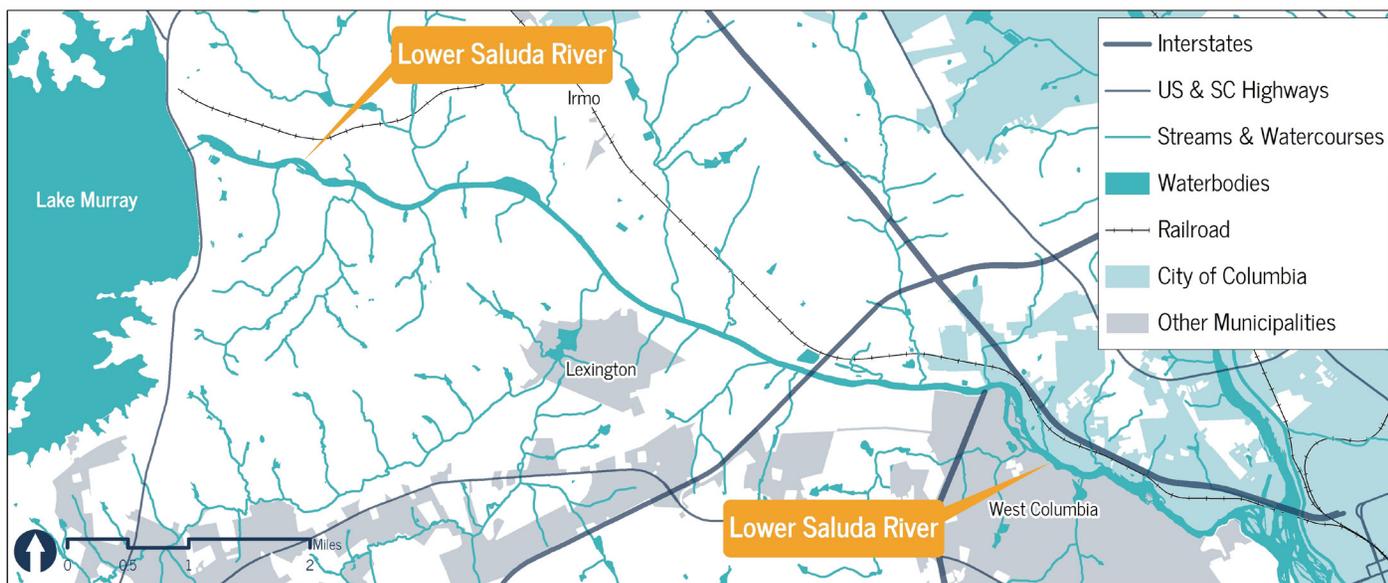
The above map indicates wetlands, by type, which are identified as part of the National Wetlands Inventory (data current as of 10.15.2018).¹⁷

Data & Maps

SOUTH CAROLINA SCENIC RIVERS

A ten-mile segment of the Lower Saluda has been designated as a South Carolina Scenic River, which means it is targeted for river corridor protection by the South Carolina Department of Natural Resources (SCDNR) as part of a voluntary cooperative community-based process.¹⁸ This segment, which begins one mile below the Lake Murray Dam and terminates at the confluence with the Broad River (forming the Congaree), was designated a State Scenic River in 1991. Columbians are well aware of the Saluda's role as a recreational resource – whitewater and flatwater paddling, as well as fishing for trout and striped bass, are popular pastimes. The Lower Saluda River Corridor Planning Project took place in 1990, and was updated in 2000. This effort focused on strategies to improve recreational access, protection of the riparian corridor (inclusive of wetlands and marshes) to provide for water quality and wildlife habitat, and control of invasive species.¹⁹

Providing controlled public access to the Lower Saluda continues to be a focus of the program, a theme which has also been reflected in some of the public feedback received during the Columbia Compass planning process. SCDNR does have an easement along part of the riverbank in Columbia, however as part of the proposed Federal Energy Regulatory Commission (FERC) relicensing of the Saluda hydro plant more SCE&G land is proposed to be placed in the project boundary (roughly 200 acres) which could result in increased public access. This relicensing process started over a decade ago, but is currently awaiting a biological opinion from the National Marine Fisheries Service regarding potential impacts and to the short-nose mid-Atlantic sturgeon.²⁰



The Lower Saluda River is designated as a Scenic River from one mile south of the Lake Murray dam to its confluence with the Broad River.

Data & Maps

DATA GAPS: TREE/VEGETATION COVERAGE

The extent and health of Columbia's tree and vegetative cover cannot easily be quantified given current data limitations. Aerial photography taken for tax-mapping and code enforcement purposes does not accurately portray vegetative cover, as these images are purposefully taken at a time when the tree canopy and other vegetative cover is least visible, so as not to interfere with the visibility of structures and other improvements. This means that imagery does not capture the health of vegetation, nor the width of canopies. Furthermore, analysis of imagery colors on a pixelated level can be problematic, as the brown-grey of trees often matches the color of roofs, rivers, and other non-vegetated surfaces.

The last extensive survey of street trees maintained by the City of Columbia was conducted in the late 1990s. Land use / land cover mapping technology has been adapted for planning work, and when data is available, can be extraordinarily helpful in determining vegetative cover. Where available in other communities, accurate and up-to-date data on vegetative cover has been used along with other data sets to calculate the urban heat island effect; the value of the tree canopy to ecosystem (and specifically stormwater) services; and the (in)equitable distribution of the urban tree canopy across a community.

DATA GAPS: SPECIES RICHNESS

A greater variety of species leads to increased resiliency in the local food system and within the local ecosystem. While the SC Gap Analysis mapping project helped to identify land cover, species distributions, species richness, and stewardship lands, this project was closed out in 2001.²¹ Though this data set has not been updated, it is important to note the value of biodiversity to our region.

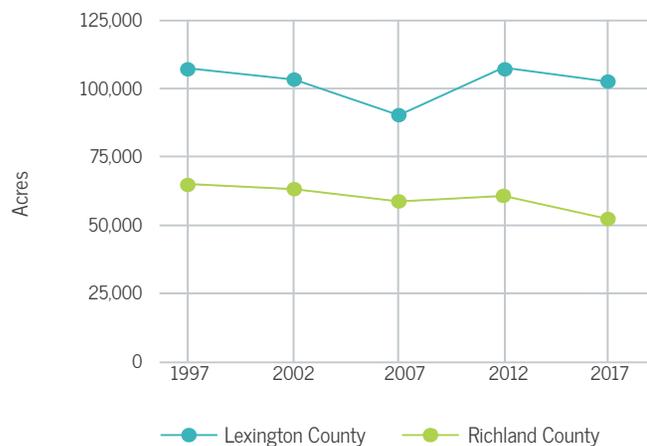
In May of 2019, the United Nations released a report stating that up to one million of the world's estimated 8 million plant and animal species are at risk of extinction. Though these extinctions are not expected to be evenly distributed across the globe, some of these impacts will be felt locally. As part of the May 6, 2019 Media Release on the Global Assessment, Cristiana Pasça Palmer, Executive Secretary of the Convention on Biological Diversity, noted, "Healthy biodiversity is the essential infrastructure that supports all forms of life on earth, including human life. It also provides nature-based solutions on many of the most critical environmental, economic, and social challenges that we face as human society, including climate change, sustainable development, health, and water and food security."

Data & Maps

AGRICULTURE

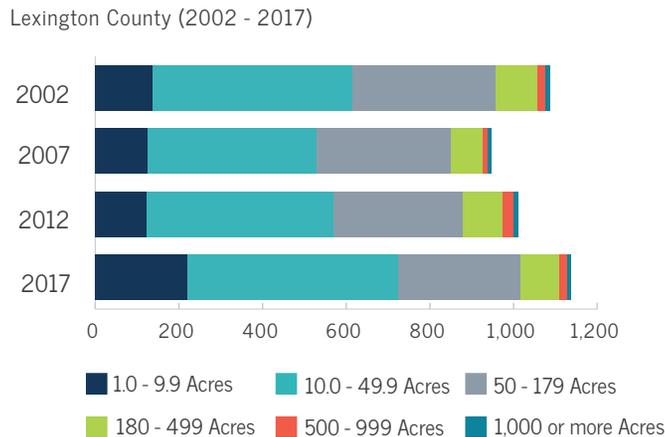
The United States Department of Agriculture (USDA) recently published the 2017 Census of Agriculture, which counts all farms and ranches nationwide which raise and sell (or would normally sell) \$1,000 of products within the Census year. This Census is taken once every five years, and provides vital insight into agricultural practices both nationally and at a county level. This data is summarized at the county level, and the data available since 1997 show that Lexington County has a larger number of farms, and a greater number of acres in farmland operation, than Richland County, which is not surprising given its more rural nature.²²

Farm Operations - Total Acres
(1997 - 2017)



Acres in Farm Operation, Lexington and Richland counties.²³ The above graph depicts acreage in farm operation. While the combined number of acres in farming in both counties have been relatively stable since 1997, the overall acreage under farming activity has decreased

Farm Operations by Farm Size
Lexington County (2002 - 2017)



Farm Operations by Farm Size
Richland County (2002 - 2017)



Farm Operations by Farm Size, Lexington and Richland counties²⁴ As shown in the above two graphs, both Richland and Lexington counties, the largest percentage of farming practices takes place on farms between 10 and 50 acres in size. The majority of farming practices in both counties take place on farms between 10 and 179 acres in size.

Data & Maps

AGRICULTURE, CONTINUED

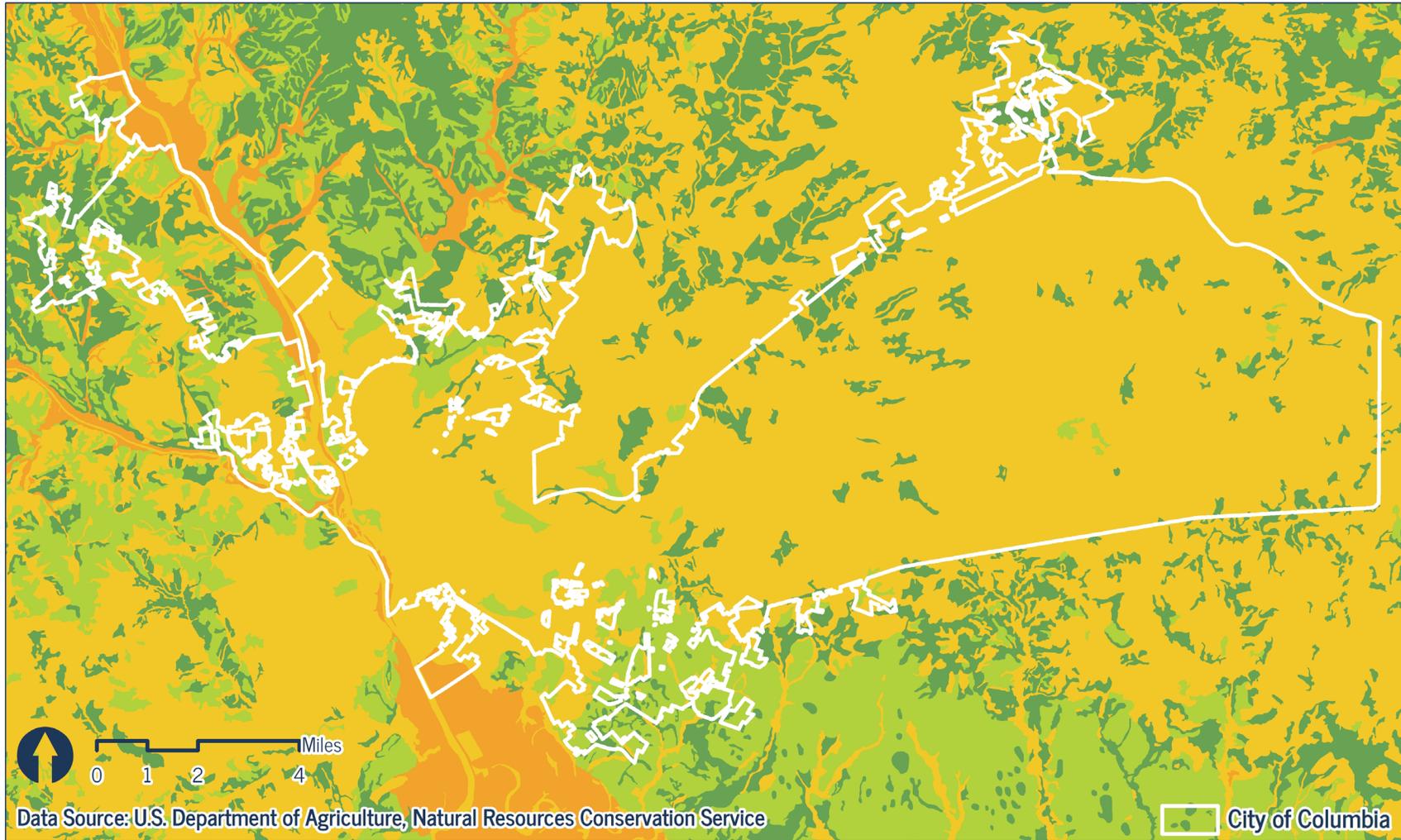
The map on the following page indicates the agricultural value of soils as surveyed by the U.S. Department of Agriculture, Natural Resources Conservation Service.²⁵ Within the City of Columbia, a large portion of the farmland of statewide importance and prime farmland areas fall within the Harbison/Broad River area and are scattered throughout Fort Jackson and towards the southeastern areas of the City. These farmland areas are relevant not just for food production, but also timber and other natural resource production.

The most productive agricultural land around Columbia can be found in the Coastal Plain, specifically within the Dothan-Coxville-Clarendon and Norfolk-Marlboro-Goldsboro soil associations. Within the Piedmont, this kind of soil is in the Tatum-Georgeville-Herndon and Herndon-Helena-Georgeville associations. When coupled with their geographic condition of being relatively flat, these currently forested lands could have strong potential for agricultural use, although they may be equally valuable as a source of sustainable timber harvesting that allows preservation of existing biodiversity.

While it is a state-wide effort, the South Carolina Department of Agriculture (SCDA) facilitates the Certified SC Grown program, which is a collaborative effort to promote the sustainability, accessibility, and desirability of agricultural products grown in the state. SCDA partners with producers, processors, wholesalers, and retailers to market South Carolina-grown products and improve awareness and public perception of local products. In addition to the labeling found in the grocery store, the program has more than 155 roadside stands and 120 farmers' markets throughout the state, and works with producers of specialty products, providers of Community Supported Agriculture (CSA) subscriptions, and restaurants which serve South Carolina-grown products (through the Fresh on the Menu program) to spread awareness and increase the market share.

According to the Certified SC Grown website²⁶, within Richland County, there are 70 listed participating Fresh Off the Menu restaurants, and 36 certified markets, but no farms which provide CSA subscriptions. Within Lexington County, there are 18 listed participating Fresh Off the Menu restaurants, 16 certified markets, and two farms which provide CSA subscription opportunities.

Soil types classified by agricultural value as defined by the USDA Natural Resources Conservation Service²⁷



- Farmland of statewide importance
- All areas are prime farmland
- Prime farmland if drained & either protected from flooding or not frequently flooded during the growing season
- Not prime farmland

Within the City of Columbia, a large portion of the farmland of statewide importance and prime farmland areas fall within the Harbison/Broad River area and are scattered throughout Fort Jackson and towards the southeastern areas of the City. These farmland areas are relevant not just for food production, but also timber and other natural resource production.

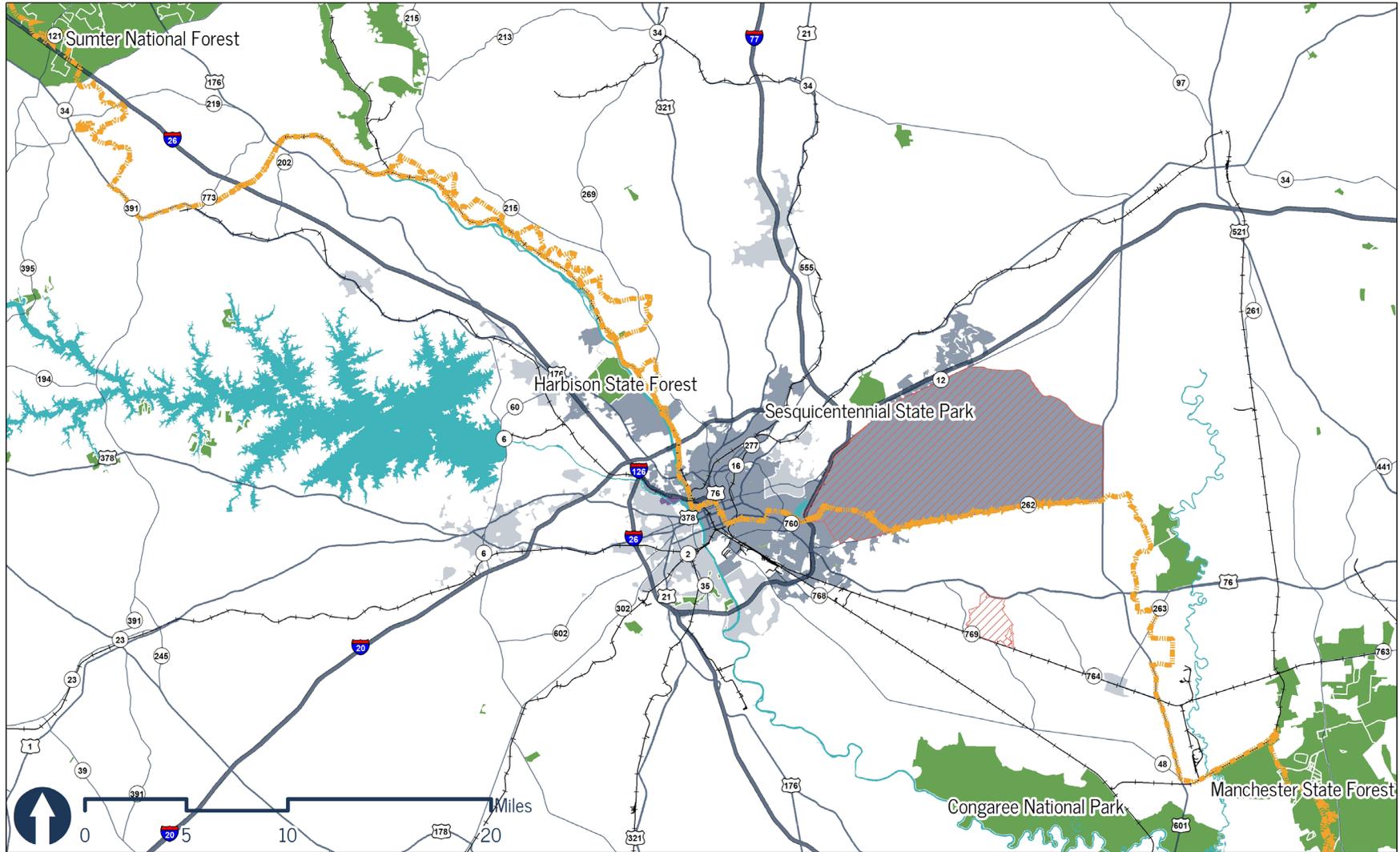
Data & Maps

ACCESS TO NATURAL AREAS

Access to high-quality natural areas is in turn a quality of life indicator, and is a desirable asset for all generations. For example, while the Midlands as whole has a younger population than the state²⁸, we know that this access is important to our aging population as well. A 2002 study found that two of the best predictors for 5-year survival for older adults were having a place to take a stroll, and living near parks and trees.²⁹ Located at the confluence of two rivers, Columbians have access to a number of natural areas, many within local and state parks. The Midlands is also home to South Carolina's first³⁰ National Park, Congaree National Park, designated for its natural significance. As noted earlier, and in the survey results that follow in this appendix as well as other *Columbia Compass* appendices, citizens strongly desire both the protection of and access to natural areas, especially areas along rivers and streams. Often, these discussions center around “controlled access” – balancing the desire for public access with strategies to mitigate potential environmental and other impacts resulting from unfettered access.

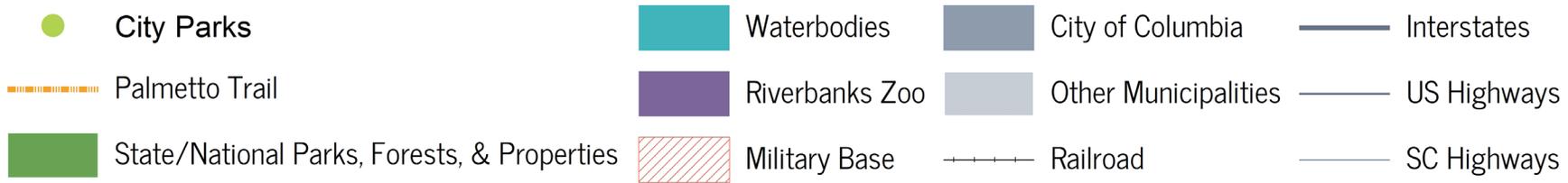
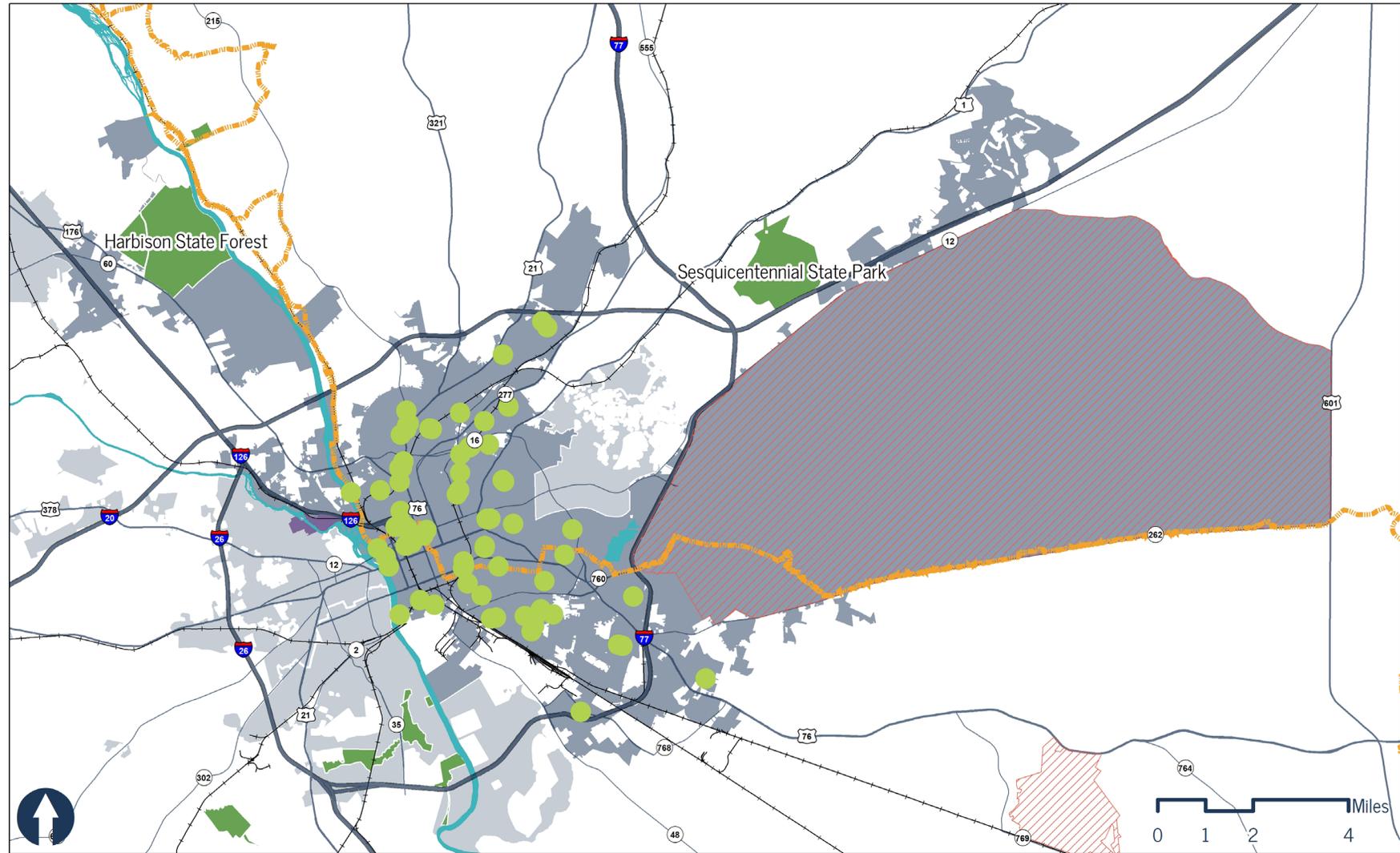
The Community Facilities Existing Conditions Report discusses in greater depth local parks, park facilities, and the proximity of City residents to parks.

Natural & Recreational Areas - Regional



Data sources: City of Columbia and South Carolina Department of Natural Resources³¹

Natural & Recreational Areas - City of Columbia



Data sources: City of Columbia and South Carolina Department of Natural Resources³²

Data & Maps

PUBLIC HEALTH & NATURAL RESOURCES

Access to quality natural resources has a direct impact on public health. Natural resources provide important ecosystem services, support local agriculture, and provide opportunities for recreation. Locally, we know that residents of the Midlands suffer from some rather striking health outcomes, with high rates of chronic health issues like diabetes and obesity. According to DHEC, almost ½ of Richland County adults consume less than one serving of fruit per day³³, and nearly 70% of Richland County adults are overweight or obese.³⁴ In addition to those ecosystem services that natural resources provide that affect our daily health (such as clean water, air, and sunlight), we know that individuals with access to built and natural facilities are 43% more likely to exercise than those with poor access³⁵ - making public access to natural areas essential to community health. In fact, there are over 485 published studies linking time in nature to better health.³⁶



The above diagram depicts some of the many natural resource impacts on public health.

Data & Maps

RESOURCE EXTRACTION

Resource extraction, which is separate from agricultural harvesting, does occur throughout the Midlands, and includes the extraction and treatment of water, and the extraction of rock, clay, and sand.

WATER SYSTEMS

There are a variety of water system types permitted by SCDHEC. Community water systems are public water systems that include municipal systems and private systems that serve at least 15 service connections used by year-round residents or at least 25 year-round residents.³⁸ According to SCDHEC’s Drinking Water Watch, there are currently 31 permitted community water systems principally serving Richland County, and 89 permitted community water systems which principally serve Lexington County.³⁹ Of these permitted community systems, the bulk are private. Publicly-operated systems principally operating in one of the two counties are listed in the chart to the right.

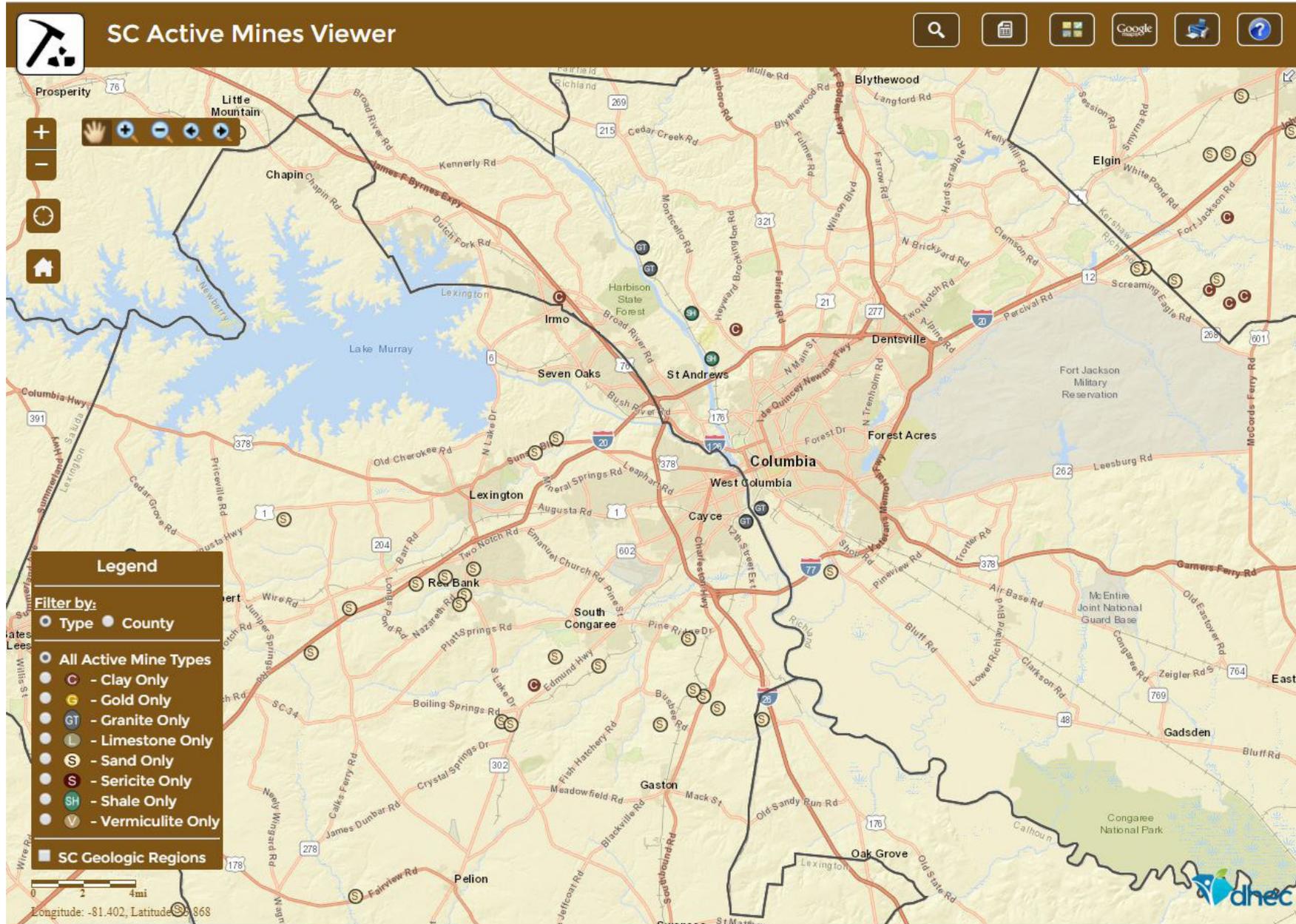
MINING

Mining operations in the Midlands extract sand, clay, granite, and shale over a variety of locations. SCDHEC issues mine permits and certificates through the Section of Mining and Reclamation. All operations of this type of resource extraction currently occurs outside of the City limits. The mining operations in greatest proximity to the urban core of Columbia are granite quarries – Vulcan operates a quarry located on the eastern bank of the Congaree just outside municipal limits near the Granby, Olympia, and Whaley historic mill communities, and Martin Marietta Materials operates a quarry opposite the Vulcan Quarry on the western bank of the Congaree. Both of these more urban quarry operations are anticipated to continue through the scope of this plan, but re-use strategies may

need to be contemplated in the longer term. A graphic showing permitted mining operations is provided on the following page.

Water System Name	Water Source
City of Columbia	Surface Water
Amicks Ferry Water System	Surface Water Purchased
Batesburg-Leesville #2	Ground Water Purchased
Batesburg-Leesville DPW	Surface Water
City of Cayce	Surface Water
City of West Columbia	Surface Water
Fort Jackson	Surface Water Purchased
Hopkins Community Water System	Ground Water
Joint Municipal WSC	Surface Water Purchased
Lexington County Joint Municipal WSC – Town of Pelion	Surface Water Purchased
Richland County/Pond Drive	Ground Water
Town of Eastover	Ground Water
Town of Lexington	Surface Water Purchased
Town of Swansea	Surface Water Purchased

Publicly-operated Community Water Systems in the Midlands⁴⁰



SCDHEC hosts an interactive map services that allows users to search for active mines by type and location.

Policies & Programs

CITY SERVICES

As a large employer, service provider, and utility, the efficiency and resiliency of City services and programs has a direct impact on our regional natural resources. The City continues to invest in solid waste and recycling services, and has begun to invest in sustainable building practices and renewable energy generation. While these City services are addressed more fully in the Community Facilities section, it is important to note the power the City has to both conserve and protect our natural resources and set a positive example for the Midlands as a whole.

COMMISSIONS & ADVISORY COMMITTEES

The City of Columbia has established several commissions and committees that help focus on, promote, and advocate for City policies regarding natural resource-related concerns. The Tree & Appearance Commission, Climate Protection Action Committee (CPAC), Food Policy Committee, and to some degree the Bicycle Pedestrian Advisory Committee (BPAC), are all engaged on topics which impact natural resource management and sustainable practices.

TREE & APPEARANCE COMMISSION

Columbia's Tree & Appearance Commission was established in 1999⁴² when City Council joined the Tree Commission and the Columbia Appearance Commission into one body, and is made up of citizens appointed by Council. The 11-member commission includes an arborist, horticulturalist, or landscape architect; a developer or realtor; an architect or engineer; and a member of Columbia Green.

In addition to sponsoring the annual Arbor Day celebration, the Treasured Tree program, and the Columbia Choice Awards, the Commission has the following powers and duties:

- review and recommend policies and ordinances affecting the planting, removal and preservation of trees on public and private property;
- provide advice on the allocation of resources and policies for the planting, care and removal of trees in the City of Columbia;
- serve as an advisory body to the City Forestry and Beautification Superintendent in the administration of the City's urban tree canopy and care of city property and public rights-of-way;
- review and make recommendations related to the City Forestry and Beautification Division's annual work plan and any comprehensive urban forestry or reforestation plans;
- provide public education and advocacy on tree value, preservation and care; make recommendations to City Council on disbursements of the Columbia Landscape and Tree Fund;
- oversee the development and implementation of a master plan for the beautification of the City of Columbia; and
- advise the City and its boards and commissions regarding landscaping, tree planting, protection and removal.

The Commission's top two current priorities are the undergrounding of utilities (both for beautification and to allow for a mature urban tree canopy) and the collection of data regarding the urban tree canopy (both to facilitate more informed forestry practices and to help in the calculation of the urban heat island affect for Columbia.⁴³ The Commission also expressed an interest in reforestation efforts, beautification projects, complete streets, green infrastructure, and public awareness/education.

Policies & Programs

COMMISSIONS & ADVISORY COMMITTEES, CONT.

CLIMATE PROTECTION ADVISORY COMMITTEE (CPAC)

Columbia's Climate Protection Advisory Committee was established in 2006 shortly after the City of Columbia signed the U.S. Conference of Mayors Climate Protection Agreement. The volunteer group addresses four areas which impact climate change and quality of life: air quality; energy conservation; water conservation; and recycling and waste reduction. CPAC has both appointee (appointed by Council) and advisory (invited by way of their position or affiliation with related agencies or groups) members.⁴⁴ The initial focus of the group was internal to City government, but the group is now also focusing on community outreach and education programs to encourage citizens to take action and live more sustainably. CPAC recently served in an advisory capacity during the STAR Community certification process.

FOOD POLICY COMMITTEE

The Food Policy committee was established by Council in 2017⁴⁵ and consists of 20 members which are working to gather information on and address problems found within food production, consumption, processing, distribution, and waste disposal within the City. Members represent the different components of the food system: farming, chefs, education, nutrition, public health, food distribution/food banks, social work, planning, and advocacy. The committee is dedicated to promoting sustainability, economic development, and social justice in the food system of the Columbia area through education of public officials, policy recommendations, and by fostering cooperation in the community. Since their inception, the committee has been working in subcommittees dedicated to: food equity, evaluation/research, marketing and communications, procurement, and zoning and land use. Overall as a committee

they are interested in increasing access to healthy foods, and committee members have been working to gather feedback from residents through a series of listening sessions prior to making policy recommendations to City Council, set forth in a robust report adopted by Council in December 2019.

BICYCLE PEDESTRIAN ADVISORY COMMITTEE (BPAC)

The Bicycle and Pedestrian Advisory Committee was established in 2006⁴⁶, and is made up of 17 citizens appointed by Council. The committee was established to further bicycle and pedestrian planning and awareness in the City of Columbia, and was instrumental in the development and 2015 adoption of the *Walk Bike Columbia Pedestrian and Bicycle Master Plan* by City Council. BPAC has focused on bringing the Open Streets initiative to the City of Columbia, and continues to focus on education, outreach, awareness, infrastructure, safety, and equity regarding bicycle, pedestrian, and transit issues, while also advising Council and furthering the recommendations of *Walk Bike Columbia*.

Policies & Programs

STAR COMMUNITIES

The City participated in the STAR Communities program, receiving a three-star community rating in 2017, and was the first STAR Community to be certified in South Carolina. The STAR Community rating system is utilized by cities and counties to identify successes as well as opportunities for improvement, and to focus on sustainability and resilience in local government. Since the City's three-star rating, the STAR program has merged with the U.S. Green Building Council, to combine with the LEED for Cities certification program. The City was awarded the following scores in each goal area:

Goal Area	Points Achieved
Built Environment	59.0 / 100
Climate & Energy	50.4 / 100
Economy & Jobs	70.4 / 100
Education, Arts, & Community	68.5 / 100
Equity & Empowerment	39.4 / 100
Health & Safety	45.8 / 100
Natural Systems	43.9 / 100
Innovation & Process	32.5 / 50
Total	409.9 / 750

STAR Community Report - Overall Scores for Columbia, SC

READY FOR 100% CLEAN RENEWABLE ENERGY

City Council committed to transitioning to 100% clean and renewable energy in Columbia by 2036, the City's 250th anniversary. This commitment was made in Resolution 2017-058, and nationally the City was the 36th city to make such a commitment as part of the Sierra Club's Ready for 100 Campaign. Though this resolution is not an existing condition per se, as a policy announcement, it will lay the groundwork (along with the existing conditions herein) for how Columbia addresses natural resource issues in the years to come.

Committed communities throughout the nation are exploring strategies to shift to clean and renewable energy while addressing equity and access issues. The Sierra Club is actively working to help identify strategies for the diverse group of communities that have signed on to the Ready for 100 Campaign. At the local government level, these strategies tend to fall into three categories: addressing the local government agency's resource use through increased efficiencies, alternative fuels and power sources, and/or the purchase of offsets; incentivizing private developers to utilize clean and renewable energy and address resource conservation through site design; and working with local utility providers to address the needs of the local community while pursuing clean and renewable energy solutions.

Anticipating Change

DEMOGRAPHIC SHIFTS

The population in the Central Midlands is expected to continue to grow exponentially, from 839,819 people in 2020 to an estimated 1,365,128 in 2050.⁴⁷ No matter where in the Midlands these new residents choose to live, work, and play, this growth will place pressures on both our built and natural systems, the latter of which do not adhere to municipal boundaries.

Among other items, access to quality natural resources, walkable communities, and outdoor recreation, as well as a focus on sustainable practices and local foods in a large part defines quality of life⁴⁸ for many in the Millennial and younger generations. While Columbia's population will likely remain younger than the state average, a portion of our population will age⁴⁹, and the elderly population has greater health risks associated with air quality and extreme temperatures. Our changing climate and increasing population will strain our resources and require a shift in our processes and approaches to natural resource management, conservation, and preservation. It is yet unclear how the impacts of climate change will lead to further demographic shifts for our region.

URBAN HEAT ISLANDS

Urban areas tend to be hotter than nearby rural areas because they contain more impervious areas than vegetative natural areas.⁵⁰ These urban areas become “heat islands” because they are warmer than their surroundings. Impervious surfaces – areas rainwater cannot penetrate – hold and reflect heat.⁵¹ Such surfaces include concrete, asphalt, roofs, and highly compacted urban soils which cannot support vegetative growth or help filter rainwater. The urban

heat island effect is detrimental to natural resources both because of direct impacts to our natural systems (such as water quality, vegetation, and animal life), and indirectly through causing an increase in energy consumption.

According to the USEPA, heat islands affect communities by increasing summertime peak energy demand⁵², air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality. High pavement and rooftop surface temperatures also heat stormwater runoff, which quickly drains into streams, rivers, and lakes. Rapid temperature changes resulting from warm stormwater runoff are particularly stressful, even fatal, to aquatic life. Many cities have worked to calculate baseline data, and track the effects of both the urban heat island, and mitigation strategies, over time. At this time, the City of Columbia does not gather or maintain all of the data sets necessary to develop a baseline and track mitigation progress.



The illustrative map to the left shows (in gray) non-residential impervious areas and roadways in a section of Columbia's urban core.

Anticipating Change

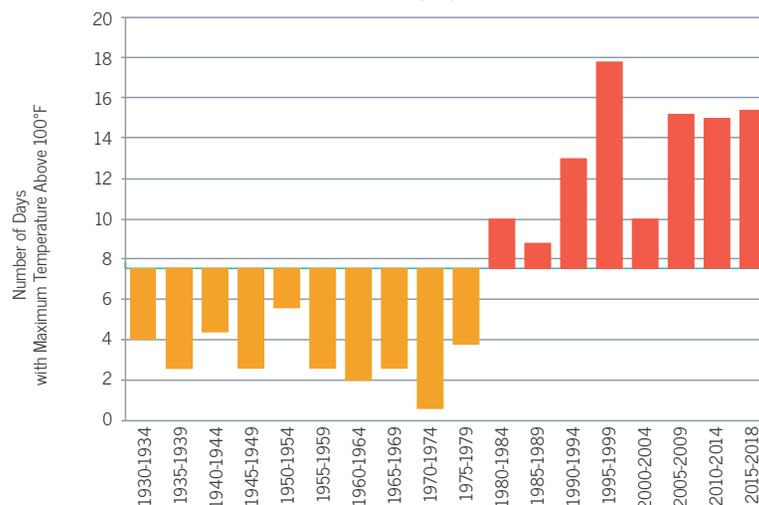
CLIMATE CHANGE

Our climate is changing. In the southeast, we continue to see historical shifts, with an increase in the number of hot days, warm nights, and days with heavy precipitation (greater than three inches). While it may be easiest to visualize record days and nights, we are also beginning to see shifting seasons - such as when summer bleeds further into fall, with a record 132 days between our first and last 100 degree days in 2019.⁵³ These shifts are also indicators of the changing strain on our energy and natural resources.

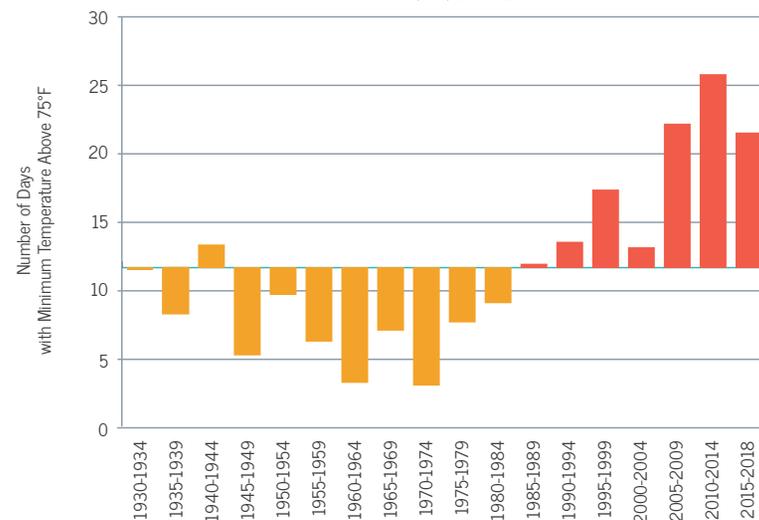
The charts that follow track historical shifts in temperature, many of which we also understand anecdotally. In 2017, Columbia observed its highest annual count of days with a maximum temperature at or above 80°F – 198 straight days (54% of the year).⁵⁴ In 2018, the warmest temperature of the year observed at any weather station in the southeast was in Columbia, SC; a temperature of 105°F was observed at the University of South Carolina on July 11.⁵⁵ These records, combined with the data shown herein which indicates shifting temperatures and increased extremes, all have real impacts – to our growing seasons and the viability of local crops; to our heating and cooling costs; to ozone levels and therefore health risks; and to the size of the insect population (and therefore increases in vector-borne diseases).

The Columbia, SC data depicted in the charts that follow in this section of *Columbia Compass* was compiled and analyzed by Dr. Ken Kunkel, North Carolina Institute for Climate Studies and Dr. Greg Carbone, Department of Geography, University of South Carolina; data source CICS-NC and NOAA NCEI.

Observed Number of Extremely Hot Days
Columbia, SC, 1930-2018

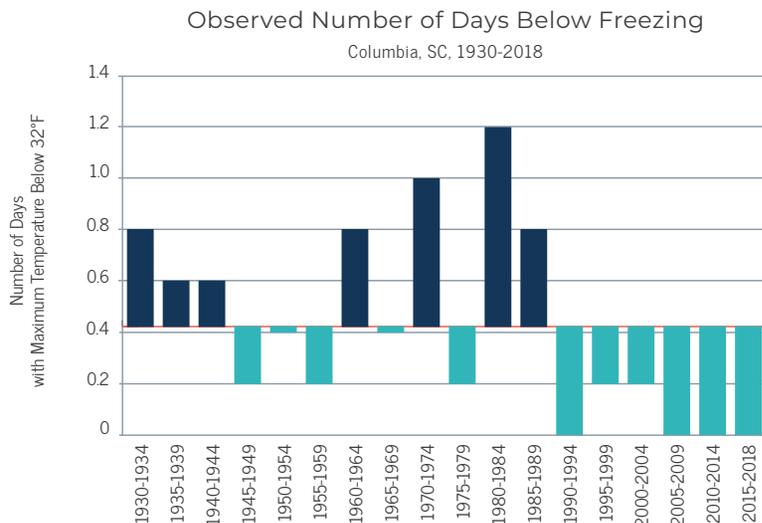


Observed Number of Very Warm Nights
Columbia, SC, 1930-2018



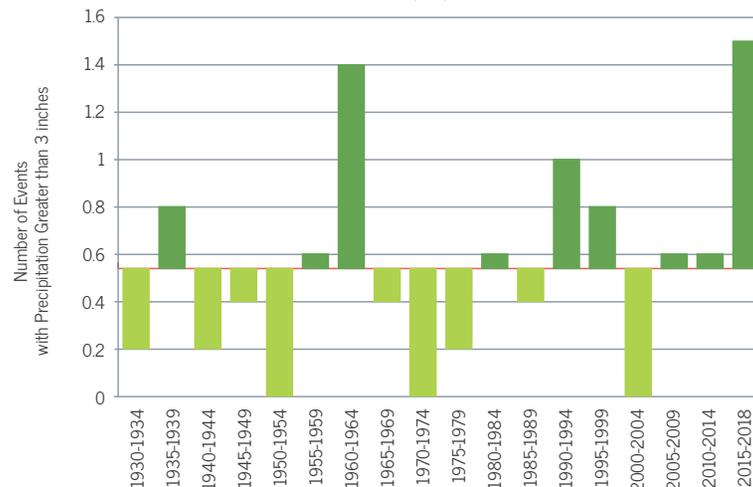
Anticipating Change

CLIMATE CHANGE, CONTINUED



While Columbians are quick to cite the records broken in October of 2015⁵⁶, the increase in extreme precipitation events, not just in Columbia but also upstream of the City’s waterbodies, have led to increased flooding throughout our region. Extreme precipitation events (precipitation events of greater than three inches) often overwhelm stormwater management systems, leading to increased flooding, and decreased ability to provide filtration and treatment for nonpoint source pollution associated with stormwater. It is important to note that flood hazard mapping (discussed earlier in this report) is developed by using historical data and flood risks, and does not (and to some degree cannot) address those increased risks associated with the increased number of extreme events tied to climate change.

Observed Number of Extreme Precipitation Events
Columbia, SC, 1930-2018



Climate change will continue to directly impact our natural resources and our way of life; how proactively we approach the factors that lead to climate change as well as the effects of climate change will define our future as a community. The Fourth National Climate Assessment, Volume II⁵⁷, identified four key messages for the Southeast:

- Increased urban infrastructure and health risks are posed by heat, flooding, and vector-borne diseases.
- Flood risks in coastal and low-lying regions will continue to increase.
- Natural ecosystems will be transformed, placing the ecological resources we depend on at risk.
- Economic and health risks will increase for rural communities, especially in the agricultural, timber, and manufacturing sectors.

Anticipating Change

ADAPTATION & RESILIENCY

“Resilience is the capacity of a system to absorb disturbance and still retain its basic function and structure.”⁵⁸ Planning for resiliency involves thinking about how we adapt to and mitigate risks resulting from changes - whether those changes are due to population growth, development pressures, or our changing climate. The system in which we operate is dependent on our natural resources; in planning for resiliency, we seek to mitigate damaging impacts on those resources, while also relying on those same resources to provide our system with resiliency. In the face of shifting demographics, climate change, and increased ecosystem stressors, planning for resiliency appears to be the next global shift in planning practice that has a direct interest in natural resource planning.

While CPAC has an interest in the City’s resiliency, and many City operations are shifting to include resilience thinking⁵⁹, the City does not currently have a municipal resiliency strategy. Resiliency planning does not follow a specific model, but considers three broad forms:

- "The direct strength of structures or institutions when placed under pressure
- The ability of systems to absorb the impact of disruptive events without fundamental changes in function or structure
- The ability of systems to adjust to provide similar functions achieved in new ways.”⁶⁰

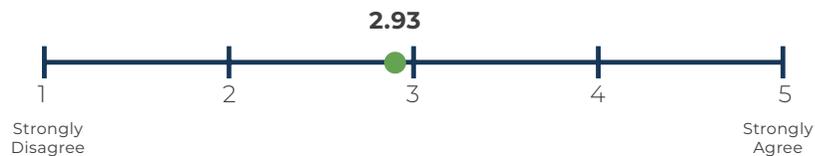
Public Input

FALL SURVEY

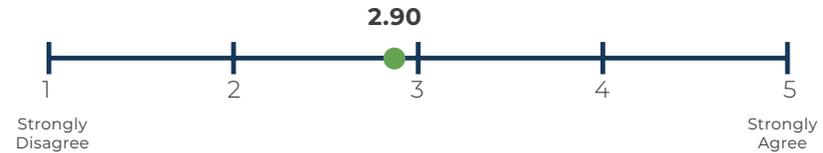
As part of the Columbia Compass planning process, an initial survey was launched through the MetroQuest platform to provide an opportunity for citizens to offer input on eight of the nine elements of the comprehensive plan (priority investment was not included). The survey launched on September 28, 2018 and was active until November 8, 2018. In addition to collecting participant demographics, the survey collected information on each plan element by requesting feedback on a series of statements, allowed participants to place map markers on an interactive map to identify issues and concerns, and asked for open-ended comments on a vision for Columbia’s future. Overall, there were 1,197 survey responses, which included 5,085 comments and 37,014 data points.

Of those responses, 742 respondents chose to address statements relative to the Natural Resources Element. Of the eight topics, Natural Resources was the third most popular. Respondents were asked to rank each statement on a scale of 1-5 based on how much they agreed or disagreed with the statement (1 = strongly disagree, 5 = strongly agree). The aggregate results of these rankings were analyzed to find an average position, which is reported for each land use statement.

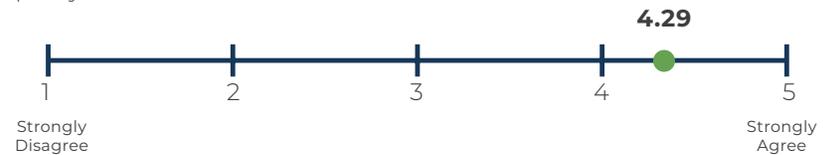
“The City is actively involved in the conservation of natural areas.”



“Residents throughout the City have access to high quality natural resources.”



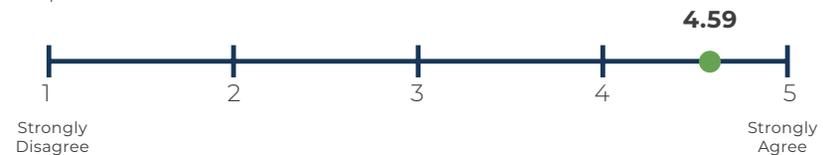
“Pedestrian, bike, and transit improvements will help improve air quality and quality of life.”



“My neighborhood has a rich and healthy urban tree canopy.”



“Land near rivers and streams should be protected and made accessible to the public.”



Public Input

FALL SURVEY. CONTINUED

Respondents also identified strong places, weak places, and opportunities on an interactive map platform. Maps are available in Appendix I, and were also published online in an interactive format and on the plan website, columbiacompass.org, allowing the viewer to review the comments made about each map marker.

Through their comments, respondents focused on the need for:

- Protection and access (where appropriate) to rivers and streams
- The importance of the tree canopy
- Opportunities for improvement of parks and green spaces



Survey respondents also left 254 comments specific to natural resources. The most commonly used words are shown above, scaled to represent their frequency of usage.

FOCUS GROUPS

In addition to public and neighborhood meetings, and other outreach opportunities, a number of focus groups and conversations were held with those engaged in natural resource research, protection, and conservation during the planning process. These discussions helped provide City staff with valuable information during the research phase, and helped to identify baseline data and priorities for the planning process.

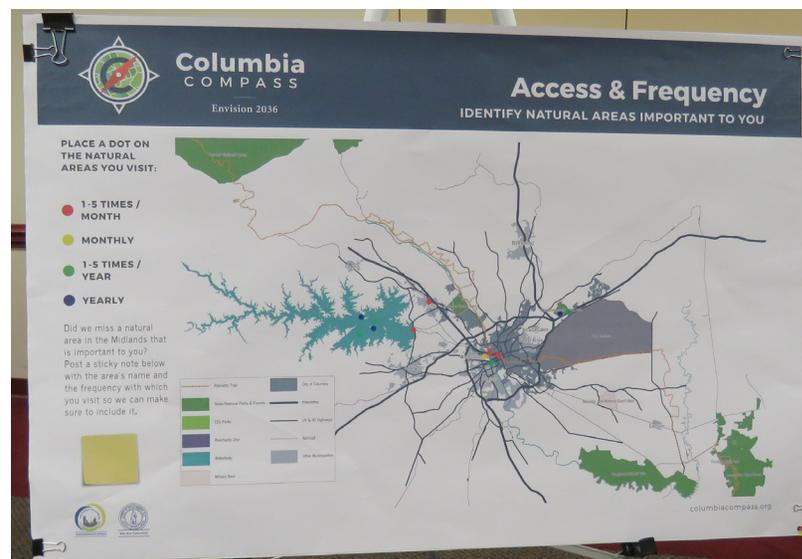
Focus groups and one-on-one interviews were held with the following:

- **City Departments** – Parks & Recreation, Forestry, Solid Waste & Recycling, Sustainability, Columbia Water
- **City Advisory Committees** – Tree & Appearance Commission, BPAC, CPAC, Food Policy Committee
- **USC Faculty** – Geography (including climatology, hazard mitigation, and planning)
- **State Agencies** – SCDNR, SCDHEC (Air Quality and Water), SC Department of Commerce – Recycling
- **Nonprofit Organizations and Advocates** – Congaree Riverkeeper, Gills Creek Watershed Association, Sustainable Midlands, Sierra Club

Public Input

PUBLIC OPEN HOUSES - OCTOBER 2018

The October 2018 Open Houses served to introduce citizens to each of the elements of the comprehensive plan. Stations were staffed topically and included *Envision Columbia* and each of the elements, with the exception of the priority investment element. Boards for the land use element included information summarizing *Plan Columbia's* vision, guiding principles, and critical components, as well as the current future land use maps for the City as a whole. An interactive board asked participants to identify the natural areas important to them, placing a colored dot on the natural areas they visited indicating the frequency of their visits. Most participants reported that they utilized public access areas to gain natural resource areas, many cited our rivers as an important natural resource for the City.



Dots placed on an interactive board at the October meetings identified natural areas visited and the frequency at which participants visited them. The board on the left was utilized at the October 3rd meeting at Richland Library Main; the board on the right was utilized at the October 4th meeting at the Eau Claire Print Building.

A summary of the feedback received at the February 2019 Open Houses is provided within the Appendices of Columbia Compass, and as such is not repeated herein.

Endnotes

- 1 A recent Clemson University study found that natural resource based sectors contribute \$33.4 billion in economic activity to the state's economy, and are responsible for 218,719 jobs Clemson University. (2018, January 18). *Clemson study: Natural resources have a \$33.4B impact on the state's economy*. Retrieved from The Newsstand: <https://newsstand.clemson.edu/mediarelations/clemson-study-natural-resources-have-33-4b-impact-on-states-economy/>
- 2 U.S. Forest Service. (2011, March 8). *News Releases - 2011*. retrieved from U.S. Forest Service Pacific Southwest Research Station; https://www.fs.fed.us/psw/news/2011/110308_arborday.shtml
- 3 According to the USEPA, when compared to the 1960s, tailpipe emissions from new passenger vehicles are 98-99% cleaner, sulfur levels in fuel are more than 90% lower, and lead in fuel has been eliminated. USEPA. (2019, April 19). *History of Reducing Air Pollution from Transportation in the United States*. Retrieved from USEPA Website: <https://www.epa.gov/transportation-air-pollution-and-climate-change/accomplishments-and-success-air-pollution-transportation>
- 4 USEPA. (2019, April 19). *Health Effects of Ozone Pollution*. Retrieved from USEPA Website: <https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution>
- 5 SC DHEC Bureau of Air Quality. (2019). South Carolina Historic Design Values Ozone (8 hr): 1975-2017.
- 6 As of December 2019
- 7 SC DHEC. (2019, April 20). GIS Data - 303(d) waters & major river basins.
- 8 SCDHEC. (2018, October 15). GIS Data: watersheds & permitted dams.
- 9 1987 amendments to the Clean Water Act established Section 319: Nonpoint Source Management Program. These grants provide funding for demonstration projects and monitoring to address nonpoint source pollution – pollution generated from stormwater runoff.
- 10 As of December 2019
- 11 SC DHEC. (2019, April 20). GIS Data - 303(d) waters & major river basins.
- 12 SC DHEC. (2019, April 20). GIS Data - 303(d) waters & major river basins.
- 13 SCDHEC. (2018, October 15). GIS Data: watersheds & permitted dams.
- 14 FEMA. (2019, May 29). *Managing Floodplain Development Through the NFIP - Appendix D: Glossary*. Retrieved from FEMA Website: <https://www.fema.gov/media-library/assets/documents/6029>
- 15 Section 404 of the Clean Water Act does address the discharge of dredged or fill materials into wetlands and waters of the US, but this is tied to a specific type of activity.
- 16 SCDNR. (2019, April 19). *Wetlands*. Retrieved from SCDNR Website: <http://www.dnr.sc.gov/wildlife/wetlands/>
- 17 U.S. Fish & Wildlife Service. (2018, October 15). National Wetlands Inventory (GIS data).
- 18 SCDNR. (2019, March). *Scenic Rivers - Overview*. Retrieved from SCDNR Website: <http://www.dnr.sc.gov/water/river/overview.html>
- 19 SCDNR. (2019, March). *Lower Saluda Scenic River*. Retrieved from SCDNR Website.
- 20 Marshall, B. (2019, March 15). Program Manager, S.C. Scenic Rivers Program, SCDNR. (L. DeForth, Interviewer)
- 21 SCDNR. (2019, March). *South Carolina GAP Analysis*. Retrieved from SC DNR Website: <http://www.dnr.sc.gov/GIS/gap/scGAPhome.html>
- 22 USDA. (2019, May 7). Census of Agriculture Data, Census Data Query Tool, County Summary Highlights, Richland & Lexington counties, SC.
- 23 Ibid
- 24 Ibid
- 25 USDA Natural Resources Conservation Service. (2019, April 20). GIS Data: Web Soil Survey - Lexington, Richland, and Kershaw counties.
- 26 Certified South Carolina Grown. (2019, May 29). *Where to Buy Local*. Retrieved from Certified South Carolina Grown: <https://www.certifiedscgown.com/where-to-buy-local/>
- 27 USDA Natural Resources Conservation Service. (2019, April 20). GIS Data: Web Soil Survey - Lexington, Richland, and Kershaw counties.
- 28 The Population Chapter of Columbia Compass provides a detailed demographic analysis of both the City and Midlands population.
- 29 Wells, N. M. (2017). The Role of the Natural Environment in Human Health & Well-Being. *Cornell Sustainability Conference*. Kowloon, Hong Kong.
- 30 There are other parks and sites within South Carolina which are designated for their historic significance and managed by the National Park Service, however Congaree National Park is the only National Park in the state designated for its natural significance.
- 31 SCDNR. (2019, March 18). GIS Data: SCDNR Lands (Leased & Owned).
- 32 SCDNR. (2019, March 18). GIS Data: SCDNR Lands (Leased & Owned).
- 33 SCDHEC tracks health statistics at the county level; the bulk of Columbia's population resides in Richland County.
- 34 Alta Planning + Design. (2016). *Walkable 29203: Crane Creek & North Main Areas Pedestrian Master Plan*
- 35 SCDHEC & Eat Smart Move More SC. (2015). *South Carolina Health + Planning Toolkit*.
- 36 Reuben, A. (2019, May). Science's Newest Miracle Drug is Free. *Outside Magazine*.
- 37 Alta Planning + Design. (2016). *Walkable 29203: Crane Creek & North Main Areas Pedestrian Master Plan*.
- 38 SCDHEC. (2019, November 11). *Water System Classifications*. Retrieved from SCDHEC Water Quality, Drinking Water: <https://www.scdhec.gov/environment/water-quality/drinking-water/water-system-classifications>

- 39 SCDHEC. (2019, November 10). Retrieved from Drinking Water Watch Version 3.01: <http://dwwwwebvm.dhec.sc.gov:8080/DWW/>
 40 Ibid
 41 SCDHEC. (2019, November 10). *Active Mines Viewer*. Retrieved from SC DHEC Land & Waste Management, Mining & Reclamation: <https://gis.dhec.sc.gov/activeminesviewer/>
 42 October 27, 1999 City Council Work Session minutes
 43 Planning Division staff attended the November 2018 Tree & Appearance Commission meeting to better understand their vision and goals for Columbia in the coming years.
 44 Planning Division staff regularly attends CPAC meetings in this advisory role.
 45 The Committee was established by R-2017-037 signed on April 18, 2017, began meeting in July 2017.
 46 Initially established as the Bicycle Friendly Committee, referenced in R-2006-021. Planning Division staff serves the BPAC.
 47 Central Midlands Council of Governments (March 2018), *Central Midlands Region Population Projection Report, 2020-2050*. Columbia.
 48 For further discussion: Flint, A. (2014, May 5). *What Millennials Want - And Why Cities Are Right to Pay Them So Much Attention*. Retrieved from CITYLAB Website: <https://www.citylab.com/equity/2014/05/what-millennials-want-and-why-cities-are-right-pay-them-so-much-attention/9032/>. Hewko, J. (2018, January 10). *This is what millennials want in 2018*. Retrieved from World Economic Forum website: <https://www.weforum.org/agenda/2018/01/this-is-what-millennials-want-in-2018/>. Rosenbloom, C. (2019, February 21). 9 ways millennials are changing the way we eat. *The Washington Post*.
 49 For an in-depth discussion of the age cohorts of Columbia's population, see the Population Element.
 50 Surfaces shaded by trees or vegetation may be 20-45 degrees cooler than peak temperatures of unshaded materials. USEPA, <https://www.epa.gov/heat-islands-using-trees-and-vegetation-reduce-heat-islands#1> accessed 11.10.19. Akbari, H., D. Kurn, et al. 1997. Peak power and cooling energy savings of shade trees. *Energy and Buildings* 25:139-148
 51 On a sunny summer day, roofs and pavement can be 50-90 degrees hotter than air temperatures. USEPA, <https://www.epa.gov/heat-islands/heat-island-impacts#1>, accessed 11.10.19. Berdahl P. and S. Bretz. 1997. Preliminary survey of the solar reflectance of cool roofing materials. *Energy and Buildings* 25:149-158
 52 Studies suggest 5-10% of community-wide demand for electricity is tied to the heat island effect. Ibid.
 53 U.S. National Weather Service Columbia SC. (2019, October 5). Daily Temperature Data - Columbia Area, SC (Facebook post), and follow up telephone conversation with Leonard Vaughan, Climate Programs Lead, October 9, 2019
 54 NOAA National Centers for Environmental Information. (2017, December). *National Climate Report - Annual 2017*. Retrieved from NOAA Website: <https://www.ncdc.noaa.gov/sotc/national/201713>
 55 NOAA National Centers for Environmental Information. (2018, December). *National Climate Report - Annual 2018*. Retrieved from NOAA Website: <https://www.ncdc.noaa.gov/sotc/national/201813>
 56 State records were broken for both the 24-hour and 5-day total rainfall records throughout the State in October 2015 – in Columbia, 17.7 inches of rain were recorded on October 4th, with 15.1 inches falling in less than 10 hours that morning. Runkle, J., Kunkel, K., Stevens, L., Frankson, R., Stewart, B., & Sweet, W. (2017). *NOAA National Centers for Environmental Information State Climate Summaries South Carolina*. NOAA Technical Report NESDIS 149-SC.
 57 Reidmiller, D.R.; Avery, C.W.; Easterling, D.R.; Kunkel, K.E.; Lewis, K.L.M.; Maycock, T.K; Stewart, B.C. (eds). (2018). *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II, Report-in-Brief*. Washington, D.C.: U.S. Global Change Research Program, U.S. Government Publishing Office.
 58 Walker, B., & Salt, D. (2006). *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*. Washington, D.C.: Island Press.
 59 For example, the City of Columbia is a part of a water system agreement that allowed for drinking water aid during the 2015 hurricanes.
 60 Boswell, M.R.; Greve, A.I.; Seale, T.L.. (2019). *Climate Action Planning: A Guide to Creating Low-Carbon, Resilient Communities*. Washington, D.C.: Island Press, page 193.