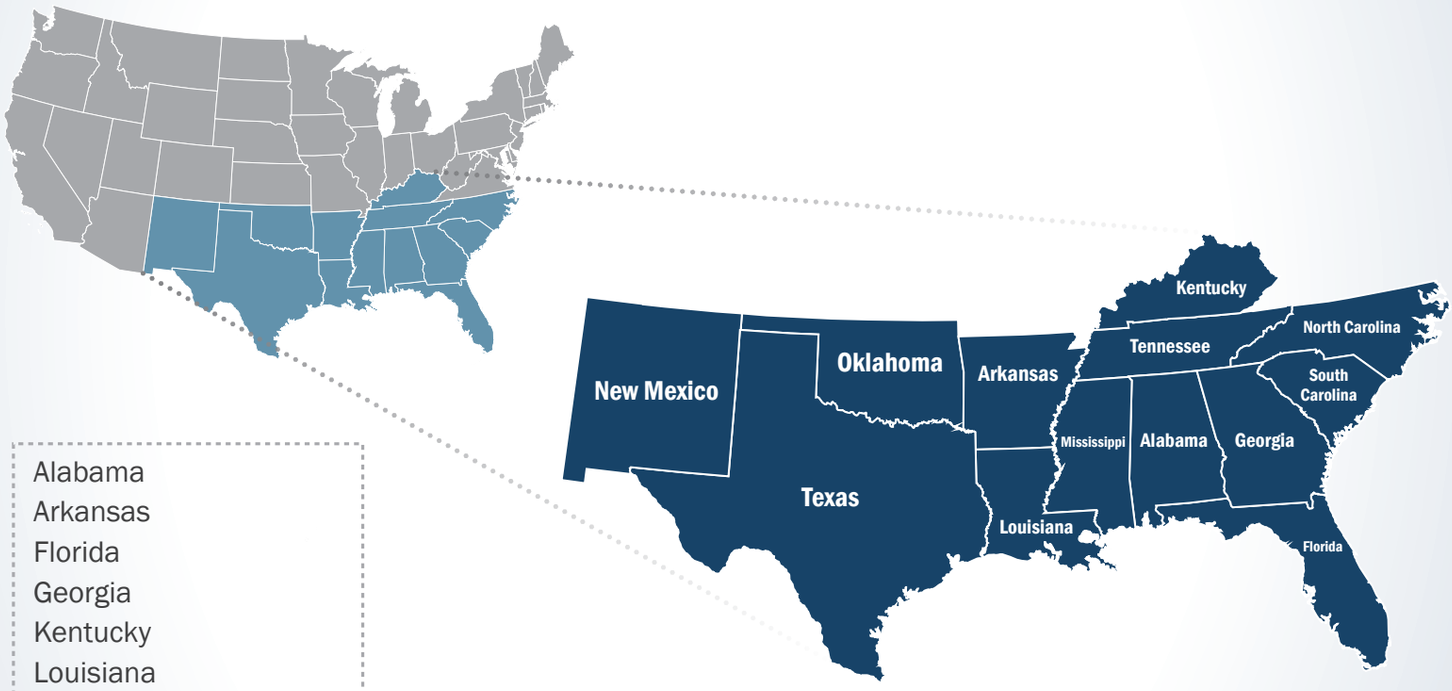
FirstNet®

Nationwide Public Safety Broadband Network

Draft Programmatic Environmental Impact Statement for the Southern United States

VOLUME 11 - CHAPTER 13



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North Carolina
Oklahoma
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Tennessee
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First Responder Network Authority

FirstNet®

Nationwide Public Safety Broadband Network
Draft Programmatic Environmental Impact Statement for the Southern United States

VOLUME 11 - CHAPTER 13

Amanda Goebel Pereira, AICP
NEPA Coordinator
First Responder Network Authority
U.S. Department of Commerce
12201 Sunrise Valley Dr. M/S 243
Reston, VA 20192

Cooperating Agencies
Federal Communications Commission
General Services Administration
U.S. Department of Agriculture—Rural Utilities Service
U.S. Department of Agriculture—U.S. Forest Service
U.S. Department of Agriculture—Natural Resource Conservation Service
U.S. Department of Defense—Department of the Air Force
U.S. Department of Energy
U.S. Department of Homeland Security

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13. SOUTH CAROLINA

Human beings have inhabited the South Carolina region for more than 13,500 years. American Indian tribes with a rich cultural history lived in what is now South Carolina prior to the 1600s, when European settlers arrived. North and South Carolina were originally part of the English colony Carolina, but were divided in 1710. South Carolina was one of the 13 original colonies and has the distinction of having been the site of the most battles during the Revolutionary War. In 1788, South Carolina ratified the U.S. Constitution and became the eighth state to join the Union (South Carolina State Library, 2015). South Carolina is bordered by North Carolina to the north, Georgia to the south and west, and the Atlantic Ocean to the east. This chapter provides details about the existing environment of South Carolina as it relates to the Proposed Action.

General facts about South Carolina are provided below:

- **State Nickname:** The Palmetto State (State Symbol USA, 2016)
- **Land Area:** 30,061 square miles (2010); **U.S. Rank:** 40 (U.S. Census Bureau, 2015a)
- **Capital:** Columbia
- **Counties:** 46 (South Carolina Association of Counties, 2016)
- **2015 Estimated Population:** Over 4.8 million people; **U.S. Rank:** 24 (U.S. Census Bureau, 2015a)
- **Most Populated Cites:** Columbia, Charleston, and North Charleston (U.S. Census Bureau, 2015b)
- **Main Rivers:** Broad River, Black River, Catawba River, Lynches River, Edisto River, Great Pee Dee River, and Santee River (DNR, 2015)
- **Bordering Waterbodies:** Atlantic Ocean
- **Mountain Ranges:** Blue Ridge Mountains, and a portion of the Appalachian Mountains
- **Highest Point:** Sassafras Mountain (3,563 feet) (USGS, 2015a)

13.1. AFFECTED ENVIRONMENT

13.1.1. Infrastructure

13.1.1.1. Definition of the Resource

This section provides information on key South Carolina infrastructure resources that could potentially be affected by FirstNet projects. Infrastructure consists of the systems and physical structures that enable a population in a specified area to function. Infrastructure is entirely manmade with a high correlation between the type and extent of infrastructure and the degree to which an area is characterized as "developed." Infrastructure includes a broad array of facilities such as utility systems, streets and highways, railroads, airports, buildings and structures, ports, harbors and other manmade facilities. Individuals, businesses, government entities, and virtually all relationships between these groups depend on infrastructure for their most basic needs, as well as for critical and advanced needs (e.g., emergency response, health care, and telecommunications).

Section 13.1.1.3 provides an overview of South Carolina's traffic and transportation infrastructure, including road and rail networks and waterway facilities. South Carolina's public safety infrastructure could include any infrastructure utilized by a public safety entity[1] as defined in Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (Public Law [Pub. L.] No. 112-96, Title VI Stat. 156 (codified at 47 United States Code [U.S.C.] 1401 et seq.) (the Act), including infrastructure associated with police, fire, and emergency medical services (EMS). However, other organizations can qualify as public safety services as defined by the Act. Public safety services in South Carolina are presented in more detail in Section 13.1.1.4. Section 13.1.1.5 describes South Carolina's public safety communications infrastructure and commercial telecommunications infrastructure. An overview of South Carolina utilities, such as power, water, and sewer, is presented in Section 13.1.1.6.

13.1.1.2. Specific Regulatory Considerations

Multiple South Carolina laws and regulations pertain to the state's public utility and transportation infrastructure and its public safety community. Table 13.1.1-1 identifies the relevant laws and regulations, the affected agencies, and their jurisdiction as derived from the state's applicable statutes and administrative rules referenced in column one. Appendix C, Environmental Laws and Regulations, identifies applicable federal laws and regulations.

Table 13.1.1-1: Relevant South Carolina Infrastructure Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
South Carolina Code of Laws: Title 23 Law Enforcement and Public Safety	South Carolina Emergency Management Division	Leads the state emergency management program to minimize the loss of life and property from all-hazard events; creates and carries out an emergency operations plan and coordinates with various federal, state, and local agencies to carry out the plan.

[1] The term "public safety entity" means an entity that provides public safety services (7 U.S. Code [U.S.C.] § 1401(26)).

State Law/Regulation	Regulatory Agency	Applicability
South Carolina Code of Laws: Title 58 Public Utilities, Services and Carriers	Public Service Commission	Provides fair, open, and efficient regulatory process that promotes cost-effective and reliable utility services; seeks to ensure that citizens receive appropriate levels of customer satisfaction and quality of service; provides a more competitive utility environment; and regulates investor owned electric and gas utility companies, water and wastewater companies, telecommunications companies, motor carriers of household goods, hazardous waste disposal, and taxicabs.
South Carolina Code of Laws: Title 57 Highways, Bridges and Ferries	Department of Transportation	Provides for the planning, construction, maintenance, and operation of a highway system and the development of a statewide mass transit system.

13.1.1.3. Transportation

This section describes the traffic and transportation infrastructure in South Carolina, including specific information related to the road networks, airport facilities, rail networks, harbors and ports (this PEIS defines "harbor" as a body of water deep enough to allow anchorage of a ship or boat). The movement of vehicles is commonly referred to as traffic, as well as the circulation along roads. Roadways in the state can range from multilane road networks with asphalt surfaces, to unpaved gravel or private roads. The information regarding existing transportation systems in South Carolina are based on a review of maps, aerial photography, and federal and state data sources.

The South Carolina Department of Transportation (SCDOT) has jurisdiction over freeways and major roads, airports, railroads, mass transit, and ports in the state; local counties have jurisdiction for smaller streets and roads. The SCDOT is "responsible for operating and maintaining over 41,000 miles (90,000 lane miles) of roads and over 8,400 bridges, ranking SC as the fourth largest state-owned highway system in the nation according to the Federal Highway Administration [FHWA]" (SCDOT, 2015a).

South Carolina has an extensive and complex transportation system across the entire state. The state's transportation network is comprised of:

- Over 41,000 miles of roads and over 8,400 bridges (SCDOT, 2015a);
- 2,258 miles of rail network that includes passenger rail and freight (SCDOT, 2014);
- 194 aviation facilities, including airstrips and heliports (FAA, 2015a);
- 75 harbors (U.S. Harbors, 2015); and
- Two major ports that includes both public and private facilities.

Road Networks

As identified in Figure 3.1.1-1, the major urban centers of the state from north to south are Charlotte-Concord, Greenville-Spartanburg-Anderson, Columbia-Orangeburg-Newberry, and Myrtle Beach-Conway (U.S. Census Bureau, 2013). South Carolina has five major interstates connecting its major metropolitan areas to one another, as well as to other states. Travel outside the major metropolitan areas is conducted on interstates, and state and county roads. Table

13.1.1-2 lists the interstates and their start/end points in South Carolina. Per the national standard, even numbered interstates run from west to east with the lowest numbers beginning in the south; odd numbered interstates run from north to south with the lowest numbers beginning in the west (FHWA, 2015a).

Table 13.1.1-2: South Carolina Interstates

Interstate	Southern or western terminus in SC	Northern or eastern terminus in SC
I-20	GA line at North Augusta	I-95 in Florence
I-26	NC line near Landrum	US-17 in Charleston
I-77	I-26 in Cayce	NC line at Fort Mill
I-85	GA line near Fair Play	NC line at Blacksburg
I-95	GA line at Hardeeville	NC line at Hamer

In addition to the Interstate System, South Carolina has both National Scenic Byways and State Scenic Byways. National and State Scenic Byways are roads that are recognized for one or more archaeological, cultural, historic, natural, recreational, and scenic qualities (FHWA 2013). Figure 13.1.1-1 illustrates the major transportation networks, including roadways, in South Carolina. Section 13.1.8, Visual Resources, describes the National and State Scenic Byways found in South Carolina from an aesthetic perspective.

National Scenic Byways are roads with nationwide interest; the U.S. Department of Transportation's Federal Highway Administration designates and manages the byways. South Carolina has four National Scenic Byways (FHWA, 2015b):

- Ashley River Road: 11 miles in southeast South Carolina;
- Cherokee Foothills Scenic Highway: 112 miles in northwest South Carolina;
- Edisto Island National Scenic Byway: 16.8 miles in southeast South Carolina; and
- Savannah River Scenic Byway: 110 miles in western South Carolina.

State Scenic Byways are roads with statewide interest; SCDOT designates and manages State Scenic Byways. Some State Scenic Byways may be designated on portions of National Scenic Byways. South Carolina has 17 State Scenic Byways that crisscross the entire state[2] (SCDOT, 2015b):

- Bohicket Road
- Cowpens Battlefield
- Edisto Beach
- Falling Waters
- Fort Johnson Road
- Hilton Head
- Hilton Head Island
- Long Point Road
- Mathis Ferry Road
- May River
- McTeer Bridge
- Old Sheldon Church
- Plantersville
- Riverland Drive
- SC 170
- US 21
- Western York

[2] The total number of State Scenic Byways may not include those segments of National Scenic Byways that are also designated as State Scenic.

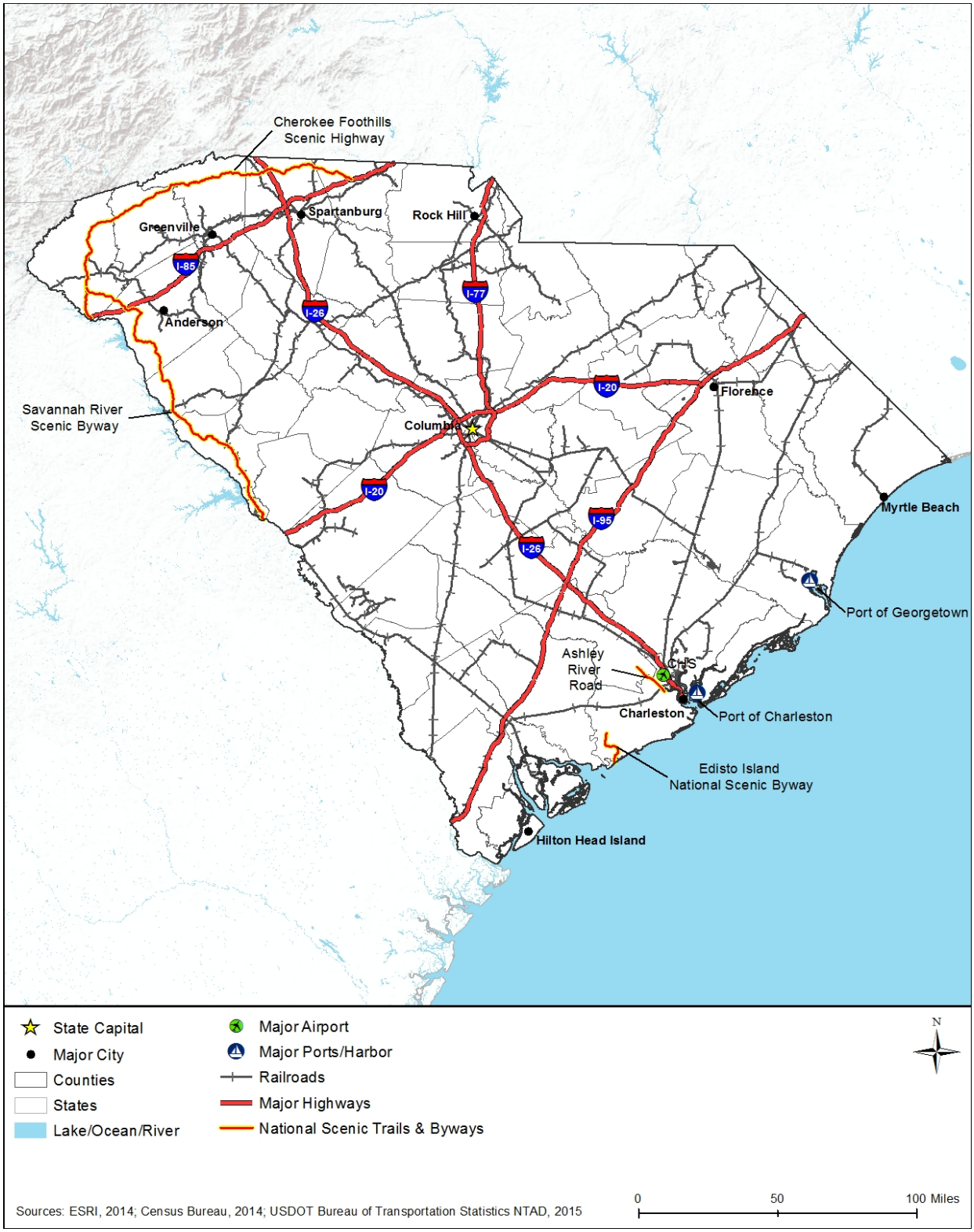


Figure 13.1.1-1: South Carolina Transportation Networks

Airports

In South Carolina, Charleston International Airport (CHS), Greenville-Spartanburg International Airport (GSP), and Myrtle Beach International Airport (MYR) have more than 303,000 annual operations combined (FAA, 2015b). CHS is owned and operated by the Charleston County Aviation Authority (CHS, 2015). In 2014, CHS served 3,131,072 passengers, facilitated 105,782 aircraft operations, and moved 55,936,125 pounds of cargo (CHS, 2014). CHS is the 69th busiest airport in the nation, in terms of the number of passengers served (FAA, 2015c). Figure 13.1.1-1 illustrates the major transportation networks, including airports, in the state. Section 13.1.1.5, Airspace, provides detail on airports and airspace in South Carolina.

Rail Networks

South Carolina is connected to a rail network of passenger rail (Amtrak) and freight rail. Figure 13.1.1-1 illustrates the major transportation networks, including rail lines, in South Carolina. Amtrak runs two lines through South Carolina: Crescent and Silver Service/Palmetto (Amtrak, 2015a). The Crescent runs every day between New York and New Orleans, making three stops in South Carolina. However, the Crescent stops at the South Carolina stations "in evening or early morning hours, which tend to be inconvenient for riders" (SCDOT, 2014). The Silver Service/Palmetto also provides daily service between New York and Florida, with eight stops in South Carolina. In fiscal year 2012, Amtrak served 243,669 (SCDOT, 2014). Table 13.1.1-3 provides a complete list of Amtrak lines that run through South Carolina.

Table 13.1.1-3: Amtrak Train Routes Serving South Carolina

Route	Starting Point	Ending Point	Length of Trip	Major Cities Served in South Carolina
Crescent	New York, NY	New Orleans, LA	30 hours	Spartanburg, Greenville, Clemson
Silver Service/Palmetto	New York, NY	Tampa/Miami, FL	28+ hours	Dillon, Florence, Kingstree, North Charleston, Yemassee, Camden, Columbia, Denmark

Sources: (Amtrak, 2015a) (Amtrak, 2015b)

Two Class I freight railroads operate in the state: CSX Transportation (CSXT) and Norfolk Southern Railway (NSR) (SCDOT, 2014). CSXT owns and operates 1,269 miles of track, which is 56 percent of all the rails in South Carolina (SCDOT, 2014). NSR owns and operates 679 miles, which is 30 percent of the state's rail system (SCDOT, 2014). An additional 10 smaller railroad companies operate in the state (SCDOT, 2014). In 2011, 70.3 million tons of freight traveled through South Carolina via freight rail (SCDOT, 2014). Of that, 43.9 percent is pass-through traffic, 37.9 percent is inbound, 11.5 percent is outbound, and 6.7 percent is freight rail moving within South Carolina (SCDOT, 2014).

Harbors and Ports

The state of South Carolina shares its eastern border with the Atlantic Ocean. Its coastline contains bays and rivers, some of which support boating or shipping facilities. The Charleston Harbor, just east of the City of Charleston, is one of the most important of these locations as it is home to the Port of Charleston (SCPorts, 2015a). The Port of Charleston operates five terminals:

Waldo Welch, North Charleston, Columbus Street, Union Pier, and Veterans. These terminals handle a variety of cargo, including vehicle service at the Columbus Street terminal, containerized cargo at the Waldo Welch terminal, and refrigerated boxed cargo at the North Charleston terminal (SCPorts, 2015c). CSX and Norfolk Southern railway lines aid the port's ability to move cargo inland (SCPorts, 2015d). As depicted in Figure 13.1.1-1, the port can also be reached via I-26, which runs within two miles of all of the port's terminals. Nearby connections to I-95, I-77, I-20, I-40, and I-85 also aid inland transportation (SCPorts, 2015e). The ports location on the Charleston Harbor and its inland connections allow it to be an important overseas shipping facility. In 2013, the Port of Charleston imported $40.7 billion worth of cargo, weighing 9.8 million tons and exported $24.4 billion, weighing 7.0 million tons (U.S. Census Bureau, 2015z).

About 60 miles north of the Port of Charleston is the Port of Georgetown, a breakbulk, and bulk cargo port located in an inlet of the Sampit River (SCPorts, 2015b). The Sampit River extends north from the Winyah and Mud Bays, which are protected from Atlantic storms by the Baruch-North Island Reserve and the Yawkey-South Island Reserve. The Port of Georgetown is a "dedicated breakbulk and bulk cargo port" that handles cargo such as steel, aggregates, forest products, and cement (SCPorts, 2015b). Seen in 13.1.1-1, the port is can be accessed via US Highway 17 and offers rail access from CSX Transportation (SCPorts, 2015f). Though it is a smaller facility than the Port of Charleston, the Port of Georgetown also does some amount of overseas shipping. In 2013, the Port of Georgetown imported $6.7 million, weighing 36 thousand tons; as well as exporting $500,000, weighing about 110 tons (U.S. Census Bureau, 2015z).

13.1.1.4. Public Safety Services

South Carolina public safety services consist of public safety infrastructure and first responder personnel aligned with the demographics of the state. Table 13.1.1-4 presents South Carolina's key demographics including population; land area; population density; and number of counties, cities/towns, and municipal governments. More information about these demographics is presented in Section 13.1.9, Socioeconomics; however, these demographics are key to understanding the breadth of public safety services throughout the state.

Table 13.1.1-4: Key South Carolina Indicators

South Carolina Indicators	
Estimated Population (2015)	4,896,146
Land Area (square miles) (2010)	30,061
Population Density (persons per sq. mile) (2010)	153.9
Municipal Governments (2013)	268

Sources: (National League of Cities, 2007) (U.S. Census Bureau, 2015c)

Table 13.1.1-5 presents South Carolina's public safety infrastructure, including fire and police stations. Table 13.1.1-6 identifies first responder personnel including dispatch, fire and rescue, law enforcement, and medical personnel in the state.

Table 13.1.1-5: Public Safety Infrastructure in South Carolina by Type

Infrastructure Type	Number
Fire and Rescue Stations [a]	1,062
Law Enforcement Agencies [b]	272
Fire Departments [c]	441

[a] Data collected by the U.S. Fire Administration in 2015.
[b] Number of agencies from state and local law enforcement include: local police departments, sheriffs' offices, primary state law enforcement agencies, special jurisdictional agencies, and other miscellaneous agencies, collected by the U.S. Bureau of Justice Statistics in 2008.
[c] Data collected by the U.S. Fire Administration in 2015.
Sources: (U.S. Fire Administration, 2015) (U.S. Bureau of Justice Statistics, 2011)

Table 13.1.1-6: First Responder Personnel in South Carolina by Type

First Responder Personnel	Number
Police, Fire and Ambulance Dispatchers [a]	1,360
Fire and Rescue Personnel [b]	19,861
Law Enforcement Personnel [c]	16,111
Emergency Medical Technicians and Paramedics [d e]	5,130

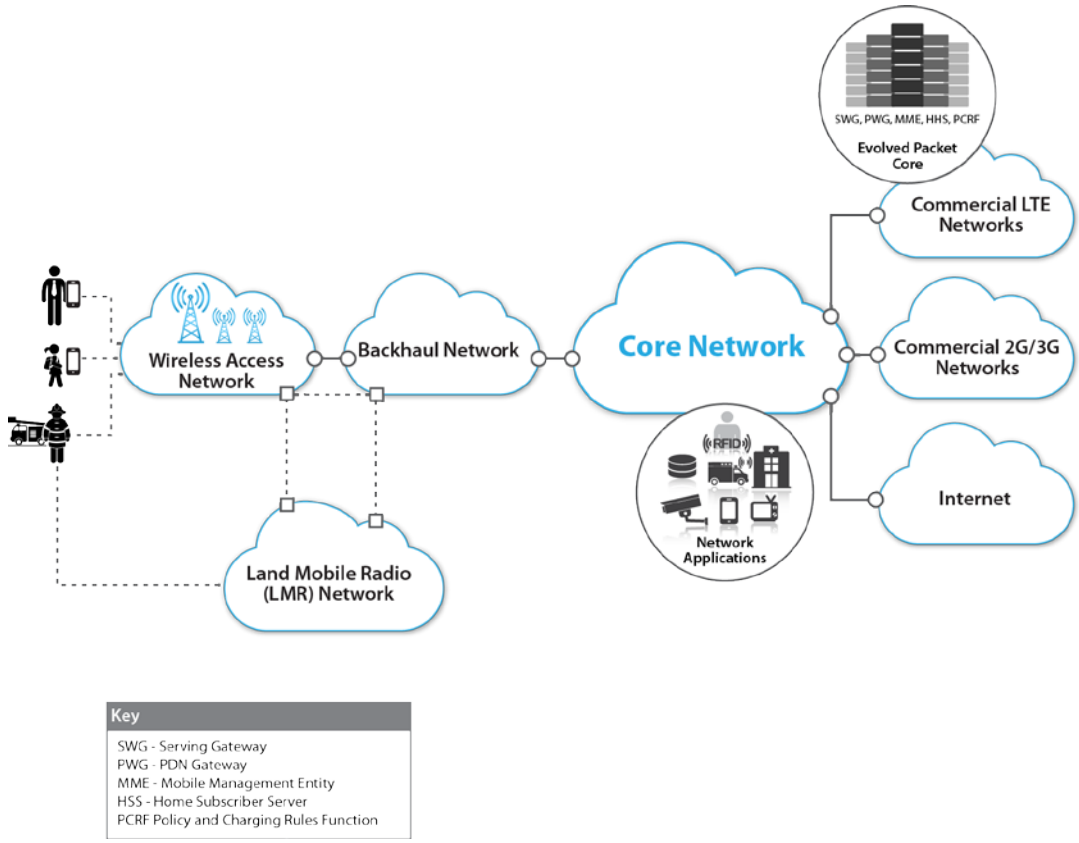
[a] BLS Occupation Code: 43-5031
[b] BLS Occupation Codes: 33-2011 (Firefighters), 33-2021 (Fire Inspectors and Investigators), 33-1021 (First-Line Supervisors of Fire Fighting and Prevention Workers), and 53-3011 (Ambulance Drivers and Attendants, Except Emergency Medical Technicians). Volunteer firefighters reported by the U.S. Fire Administration.
[c] Full-time employees from state and local law enforcement agencies which include: local police departments, sheriffs' offices, primary state law enforcement agencies, special jurisdictional agencies, and other miscellaneous agencies, collected by the U.S. Bureau of Justice Statistics in 2008.
[d] BLS Occupation Code: 29-2041
[e] All BLS data collected in 2015.
Sources: (U.S. Fire Administration, 2015) (U.S. Bureau of Justice Statistics, 2011) (BLS, 2015h)

13.1.1.5. Telecommunications Resources

There is no central repository of information for public safety communications infrastructure and commercial telecommunications infrastructure; therefore, the following information and data are combined from a variety of sources, as referenced.

Communications throughout the state are based on a variety of publicly and commercially owned technologies, including coaxial cable (traditional copper cable), fiber optics, hybrid fiber optics/coaxial cable, microwave, wireless, and satellite systems providing voice, data, and video services (BLS, 2016).

Figure 13.1.1-2 presents a typical wireless configuration including both a narrowband public safety land mobile radio network (traditional radio network) and a commercial broadband access network (wireless technology); backhaul (long-distance wired or wireless connections), core, and commercial networks including a long term evolution (LTE) evolved packet core (modern broadband cellular networks); and network applications (software) delivering voice, data, and video communications (FCC, 2016a).



Prepared by: Booz Allen Hamilton

Figure 13.1.1-2: Wireless Network Configuration

Public Safety Communications

In order to protect and best serve the public interest, first responder and law enforcement communities must be able to communicate effectively. The evolution of the communications networks used by public safety stakeholders toward a broadband wireless technology, such as LTE (see Section 13.1.1), has the potential to provide users with better coverage, while offering additional capacity and enabling the use of new applications that would likely make their work safer and more efficient. Designing such a network presents several challenges due to the uniqueness of the deployment, the requirements, and the nationwide scale (NIST 2015). Historically, there have been many challenges and impediments to timely and effective sharing of information. Chief among these factors impacting information sharing are: network coverage gaps, land mobile radio system infrastructure diversity, insufficient budgets, and diverse radio frequencies.

Communication interoperability has also been a persistent challenge, along with issues concerning spectrum availability, embedded infrastructure, and differing standards among stakeholders (NTFI, 2005). This has caused a fragmented approach to communications

implementation across the U.S. and specifically in South Carolina. There are five key reasons why public safety agencies often cannot connect through existing communications (NTFI, 2005):

- Incompatible and aging communications equipment;
- Limited and fragmented funding;
- Limited and fragmented planning;
- A lack of coordination and cooperation; and
- Limited and fragmented radio spectrum.

To enable the public safety community to incorporate disparate Land Mobile Radio networks into a nationwide public safety LTE broadband network, in 2015, the U.S. Department of Commerce Public Safety Communications Research (PSCR) prepared a locations-based services (LBS) research and development "roadmap" to examine the current state of location-based technologies. The program also forecasts the evolution of LBS capabilities and gaps, and identifies potential research and development opportunities that would improve the public safety community's use of LBS within operational settings. This is the first of several technology roadmaps that PSCR plans to develop over the next few years. (PSCR, 2015)

South Carolina's public safety LMR network environment is facing transition due to the challenges of the need for greater system capabilities. These increasing capabilities require investment in the state's Project 25 (P25) Palmetto 800 MHz network, continuing site maintenance and upgrades, incremental site resiliency and reliability improvements, investment to complete the fuller transition to the broader implementation of the Palmetto 800 MHz P25 Project 25 digital technology, and planning for the adoption of broadband and new data services.

The South Carolina Department of Administration summarizes the statewide 800 MHz network ownership, coverage, and objectives as follows, "The South Carolina Statewide 800 MHz Radio and Mobile Data Network is a cost-shared public/private partnership between state government, local governments, power utilities, and Motorola, Inc.… The Palmetto 800 Network serves South Carolina as well as Augusta-Richmond County, Georgia. The goal of the shared network is to provide statewide coverage, enhance statewide interoperability, coordinate the state's response to emergencies, and to provide an economical solution for standalone public safety radio systems. This statewide shared trunked network,[3] operational since 1992, is in the process of being upgraded to the digital P25 technology and has grown from over 20,000 users in 2006, to over 40,000 users today (South Carolina Department of Administration, 2015).

The South Carolina Department of Technology, within the Department of Administration, oversees the Palmetto 800 MHz network with input from an elected advisory committee. This committee ensures that public safety stakeholder and user inputs are incorporated into requirements planning and capability enhancements for the network.

[3] A trunk or trunked network is one where system design allows for multiple users to share multiple lines or frequencies.

Statewide/Multi-County Public Safety Networks

South Carolina's Palmetto shared trunked 800 MHz network (referred to in the state typically as "the Palmetto 800") according to the state's Department of Administration was launched in 1992 as an analog LMR network. The Palmetto 800 MHz system supports 175 state, local, and federal agencies, as well as public utility users through its LMR public-private partnership structure. (South Carolina Department of Administration, 2015)

This network is being been upgraded to the digital P25 technology. The network's radios will be converted to digital units and are projected to be completed by December 2016, with radio sites to be upgraded with digital infrastructure equipment beginning on January 1, 2017. (Crouch, 2015)

In addition to "the Palmetto 800" statewide voice and data network, South Carolina also continues to maintain a statewide emergency communications network called the Palmetto Tactical Communications Network (PATCON). This is a state-owned LMR network using state and national interoperability frequencies in order to meet the need for public safety users who do not have access to a trunked radio system. In addition, it also provides backup for the Palmetto 800 network. (South Carolina Department of Administration, 2015) The tower map and coverage for the PATCON network is depicted in Figure 13.1.1-3 below (South Carolina Department of Administration, 2015).

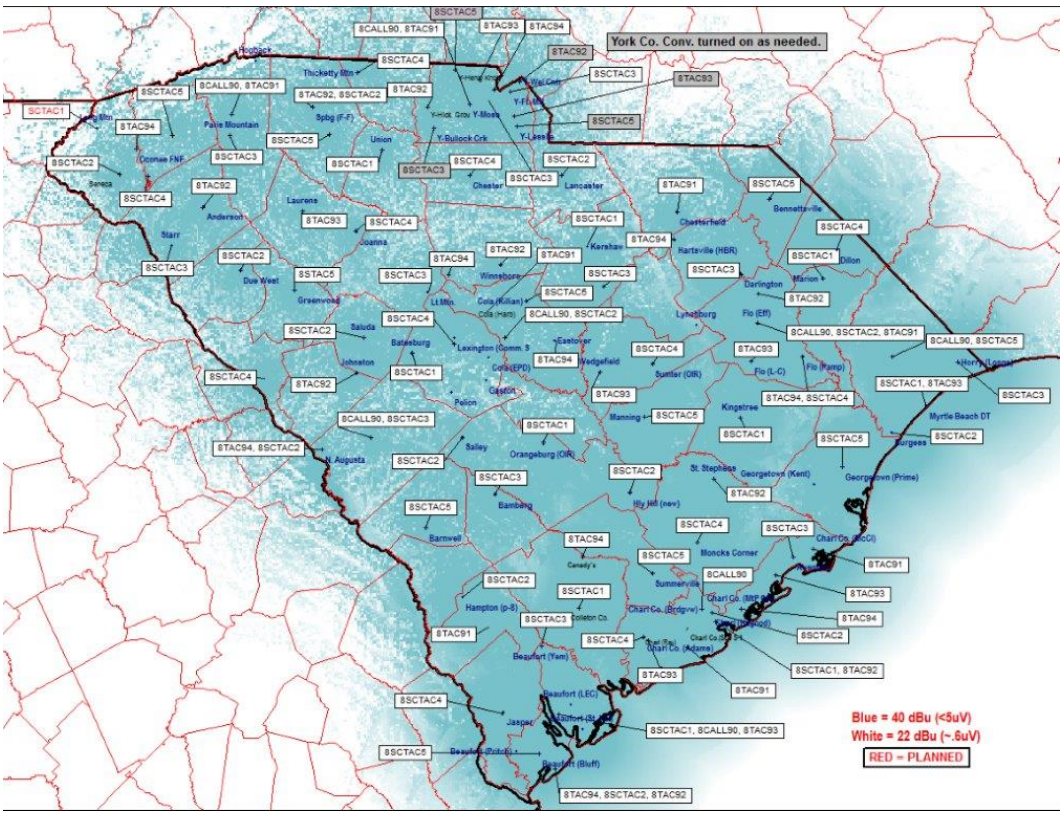


Figure 13.1.1-3: Palmetto 800 MHz Network Tower Locations and Coverage Map

Source: (South Carolina Department of Administration, 2015)

County/City Public Safety Networks

Most city and county public safety LMR users across the state's counties participate in assigned talk groups (police/sheriff, fire, EMS) on the Palmetto 800 MHz system. In addition, they also have access to analog legacy Very High Frequency (VHF)[4] and/or Ultra High Frequency (UHF)[5] frequencies. As digital wireless equipment is deployed in the network over the next few years, public safety users will communicate over the Palmetto digital P25 system.

Abbeville County is an example in the state of the mix of frequencies and talk groups that counties and cities have in South Carolina is. In Abbeville County, located in western South Carolina, the Palmetto 800 is accessed by the Abbeville County fire, EMS, police, and sheriff departments (RadioReference.com, 2015a). In addition to the Palmetto 800 MHz network in Abbeville County, VHF systems are used by county fire and EMS for tactical communications and dispatch, while the county's sheriff department uses UHF for tactical communications and dispatch. In the city of Abbeville, fire dispatch is done on VHF while police dispatch occurs on UHF (RadioReference.com, 2015a).

An example of the broad adoption enjoyed by the state's digital P25 system is York County (which also has adopted a digital P25 system for county and city use). York County, which is located in northern South Carolina bordering North Carolina, has deployed a countywide digital P25 network, which is used by the York County Public Safety agencies (sheriff, fire, and EMS departments). The cities within York County (York City, Clover, Fort Mill, Tega Cay) have all adopted the digital P25 Palmetto 800 systems for their police departments, and many of the analog VHF legacy systems have been shut down with the adoption of the higher frequency 800 MHz system (RadioReference.com, 2015b).

Commercial Telecommunications Infrastructure

South Carolina's commercial telecommunications industry and infrastructure is robust with multiple service providers, offering products and services via the full spectrum of telecommunications technologies (FCC, 2014a) (FCC, 2014b). The following sub-sections present information on South Carolina's commercial telecommunications infrastructure, including information on the number of carriers and technologies deployed; geographic coverage; voice, Internet access, and wireless subscribers; and the quantity and location of telecommunications towers, fiber optic plant, and data centers.

Carriers, Coverage, and Subscribers

South Carolina's commercial telecommunications industry provides the full spectrum of telecommunications technologies and networks, including coaxial cable (traditional copper cable), fiber optics, hybrid fiber optics/coaxial cable, microwave, wireless, and satellite systems.

[4] VHF band covers frequencies ranging from 30 MHz to 300 MHz (NTIA, 2005).
[5] UHF band covers frequencies ranging from 300 MHz to 3000 MHz (NTIA, 2005).

Table 13.1.1-7 presents the number of providers of switched access[6] lines, Internet access,[7] and mobile wireless services including coverage.

Table 13.1.1-7: Telecommunications Access Providers and Coverage in South Carolina as of December 31, 2013

Commercial Telecommunications Access Providers	Number of Service Providers	Coverage of Households
Switched access lines [a]	149	97.7% of households [b]
Internet access [c]	42	55% of households
Mobile wireless [d]	8	92% of population

[a] Switched access lines are a service connection between an end user and the local telephone company's switch (the basis of older telephone services); this number of service providers was reported by the FCC as of December 31, 2013 in Table 17 in "Local Telephone Competition: Status as of December 31, 2013" as the total of ILEC and non-ILEC providers (FCC, 2014b).
[b] Household coverage data provided by the FCC in "Universal Service Monitoring Report" as a Voice Penetration percentage (percentage of household with a telephone in the unit) and is current as of 2013.
[c] Internet access providers are presented in Table 21 in "Internet Access Services: Status as of December 31, 2013" by technology provided; number of service providers is calculated by subtracting the reported Mobile Wireless number from the total reported number of providers (FCC, 2014a).
[d] Mobile wireless provider data is provided by the FCC in the sources identified. However, NTIA's National Broadband Map provides newer data, so FirstNet is using NTIA's GIS-based data from the National Broadband Map instead of the data reported by the FCC. The process for retrieving the National Broadband Map data is explained in detail in a subsequent footnote in Section 13.1.1.5, Last Mile Fiber Assets.

Sources: (FCC, 2014a; FCC, 2014b) (NTIA, 2014) (FCC, 2013)

Table 13.1.1-8 shows the wireless providers in South Carolina along with their geographic coverage. The following four maps: Figure 13.1.1-4, Figure 13.1.1-5, Figure 13.1.1-6 , and Figure 13.1.1-7 show: the combined coverage for the top two providers, Sprint and T-Mobile's coverage, FTC Wireless, Cricket Wireless, and, U.S. Cellular's coverage, and the coverage of all other providers with less than 5 percent coverage area, respectively.[8]

[6] "A service connection between an end user and the local telephone company's switch; the basis of plain old telephone services (POTS)" (FCC, 2014b).
[7] Internet access includes Digital Subscriber Line (DSL), cable modem, fiber, satellite, and fixed wireless providers.
[8] The broadband map utilized data collected as part of the broadband American Recovery and Reinvestment Act initiative. The data was retrieved from the FCC National Broadband Map website (www.broadbandmap.gov/data-download). Each state's broadband data was downloaded accordingly. The data pertaining to broadband data/coverage for census blocks, streets, addresses, and wireless were used. Census blocks, roads, and addresses were merged into one file and dissolved by similar business and provider names. Square miles were calculated for each provider. The maps show all providers over 5% on separate maps; providers with areas under 5% were merged and mapped as "South Carolina Other Fiber Providers." All Wireless providers were mapped as well; those with areas under 5% were merged and mapped as "South Carolina Other Wireless Providers." Providers under 5% were denoted in their respective tables.

Table 13.1.1-8: Wireless Telecommunications Coverage by Providers in South Carolina

Wireless Telecommunications Providers	Coverage
AT&T Mobility LLC	96.17%
Verizon Wireless	95.96%
Sprint	52.81%
T-Mobile	21.59%
FTC Wireless	9.59%
Cricket Wireless	7.86%
U.S. Cellular	5.33%
Other[a]	14.09%

[a] Other: Provider with less than 5% coverage area. Providers include: NTInet, Inc.; Comporium Communications; PRT Communications; Electronics Service Company; PDOL.com; Globalvision; Countrywide Wireless; Skyrunner, Inc.; PBT Communications, Inc.
Source: (NTIA, 2014)

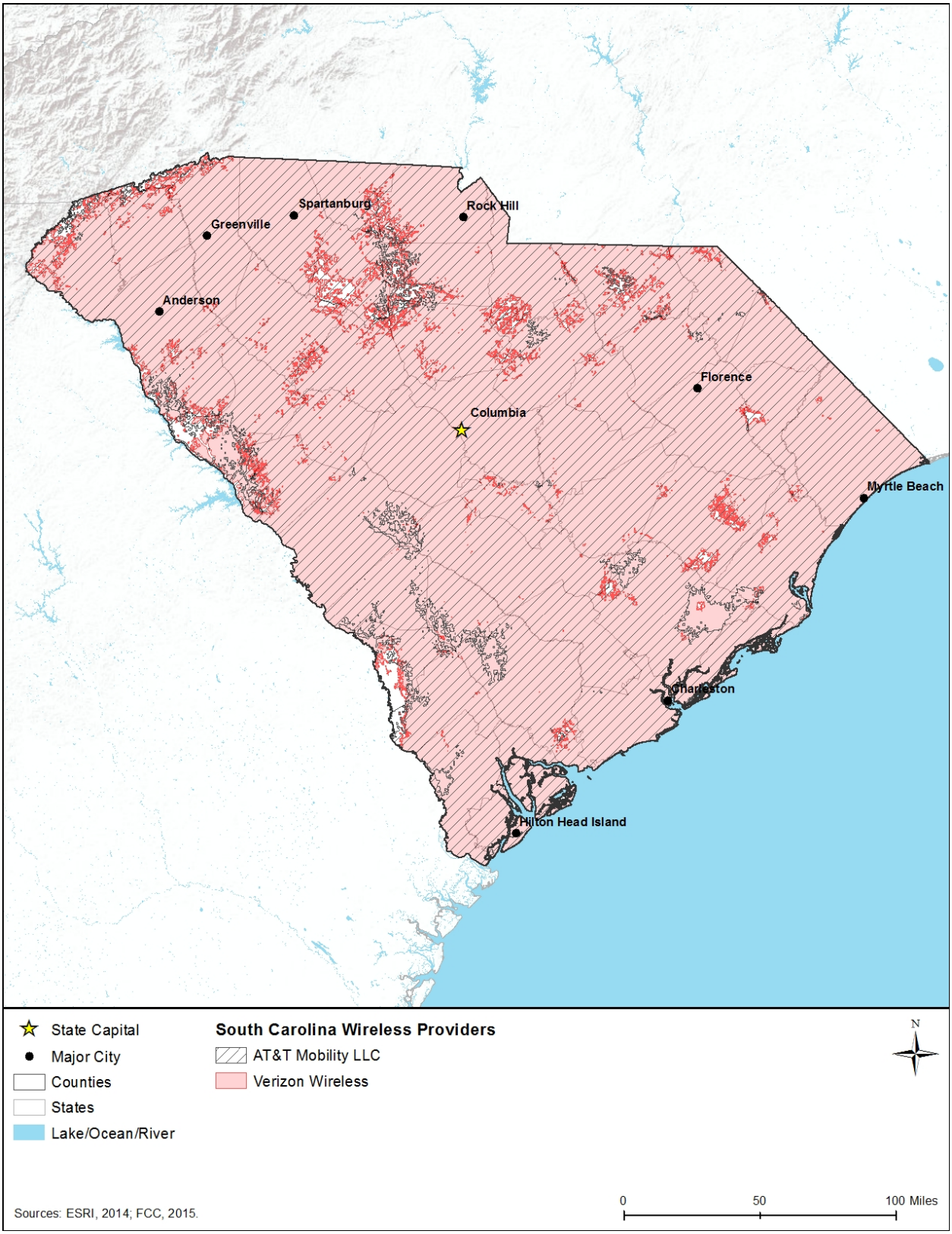


Figure 13.1.1-4: Top Wireless Providers Availability in South Carolina

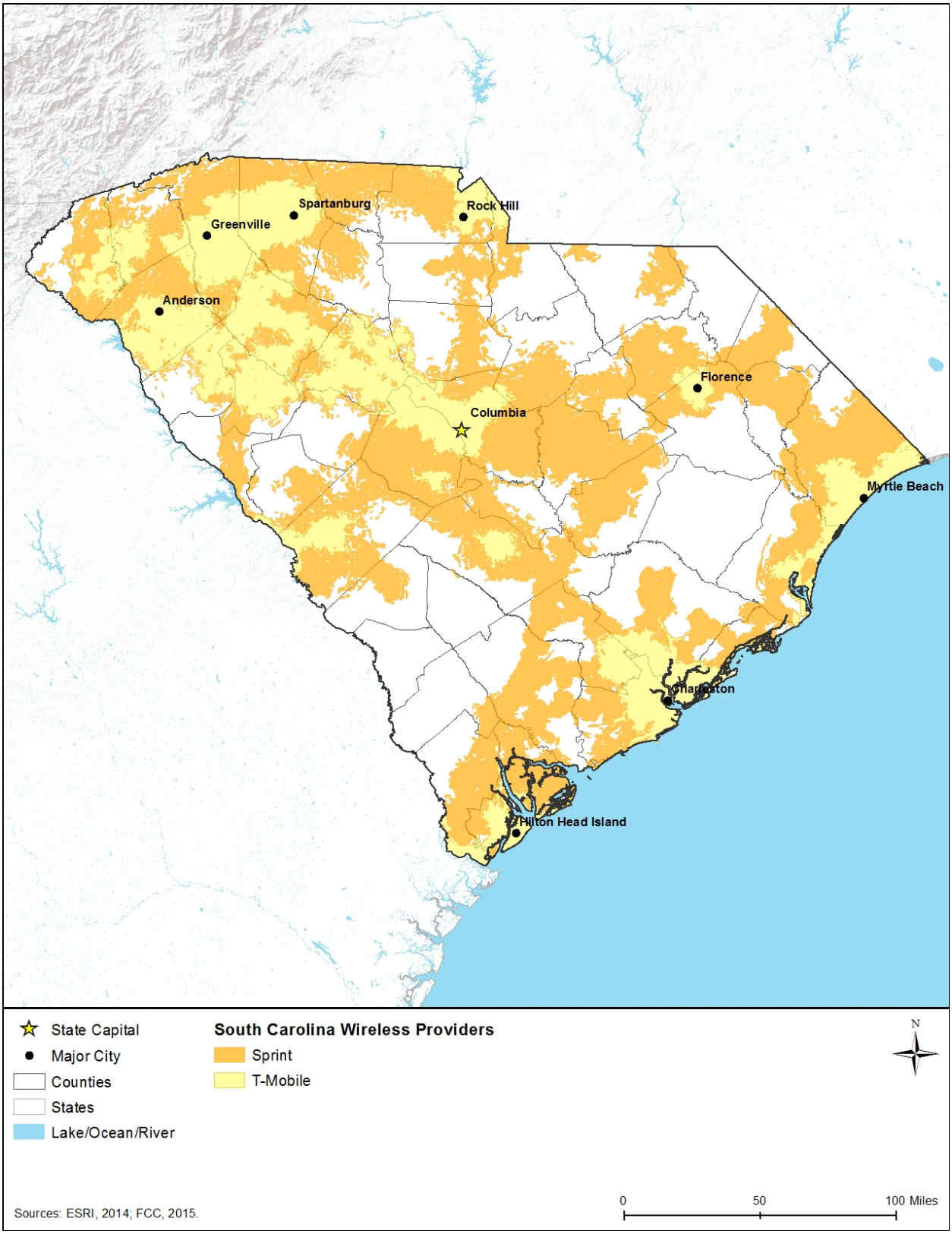


Figure 13.1.1-5: Sprint and T-Mobile Wireless Availability in South Carolina

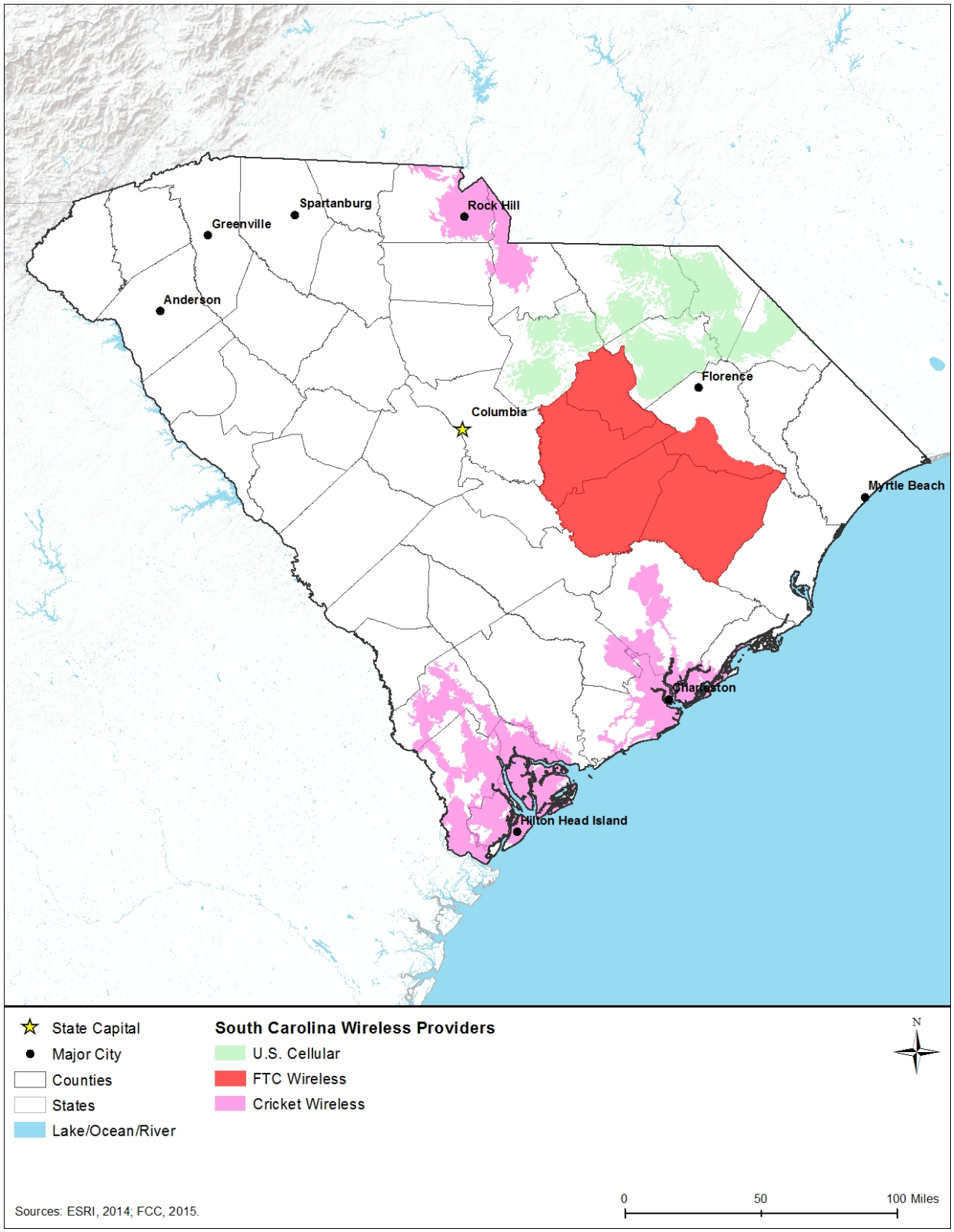


Figure 13.1.1-6: FTC Wireless, Cricket Wireless, and U.S. Cellular Wireless Availability in South Carolina

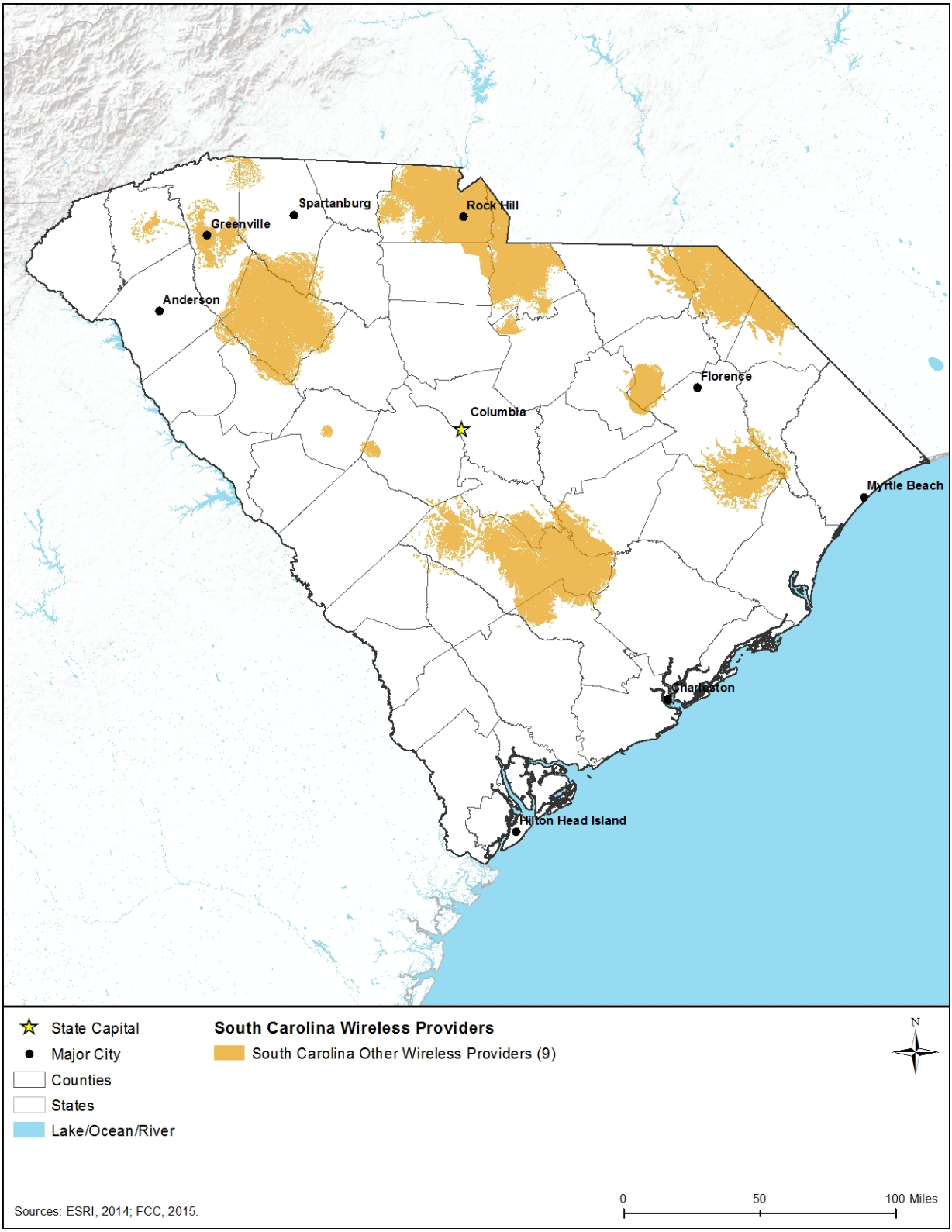


Figure 13.1.1-7: Other Provider Wireless Availability in South Carolina

Towers

There are many types of domestic towers employed today by the telecommunications industry, government agencies, and other owners. Towers are designed and used for a variety of purposes, and the height, location, and supporting structures and equipment are all designed, constructed, and operated according to the technical specifications of the spectrum used, the type of equipment mounted on the tower, geographic terrain, need for line-of-sight transmissions to other towers, radio frequency needs, and other technical specifications. There are three general categories of stand-alone towers: monopole, lattice, and guyed. Typically, monopole towers are the smallest, followed by lattice towers at a moderate height, and guyed towers at taller heights (with the guyed wires providing tension support for the taller heights) (CSC, 2007). In general, taller towers can provide communications coverage over larger geographic areas, but require more land for the actual tower site, whereas shorter towers provide less geographic coverage and require less land for the tower site (USFS, 2009a). Figure 13.1.1-8 presents representative examples of each of these categories or types of towers.

Monopole
100 – 200 feet
Source: http://laps.noaa.gov/birk/laps_intranet/site_photos/Monarch/tower.jpg

Lattice
200 – 400 feet
Source: Personal Picture

Guyed
200 – 2,000 feet
Source: http://www.esrl.noaa.gov/gmd/ccgg/insitu/

Figure 13.1.1-8: Types of Towers

Telecommunications tower infrastructure proliferates throughout South Carolina, although tower infrastructure is concentrated in the higher and more densely populated areas of South Carolina; Rock Hill, Spartanburg, Greenville, Anderson, Columbia, Florence, Myrtle Beach, Charleston, and Hilton Head Island. Owners of towers and some types of antennas are required to register those infrastructure assets with the FCC (FCC, 2016b).[9] Table 13.1.1-9 presents the number of

[9] An antenna structure must be registered with the FCC if the antenna structure is taller than 200 feet aboveground level or may interfere with the flight path of a nearby airport (FCC, 2016b).

towers (including broadcast towers) registered with the FCC in South Carolina by tower type, and Figure 13.1.1-9 presents the location of those 2,608 structures, as of June 2016.

Table 13.1.1-9: Number of Commercial Towers in South Carolina by Type

Constructeda Towersb		**Constructed Monopole Towers**	
100ft and over	403	100ft and over	0
75ft – 100ft	1,014	75ft – 100ft	6
50ft – 75ft	425	50ft – 75ft	66
25ft – 50ft	206	25ft – 50ft	44
25ft and below	25	25ft and below	5
Subtotal	**2,073**	**Subtotal**	**121**
Constructed Guyed Towers		**Buildings with Constructed Towers**	
100ft and over	70	100ft and over	3
75ft – 100ft	70	75ft – 100ft	1
50ft – 75ft	19	50ft – 75ft	4
25ft – 50ft	4	25ft – 50ft	1
25ft and below	0	25ft and below	1
Subtotal	**163**	**Subtotal**	**10**
Constructed Lattice Towers		**Multiple Constructed Structures[c]**	
100ft and over	11	100ft and over	0
75ft – 100ft	137	75ft – 100ft	0
50ft – 75ft	70	50ft – 75ft	0
25ft – 50ft	13	25ft – 50ft	0
25ft and below	0	25ft and below	0
Subtotal	**231**	**Subtotal**	**0**
Constructed Tanks[d]			
Tanks	10		
Subtotal	**10**		
Total All Tower Structures		**2,608**	

[a] Planned construction or modification has been completed. Results will return only those antenna structures that the FCC has been notified are physically built or planned modifications/alterations to a structure have been completed (FCC, 2015).
[b] Self standing or guyed (anchored) structure used for communication purposes (FCC, 2012).
[c] Multiple constructed structures per antenna registration (FCC, 2016c).
[d] Any type of tank – water, gas, etc. with a constructed antenna (FCC, 2016c).
Source: (FCC, 2015)

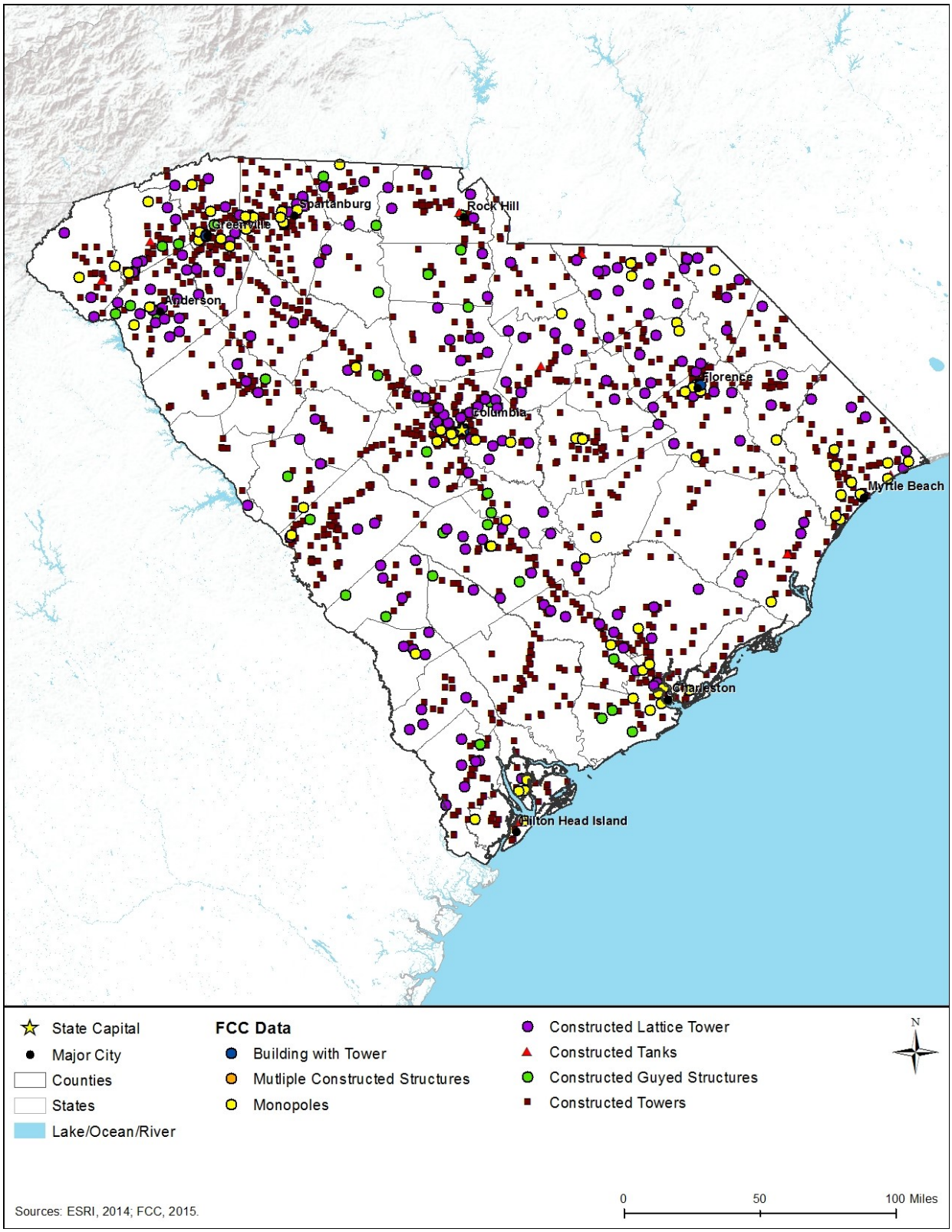
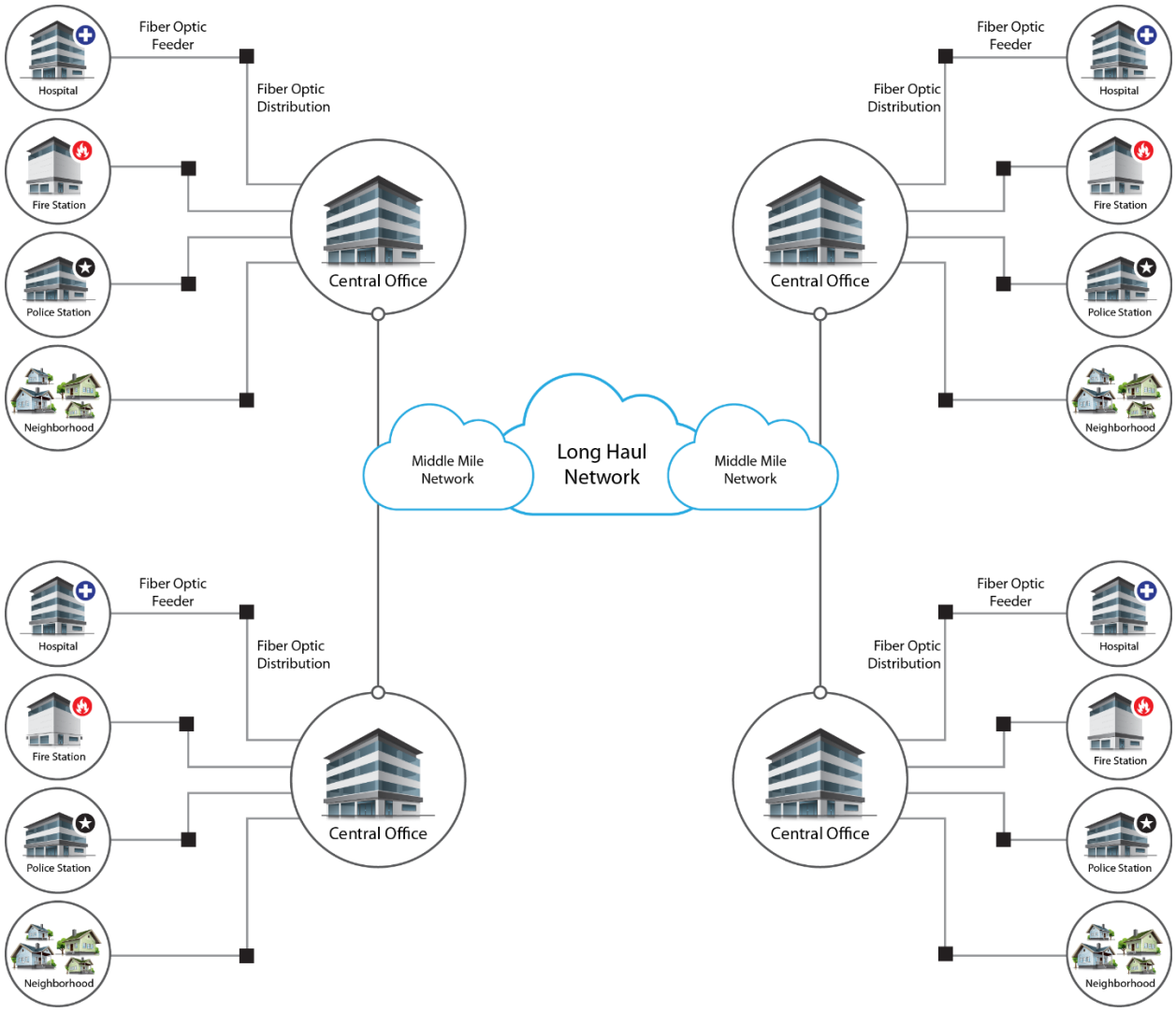


Figure 13.1.1-9: FCC Tower Structure Locations in South Carolina

Fiber Optic Plant (Cables)

Fiber optic plant, or cables, can be buried directly in the ground; pulled, blown, or floated into ducts, conduits, or innerduct (flexible plastic protective sleeves or tubes); placed under water; or installed aerially between poles, typically on utility rights-of-way (ROWs). A fiber optic network includes an access network consisting of a central office, distribution and feeder plant (cables of various sizes directly leaving a central office and splitting to connect users to the network), and a user location, as shown in Figure 13.1.1-10. The network also may include a middle mile component (shorter distance cables linking the core network between central offices or network nodes across a region) and a long haul network component (longer distance cables linking central offices across regions) (FCC, 2000).



Prepared by: Booz Allen Hamilton

Figure 13.1.1-10: Typical Fiber Optic Network in South Carolina

Last Mile Fiber Assets

In South Carolina, fiber access networks are concentrated in the highest population centers as shown in the figures below. Thirty-one fiber providers offer service in the state, as listed in Table 13.1.1-10. Figure 13.1.1-11 shows coverage for AT&T South Carolina and Charter Communications Inc.; Figure 13.1.1-12 shows coverage for Charter Communications Inc., Farmers Telephone Cooperative, Frontier Communications of the Carolinas Inc., and Comporium Communications; and Figure 13.1.1-13 shows coverage for other providers with less than 5 percent coverage area, respectively.

Table 13.1.1-10: Fiber Provider Coverage in South Carolina

Fiber Provider	Coverage
AT&T South Carolina	18.52%
Time Warner Cable	11.20%
Charter Communications, Inc.	9.75%
Farmers Telephone Cooperative	6.72%
Frontier Communications of the Carolinas, Inc.	5.50%
Comporium Communications	5.20%
Other [a]	30.09%

[a] Other: Provider with less than 5 percent coverage area. Providers include: CenturyLink; Horry Telephone Cooperative, Inc.; TruVista, Home Telecom; Comcast; PRTC; Sandhill Telephone Cooperative; West Carolina Tel; Atlantic Broadband; Windstream North Carolina, LLC; Northland Cable Television; TDS Telecom; PRT Communications; Level 3 Communications, LLC; Bluffton Telephone; WOW!; Hargray Telephone; MetroCast Communications; Chesnee Communications; FTC Diversified Services, Inc.; PBT Telecom, Inc.; Southern Coastal Cable LLC; Family View Cable; TW Telecom of South Carolina LLC; and Palmetto Telephone Communications.
Source: (NTIA, 2014)

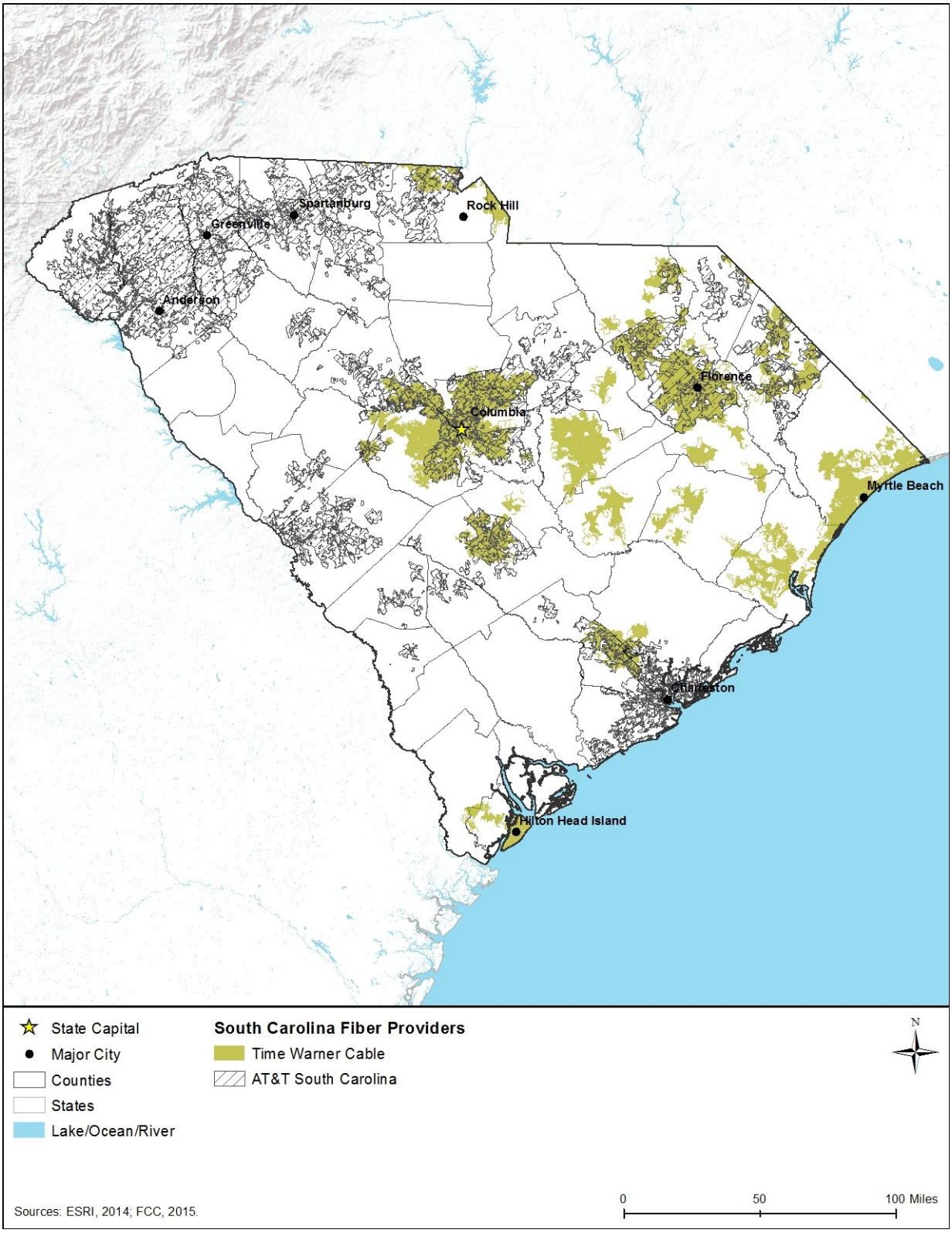


Figure 13.1.1-11: Fiber Availability in South Carolina for AT&T South Carolina and Time Warner Cable

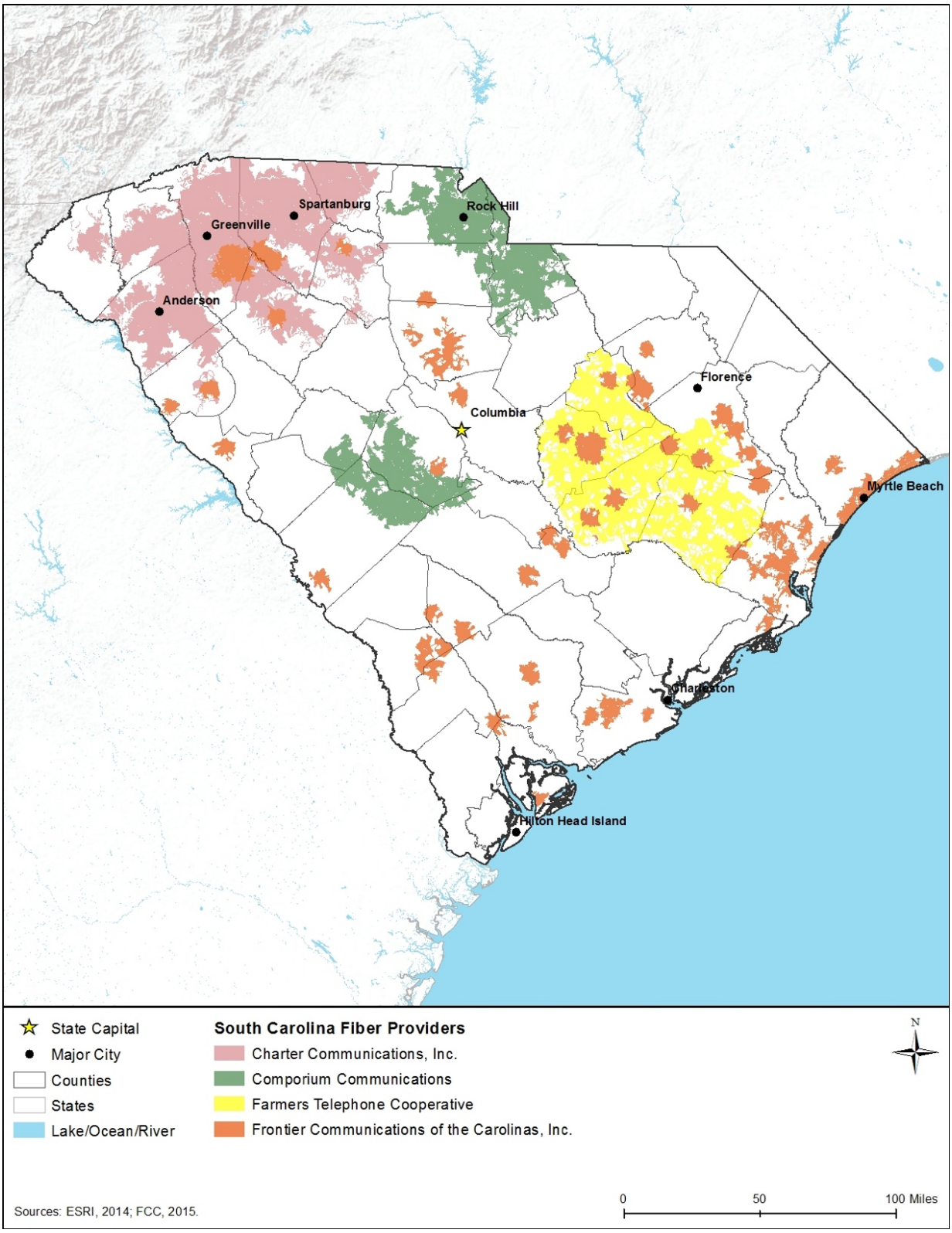


Figure 13.1.1-12: Charter Communications Inc., Farmers Telephone Cooperative, Frontier Communication of the Carolinas Inc., and Comporium Communication's Fiber Availability in South Carolina

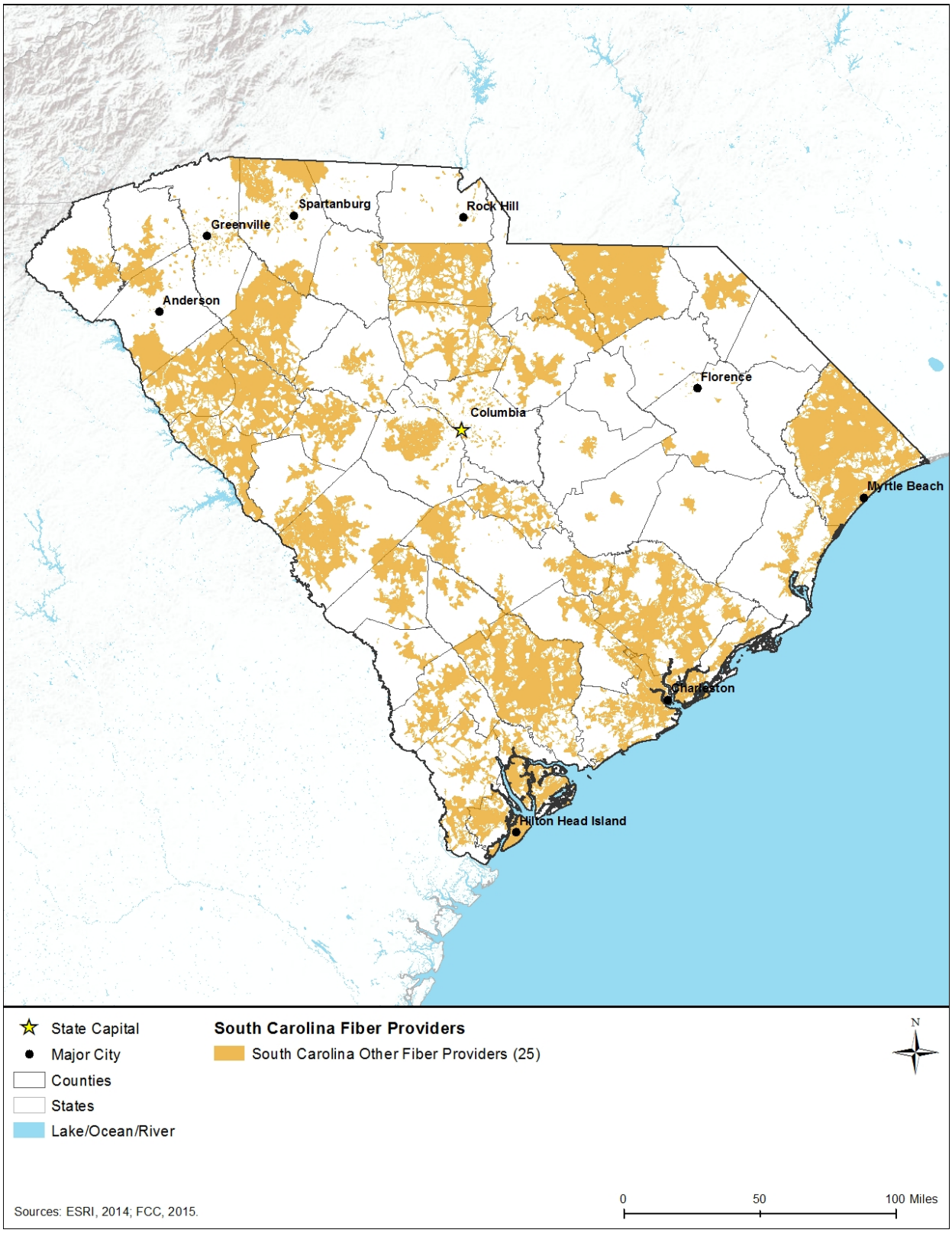


Figure 13.1.1-13: Other Providers Fiber Availability in South Carolina

Data Centers

Data centers (also known as network access points, collocation facilities, hosting centers, carrier hotels, and Internet exchanges) are large telecommunications facilities that house routers, switches, servers, storage, and other telecommunications equipment. These data centers facilitate efficient network connectivity among, between telecommunications carriers, and between carriers and their largest customers. These facilities also provide racks and cages for equipment, power and cooling, cabling, physical security, and 24x7 monitoring (CIO Council, 2015; GAO, 2013). Ownership of data centers may be public or private; comprehensive information regarding data centers may not be publicly available as some are related to secure facilities.

13.1.1.6. Utilities

Utilities are the essential systems that support daily operations in a community and cover a broad array of public services, such as electricity, water, wastewater, and solid waste. Section 13.1.4, Water Resources, describes the potable water sources in the state.

Electricity

The South Carolina Public Service Commission (PSC) regulates some aspects of the operation of South Carolina's investor-owned electricity companies. This regulation includes the quality of service provided and the rates charged by electric utilities. The PSC does not regulate Electric Membership Corporations or municipal electric systems. Four companies exist under their authority: "Duke Energy Carolinas, LLC, Lockhart Power Company, Progress Energy Carolinas, Inc., and South Carolina Electric & Gas Company" (PSC, 2015). Most of South Carolina's electricity comes from electric generation facilities using either coal or nuclear power (EIA, 2015a). In 2014, nuclear power provided 52,418,553 megawatthours[10] of electricity, or 54 percent of the total 97,158,465 megawatthours created in the state (EIA, 2015a). The states four nuclear power plants supplied this energy. In addition, there are two additional reactors are currently under construction (EIA, 2015b). Coal fueled electricity facilities generated 28,914,307 megawatthours of electricity in the same year, or 30 percent of the total produced. Other sources of electricity generation included natural gas, hydroelectric facilities, and biomass (EIA, 2015a). "South Carolina enacted a renewable portfolio standard in 2014 authorizing the creation of distributed energy resource programs to encourage the development of in-state renewable energy generation capacity" (EIA, 2015b). Regarding the consumption of electricity in South Carolina, the industrial sector uses the largest percentage (33.3 percent). The state's transportation sector uses 27.2 percent of its power, while the residential and commercial sectors use 23.1 and 16.4 percent, respectively (EIA, 2015b).

Water

The South Carolina Department of Health and Environmental Control (SCDHEC) oversees the quality of South Carolina's water. The SCDHEC enforces the Federal Safe Drinking Water Act

[10] One megawatthour is defined as one thousand kilowatt-hours or one million watt-hours; where one watthour is "the electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electric circuit steadily for one hour." (EIA, 2016).

(SDWA), under which the United States Environmental Protection Agency (USEPA) sets drinking water quality standards. This law sets standards for the acceptable levels of 90 contaminants that may be found in water. The SCDHEC also enforces the South Carolina State SDWA and state drinking water regulations, all of which concern water-borne contaminants (SCDHEC, 2015a). They also enforce National Secondary Drinking Water Regulations, which give "guidelines for 15 contaminants that may cause cosmetic or aesthetic effects in drinking water (e.g., skin or tooth discoloration, taste, odor), but pose no known health risk" (SCDHEC, 2015a). The oversight of the SCDHEC extends to all public water systems, which are federal defined as systems "that provide water via piping or other constructed conveyances for human consumption to at least fifteen service connections [taps] or to an average of at least twenty-five people for at least sixty days each year" (SCDHEC, 2014i). The state has 1,444 public water systems and of these, 94 systems had violations in 2013, with 174 total violations. Of the 94 systems, 55 only had one violation (SCDHEC, 2014i). In addition, all water utilities must complete a Consumer Confidence Report, which details the source of the system's drinking water, as well as any contaminants or compliance violations. These reports are then made public and mailed to consumers (SCDHEC, 2015b).

Wastewater

The SCDHEC oversees the management of wastewater in the state through the issuing of permits for the discharge of wastewater. The National Pollutant Discharge Elimination System (NPDES) was designed as a part of the Federal Clean Water Act in 1972. The USEPA gave authority over the program in the state to the SCDHEC in 1975. The SCDHEC is now "responsible for the permitting, compliance, monitoring, and enforcement activities of the program" (SCDHEC, 2015c). NPDES permits are required by anyone wishing to discharge wastewater in state surface waters (SCDHEC, 2015c). These permits are categorized as either general or individual. General permits are used in cases where operations for several facilities are similar, such as the dischargers would be discharging similar types of waste or they would require similar limitations on the amount to be discharged (SCDHEC, 2015d). Individual permits are used in when a general permit would not apply (SCDHEC, 2015c).

Solid Waste Management

The management of South Carolina's solid waste also falls under the jurisdiction of the DHEC. The state is home to 406 facilities dedicated to the management of solid waste including landfills, compost facilities, land application facilities, transfer stations, waste tire recyclers, and wood chipping facilities (SCDHEC, 2015p). Among these are 174 landfills that are split between classes 1, 2, and 3. Class 1 landfills handle land-clearing debris such as stumps or wood chips, Class 2 landfills deal with medical waste, and Class 3 landfills accept municipal wastes (SCDHEC, 2015f). Additionally, there are114 composting or wood chipping facilities, and 21 waste tire facilities in the state. In 2013, municipal landfills received 2,985,852 tons of solid waste material. Approximately 69 percent of the 4,357,812 tons of municipal waste generated in 2013 was placed in out of state landfills. The remaining 1,371,960 tons were recycled, representing the highest amount since 2007. This was an increase of over 11 percent compared to the previous year, giving the state a recycling rate of 31.5 percent. The state also saw a 25

percent increase in the recycling of electronic, a quantity of 11,560 tons of materials (SCDHEC, 2013). South Carolina law requires the SCDHEC to maintain a solid waste management plan for the state, as well as requiring country or regional governments to develop their own plans. Goals set in the fiscal year 2011 Annual Report outlined a need to recycle at least 40 percent of municipal waste by 2020, as well as a desire to reduce overall disposal of waste to 3.25 pounds per person per day across the state. By 2013, three counties had met the goal of a 40 percent recycling rate, while 31 counties met or exceeded the goal (SCDHEC, 2013).

13.1.2. Soils

13.1.2.1. Definition of the Resource

The Soil Science Society of America defines soil as:

(i) "The unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants" (NRCS, 2015b).

(ii) "The unconsolidated mineral or organic matter on the surface of the Earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics" (NRCS, 2015b).

Five primary factors account for soil development patterns. A combination of the following variables contributes to the soil type in a particular area (University of Minnesota, 2001):

- *Parent Material*: The original geologic source material from the soil formed affects soil aspects, including color, texture, and ability to hold water.
- *Climate*: Chemical changes in parent material occur slowly in low temperatures. However, hot temperatures evaporate moisture, which also facilitates chemical reactions within soils. The highest degree of reaction within soils occurs in temperate, moist climates.
- *Topography*: Steeper slopes produce increased runoff, and, therefore, downslope movement of soils. Slope orientation also dictates the microclimate to which soils are exposed, because different slope faces receive more sunlight than others do.
- *Biology*: The presence/absence of vegetation in soils affects the quantity of organic content of the soil.
- *Time*: Soil properties are dependent on the period over which other processes act on them.

13.1.2.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of the National Environmental Policy Act (NEPA) and other applicable laws and regulations. Applicable federal laws and regulations that apply for Soils, such as the Farmland Protection Policy Act of 1981, are in Appendix C, Environmental Laws and Regulations. A list of applicable state laws and regulations is included in Table 13.1.2-1 below.

Table 13.1.2-1: Relevant South Carolina Soils Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
South Carolina National Pollutant Discharge Elimination System (NPDES) General Permit SCR-100000	SCDHEC	Erosion controls are required as part of the NPDES General Permit SCR-100000 for construction activities that disturb one acre or more.

13.1.2.3. Environmental Setting

South Carolina is composed of three Land Resource Region,[11] as defined by the National Resources Conservation Service (NRCS) (NRCS, 2006):

- Atlantic and Gulf Coast Lowland Forest and Crop Region;
- East and Central Farming and Forest Region; and
- South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region.

Within and among South Carolina's three land resource regions are six Major Land Resource Areas (MLRA),[12] which are characterized by patterns of soils, climate, water resources, land uses, and type of farming. The locations and characteristics of South Carolina's MLRAs are presented in Figure 13.1.2-1 and Table 13.1.2-2.

Soil characteristics are an important consideration for FirstNet insomuch as soil properties could influence the suitability of sites for network deployment. Soil characteristics can differ over relatively short distances, reflecting differences in parent material, elevation and position on the landscape, biota[13] such as bacteria, fungi, biological crusts, vegetation, animals, and climatic variables such as precipitation and temperature. For example, expansive soils[14] with wet and dry seasons alternately swell and shrink, which presents integrity risks to structural foundations (Rogers, Olshansky, & Rogers, 2004). Soils can also be affected by a variety of surface uses that loosen topsoil and damage or remove vegetation or other groundcover, which may result in accelerated erosion, compaction, and rutting[15] (discussed further in the subsections below).

[11] Land Resource Region: "A geographical area made up of an aggregation of Major Land Resource Areas (MLRA) with similar characteristics" (NRCS, 2006).
[12] Major Land Resource Area: "A geographic area, usually several thousand acres in extent, that is characterized by a particular pattern of soils, climate, water resources, land uses, and type of farming" (NRCS, 2006).
[13] The flora and fauna of a region.
[14] Expansive soils are characterized by "the presence of swelling clay minerals" that absorb water molecules when wet and expand in size or shrink when dry leaving "voids in the soil" (Rogers, Olshansky, & Rogers, 2004).
[15] Rutting is indentations in soil from operating equipment in moist conditions or soils with lower bearing strength (USFS, 2009b).

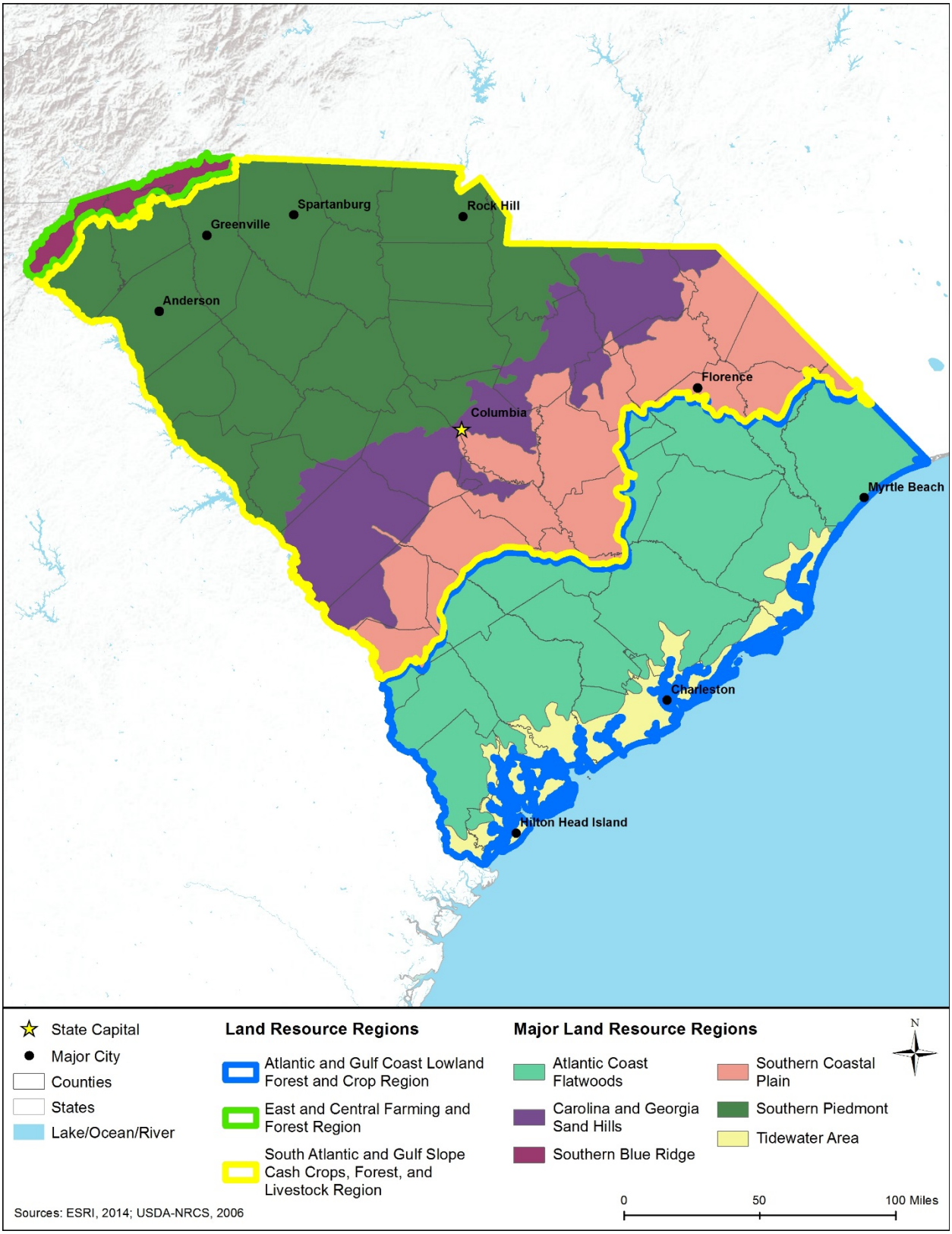


Figure 13.1.2-1: Locations of Major Land Resource Areas in South Carolina

Table 13.1.2-2: Characteristics of Major Land Resource Areas in South Carolina

MLRA Name	Region of State	Soil Characteristics
Atlantic Coast Flatwoods	Eastern South Carolina	Spodosols[a] and Ultisols[b] are the dominant soil orders. These clayey or loamy soils[c] typically range from well drained to poorly drained, and are very deep.
Carolina and Georgia Sand Hills	Central South Carolina	Entisols[d] and Ultisols are the dominant soil orders. These loamy or sandy soils range from well drained to excessively drained, and are very deep.
Southern Blue Ridge	Western South Carolina	Inceptisols[e] and Ultisols are the dominant soil orders. These clayey or loamy soils range from shallow to very deep.
Southern Coastal Plain	Central South Carolina	Entisols, Inceptisols, and Ultisols are the dominant soil orders. These loamy soils range from poorly drained to somewhat excessively drained, and are typically very deep.
Southern Piedmont	Western South Carolina	Alfisols,[f] Inceptisols, and Ultisols are the dominant soil orders. These well drained soils are clayey or loamy and typically range from shallow to very deep.
Tidewater Area	Eastern South Carolina	Alfisols and Entisols are the dominant soil orders, with Histosols[g] less so. These soils are very deep, and clayey or loamy, with "restricted drainage."

[a] Spodosols: "Spodosols formed from weathering processes that strip organic matter combined with aluminum from the surface layer and deposit them in the subsoil. They commonly occur in areas of course-textured deposits under coniferous forests of humid regions, tend to be acid and infertile, and make up about 4% of the world's ice-free land surface." (NRCS, 2015d)
[b] Ultisols: "Soils found in humid environments that are formed from fairly intense weathering and leaching processes. This results in a clay-enriched subsoil dominated by minerals. They have nutrients concentrated in the upper few inches and make up 8% of the world's ice-free land surface." (NRCS, 2015d)
[c] Loamy Soil: "[A soil] that combines [sand, silt, and clay] in relatively equal amounts." (Purdue University Consumer Horticulture, 2006)
[d] Entisols: "Soils that show little to no pedogenic horizon development. They occur in areas of recently deposited parent materials or in dunes, steep slopes, or flood plains where erosion or deposition rates are faster than rate of soil development. They make up nearly 16% of the world's ice-free land surface." (NRCS, 2015d)
[e] Inceptisols: "Soils found in semiarid to humid environments that exhibit only moderate degrees of soil weathering and development. They have a wide range of characteristics, can occur in a wide variety of climates, and make up nearly 17% of the world's ice-free land surface." (NRCS, 2015d)
[f] Alfisols: "Soils found in semiarid to moist areas that are formed from weathering processes that leach clay minerals and other constituents out of the surface layer and into the subsoil. They are productive for most crop, are primarily formed under forest or mixed vegetative cover, and make up nearly 10% of the world's ice-free land surface." (NRCS, 2015d)
[g] Histosols: "Histosols have a high content of organic matter and no permafrost. Most are saturated year round, but a few are freely drained. They form in decomposed plan remains that accumulate in water, forest litter, or moss faster than they decay. Histosols make up about 1% of the world's ice-free land surface." (NRCS, 2015d)
Source: (NRCS, 2006)

13.1.2.4. Soil Suborders

Soil suborders are part of the soil taxonomy (a system of classification used to make and interpret soil surveys). Soil orders are the highest level in the taxonomy; there are twelve soil orders in the world and they are characterized by both observed and inferred properties, such as texture, color, temperature, and moisture regime. Soil suborders are the next level down, and are differentiated within an order by soil moisture and temperature regimes, as well as dominant physical and chemical properties (NRCS, 2015e). The STATSGO2[16] soil database identifies 13

[16] STATSGO2 is the Digital General Soil Map of the United States that shows general soil association units across the landscape of the nation. Developed by the National Cooperative Soil Survey, STATSGO2 supersedes the State Soil Geographic (STATSGO) dataset.

different soil suborders in South Carolina (NRCS, 2015a). Figure 13.1.2-2 depicts the distribution of the soil suborders, and Table 13.1.2-3 provides a summary of the major physical-chemical characteristics of the various soil suborders found.

13.1.2.5. Runoff Potential

The NRCS uses four Hydrologic Soil Groups (A, B, C, and D) that are based on a soil's runoff potential.[17] Group A generally has the smaller runoff potential, whereas Group D generally has the greatest (Purdue University, 2015). Table 13.1.2-3 provides a summary of the runoff potential for each soil suborder in South Carolina.

Group A. Sand, loamy sand or sandy loam soils. This group of soils has "low runoff potential and high infiltration rates[18] even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission" (Purdue University, 2015). Aquepts, Orthods, Psamments, and Udults fall into this category in South Carolina.

Group B. Silt loam or loam soils. This group of soils has a "moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures" (Purdue University, 2015). This group has medium runoff potential. Aquepts, Aquods, Aquults, Fluvents, Orthods, Udepts, and Udults fall into this category in South Carolina.

Group C. Sandy clay loam soils. This group of soils has "low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure" (Purdue University, 2015). This group has medium runoff potential. Aquults, Udalfs, Udepts, and Udults fall into this category in South Carolina.

Group D. Clay loam, silty clay loam, sandy clay, silty clay, or clay soils. This group of soils "has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material" (Purdue University, 2015). Aqualfs, Aquents, Aquepts, Aquods, Aquolls, Aquults, Orthods, Saprists, Udalfs, and Udults fall into this category in South Carolina.

[17] Classifying soils is highly generalized and it is challenging to differentiate orders as soil properties can change with distance or physical properties. The soil suborders are at a high level, therefore soil groups may be found in multiple hydrologic groups within a state, as composition, topography, etc. varies in different areas.
[18] Infiltration Rate: "The rate at which a soil under specified conditions absorbs falling rain, melting snow, or surface water expressed in depth of water per unit time." (FEMA, 2010)

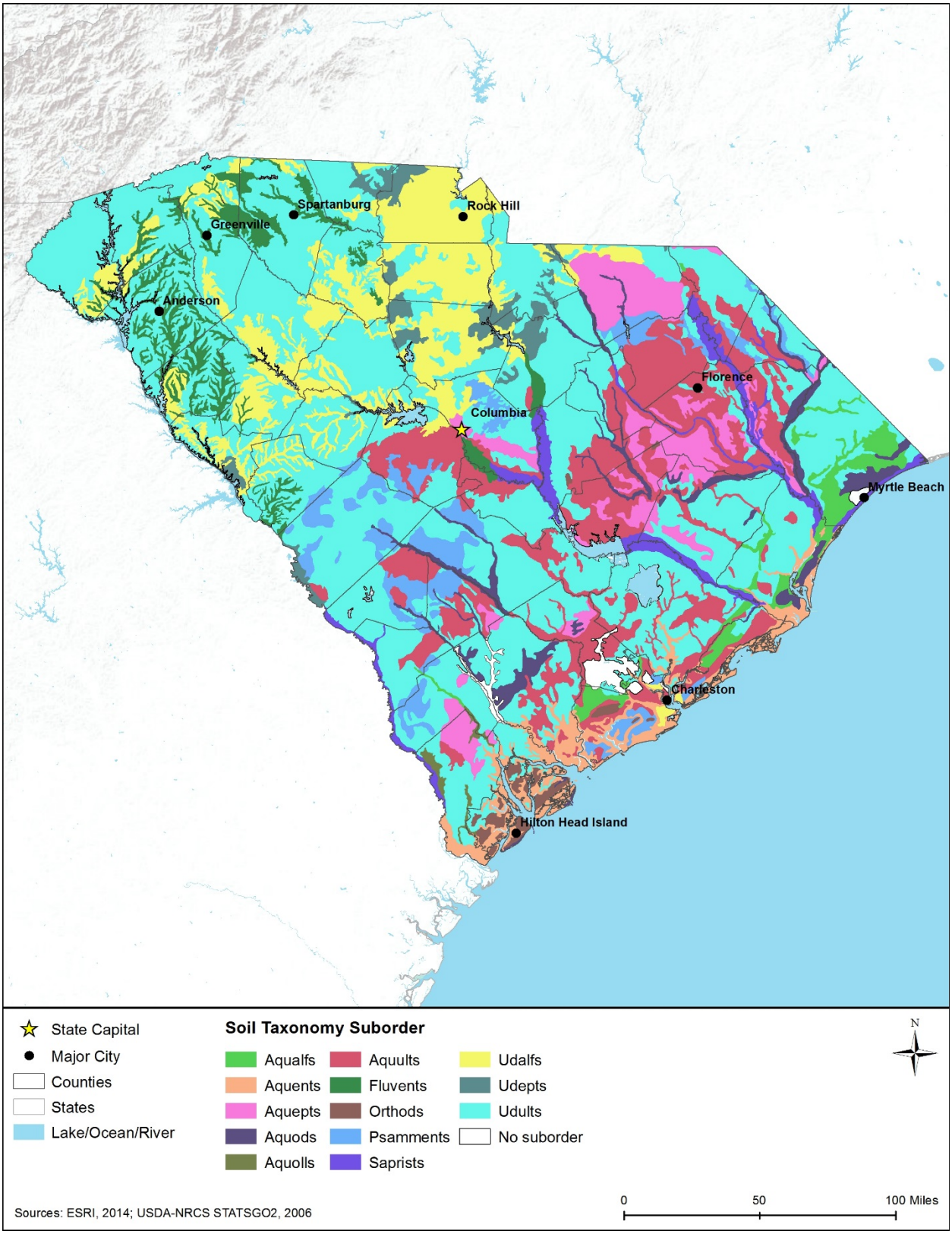


Figure 13.1.2-2: South Carolina Soil Taxonomy Suborders

Table 13.1.2-3: Major Characteristics of Soil Suborders[c] Found in South Carolina, as depicted in Figure 13.1.2-2

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Drainage Class	Hydric Soil[a]	Hydrologic Group	Runoff Potential	Permeability[b]	Erosion Potential	Compaction and Rutting Potential
Alfisols	Aqualfs	Generally have warm and aquic (saturated with water long enough to cause oxygen depletion) conditions. Aqualfs are used as cropland for growing corn, soybeans, and rice, and most have some artificial drainage or other water control. Nearly all Aqualfs have likely supported forest vegetation in the past.	Fine sandy loam, Loamy fine sand, Loamy sand, Sandy clay loam, Sandy loam	0-2	Very poorly drained to poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Entisols	Aquents	Widely distributed, with some forming in sandy deposits, and most forming in recent sediments. Aquents support vegetation that tolerates either permanent or periodic wetness, and are mostly used for pasture, cropland, forest, or wildlife habitat.	Clay, Silty clay loam	0-2	Very poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Inceptisols	Aquepts	Aquepts have poor or very poor natural drainage. If these soils have not been artificially drained, groundwater is at or near the soil surface at some time during normal years (although not usually in all seasons). They are used primarily for pasture, cropland, forest, or wildlife habitat. Many Aquepts have formed under forest vegetation, but they can have almost any kind of vegetation.	Loamy fine sand, Loamy sand, Sand, Stratified sand to loamy sand, Stratified sandy loam to fine sandy loam	0-2	Very poorly drained	Yes	A, B, D	Low, Medium, High	High, Moderate, Very Low	Low to High, depending on slope	High, due to hydric soil and poor drainage conditions
Spodosols	Aquods	Aquods are characterized by a shallow fluctuating water table, with water-loving vegetation, ranging from moss, shrubs, and trees in cold areas to mixed forests and palms in the warmest areas. Although some Aquods have been cleared and are used as cropland or pasture, most are used as forest or wildlife habitat, as they are naturally infertile (but they can be highly responsive to good management).	Fine sand, Loamy sand, Sand	0-3	Poorly drained	Yes	B, D	Medium, High	Moderate, Very Low	Medium to High, depending on slope	High, due to hydric soil and poor drainage conditions
Mollisols	Aquolls	Aquolls support grass, sedge, and forb vegetation, as well as some forest vegetation. However, most have been artificially drained and utilized as cropland.	Fine sandy loam	0-2	Very poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Ultisols	Aquults	Aquults are found in wet areas where groundwater is very close to the surface during part of each year, usually in winter and spring. Their slopes are gentle, with many soils formerly and currently supporting forest vegetation.	Clay, Clay loam, Fine sandy loam, Loam, Loamy sand, Sandy clay, Sandy clay loam, Sandy loam, Variable	0-4	Very poorly drained to somewhat poorly drained	No, Yes	B, C, D	Medium, High	Moderate, Low, Very Low	Medium to High, depending on slope	High, due to hydric soil and poor drainage conditions
Entisols	Fluvents	Fluvents are mostly freely drained soils that form in recently deposited sediments on flood plains, fans, and deltas located along rivers and small streams. Unless protected by dams or levees, these soils frequently flood. Fluvents are normally utilized as rangeland, forest, pasture, or wildlife habitat, with some also used for cropland.	Loam, Sandy loam	0-2	Moderately well drained to well drained	No	B	Medium	Moderate	Medium	Low

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Drainage Class	Hydric Soil[a]	Hydrologic Group	Runoff Potential	Permeability[b]	Erosion Potential	Compaction and Rutting Potential
Spodosols	Orthods	Orthods have a moderate accumulation of organic carbon, and are relatively freely drained. Most of these soils are either used as forest or have been cleared and are used as cropland or pasture. Although they are naturally infertile, they can be highly responsive to good management.	Fine sand, Loamy fine sand	0-2	Somewhat poorly drained to excessively drained	No	A, B, D	Low, Medium, High	High, Moderate, Very Low	Low to High, depending on slope	Low
Entisols	Psamments	Psamments are sandy in all layers. In some arid and semi-arid climates, they are among the most productive rangeland soils, and are primarily used as rangeland, pasture, or wildlife habitat. Those Psamments that are nearly bare are subject to wind erosion and drifting, and do provide good support for wheeled vehicles.	Fine sand, Loamy sand, Sand	2-15	Moderately well drained to excessively drained	No	A	Low	High	Low	Low
Histosols	Saprists	Saprists have organic materials are well decomposed, and many support natural vegetation and are used as woodland, rangeland, or wildlife habitat. Some Saprists, particularly those with a mesic or warmer temperature regime, have been cleared, drained, and used as cropland.	Muck, Sand	0-1	Very poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Alfisols	Udalfs	Udalfs have an udic (humid or subhumid climate) moisture regime, and are believed to have supported forest vegetation at some time during development.	Clay, Clay loam, Fine sandy loam, Loam, Sandy loam, Variable, Weathered bedrock	0-45	Somewhat poorly drained to well drained	No	C, D	Medium, High	Low, Very Low	Medium to High, depending on slope	Low
Inceptisols	Udepts	Udepts have an udic or perudic (saturated with water long enough to cause oxygen depletion) moisture regime, and are mainly freely drained. Most of these soils currently support or formerly supported forest vegetation, with mostly coniferous forest in the Northwest and mixed or hardwood forest in the East. Some also support shrub or grass vegetation, and in addition to being used as forest, some have been cleared and are used as cropland or pasture.	Channery silty clay loam, Loam, Sand, Silt loam	0-4	Somewhat poorly drained to well drained	No, Yes	B, C	Medium	Moderate, Low	Medium	High, due to hydric soil and poor drainage conditions
Ultisols	Udults	Udults are more or less freely drained, relatively humus poor, and have an udic moisture regime. Most of these soils currently support or formerly supported mixed forest vegetation, and many have been cleared and used as cropland (mostly with the use of soil amendments).	Clay, Clay loam, Fine sandy loam, Gravelly clay loam, Loam, Loamy fine sand, Loamy sand, Sand, Sandy clay, Sandy clay loam, Sandy loam, Stratified sand to fine sandy loam, Variable	0-50	Moderately well drained to somewhat excessively drained	No	A, B, C, D	Low, Medium, High	High, Moderate, Low, Very Low	Low to High, depending on slope	Low

[a] Hydric Soil: "A soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (NRCS, 2015c) Soil suborders constitute a broad range of soil types. Within each soil suborder, some specific soil types are hydric while others are not. Soil suborders constitute a broad range of soil types. Within each soil suborder, some specific soil types are hydric while others are not.
[b] Based on Runoff Potential, described in Section 13.1.2.5.
[c] Soil suborders constitute a broad range of soil types. Within each suborder, the range of soil types may have a range of properties across the state, which result in multiple values being displayed in the table for that suborder.
Source: (NRCS, 2015a) (NRCS, 1999)

13.1.2.6. Soil Erosion

"Soil erosion involves the breakdown, detachment, transport, and redistribution of soil particles by forces of water, wind, or gravity" (NRCS, 2015f). Water-induced erosion can transport soil into streams, rivers, and lakes, degrading water quality and aquatic habitat. When topsoil is eroded, organic material is depleted, creating loss of nutrients available for plant growth. Soil particles displaced by wind can cause human health problems and reduced visibility, creating a public safety hazard (NRCS, 1996a). Table 13.1.2-3 provides a summary of the erosion potential for each soil suborder in South Carolina. Soils with medium to high erosion potential in South Carolina include those in the Aqualfs, Aquents, Aquepts, Aquods, Aquolls, Aquults, Fluvents, Orthods, Saprists, Udalfs, Udepts, and Udults suborders, which are found throughout most of the state (Figure 13.1.2-2).

13.1.2.7. Soil Compaction and Rutting

Soil compaction and rutting occurs when soil layers are compressed by machinery or animals, which decreases both open spaces in the soil, as well as water infiltration rates (NRCS, 1996b). Moist soils with high soil water content are most susceptible to compaction and rutting, as they lack the strength to resist deformation caused by pressure. When rutting occurs, channels form and result in downslope erosion (USFS, 2009b). Other characteristics that factor into compaction and rutting risk include soil composition (i.e., low organic soil is at increased risk of compaction), amount of pressure exerted on the soil, and repeatability (i.e., the number of times the pressure is exerted on the soil). Machinery and vehicles that have axle loads greater than ten tons can cause soil compaction of greater than 12 inches depth (NRCS, 1996b), (NRCS, 2003).

Loam, sandy loam, and sandy clay loam soils are most susceptible to compaction and rutting; silt, silty clay, silt loam, silty clay loam, and clay soils are more resistant to compaction and rutting (NRCS, 1996b). Table 13.1.2-3 provides a summary of the compaction and rutting potential for each soil suborder in South Carolina. Soils with the highest potential for compaction and rutting in South Carolina include those in the Aqualfs, Aquents, Aquepts, Aquods, Aquolls, Aquults, Saprists, and Udepts suborders, which are found throughout the state (Figure 13.1.2-2).

13.1.3. Geology

13.1.3.1. Definition of the Resource

The U.S. Geological Survey (USGS) is the primary government organization responsible for the nation's geological resources. USGS defines geology as an interdisciplinary science with a focus on the following aspects of earth sciences: geologic hazards and disasters, climate variability and change, energy and mineral resources, ecosystem and human health, and ground-water availability. Several of these elements are discussed in other sections of this PEIS, including Water Resources (Section 13.1.4), Human Health and Safety (Section 13.1.15), and Climate Change (Section 13.1.14).

This section covers the six aspects of geology most relevant to the Proposed Action and Alternatives:

- Section 13.1.3.3, Environmental Setting: Physiographic Regions[19] and Provinces;[20]
- Section 13.1.3.4, Surface Geology;
- Section 13.1.3.5, Bedrock Geology;[21]
- Section 13.1.3.6, Paleontological Resources;[22]
- Section 13.1.3.7, Fossil Fuel and Mineral Resources; and
- Section 13.1.3.8, Geologic Hazards.[23]

13.1.3.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of NEPA and other applicable laws and regulations. A list of applicable state laws and regulations is included in Table 13.1.3-1.

Table 13.1.3-1: Relevant South Carolina Geology Laws and Regulations

State Law/ Regulation	Regulatory Agency	Applicability
South Carolina Building Code	South Carolina Department of Labor, Licensing and Regulation	Check adopted building code (International Building Code), South Carolina modifications to adopted codes, and local modifications for seismic guidelines.

13.1.3.3. Environmental Setting: Physiographic Regions and Provinces

Geologist Nevin Fenneman as a way to describe areas of the United States based on common landforms (i.e., not climate or vegetation) created the concept of physiographic regions in 1916. Physiographic regions are areas of distinctive topography, geography, and geology. Important physiographic differences between adjacent areas are generally due to differences in the nature or structure of the underlying rocks. There are eight distinct physiographic regions in the continental United States: 1) Atlantic Plain, 2) Appalachian Highlands, 3) Interior Plains, 4) Interior Highlands, 5) Laurentian Upland, 6) Rocky Mountain System, 7) Intermontane Plateaus, and 8) Pacific Mountain System. Regions are further sub-divided into physiographic provinces based on differences observed on a local scale (Fenneman, 1916).

South Carolina is within two major physiographic regions: Atlantic Plain (Coastal Plain Province) and Appalachian Highlands (Piedmont and Blue Ridge Provinces). The locations of these regions and provinces are shown in Figure 13.1.3-1 and their general characteristics summarized in the following subsections.

[19] Physiographic regions: Areas of the United States that share commonalities based on topography, geography, and geology (Fenneman, 1916).
[20] Physiographic provinces: Subsets within physiographic regions (Fenneman, 1916).
[21] Bedrock: Solid rock beneath the soil and superficial rock (USGS, 2015e).
[22] Paleontology: "Study of life in past geologic time based on fossil plants and animals" (USGS, 2015h).
[23] Geologic Hazards: Any geological or hydrological process that poses a threat to people and/or their property, which includes but is not limited to volcanic eruptions, earthquakes, landslides, sinkholes, mudflows, flooding, and shoreline movements (NPS, 2013).

Atlantic Plain Region

The Atlantic Plain Region includes the Continental Shelf and the Gulf and Atlantic Coast plains stretching from New York south to Florida and west to Texas. The Atlantic Plain Region formed through the repetitive rise and fall of the oceans over the last 150 million years. Sedimentary strata become thinner moving westward through the region, and thicken to several thousand feet thick along the coastline. Erosion from the Appalachian Mountains, which began to form 480 to 440 million years ago (MYA), dislodged sediments, which were subsequently deposited by rivers to form the Atlantic Plain.[24] Gentle topography and a transition zone between the land and sea often having marshes, lagoons, swamps, sand bars, and reefs characterize the area. Deposits of coastal marine life over millions of years form the basis for rich fossil fuel reserves in the region. (NPS, 2015a)

As reported above, the Atlantic Plain Region within South Carolina is composed of one physiographic province the Coastal Plain Province (USGS, 2003a).

Coastal Plain Province: The Coastal Plain Province includes roughly 20,000 miles of South Carolina (i.e., about 64.5 percent of the state's total area) southeast of the Fall Line[25] boundary with the Piedmont Province (discussed below). In most locations, the Coastal Plain reaches 120 to 150 miles inland from the coastline. The eastern 80 to 90 miles of the Coastal Plain Province are characterized as seven terraces that record previous shoreline locations from throughout the Pliocene Epoch (5.3 to 2.6 MYA). Based on the topography of the westernmost terrace, the Brandywine Terrace, it is estimated that sea level may have once exceeded 270 feet above current sea levels. "The Coastal Plain of South Carolina is underlain by sedimentary[26] deposits ranging in age from Upper Cretaceous [(151 to 66 MYA)] to Recent." The topography of South Carolina's Coastal Plain does not exceed 600 feet above sea level and generally slopes downward to the southeast. (Cooke, 1936)

[24] For consistency, this PEIS uses the University of California Berkeley Geologic Time Scale for all of the FirstNet PEIS state documents. Time scales differ among universities and researchers; FirstNet utilized a consistent time scale throughout, which may differ slightly from other sources. (University of California Museum of Paleontology, 2011)
[25] Fall Line: "A somewhat indefinite line which derives its name from the falls or rapids in the rivers at the places where they pass from the Piedmont crystalline rocks to the softer and less resistant rocks of the Coastal Plain." (Geological Survey of Georgia, 1911)
[26] Sedimentary Rock: "Rocks that formed from pre-existing rocks or pieces of once-living organisms. They form from deposits that accumulate on the Earth's surface. Sedimentary rocks often have distinctive layering or bedding" (USGS, 2014c).

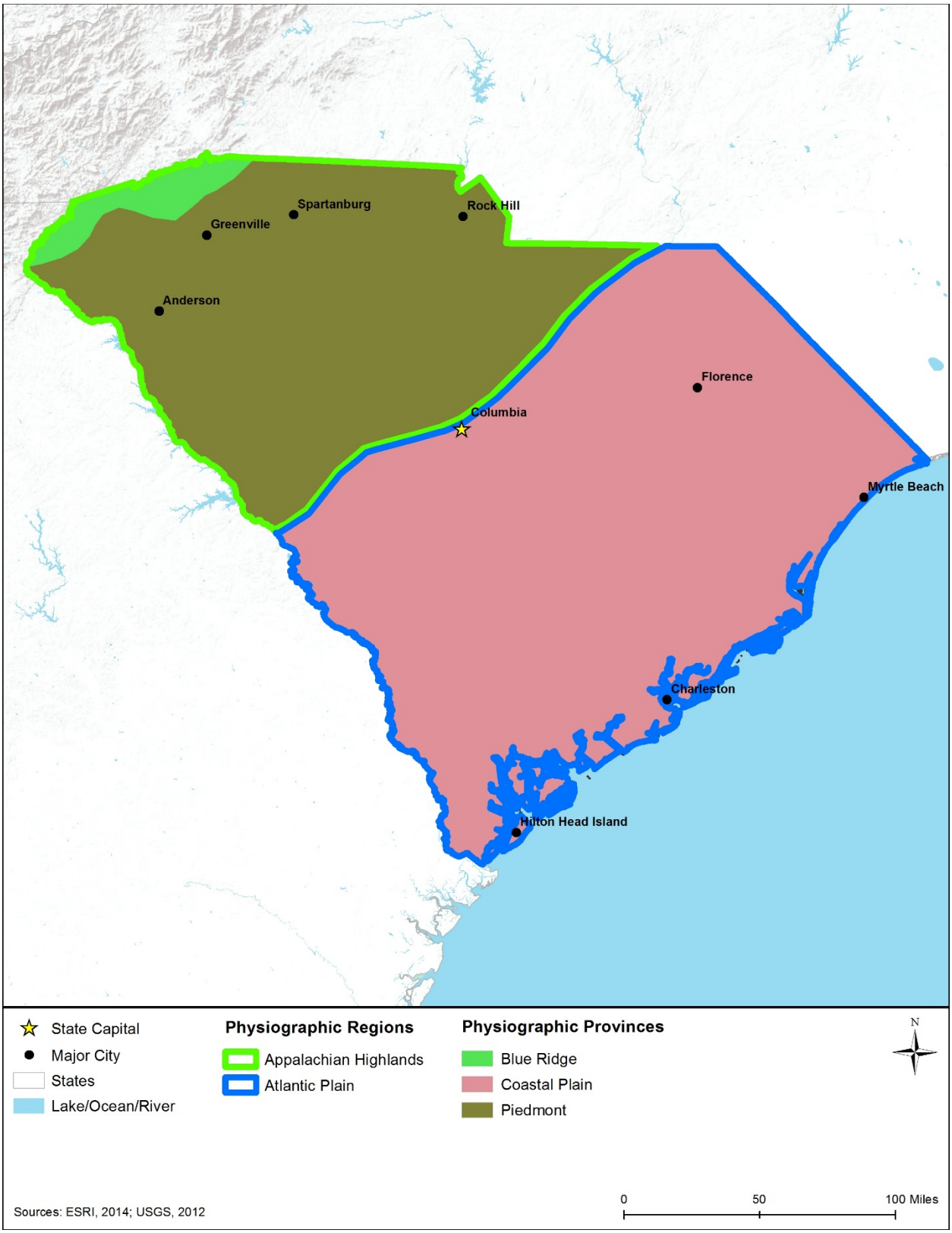


Figure 13.1.3-1: Physiographic Regions and Provinces of South Carolina

Appalachian Highlands Region

The Appalachian Highlands Region extends from Canada to Alabama. This region is composed of layers of folded sedimentary rock created when the North American plate collided with Eurasian and African plates more than 500 million years ago (MYA). Once similar in height to the present-day Rocky Mountains,[27] the Appalachian Highlands have eroded considerably, and most peaks are now under 5,000 feet above sea level (ASL). The current Appalachian Highlands Region is characterized by prime and unique farmlands and is rich in mineral resources (USGS, 2003a).

As reported above, the Appalachian Highlands Region within South Carolina is composed of the Piedmont and Blue Ridge physiographic provinces (USGS, 2003a).

Piedmont Province – The Piedmont Province includes much of South Carolina to the north and west of the Fall Line. The topography of South Carolina's Piedmont Province varies between 375 and 1,000 feet ASL (SCDNR, 2015a), and the province is noted for its characteristic rolling hills (USGS, 1990a). Much of the Piedmont Province is underlain by igneous[28] and metamorphic[29] rocks, including gneiss,[30] schist,[31] phyllite,[32] and slate[33] (Waters, 2003), which may date to the late Precambrian (older than 542 MYA) through the Permian (299 to 251 MYA) Period (USGS, 1990a).

Blue Ridge – The Blue Ridge Province includes extreme northwestern South Carolina, including parts of Oconee, Greenville, and Pickens Counties. Elevations range from near 650 feet ASL at the Fall Line to more than 3,500 feet (Waters, 2003) at the state's highest point, Sassafras Mountain (3,533 feet ASL) (USGS, 2001). Precambrian to Permian "metamorphic and igneous rocks [crop] out in a broad, northeast-trending band that widens from eastern Alabama into eastern Georgia and western South Carolina. The crystalline rocks are hard, and generally are more resistant to weathering and erosion than sedimentary rocks," contributing to the province's elevated topography (USGS, 1990a).

13.1.3.4. Surface Geology

Surficial geology is characterized by materials such as till,[34] sand and gravel, or clays that overlie bedrock. The surface terrain, which can include bedrock outcrops, provides information on the

[27] The Rocky Mountains exceed 14,000 feet above sea level (NPS, 2004).
[28] Igneous Rock: "Rock that forms when hot, molten rock (magma) crystallizes and solidifies" (USGS, 2014d).
[29] Metamorphic Rock: "A rock that has undergone chemical or structural changes produced by increase in heat or pressure or by replacement of elements by hot, chemically active fluids" (USGS, 2015f).
[30] Gneiss: "A coarse-grained, foliated metamorphic rock that commonly has alternating bands of light and dark-colored minerals" (USGS, 2015f).
[31] Schist: "Metamorphic rock usually derived from fine-grained sedimentary rock such as shale. Individual minerals in schist have grown during metamorphism so that they are easily visible to the naked eye" (USGS, 2015f).
[32] Phyllite: "A very fine-grained, foliated metamorphic rock generally derived from shale or fine-grained sandstone. Phyllites are usually black or dark gray; the foliation is commonly crinkled or wavy" (USGS, 2015f).
[33] Slate: "A hard, fine-grained rock with a well-developed rock cleavage or slaty cleavage caused by the incipient growth of platy (micaceous) minerals, due to metamorphism of fine-grained clastic sediments such as shale and siltstone and also volcanic tuffs" (Columbia University, 2015).
[34] Till: "An unsorted and unstratified accumulation of glacial sediment, deposited directly by glacier ice. Till is a heterogeneous mixture of different sized material deposited by moving ice (lodgement till) or by the melting in-place of stagnant ice (ablation till). After deposition, some tills are reworked by water" (USGS, 2013a).

rock compositions and structural characteristics of the underlying geology. Because surface materials are exposed, they are subject to physical and chemical changes due to weathering from precipitation (rain and snow), wind and other weather events, and human-caused interference. Depending on the structural characteristics and chemical compositions of the surface materials, heavy precipitation can cause slope failures,[35] subsidence,[36] and erosion (Thompson, 2015).

Most of the surficial materials are marine deposited sediments that were emplaced since the Cretaceous Period (151 to 66 MYA). These marine deposits are only present throughout the Coastal Plain Province, with the oldest deposits being present in the western portion of the province along the Fall Line boundary with the Piedmont Province. In general, sediment thickness increases moving toward the coastline. These deposits are discussed in greater detail below (moving from west to east) (South Carolina Geological Survey, 2015). Figure 13.1.3-2 displays the general surface geology for South Carolina.

- Sediments closest to the Fall Line are characterized as "mostly micaceous,[37] kaolinitic[38] sands, with lenses of clay of variable thickness. Sands are mostly coarse sand to granule size, angular to subangular and poorly sorted, but some fine-grained, fairly well-sorted sand does occur. These sediments represent fluvial or upper delta-plain environments." (South Carolina Geological Survey, 2015)
- Paleocene (66 to 56 MYA) and Eocene (56 to 34 MYA) marine to marginal-marine sediments cover much of the area between Columbia and Augusta. These carbonate[39] units are fossil rich and are buried under younger deposits closer to the coastline. (South Carolina Geological Survey, 2015)
- Further to the east, Pliocene (5.3 to 2.6 MYA) sediments are preserved at the surface along the Orangeburg Scarp.[40] These sediments "[document] the last major transgression of the sea over the Coastal Plain." (South Carolina Geological Survey, 2015)
- Closer to South Carolina's coastline, Pleistocene (2.6 MYA to 11,700 years ago) sediments "contains recent fluvial sands, backbarrier muds (i.e., marsh), and barrier beach sands that are less than 3M years of age. (South Carolina Geological Survey, 2015)
- Along South Carolina's coastline, Holocene (11,700 years ago to present) sediments constitute "a 5- to 10-m thick blanket of unconsolidated Quaternary marine and fluvial deposits, which lies on semi-lithified Tertiary sediments. The oldest beach deposits are farthest inland and at the highest elevations; younger beach deposits are progressively closer to the ocean and at lower elevations." (South Carolina Geological Survey, 2015)

[35] Slope failure, also referred to as mass wasting, is the downslope movement of rock debris and soil in response to gravitational stresses (Idaho State University 2000).
[36] Subsidence: "Gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials" (USGS, 2000).
[37] Micaceous: "A general term for mica-rich rocks" (USGS, 2015f).
[38] Kaolinite: Aluminum silicate mineral ($Al_2Si_2O_5(OH)_4$).
[39] Carbonate: "A sedimentary rock made mainly of calcium carbonate ($CaCO_3$). Limestone and dolomite are common carbonate sedimentary rocks" (USGS, 2015f).
[40] Scarp: "A cliff formed by faulting, erosion, or landslides. (Also called escarpment)" (USGS, 2015f).

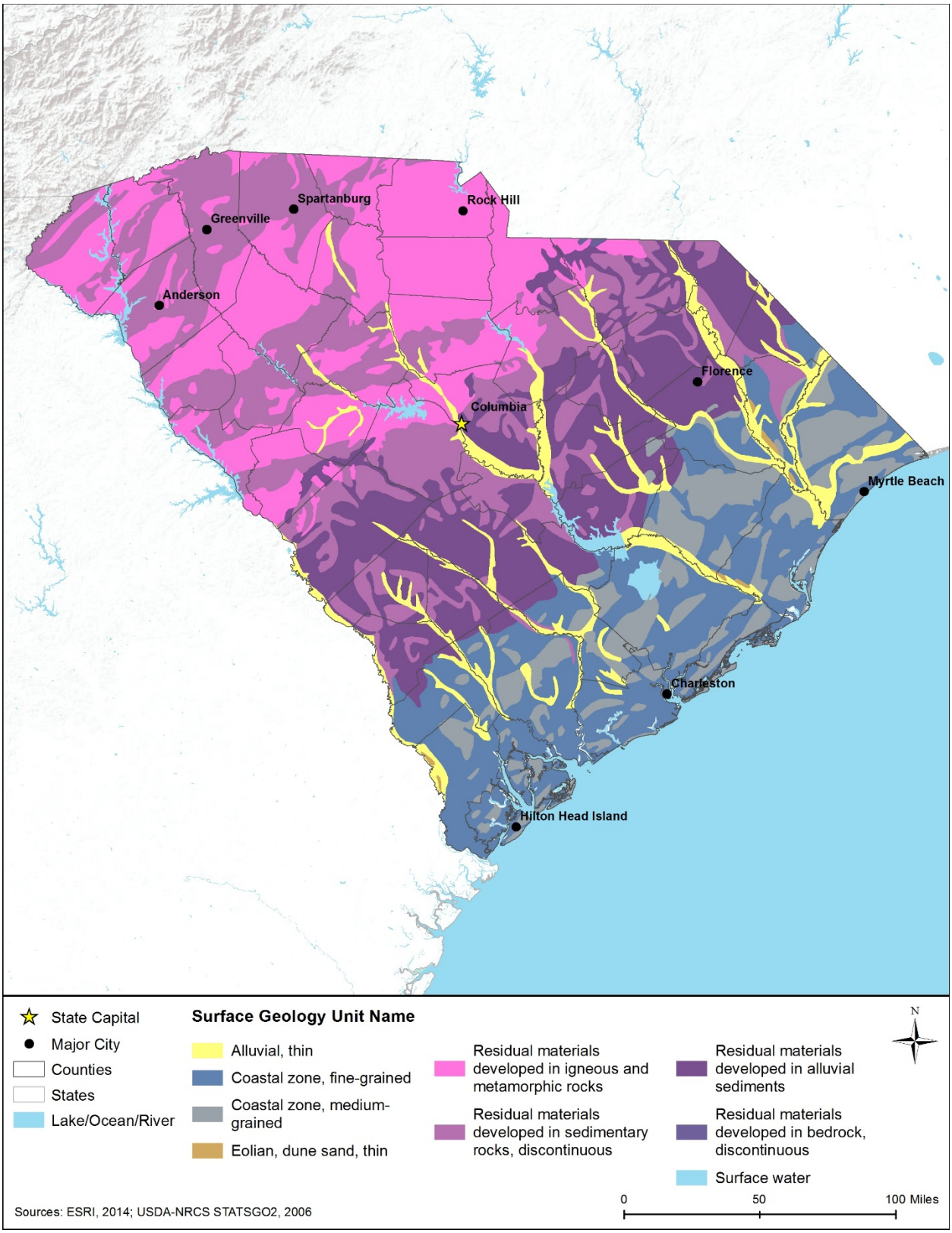


Figure 13.1.3-2: Generalized Surface Geology for South Carolina

13.1.3.5. Bedrock Geology

Bedrock geology analysis, and "the study of distribution, position, shape, and internal structure of rocks" (USGS, 2015b) reveals important information about a region's surface and subsurface characteristics (i.e., three-dimensional geometry), including dip (slope of the formation),[41] rock composition, and regional tectonism.[42] These structural aspects of bedrock geology are often indicative of regional stability, as it relates to geologic hazards such as landslides, subsidence, earthquakes, and erosion (New Hampshire Department of Environmental Services, 2014).

As noted in Section 13.1.3.3, South Carolina's Coastal Plain Province is composed of Cretaceous and Cenozoic sedimentary deposits that dip to the southeast. Deposits on the western edge of the Coastal Plain include "Lower Paleocene through Upper Eocene marine and fluvial units, [which] extend, in the subsurface, toward the Atlantic Ocean… Older Pliocene marine sediments occur in the Lower Coastal Plain [(in southeastern South Carolina)], either in the subsurface or at low elevations at the surface… Holocene sediments occur at the coast and in the river valleys" (South Carolina Geological Survey, 1999). Metamorphic rocks from the Precambrian and Paleozoic Eras underlie much of South Carolina's Piedmont and Blue Ridge Provinces. "[These] intensely deformed metamorphic rocks of the Piedmont and Blue Ridge physiographic provinces that have been intruded by small to large bodies of igneous rocks" (USGS, 1990a). Figure 13.1.3-3 displays the general bedrock geology for South Carolina.

13.1.3.6. Paleontological Resources

Cambrian Period (542 to 488 MYA) fossils in South Carolina have yielded trilobites[43] that indicate the presence of a marine environment during that time. Marine environments also dominated the Mesozoic Era (251 to 66 MYA). Cretaceous Period (146 to 66 MYA) rocks have yielded tube-making worms, oysters, and other marine animals. Cenozoic Era (66 MYA to present) fossils are encountered in southeastern South Carolina, with fossils preserved in eroded Tertiary (66 to 2.6 MYA) Appalachian sediments. The climate during this period was mostly warm and tropical, as evidenced by the preservation of whales, large crocodiles, and other tropical fauna. Sea level has fluctuated throughout the Quaternary period (2.6 MYA to present). Fossils that include pollen from jack pines indicates cooler conditions at various points throughout this time. (The Paleontology Portal, 2015)

[41] Dip: "A measure of the angle between the flat horizon and the slope of a sedimentary layer, fault plane, metamorphic foliation, or other geologic structure" (NPS, 2000).
[42] Tectonism: "Structure forces affecting the deformation, uplift, and movement of the earth's crust." (USGS, 2015g)
[43] Trilobite: "Any member of Trilobita, an extinct class of marine arthropods. Trilobites are known from the Cambrian to the Permian. They had segmented, oval-shaped bodies and were the first animals to have complex eyes (similar to the compound eyes in modern insects)." (Smithsonian Institution, 2016)

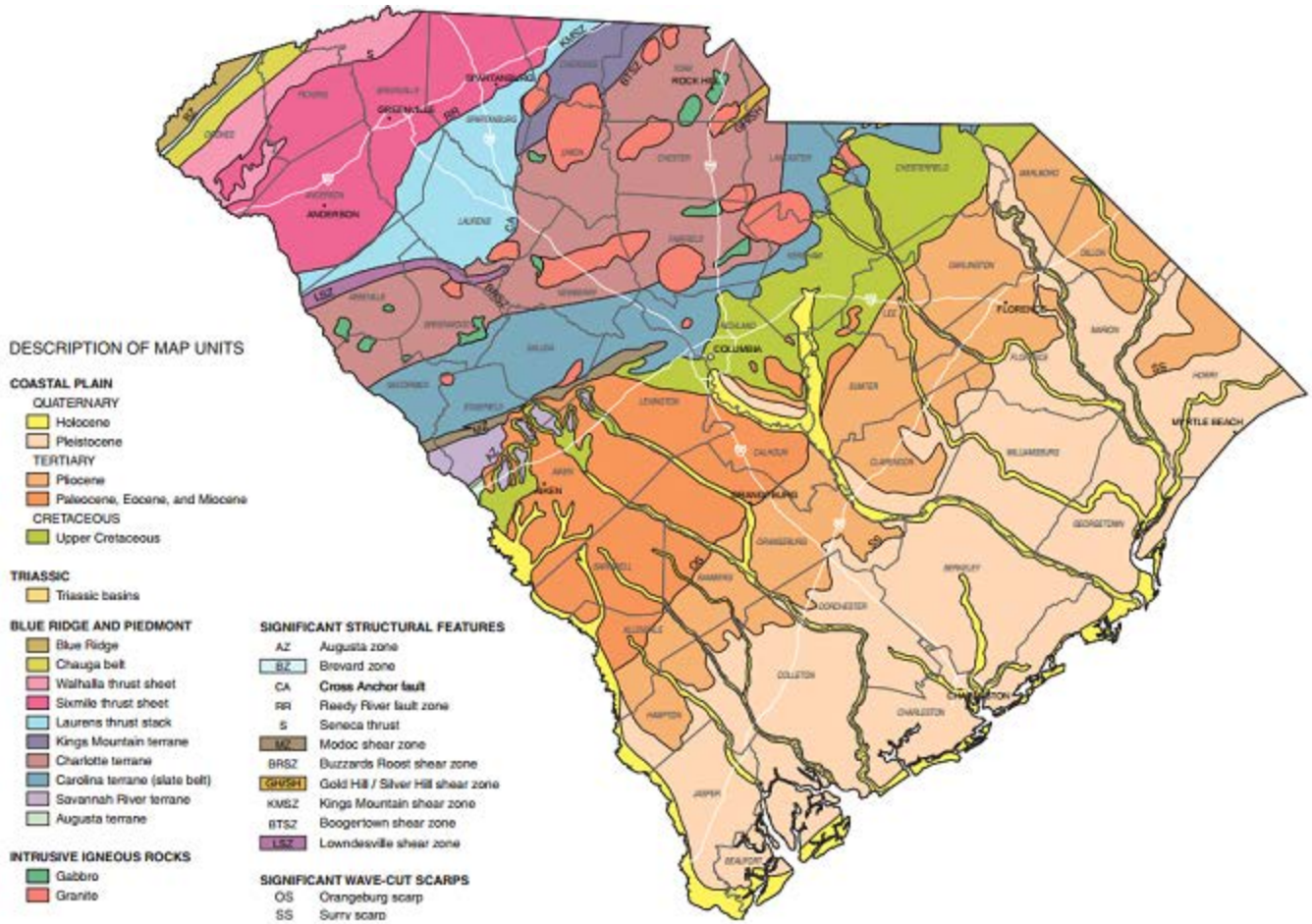


Figure 13.1.3-3: Generalized Bedrock Geology for South Carolina

Source: (South Carolina Geological Survey, 2005)

13.1.3.7. Fossil Fuel and Mineral Resources

Oil and Gas

South Carolina does not produce crude oil or natural gas (EIA, 2015g).

Minerals

As of 2015, South Carolina's nonfuel mineral production value was $679M, which ranked 34rd nationwide (in terms of dollar value). This level of production accounted for less than 1.0 percent of the total nationwide production. As of 2015, South Carolina's leading nonfuel minerals were portland cement, crushed stone, construction sand and gravel, industrial sand and gravel, and masonary cement (USGS, 2016a). South Carolina was the nation's leading producer of vermiculite and second in kaolin clay production. Other minerals produced in the state are common clay and shale, dimension stone,[44] mica, aluminum, industrial sand, construction sand and gravel, and steel (USGS, 2015c).

13.1.3.8. Geologic Hazards

The three major geologic hazards of concern in South Carolina are earthquakes, landslides, and subsidence. Volcanoes were considered but not analyzed further for South Carolina because they do not occur in South Carolina and therefore do not present a hazard to the state (USGS, 2015d). A discussion of each geologic hazard is included below.

Earthquakes

Areas of greatest seismicity in South Carolina are concentrated in the northeast portions of the state. Between 1973 and March 2012, there were 10 earthquakes of a magnitude 3.5 (on the Richter scale) or greater in South Carolina (USGS, 2014a). Earthquakes are the result of large masses of rock moving against each other along fractures called faults. Earthquakes occur when landmasses on opposite sides of a fault suddenly slip past each other; the grinding motion of each landmass sends out shock waves. The vibrations travel through the Earth and, if they are strong enough, they can damage manmade structures on the surface. Earthquakes can produce secondary flooding impacts resulting from dam failure (USGS, 2012a).

Historic Earthquake in South Carolina
August 31, 1886

On August 31, 1886, Charleston, South Carolina, experienced a magnitude 7.3 earthquake, one of the most significant seismic events to occur in the eastern United States (USGS, 2014g). This earthquake was "felt over 2.5 million square miles, from Cuba to New York, and Bermuda to the Mississippi River" (South Carolina Emergency Management Division, 2012). The 1886 earthquake resulted in more than $5M in property damage, killed 60 people, and produced extensive cratering and fissuring across the ground surface (USGS, 2014g).

[44] Dimension stone: "Natural rock material quarried for the purpose of obtaining blocks or slabs that meet specifications as to size (width, length, and thickness) and shape." (USGS, 2016c)

The shaking due to earthquakes can be significant many miles from its point of origin depending on the type of earthquake and the type of rock and soils beneath a given location. Crustal earthquakes, the most common, typically occur at depths of 6 to 12 miles; these earthquakes typically do not reach magnitudes higher than 6.0 on the Richter scale.[45] Subduction zone earthquakes occur where Earth's tectonic plates collide. When tectonic plates collide, one plate slides beneath the other, where it is reabsorbed into the mantle of the earth. Convergence boundaries between two tectonic plates can result in earthquakes with magnitudes that exceed 8.0 on the Richter scale (Oregon Department of Geology, 2015).

Photo of Damage resulting from 1886 Charleston Earthquake

Source: (USGS, 2014h)

Figure 13.1.3-4 depicts the seismic risk throughout South Carolina; the box surrounding the range of colors shows the seismic hazards in the state. The map indicates levels of horizontal shaking (measured in Peak Ground Acceleration) that have a 2 percent chance of being exceeded in a 50-year period. Units on the map are measured in terms of acceleration due to gravity (% g). Most pre-1965 buildings are likely to experience damage with exceedances of 10 percent (%) g.[46] Post-1985 buildings (in California) have experienced only minor damage with shaking of 60% g. (USGS, 2010)

Areas of greatest seismicity in South Carolina are concentrated in the southeastern portion of the state, particularly near the City of Charleston (Figure 13.1.3-4). An estimated 10 to 20 earthquakes occur within South Carolina each year, though most earthquakes measure below magnitude 3.0 on the Richter scale (South Carolina Emergency Management Division, 2012). Most (70 percent) of South Carolina's earthquakes occur as a result of faults[47] within the Coastal Plain Province within the Middleton-Place Seismic Zone (South Carolina Emergency Management Division, 2015).

[45] The Richter scale is a numerical scale for expressing the magnitude of an earthquake on the basis of seismograph oscillations. The more destructive earthquakes typically have magnitudes between about 5.5 and 8.9; the scale is logarithmic and a difference of one represents an approximate thirtyfold difference in magnitude (USGS, 2014e).
[46] Post-1985 buildings (in California) have experienced only minor damage with shaking of 60% g (USGS, 2010).
[47] Fault: "A fracture in the Earth along which one side has moved in relative to the other. Sudden movements on faults cause earthquakes." (USGS, 2015f)

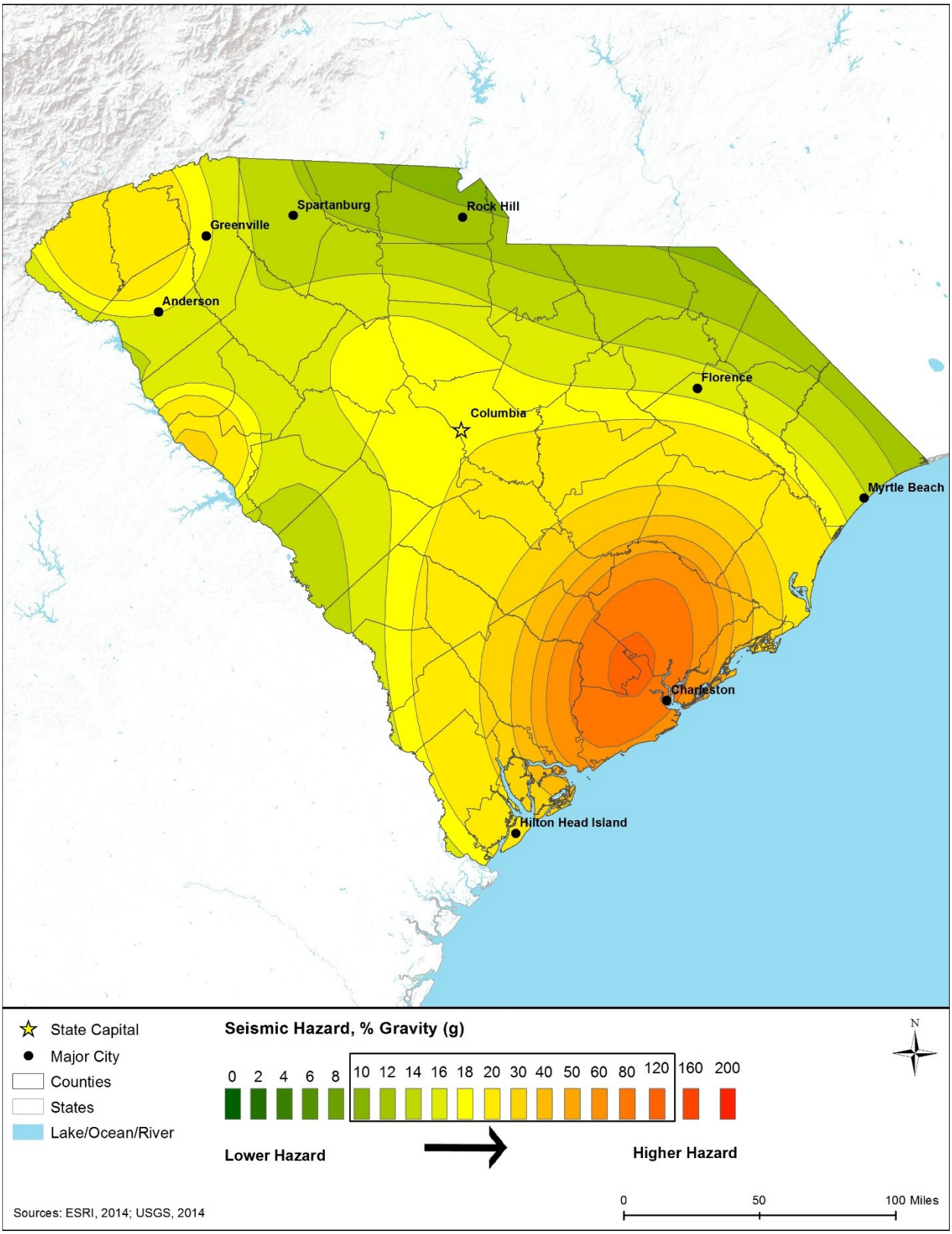


Figure 13.1.3-4: South Carolina 2014 Seismic Hazard Map

Landslides

Although South Carolina is at risk to landslide events throughout much of the state, only portions of the state within the Piedmont and Blue Ridge Provinces are at moderate to high susceptibility to landslides (USGS, 2008) (Figure 13.1.3-5). "The term 'landslide' describes many types of downhill earth movements, ranging from rapidly moving catastrophic rock avalanches and debris flows in mountainous regions to more slowly moving earth slides and other ground failures" (USGS, 2003b). Geologists use the term "mass movement" to describe a great variety of processes such as rock fall, creep, slump, mudflow, earth flow, debris flow, and debris avalanche regardless of the time scale (USGS, 2003b).

Landslides can be triggered by a single severe storm or earthquake, causing widespread damage in a short period. Most landslide events are triggered by water infiltration that decomposes and loosens rock and soil, lubricates frictional surfaces, adds weight to an incipient landslide, and imparts buoyancy to the individual particles. Intense rainfall, rapid snowmelt, freeze/thaw cycles, earthquakes, volcanic eruptions, and human alterations to the natural landscape can trigger mass land movements. Large landslides can dam rivers or streams, and cause both upstream and downstream flooding (USGS, 2003b).

South Carolina is most susceptible to landslide events in northwestern portions of the state within the Blue Ridge Province (USGS, 2008). Igneous and metamorphic rocks that are overtopped with "thick residual soil and colluvium" underlie the rolling topography in this area. "The weathered metamorphic rocks, especially mica schist and mica gneiss, are susceptible to earth flows, slumps, and rockslides" (Radbruch-Hall, et al., 1982).

Areas with slopes greater than 10 percent in the Coastal Plain Province are also at risk to landslide events. "Two major areas of landslide potential are recognized. First are oversteepened banks of major rivers, such as the bluffs of the Congaree and Wateree Rivers, and some of their minor stream tributaries… The second area consists of areas adjacent to [the Fall Line], which [includes] that area of the Coastal Plain immediately southeast of the Piedmont" (SCDNR, 2012). Portions of the Coastal Plain also are at risk to landslide events due to earthquake-induced liquefaction.[48] Areas of the Coastal Plain that are particularly susceptible to liquefaction include those areas that are underlain by unconsolidated sediments younger than 400,000 years of age, which includes much of the state within 20 miles of the coastline. Inland streams and river valleys are also at risk for experiencing liquefaction (South Carolina Geological Survey, 2012). Figure 13.1.3-5 displays landslide risk throughout South Carolina.

[48] Liquefaction: "A process by which water-saturated sediment temporarily loses strength and acts as a fluid… This effect can be caused by earthquake shaking." (USGS, 2012c)

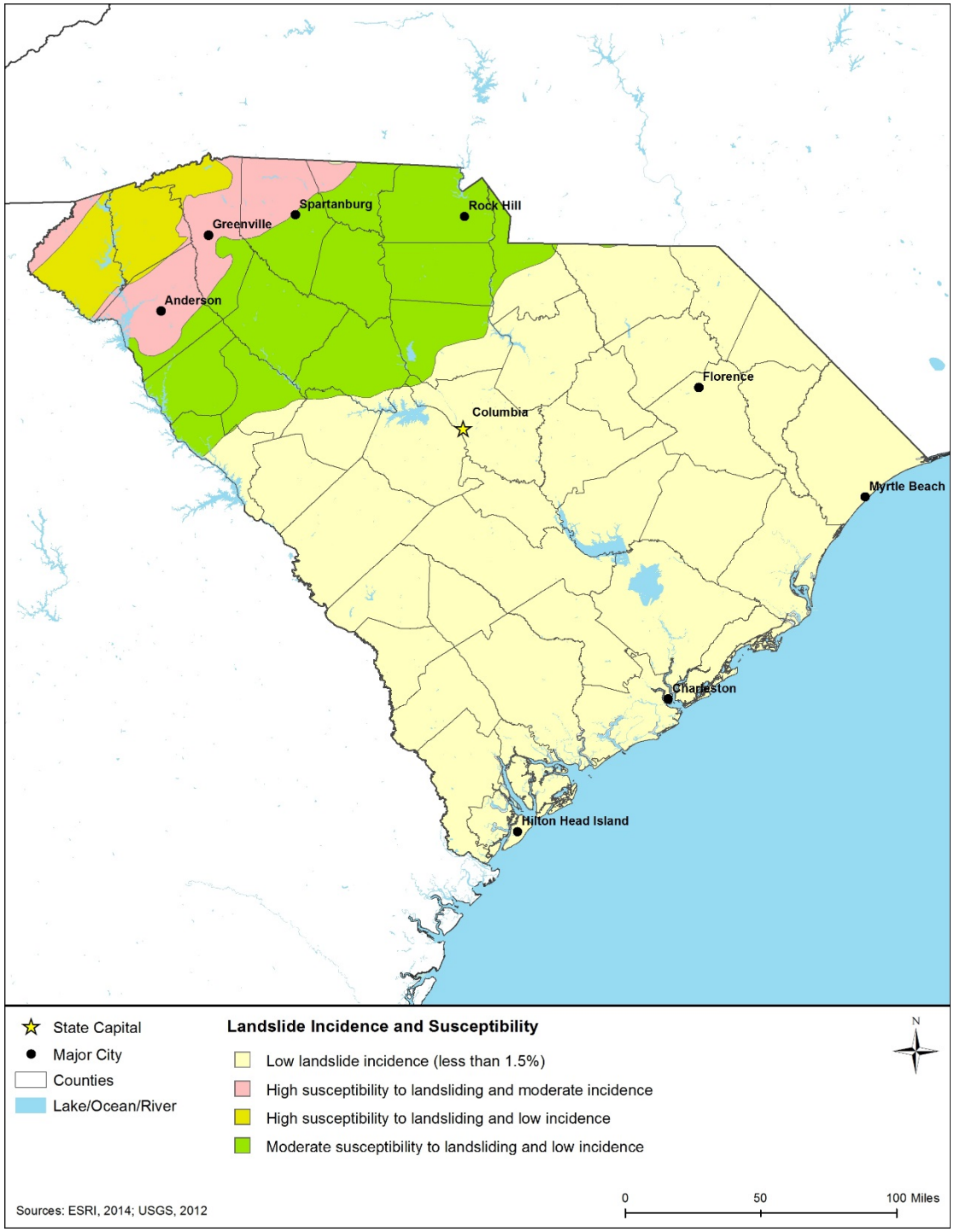


Figure 13.1.3-5: South Carolina Landslide Incidence and Susceptibility Hazard Map[49]

[49] Susceptibility hazards not indicated in Figure 13.1.3-5 where same or lower than incidence. Susceptibility to landslides is defined as the probable degree of response of areal rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying

Subsidence

Land subsidence is a "gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials" (USGS, 2000). Within South Carolina, land collapse or the development of sinkholes due to karst[50] topography constitutes a major cause of subsidence. Nationwide, the primary causes of land subsidence are attributed to aquifer system compaction, drainage of organic soils, underground mining, sinkholes, and thawing permafrost. More than 80 percent of subsidence in the United States is a consequence of over-withdrawal of groundwater. In many aquifers, which are subsurface soil layers through which groundwater moves, water is pumped from pore spaces between sand and gravel grains. If layers of silt or clay, which do not transport groundwater, confine an aquifer, the lowered water pressure in the sand and gravel causes slow drainage of water from the clay and silt beds. The reduced water pressure compromises support for the clay and silt beds, causing them to collapse on one another. The effects of this compression are seen in the permanent lowering of the land surface elevation. (USGS, 2000)

Land subsidence can result in altered stream elevations and slopes; detrimental effects to infrastructure and buildings; and collapse of wells due to compaction of aquifer sediments. Subsided areas can become more susceptible to inundation, both during storm events and non-events. Lowered terrain is more susceptible to inundation during high tides. Additionally, land subsidence can affect vegetation and land use. (USGS, 2013b)

In South Carolina, a significant cause of land subsidence is the collapse of karst. Karst is common in areas of South Carolina's Coastal Plain Province that are more than 20 miles inland from the shore. Land subsidence hazards are a risk "where near-surface sediments are either carbonate rock or contain carbonate sediment." Karst topography has led to sinkhole formation near Myrtle Beach (in northeastern South Carolina) and Beaufort (in southern South Carolina) (South Carolina Geological Survey, 2012). Figure 13.1.3-6 displays the areas in South Carolina that are subject to land subsidence due to karst topography.

the incidence of landslides. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated. (USGS, 2014f)

[50] Karst Topography: "A distinctive landscape (topography) that can develop where the underlying bedrock, often limestone or marble, is partially dissolved by surface or ground water" (USGS, 2015f).

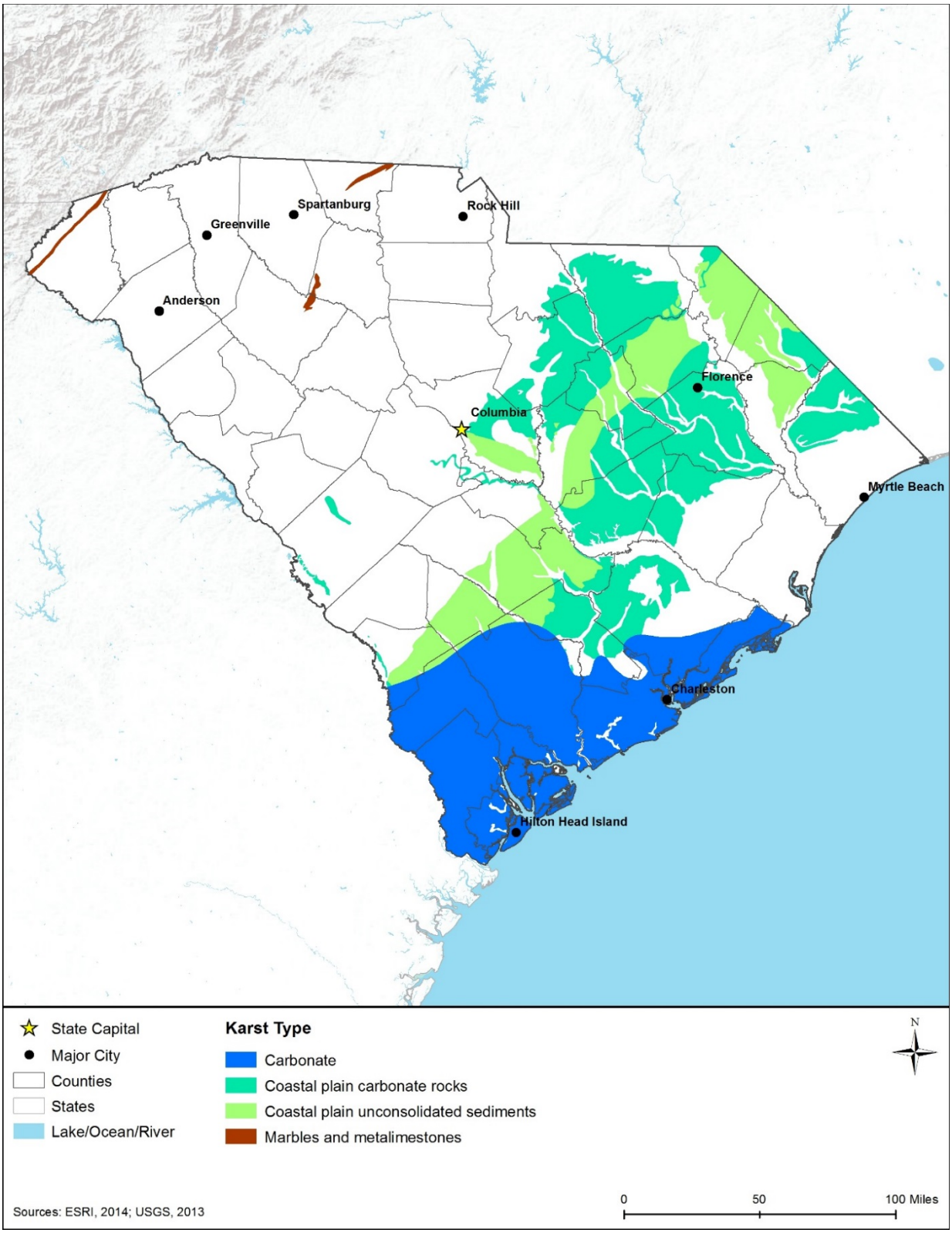


Figure 13.1.3-6: Areas Susceptible to Subsidence due to Karst Topography in South Carolina

13.1.4. Water Resources

13.1.4.1. Definition of the Resource

Water resources are defined as all surface water bodies and groundwater systems including streams, rivers, lakes, canals, ditches, estuarine waters, floodplains, aquifers, and other aquatic habitats (wetlands are discussed separately in Section 13.1.5). These resources can be grouped into watersheds, which are defined as areas of land whose flowing water resources (including runoff from rainfall) drain to a common outlet such as a river or ocean. The value and use of water resources are influenced by the quantity and quality of water available for use and the demand for available water. Water resources are used for drinking, irrigation, industry, recreation, and as habitat for wildlife. Some water resources that are particularly pristine, sensitive, or of great economic value enjoy special protections under federal and state laws. An adequate supply of water is essential for human and ecological health and economic wellbeing. (USGS, 2014b)

13.1.4.2. Specific Regulatory Considerations

Federal laws relevant to protecting the quality and use of water resources are summarized in Section 1.8, Overview of Relevant Federal Laws and Executive Orders and Appendix C, Environmental Laws and Regulations. Table 13.1.4-1 identifies the relevant laws and regulations for water resources in South Carolina.

Table 13.1.4-1: Relevant South Carolina Water Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Clean Water Act (CWA) Section 401 Water Quality Certification	SCDHEC	In accordance with Section 401 of the CWA, activities that may result in a discharge to waters of the U.S. require a Water Quality Certification from SCDHEC indicating that the proposed activity will not violate water quality standards.
CWA Section 404 Nationwide Permits (NWPs), South Carolina regional requirements	U.S. Army Corps of Engineers (USACE) Charleston District	Regional conditions apply to activities authorized by USACE NWPs in South Carolina.
CWA Section 401/404	SCDHEC	"Any activity, such as construction, dredging, filling, or other alterations, below the mean high water line (tidal waters) or the ordinary high water mark (nontidal waters) in a navigable waterway of South Carolina must first receive a Construction in Navigable Waters Permit." However, "a separate Construction in Navigable Waters Permit is not required for activities which require another SCDHEC permit or certification, including but not limited to 401 Water Quality Certifications, water supply permits, NPDES permits, wastewater construction permits, and mining permits."
South Carolina Coastal Zone Management Act	Office of Ocean and Coastal Resource Management	Regulates impacts to coastal resources within the critical areas of the state including coastal waters, tidal wetlands, tidelands, beaches and beach dune systems

State Law/Regulation	Regulatory Agency	Applicability
NPDES Program	SCDHEC	Regulates the discharge of pollutants in stormwater discharges associated with construction activities that disturb one or more acres
South Carolina Code of Laws, Title 49 – Waters, Water Resources, and Drainage	Multiple state agencies	General group of laws related to waterbodies and water resources within the state.

13.1.4.3. Environmental Setting: Surface Water

Surface water resources are lakes, ponds, rivers, and streams, as well as estuarine[51] and coastal waters. According to the SCDHEC, South Carolina has approximately 24,436 miles of freshwater rivers and streams with 393,430 acres of lakes and reservoirs, and an estimated 289 square miles of estuarine waters (SCDHEC, 2014a). Surface water uses include aquaculture, irrigation, industry, water supply, recreation, and power generation (SCDHEC, 2014a).

Watersheds

Watersheds, or drainage areas, consist of surface water and all underlying groundwater, and encompass an area of land that drains streams and rainfall to a common outlet (e.g., reservoir, bay). South Carolina's waters (lakes, rivers, and streams) are divided into 4 major watersheds or drainage basins (Figure 13.1.4-1). (SCDNR, 2009)

The Santee watershed covers approximately 10,600 square miles within South Carolina and is the largest watershed in the state. The watershed extends from the northcentral border to southeastern South Carolina, and contains several major rivers, including the Broad, Saluda, Catawba, and Santee Rivers. Within South Carolina, the Pee Dee watershed drains the area from the eastern border of the Santee watershed to the South Carolina-North Carolina border. The ACE (Ashepoo, Combahee, and Edisto) watershed extends from the southern border of the Santee watershed to South Carolina's coastline. This watershed contains Lake Moultrie, one of the state's largest lakes. The Savannah watershed extends along South Carolina's western border and contains numerous reservoirs used to generate power and control flooding within the state. (SCDNR, 2009)

[51] Estuarine: related to an estuary, or a "partially enclosed body of water where fresh water from rivers and streams mixes with salt water from the ocean. It is an area of transition from land to sea" (USEPA, 2015b).

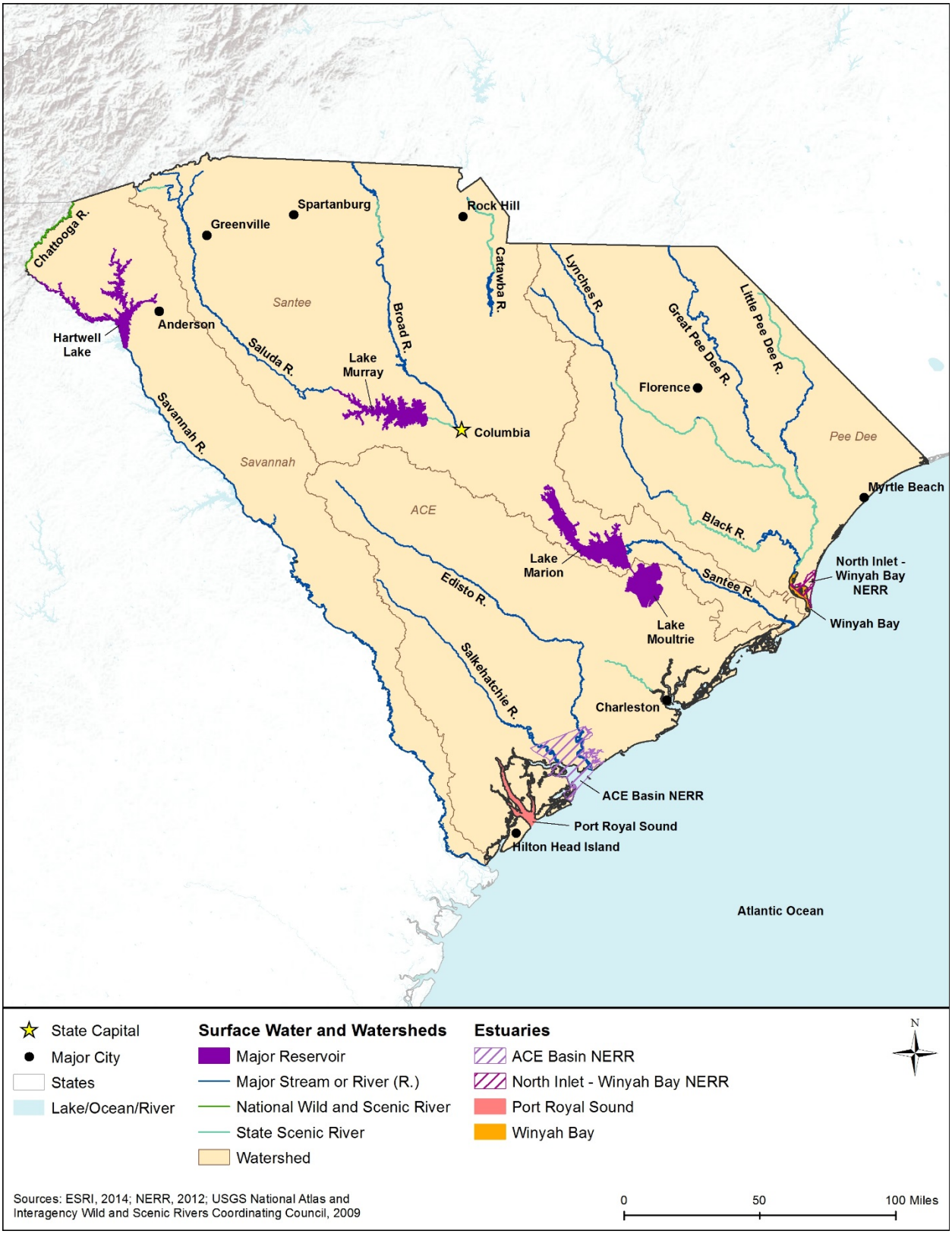


Figure 13.1.4-1: Major South Carolina Watersheds, Surface Waterbodies, and Estuaries

Freshwater

As shown in Figure 13.1.4-1, there are 10 major rivers in South Carolina: Santee River, Edisto River, Savannah River, Saluda River, Broad River, Pee Dee River (Great Pee Dee River), Black River, Catawba River, Lynches River, Salkehatchie River. On the South Carolina-Georgia border, the Savannah River flows through several large reservoirs. The Saluda River flows south from northern South Carolina and joins the Broad River in the central portion of the state. The Santee River flows through Lake Marion in central South Carolina and is channeled to Lake Moultrie, or continues to the Atlantic Ocean (SCDHEC, 2015k). In southern South Carolina, the Edisto River is formed from two forks and flows southeast to the Atlantic Ocean. In eastern South Carolina, the Pee Dee (Great) River is joined by its tributary, Little Pee Dee River, and flows south along the North Carolina-South Carolina state line, emptying into Winyah Bay (SCDHEC, 2015q). Within South Carolina, there are 14 large reservoirs covering nearly 370,000 acres (SCDNR, 2014a). Some of the state's large reservoirs provide flood control, hydropower[52] generation, recreation, and irrigation (SCDNR, 2009).

Major lakes and reservoirs in South Carolina include Lake Marion, Lake Moultrie, Lake Murray, and Hartwell Lake (Figure 13.1.4-1).

- Lake Marion is the largest lake in South Carolina, covering approximately 110,600 acres in southeast South Carolina. The lake was originally constructed to provide hydroelectric power to rural areas within the state, and is used my many residents and visitors for fishing and boating activities. Large woody debris and native aquatic vegetation create an ideal environment for many species of fish. (SCDNR, 2014b)
- Lake Moultrie is connected to Lake Marion and covers approximately 60,400 acres in southeast South Carolina. A network of dams and dikes contain more than half of the lake's shoreline. Lake Moultrie is also used to generate power to rural South Carolina. The size of freshwater fish within this lake draws many fishermen each spring. (SCDNR, 2014c)
- Lake Murray covers approximately 48,000 acres in central South Carolina. The lake supplies water for the Saluda River hydroelectric facility owned and operated by South Carolina Oil and Gas. Additionally, the lake provides a variety of recreational opportunities, including boating, swimming, and fishing. (SCDNR, 2014d)
- Hartwell Lake is an approximate 56,000-acre lake located on the South Carolina-Georgia state line in the northwestern corner of South Carolina. The lake was constructed on the Savannah River, and is a popular fishing site due to its variety of fish species. Additional recreational opportunities include camping, hunting, and boating. (SCDNR, 2014e)

Estuarine and Coastal Waters

Estuaries (including bays and tidal rivers) are bodies of water that provide transition zones between fresh river water and saline ocean water. Barrier islands, sand bars, and other landmasses protect estuaries, including those in South Carolina, from ocean waves and storms. South Carolina's estuarine environments support a variety of habitats, including tidal wetlands,

[52] Hydropower: "electrical energy produced by falling or flowing water" (USEPA, 2004).

mudflats, rocky shores, oyster reefs, freshwater wetlands, sandy beaches, and eelgrass beds, and are a critical part of the lifecycle of many different plant and animal species (USEPA, 2012a).

South Carolina has two major estuarine areas located along its southeastern coast (Figure 13.1.4-1).

- The **ACE Basin National Estuarine Research Reserve** protects approximately 99,308 acres in South Carolina. The ACE Basin is named for the Ashepoo, Combahee, and Edisto Rivers, which meet at a coastal inlet southeast of Charleston. The estuary is one of the largest undeveloped estuaries on the east coast, and includes cypress swamps, oyster reefs, and tidal marshes. Additionally, the reserve provides a variety of outdoor recreational opportunities (SCDNR, 2014f). Adjacent to ACE Basin is the Port Royal Sound**,** a salt marsh estuary with a highly productive ecosystem (SCWRC, 1972).
- The **North Inlet-Winyah Bay National Estuarine Research Reserve** encompasses 18,916 acres of tidal marshes and wetlands. The North Inlet is an "ocean-dominated estuary" with "extensive salt marshes surrounded by a small, forested watershed." Winyah Bay is a brackish estuary and receives input from four rivers (Waccamaw, Sampit, Black, and Pee Dee). (North Inlet-Winyah Bay, 2015)

13.1.4.4. Sensitive or Protected Waterbodies

Wild and Scenic Rivers

The Chattooga River in South Carolina is the only federally designated National Wild and Scenic River in South Carolina (Figure 13.1.4-1). The river is located on the far northwestern border of South Carolina, and includes approximately 41.4 miles designated as wild river, 2.5 scenic miles, and 14.6 recreational miles. The river is a free-flowing stream and considered a premier whitewater river in the Southeast. Chattooga River is characterized by "thundering falls and twisting rock-choked channels" with "narrow, cliff-enclosed deep pools." The area is largely undeveloped, consisting primarily of hiking trails for visitors. (National Wild and Scenic Rivers System, 2015a)

State Designated Scenic Rivers

South Carolina has designated ten river segments as State Scenic Rivers (Figure 13.1.4-1): Ashley, Black, Broad, Catawba, Great Pee Dee, Little Pee Dee, Little Pee Dee of Dillon County, Saluda, Middle Saluda, and Lynches. This designation includes natural, scenic, and recreational Rivers within the states, as defined by the South Carolina State Scenic Rivers Act of 1989 (SCDNR, 2014g).

13.1.4.5. Impaired Waterbodies

Several elements, including temperature, dissolved oxygen, suspended sediment, nutrients, metals, oils, observations of aquatic wildlife communities, and sampling of fish tissue, are used to evaluate water quality. Under Section 303(d) of the Clean Water Act, states are required to

assess water quality and report a listing of impaired waters,[53] the causes of impairment, and probable sources. Table 13.1.4-2 summarizes the water quality of South Carolina's assessed major waterbodies by category, percent impaired, designated use,[54] cause, and probable sources. Figure 13.1.4-2 shows the Section 303(d) waters in South Carolina as of 2012.

As shown in Table 13.1.4-2, various sources affect South Carolina's waterbodies, causing impairments. For example, segments of South Carolina lakes and reservoirs, such as Lake Marion, are impaired due to elevated phosphorus levels. SCDHEC closely monitors Lake Marion and other impaired waters to reduce these levels and prevent further pollution (SCDHEC, 2015n). Elevated mercury levels are also sources of impairment for South Carolina rivers, and result in the issuance of fish consumption advisories by the state. For example, the 2015 South Carolina Fish Consumption Advisories list includes major rivers, such as the Black and Great Pee Dee Rivers, which are currently impaired by mercury. (SCDHEC, 2015o) Statewide, the primary designated use for South Carolina's impaired waterbodies is aquatic life (SCDHEC, 2012).

Table 13.1.4-2: Section 303(d) Impaired Waters of South Carolina, 2012

Water Type[a]	Amount of Waters Assessed[b] (Percent)	Amount Impaired (Percent)	Designated Uses of Impaired Waters	Top Causes of Impairment	Top Probable Sources for Impairment
Rivers and Streams	19.5%	65%	Aquatic life, fish consumption, and primary contact recreation	Pathogens[c], dissolved oxygen, mercury, pH (acidity), metals	No probable sources reported
Lakes, Reservoirs, and Ponds	33%	25%	Aquatic life, fish consumption, and primary contact recreation	Phosphorus, pH (acidity), metals such as nickel and copper, nutrients, ammonia, algal growth	No probable sources reported
Estuaries and Bays	100%	31%	Aquatic life, primary contact recreation, and shellfish harvesting	Pathogens, turbidity, dissolved oxygen	No probable sources reported
Ocean and Near Coastal	Information unavailable	15%	Primary contact recreation	Pathogens	No probable sources reported

[a] Some waters may be considered for more than one water type.
[b] South Carolina has not assessed all waterbodies within the state.
[c] Pathogen: a bacterium, virus, or other microorganism that can cause disease (USEPA, 2015b).
Source: (USEPA, 2015c)

[53] Impaired waters: waterways that do not meet state water quality standards. Under the CWA, Section 303(d), states, territories, and authorized tribes are required to develop prioritized lists of impaired waters (USEPA, 2015b).
[54] Designated Use: an appropriate intended use by humans and/or aquatic life for a waterbody. Designated uses may include recreation, shellfishing, or drinking water supply. (USEPA, 2015b)

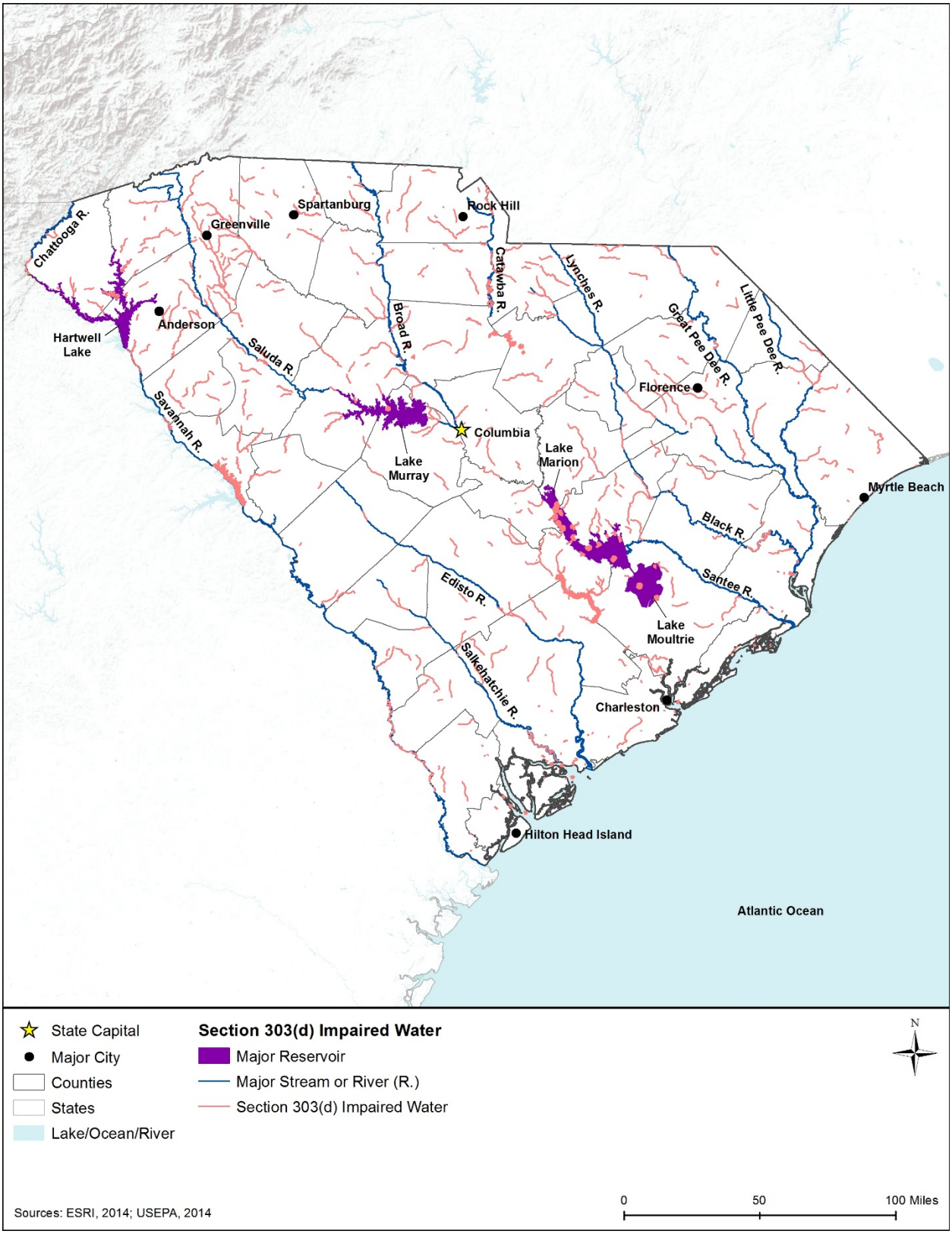


Figure 13.1.4-2: Section 303(d) Impaired Waters of South Carolina, 2012

SCDHEC works closely with federal and state agencies to implement programs to maintain and restore water quality across the state. For example, South Carolina has established a nonpoint source pollution (NPS)[55] management program to address water quality within watersheds and implement pollution reduction and prevention strategies. Pathogens are the most common measured NPS in South Carolina's rivers, stream, estuaries, and bays. Additional pollution sources, such as phosphorus and heavy metals, threaten the state's lakes, reservoirs, and ponds. Many septic system repairs within the river's watershed have been completed to restore water quality and prevent contamination. (SCDHEC, 2014b)

13.1.4.6. Floodplains

The Federal Emergency Management Agency (FEMA) defines a floodplain or flood-prone area as "any land area susceptible to being inundated by water from any source" (44 Code of Federal Regulations [CFR] 59.1) (FEMA, 2000).[56] Through FEMA's flood hazard mapping program, the agency identifies flood hazards and risks associated with the 100-year flood, which is defined as "a flood that has a 1 percent chance of occurring in any given year," to allow communities to prepare and protect against flood events (FEMA, 2013).

Floodplains provide suitable and sometimes unique habitat for a wide variety of plants and animals, and are typically more biologically diverse than upland areas due to the combination of both terrestrial and aquatic ecosystems. Vegetation along stream banks provides shade, which helps to regulate water temperature for aquatic species. During flood events, sediment and debris settle out and collect on the floodplain, enriching the soil with additional nutrients. Pollutants from floodwater runoff are also filtered by floodplain vegetation and soils; thereby improving water quality. Furthermore, floodplains protect natural and built infrastructure by providing floodwater storage, erosion control, water quality maintenance, and groundwater recharge. Historically, floodplains have been favorable locations for agriculture, aquaculture, and forest production due to the relatively flat topography and nearby water supply. Floodplains can also offer recreational activities, such as boating, swimming, and fishing, as well as hiking and camping. (FEMA, 2014a)

There are two primary types of floodplains in South Carolina:

- **Riverine and lake floodplains** occur along rivers, streams, or lakes where overbank flooding may occur, inundating adjacent land areas. In steep river valleys found in hilly areas, floodwaters can build and recede quickly, with fast moving and deep water. Flooding in these areas can cause greater damage than typical riverine flooding due to the high velocity of water flow, the amount of debris carried, and the broad area affected by floodwaters. Whereas, flatter floodplains may remain inundated for days or weeks, covered by slow-moving and shallow water. (FEMA, 2014b)

[55] Nonpoint source pollution (NPS) is a source of pollution that does not have an identifiable, specific physical location or a defined discharge point. NPS pollution includes nutrients that run off croplands, lawns, parking lots, streets and other land uses. It also includes nutrients that enter waterways via air pollution groundwater, or septic systems. (USEPA, 2015b)

[56] To search for and locate CFR records, see the Electronic Code of Federal Regulations (e-CFR): www.ecfr.gov.

- **Coastal floodplains** are found along the South Carolina border with the Atlantic Ocean. Coastal flooding can occur when strong wind and storms, usually nor'easters and hurricanes, increase water levels on the adjacent shorelines (FEMA, 2013). In addition, a storm surge event that takes place during high tide can cause floodwaters to exceed normal tide levels, resulting from strong winds preventing tidal waters to recede in conjunction with additional water pushed toward the shore.

Flooding is the leading cause for disaster declaration by the President in the U.S. and results in significant damage throughout the state annually (NOAA, 2015a). There are several causes of flooding in South Carolina, often resulting in loss of life and damage to property, infrastructure, agriculture, and the environment. These include severe rain events, hurricanes, debris and ice jams, and dam/levee failure (SCEMD, 2013).

Although some areas, such as floodplains, are more prone to flooding than others, no area in the state is exempt from flood hazards. Based on historical flooding and flood disaster declarations, flood problems are most severe in the coastal counties surrounding Charleston, South Carolina, and in the northwest counties around Greenville, South Carolina along the Saluda River (see Figure 13.1.4-1) (SCEMD, 2013).

Local communities often have floodplain management or zoning ordinances that restrict development within the floodplain. FEMA provides floodplain management assistance, including mapping of 100-year floodplain limits, to approximately 231 communities in South Carolina through the National Flood Insurance Program (NFIP) (FEMA, 2014c). Established to reduce the economic and social cost of flood damage by subsidizing insurance payments, the NFIP encourages communities "to adopt and enforce floodplain management regulations and to implement broader floodplain management programs" and allows property owners in participating communities to purchase insurance protection against losses from flooding (FEMA, 2015). As an incentive, communities can voluntarily participate in the NFIP Community Rating System (CRS), which is a program that rewards communities by reducing flood insurance premiums in exchange for doing more than the minimum NFIP requirements for floodplain management. As of May 2014, South Carolina had 42 communities participating in the CRS (FEMA, 2014d).[57]

13.1.4.7. Groundwater

Groundwater systems are sources of water that result from precipitation infiltrating the ground surface, and includes underground water that occupies pore spaces between sand, clay, or rock particles. An aquifer is a permeable geological formation that stores or transmits water to wells and springs. Groundwater is contained in either confined (bound by clays or nonporous bedrock) or unconfined (no layer to restrict the vertical movement of groundwater) aquifers (USGS, 1999). When the water table reaches the ground surface, groundwater will reappear as either

[57] A list of the 42 CRS communities can be found in the most recent FEMA CRS report dated May 1, 2014 (www.fema.gov/media-library-data/1398878892102-a5cbcaa727a635327277d834491210fec/CRS_Communites_May_1_2014.pdf) and additional program information is available from FEMA's NFIP CRS website (www.fema.gov/national-flood-insurance-program-community-rating-system).

streams, surface bodies of water, or wetlands. This exchange between surface water and groundwater is an important feature of the hydrologic (water) cycle.

South Carolina's principal aquifers consist of carbonate-rock[58] and sandstone aquifers.[59] Approximately 17 percent of total water-supply use in South Carolina originates from groundwater resources. Additionally, groundwater serves as the water supply for more than 750,000 South Carolina residents. Generally, the water quality of South Carolina's aquifers is suitable for public-supply, industrial, and irrigation use. (SCDNR, 2009). Statewide, the most serious threat to groundwater quality includes leaking underground storage tanks, discharge from hazardous waste landfills and industrial contamination, mining, chemical spills, and saltwater intrusion (saltwater moving into freshwater aquifers) (SCDHEC, 2014a).

Table 13.1.4-3 provides details on aquifer characteristics in the state; Figure 13.1.4-3: shows South Carolina's principal aquifers. There are no sole source aquifers in South Carolina.

Table 13.1.4-3: Description of South Carolina's Principal Aquifers

Aquifer Type and Name	Location in State	Groundwater Quality
Southeastern Coastal Plain aquifer system consist of sand with minor gravel and limestone beds	Southeastern part of the state, running along the coast	Generally, the water is suitable for most uses. Contains saltwater with high concentrations of dissolved-solids including iron and chloride. Principal use is public supply.
Surficial aquifer system consists of unconsolidated sand, shelly sand, and shell	Central part of the state running from west to northeast	Water is considered hard. Contains concentrations of dissolved-solids including iron in the northern plain and sodium bicarbonate in the lower plains. Principal use is public supply.
Piedmont and Blue Ridge crystalline-rock aquifers consist of bedrock, regolith (earthy, decomposed rock), and alluvium	Northwestern part of the state	Generally, the water is suitable for most uses. Water is soft in most areas. Contains concentrations of alkalinity, hardness, sodium, magnesium, and chloride in water. Principal uses are for domestic and commercial use.

Sources: (Moody, Carr, Chase, & Paulson, 1986) (USGS, 1990b)

[58] Carbonate-rock aquifers typically consist of limestone with highly variable water-yielding properties (some yield almost no water and others are highly productive aquifers) (Olcott, 1995a).

[59] Sandstone aquifers form from the conversion of sand grains into rock caused by the weight of overlying soil/rock. The sand grains are rearranged and tightly packed, thereby reducing or eliminating the volume of pore space, which results in low-permeability rocks such as shale or siltstone. These aquifer types are highly productive in many places and provide large volumes of water. (Olcott, 1995b)

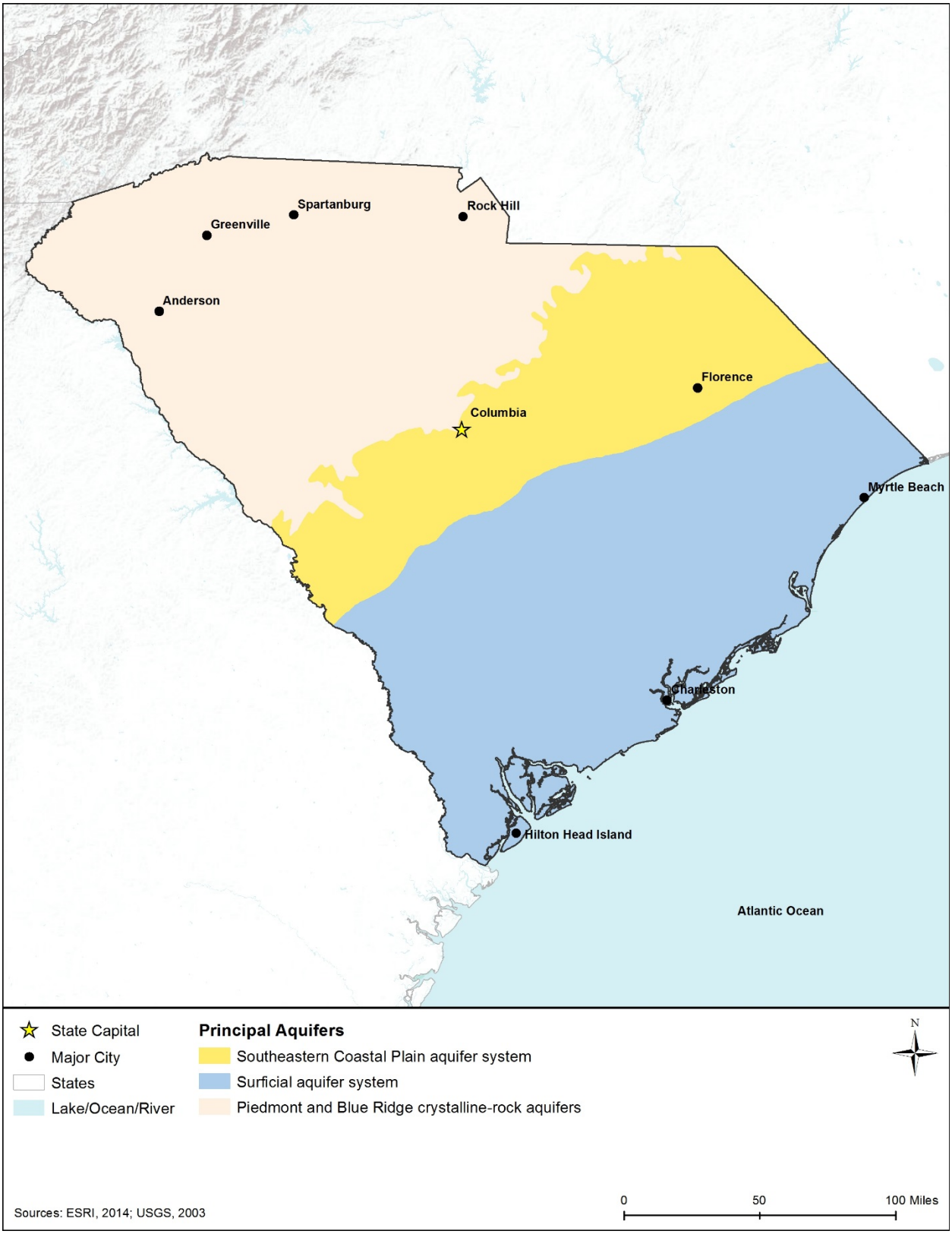


Figure 13.1.4-3: Principal Aquifers of South Carolina

13.1.5. Wetlands

13.1.5.1. Definition of the Resource

The Clean Water Act (CWA) defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (40 CFR 230.3(t), 1993).

The USEPA estimates that "more than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half of such species use wetlands at some point in their lives" (USEPA, 1995). In addition to providing habitat for many plants and animals, wetlands also provide benefits to human communities. Wetlands store water during flood events, improve water quality by filtering polluted runoff, help control erosion by slowing water velocity and filtering sediments, serve as points of groundwater recharge, and help maintain base flow in streams and rivers. Additionally, wetlands provide recreation opportunities for people, such as hiking, bird watching, and photography. (USEPA, 1995)

13.1.5.2. Specific Regulatory Considerations

Appendix C, Environmental Laws and Regulations, describes the pertinent federal laws protecting wetlands in detail. Table 13.1.5-1 summarizes the major South Carolina state laws and permitting requirements relevant to the state's wetlands.

Table 13.1.5-1: Relevant South Carolina Wetlands Laws and Regulations

State Law/Regulation	Regulatory Authority	Applicability
CWA Section 401 Water Quality Certification	SCDHEC	In accordance with Section 401 of the CWA, activities that may result in a discharge to waters of the U.S. require a Water Quality Certification from SCDHEC indicating that the proposed activity will not violate water quality standards.
CWA Section 404 Nationwide Permits (NWPs), South Carolina regional requirements	USACE Charleston District	Regional conditions apply to activities authorized by USACE NWPs in South Carolina. Including a required pre-construction notification, prior to commencing the activity if the activity will involve the permanent conversion of forested wetlands to herbaceous wetlands.
CWA Section 401/404	SCDHEC	"Any activity, such as construction, dredging, filling, or other alterations, below the mean high water line (tidal waters) or the ordinary high water mark (nontidal waters) in a navigable waterway of South Carolina must first receive a Construction in Navigable Waters Permit." However, "a separate Construction in Navigable Waters Permit is not required for activities which require another SCDHEC permit or certification, including but not limited to 401 Water Quality Certifications, water supply permits, NPDES, wastewater construction permits, and mining permits."
South Carolina Coastal Zone Management Act	Office of Ocean and Coastal Resource Management	Regulates impacts to coastal resources within the critical areas of the state including coastal waters, tidal wetlands, tidelands, beaches, and beach dune systems.

State Law/Regulation	Regulatory Authority	Applicability
NPDES Program	SCDHEC	Regulates the discharge of pollutants in stormwater discharges associated with construction activities that disturb one or more acres.

13.1.5.3. Wetland Types and Functions

The U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapping adopted a national Wetlands Classification Standard that classifies wetlands according to shared environmental factors, such as vegetation, soils, and hydrology, as defined by (Cowardin L. M., Carter, Golet, & LaRoe, 1979). The Wetlands Classification System includes five major wetland Systems: Marine, Estuarine, Riverine, Lacustrine, and Palustrine. South Carolina includes all of these Systems, as detailed in Table 13.1.5-2. The first four of these include both wetlands and deepwater habitats but the Palustrine includes only wetland habitats.

- "The Marine System consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the Water Regimes are determined primarily by the ebb and flow of oceanic tides. Salinities exceed 30 parts per thousand (ppt), with little or no dilution except outside the mouths of estuaries."
- "The Estuarine System consists of deepwater tidal habitats and adjacent tidal habitats that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean and the ocean water is at least occasionally diluted by freshwater runoff from the land."
- "Riverine System includes all wetlands and deepwater habitats contained within a channel with two exceptions (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5 ppt."
- Lacustrine System includes inland water bodies that are situated in topographic depressions, lack emergent trees and shrubs, have less than 30 percent vegetation cover, and occupy greater than 20 acres. Includes lakes, larger ponds, sloughs, lochs, bayous, etc.
- "Palustrine includes all nontidal wetlands dominated by trees, shrubs, persistent emergents plants, or emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent." The system is characterized based on the type and duration of flooding, water chemistry, vegetation, or substrate characteristics (soil types) (FGDC, 2013).

In South Carolina, the two main types of wetlands are palustrine (freshwater) wetlands found on river and lake floodplains across the state, and estuarine/marine (tidal) wetlands along the Atlantic Ocean. Riverine and lacustrine wetlands comprise approximately one percent of the wetlands in the state. Therefore, they are not discussed in detail in this PEIS.

Table 13.1.5-2 uses 2014 NWI data to characterize and map South Carolina wetlands on a broad-scale. The data is not intended for site-specific analyses and is not a substitute for field-level

wetland surveys, delineations, or jurisdictional determinations, which may be conducted, as appropriate, at the site-specific level once those locations are known. As shown in Figure 13.1.5-1, palustrine wetlands are found throughout the state, but more heavily concentrated in the southeastern portion of South Carolina, while estuarine/marine wetlands are found in the southeastern portion of the state.[60] The map codes and colorings in Table 13.1.5-2 correspond to the wetland types in the figures.

Table 13.1.5-2: South Carolina Wetland Types, Descriptions, Location, and Amount, 2014

Wetland Type	Map Code and Color	Description[a]	Occurrence	Amount (acres)[b]
Palustrine forested wetland	PFO	PFO wetlands contain woody vegetation that are at least 20 feet tall. Floodplain forests, hardwood swamps, and silver maple-ash swamps are examples of PFO wetlands.	Throughout the state, often on river and lake floodplains and more heavily concentrated in the southeastern half of the state.	2,976,045
Palustrine scrub-shrub wetland	PSS	Woody vegetation less than 20 feet tall dominates PSS wetlands. Thickets and shrub swamps are examples of PSS wetlands.		
Palustrine emergent wetlands	PEM	PEM wetlands have erect, rooted, green-stemmed, annual, water-loving plants, excluding mosses and lichens, present for most of the growing season in most years. PEM wetlands include freshwater marshes, wet meadows, fens,[c] prairie potholes, and sloughs.	Throughout the state.	193,219
Palustrine unconsolidated bottom	PUB	PUB and PAB wetlands are commonly known as freshwater ponds, and includes all wetlands with at least 25% cover of particles smaller than stones and a vegetative cover less than 30%.	Throughout the state.	99,161
Palustrine aquatic bed	PAB	PAB wetlands include wetlands vegetated by plants growing mainly on or below the water surface line.		
Other Palustrine wetland	Misc. Types	Farmed wetland, saline seep,[d] and other miscellaneous wetlands are included in this group.	Throughout the state.	2,258

[60] The wetland acreages were obtained from the USFWS (2014) National Wetlands Inventory. Data from this inventory was downloaded by state at https://www.fws.gov/wetlands/. The wetlands data contains a wetlands classification code, which are a series of letter and number codes, adapted to the national wetland classification system in order to map from (e.g., PFO). Each of these codes corresponds to a larger wetland type; those wetland areas are rolled up under that wetlands type. The codes and associated acres that correspond to the deepwater habitats (e.g., those beginning with M1, E1, L1) were removed. The wetlands acres were derived from the geospatial datafile, by creating a pivot table to capture the sum of all acres under a particular wetland type. The maps reflect/show the wetland types/classifications and overarching codes; the symbolization used in the map is standard to these wetland types/codes, per the USFWS and Federal Geographic Data Committee.

Wetland Type	Map Code and Color	Description[a]	Occurrence	Amount (acres)[b]
Riverine wetland	R	Riverine systems include rivers, creeks, and streams. They are contained in natural or artificial channels periodically or continuously containing flowing water.	Throughout the state.	22,686
Lacustrine wetland	L2	Lacustrine systems are lakes or shallow reservoir basins generally consisting of ponded waters in depressions or dammed river channels, with sparse or lacking persistent emergent vegetation, but including any areas with abundant submerged or floating-leaved aquatic vegetation. These wetlands are less than 8.2 feet deep.	Throughout the state.	17,972
Estuarine and Marine intertidal wetland	E2/M2	These intertidal wetlands include the areas between the highest tide level and the lowest tide level. Semidiurnal tides (two high tides and two low tides per day) periodically expose and flood the substrate. Wetland examples include vegetated and non-vegetated brackish (mix of fresh and saltwater), and saltwater marshes, shrubs, beaches, sandbars, or flats.	Southeastern part of the state, along the Atlantic Ocean.	377,169
			TOTAL	**3,688,510**

[a] The wetlands descriptions are based on information from the Federal Geographic Data Committee (FGDC)'s Classification of Wetland and Deepwater Habitats of the United States. Based on Cowardin, et.al, 1979, some data has been revised based on the latest scientific advances. The USFWS uses these standards as the minimum guidelines for wetlands mapping efforts. (FGDC, 2013)
[b] All acreages are rounded to the nearest whole number. The maps are prepared from the analysis of high altitude imagery. A margin of error is inherent in the use of imagery. The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. (USFWS, 2015b)
[c] Fens are nutrient-rich, grass- and sedge-dominated emergent wetlands that are recharged from groundwater and have continuous running water. (Edinger, et al., 2014)
[d] Saline seep is an area where saline groundwater discharges at the soil surface. These wetland types are characterized by saline soils and salt tolerant plants (City of Lincoln, 2015)
Sources: (Cowardin L. M., Carter, Golet, & LaRoe, 1979) (USFWS, 2015a) (FGDC, 2013)

Palustrine Wetlands

In South Carolina, palustrine wetlands include the majority of vegetated freshwater wetlands (freshwater marshes and swamps). Marshes and swamps are found in flat areas, with shallow water and minimal water flow. Marshes are typically found in a depression or near the edges of rivers and lakes, while the largest swamps in the state are associated with major river systems, including the Santee and Savannah Rivers. Herbaceous vegetation is adapted to constant flooding in marshes, and include cattails (*Typha* sp.), sedges (*Cyperaceae* sp.), and arrowheads (*Sagittaria latifolia*) in shallow water, along with pondweeds (*Potamogeton* sp.), bladderworts (*Utricularia* sp.), and water lilies (*Nymphaeaceae* sp.) in deeper water. Woody plants dominate the vegetation in South Carolina bottomland hardwood swamps, and include tupelo (*Nyssa* sp.), swamp chestnut oak (*Quercus michauxii*), and bald cypress (*Taxodium distichum*). Swamps are wet for only part of the year, and then go dry for the remaining part. (Yarrow, 2009)

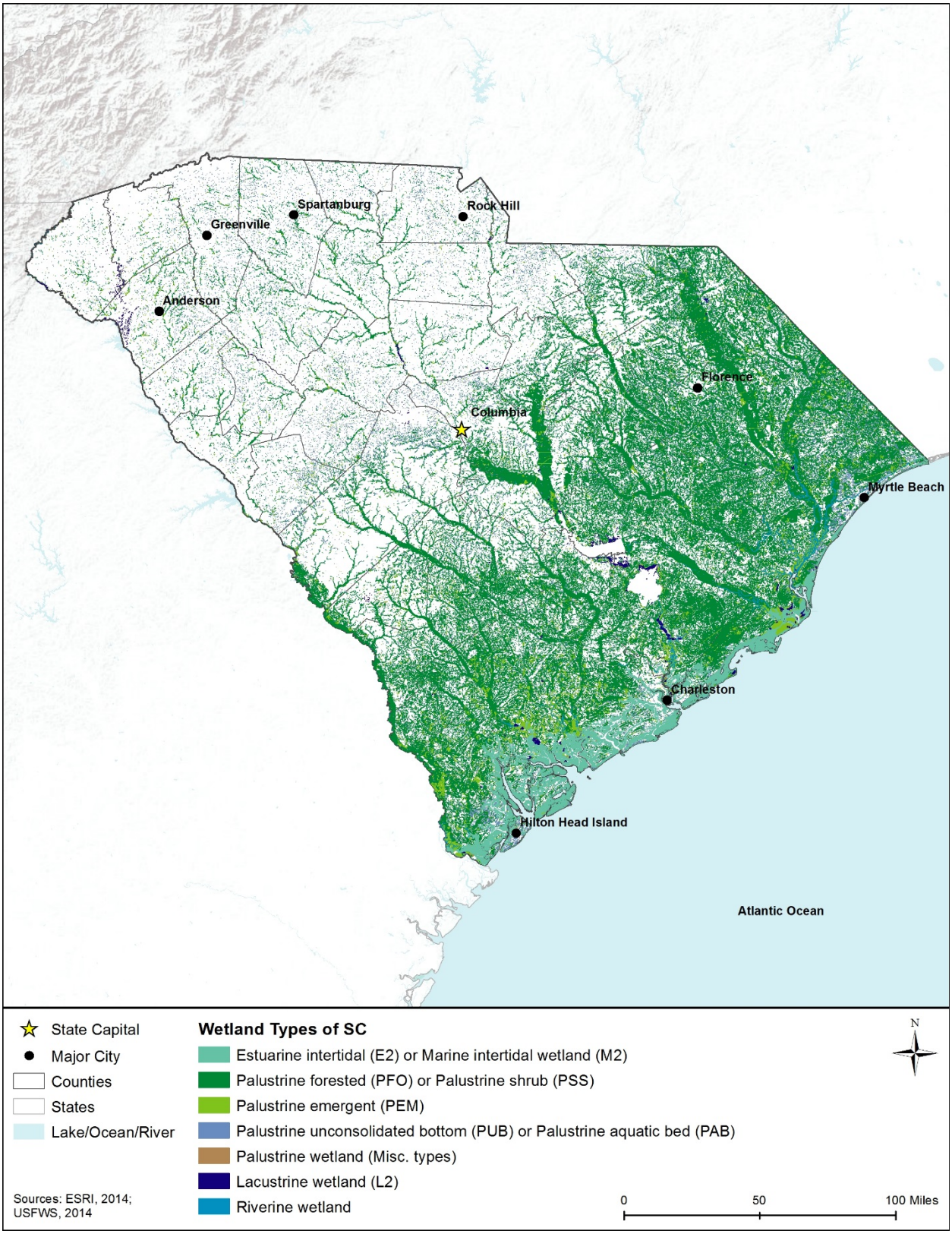


Figure 13.1.5-1: Wetlands by Type, in South Carolina, 2014

Other isolated swamps are found throughout the state, and include Carolina Bays (discussed in Section 13.1.5.4 below), as well as cypress and gum ponds, spring bogs, and bay heads. Cypress and gum ponds range in size from less than one acre to hundreds of acres. Cypress ponds tend to dry up during the summer, while gum ponds remain wet through the year. Spring bogs are found throughout South Carolina, and are usually found on slopes associated with a perched water table. Bay heads are located along the coastal plain, with dense, broadleaf vegetation. They are small swamps, and usually found at the head of coastal plain stream drainage. (Yarrow, 2009)

Based on the USFWS NWI 2014 analysis of palustrine wetlands, PFO/PSS is the dominant wetland type in South Carolina (81 percent), followed by PEM (5 percent), PUB/PAB (3 percent), and other palustrine wetlands (less than 1 percent). There are currently about 3.3 million acres of palustrine (freshwater) wetlands in the state (USFWS, 2014a).

Approximately 30 percent of all of South Carolina's original wetland acreage has been lost due to human activities, including draining lands for agriculture and commercial forestry (Yarrow, 2009) (Dahl, 1999).

Estuarine and Marine Wetlands

Estuarine and Marine Wetlands in South Carolina make up about 10 percent of all wetlands in the state, and include tidal salt marshes and estuarine (or tidal brackish) marshes. There are currently about 377,000 acres of estuarine and marine wetlands in South Carolina (USFWS, 2014a).

Tidal salt marshes are found along the coast, with salt-tolerant vegetation such as black needle rush (*Juncus gerardii*) and smooth cord grass (*Spartina alterniflora*). These marshes are productive ecosystems, supporting seafood nurseries and providing habitat for over 96 percent of the state's commercial seafood and shellfish catch. Estuarine marshes are found inland from the tidal salt marshes, in areas where saltwater and freshwater meet. Dominant vegetation in estuarine marshes includes bulrush (*Typha* sp.) and giant cord grass (*Spartina* sp.), although plant and animal life varies depending on the saltiness of the water. (Yarrow, 2009)

13.1.5.4. Wetlands of Special Concern or Value

In addition to protections under the state's coastal zone regulations and national CWA, South Carolina considers certain wetland communities as areas of special value (or high quality) due to their global or regional scarcity, "unusual local importance," or habitat they support. These include Carolina Bays and wetlands associated with the North Inlet-Winyah Bay and ACE Base NERRs.

Figure 13.1.5-2: North Inlet-Winyah Bay NERR

Source: (NOAA, 2015f)

Carolina Bays

Carolina Bays are freshwater wetlands, typically isolated and filled by rainwater in the winter and spring, and can go dry during the summer. They are

found in oval or elliptical depressions formed by unknown causes, and have a northwest to southeast orientation, perpendicular to the shoreline and parallel to each other. They can characteristically have raised sand rims, are relatively shallow, with sandy, flat bottoms under interior fill. Carolina Bays are found in South Carolina, as well as North Carolina and some bays in Delaware, Georgia, and Virginia. Carolina Bays are also sometimes referred to as "pocosins." (SCDNR, 2015b)

The North Inlet-Winyah Bay NERR protects nearly 19,000 acres of both tidal and transitional marshes, as well as open water, oyster reefs, coastal forests, and beach areas. The North Inlet estuary is characterized by large salt marshes and high water quality, while Winyah Bay estuary is brackish, heavily influenced by human activities such as forestry, and drains four major rivers. (NOAA, 2015b)

The Ace Basin NERR is nearly 100,000 acres in size, and contains one of the largest undeveloped estuaries on the eastern coast of the United States. The NERR contains tidal marshes and cypress swamps, as well as oyster reefs, old rice fields, and historic plantation homes. (NOAA, 2015c)

Other Important Wetland Sites in South Carolina

- South Carolina Department of Natural Resources (SCDNR) owns and manages Wildlife Management Areas (WMAs) and Heritage Preserves, many of which include wetlands.
- National Natural Landmarks (NNLs) range in size from 130 acres to over 23,000 acres, and are owned by SCDNR, National Park Service (NPS), and private individuals (NPS, 2012d). Section 13.1.8, Visual Resources, describes South Carolina's NNLs.
- Other wetlands protected under easements or agreements through voluntary government programs and resource conservation groups are found across the state. Easement owners include the Natural Resources Conservation Service (NRCS), those managed by natural resource conservation groups such as Ducks Unlimited, The Nature Conservancy, Lord Berkeley Conservation Trust, and other easement holders. According to the National Conservation Easement Database, a national electronic repository of government and privately held conservation easements (http://conservationeasement.us/), NRCS holds more than 73,000 acres in conservation easements in South Carolina (NCED, 2015).

13.1.6. Biological Resources

13.1.6.1. Definition of the Resource

This Chapter describes the biological resources of South Carolina. Biological resources include terrestrial[61] vegetation, wildlife, fisheries and aquatic[62] habitats, and threatened[63] and

[61] Terrestrial: "Pertaining to land" (USEPA, 2015d).
[62] Aquatic: "Pertaining to water" (USEPA, 2015d).
[63] Threatened species are "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C §1532(20)).

endangered[64] species as well as species of conservation concern. Because of the topographical variation in the state, from the Blue Ridge Mountains located north of the Fall Line to the flat plains in the south, South Carolina supports a variety of biological resources including hemlock-blanketed mountains, rolling sandhills, flooded cypress forests, and sunny palmetto-lined beaches.

13.1.6.2. Specific Regulatory Considerations

The federal laws relevant to the protection and management of biological resources in South Carolina are summarized in detail in Section 1.8, Overview of Relevant Federal Laws and Executive Orders and Appendix C, Environmental Laws and Regulations. Table 13.1.6-1 summarizes major state laws relevant to South Carolina's biological resources.

Table 13.1.6-1. Relevant South Carolina Biological Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
South Carolina Marine Resources Act 2000 (50-5-10 to 2740)	SCDNR	Regulates and manages marine resources including how the marine resources may be harvested.
Forest Management Protection Act 2000 (50-2-10 to 50)	SCDNR	Encourages and protects landowners' ability to maintain their land for forest use and to conduct forest management activities.
South Carolina Captive Alligator Propagation Act 2014 (50-15-310 to 460)	SCDNR	Allows for the regulating of business of propagating alligators for commercial purposes.
South Carolina Nongame and Endangered Species Conservation Act 1976 (§ 50-15-10 to 90)	SCDNR	Definitions and criteria for listing of species.

13.1.6.3. Terrestrial Vegetation

The distribution of flora within the state is a function of the characteristic geology,[65] soils, climate,[66] and water of a given geographic area and correlates with distinct areas identified as ecoregions.[67] Ecoregions are broadly defined areas that share similar characteristics, such as climate, geology, soils, and other environmental conditions and represent ecosystems contained within a region. The boundaries of an ecoregion are not fixed, but rather depict a general area with similar ecosystem types, functions, and qualities (National Wildlife Federation, 2015) (USFS, 2015f) (World Wildlife Fund, 2015). Ecoregion boundaries often coincide with physiographic[68] regions of a state. In South Carolina, there are two main physiographic regions, the Piedmont and the Coastal Plain (Griffith, et al., 2002). This physiographic boundary, known

[64] Endangered species are "any species which is in danger of extinction throughout all or a significant portion of its range" (16 U.S.C §1532(6)).
[65] "Geology is the study of the planet earth- the materials it is made of, the processes that act on those materials, the products formed, and the history of the planet and its life forms since its origin" (USEPA, 2015d).
[66] Climate: "The average weather conditions in a particular location or region at a particular time of the year. Climate is usually measured over a period of 30 years or more" (USEPA, 2015d).
[67] Ecoregion: "A relatively homogeneous ecological area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables" (USEPA, 2015d).
[68] Physiographic: "The natural, physical form of the landscape" (USEPA, 2015d).

as the Fall Line, corresponds to the boundary between two of South Carolina's five Level III USEPA ecoregions. The USEPA ecoregions are the most commonly referenced, although individual states and organizations have also developed ecoregions that may differ slightly from those designated by the USEPA. The USEPA divides North America into 15 broad Level I ecoregions. These Level I ecoregions are further divided into 50 Level II ecoregions. These Level II ecoregions are further divided into 182 smaller Level III ecoregions (USEPA, 2016a). This Section provides an overview of the terrestrial vegetation resources for South Carolina at USEPA Level III (Griffith, et al., 2002) (USEPA, 2016a).

As shown in Figure 13.1.6-1, the USEPA divides South Carolina into five Level III ecoregions. The five ecoregions support a variety of different plant communities, all predicated on their general location within the state. Three of the ecoregions are located in the southern half of the state, in the Coastal Plain physiographic region, where elevations are lower and communities range from forests of pine to coastal marshes. The remaining two ecoregions are north of the Fall Line, are generally at higher elevations, and include spruce-fir forests and heath balds[69] (Griffith, et al., 2002). Table 13.1.6-2 provides a summary of the general abiotic[70] characteristics, vegetative communities, and the typical vegetation found within each of the five South Carolina ecoregions.

Communities of Concern

South Carolina contains vegetative communities of concern that include rare natural plant communities, plant communities with greater vulnerability or sensitivity to disturbance, and communities that provide habitat for rare plant and wildlife species. The ranking system for these communities gives an indication of the relative rarity, sensitivity, uniqueness, or vulnerability of these areas to potential disturbances. This ranking system also gives an indication of the level of potential impact to a particular community[71] that could result from implementation of an action.

The SCDNR maintains a statewide inventory that includes lists of all types of natural communities known to occur, or that have historically occurred, in the state (SCDNR, 2014h). Historical occurrences are important for assessing previously undocumented occurrences or re-occurrences of previously documented species. Each natural community is assigned a rank based on its rarity and vulnerability. As with most state heritage programs, the SCDNR ranking system assesses rarity using a state rank (S1, S2, S3, S4, S5) that indicates its rarity within South Carolina. Communities ranked as an S1 by the SCDNR are of the greatest concern. This rank is typically based on the range of the community, the number of occurrences, the viability of the

[69] Heath bald: a shrubland found at middle to high elevations, treeless, and often on extremely steep and rocky ridges.
[70] Abiotic: "Characterized by absence of life; abiotic materials include non-living environmental media (e.g., water, soils, sediments); abiotic characteristics include such factors as light, temperature, pH, humidity, and other physical and chemical influences" (USEPA, 2016f).
[71] Community: "In ecology, an assemblage of populations of different species within a specified location in space and time. Sometimes, a particular subgrouping may be specified, such as the fish community in a lake or the soil arthropod community in a forest" (USEPA, 2015d).

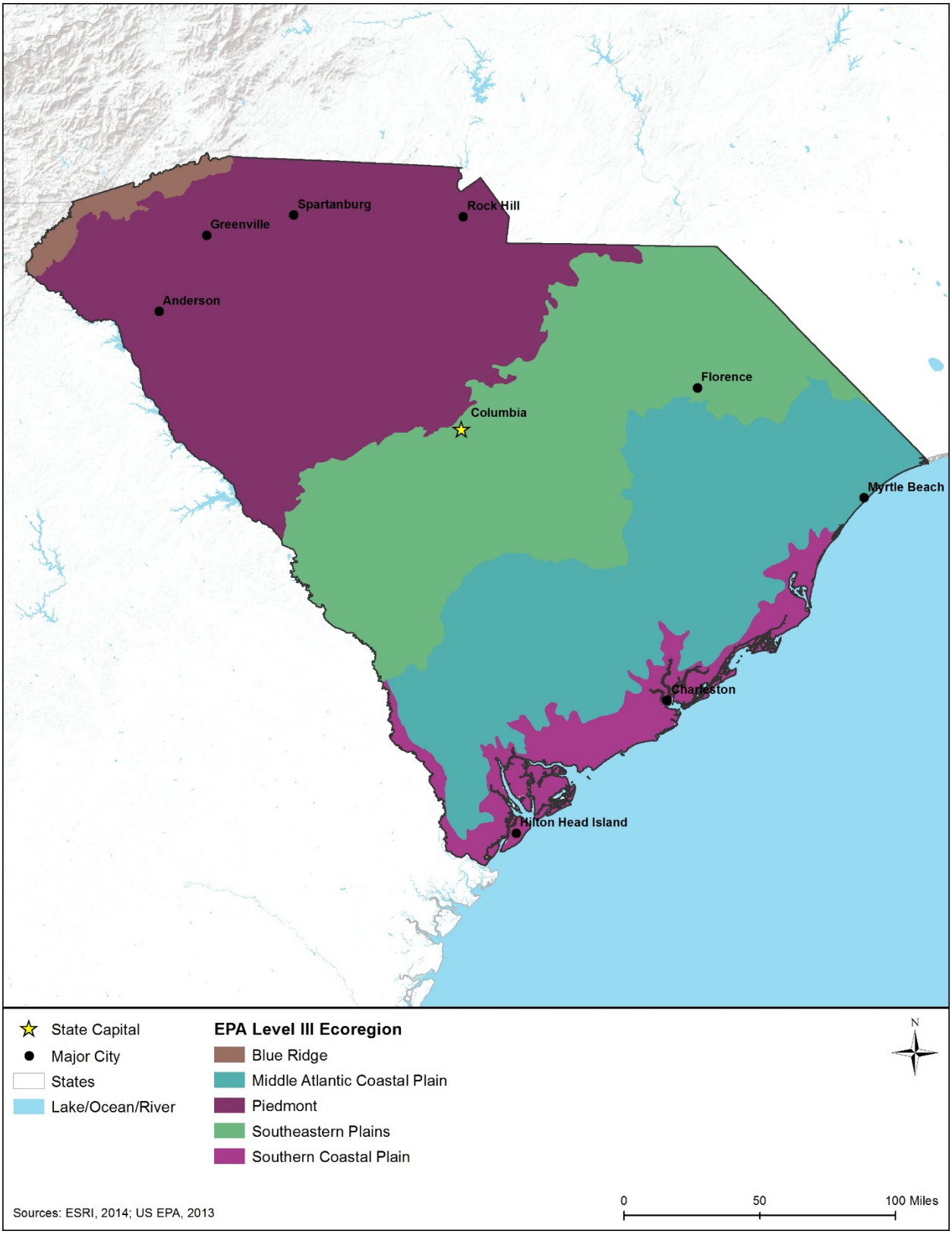


Figure 13.1.6-1: USEPA Level III Ecoregions in South Carolina

Table 13.1.6-2: USEPA Level III Ecoregions of South Carolina

Ecoregion Number	Ecoregion Description	Abiotic Characterization	General Vegetative Communities	Typical Vegetation
Geographic Region: Southern Plains (South of the Fall Line/Atlantic Plain)				
63	Middle Atlantic Coastal Plain	Low elevation, flat plains, with many swamps, marshes, and estuaries. Consists of poorly drained soils with a mix of coarse and finer textured soils compared to the more coarse soils found in the Southern Coastal Plain.	Shortleaf pines with patches of oak, gum, and cypress.	• **Hardwood Trees –** live oak, laurel oak, red maple, bald cypress, white cedar • **Conifer Trees -** loblolly pine (*Pinus taeda*) • **Marsh Grass –** saltmeadow cordgrass, saltmarsh cordgrass (*Sparina alterniflora),* black needle rush
65	Southeastern Plains	Irregular plains with less relief than Piedmont to the north. Sands, silts, and clays in the Southeastern Plains contrast with metamorphic and igneous rocks found in the Piedmont.	Mixed forest and oak-hickory-pine.	• **Hardwood Trees –** turkey oak (*Quercus laevis*), red oak (*Quercus rubra*), water oak (*Quercus nigra*), hickory (*Carya* spp.) • **Conifer Trees** – longleaf pine (*Pinus palustris)*, loblolly pine (*Pinus taeda*), shortleaf pine (*Pinus echinata*)
75	Southern Coastal Plain	This Ecoregion is composed primarily of flat plains, but also contains barrier islands, lagoons, marshes, and swamps. Soils are wetter and elevation is lower than in the Southeastern Plains to the north.	A variety of forest communities, including pine flatwoods.	• **Hardwood Trees** – pond cypress (*Taxodium ascendens*), beech (*Fagus* sp.), sweetgum (*Liquidambar styraciflua)*, southern magnolia (*Magnolia grandiflora*), oak (*Quercus* spp.) • **Conifer Trees** – Longleaf pine, pond pine (*Pinus serotina*), slash pine (*Pinus elliottii*), loblolly pine
Geographic Region: Northern Highlands (North of the Fall Line/Appalachian Highlands)				
45	Piedmont	Referred to as the non-mountainous area of the Appalachian Highlands and made up of plains and hills. Finer soil than coastal areas.	Pine and hardwood forests	• **Hardwood Trees** – oak, hickory • **Conifer Trees** – Pine (*Pinus* spp.) species including loblolly pine and shortleaf pine
66	Blue Ridge	Composed of mountainous areas, narrow ridges, and hilly plateaus of igneous, metamorphic, and sedimentary rock.	Oak forests, northern hardwoods, spruce-fir forests, heath balds	• **Hardwood Trees** – Oak, hemlock (*Tsuga* spp.) • **Conifer Trees** – Pine, spruce (*Picea* spp.), fir (*Abies* spp.)

Sources: (Nelson, 1986) (Fenneman, 1916) (Griffith, et al., 2002) (CEC, 2011)

occurrences, recent trends, and the vulnerability of the community. As new data become available, ranks are revised as necessary to reflect the most current information (SCDNR, 2014h)

There are eight vegetative communities ranked as S1 communities[72] in South Carolina. These communities represent the rarest terrestrial. South Carolina Appendix A provides a description of the communities of conservation concern in South Carolina along with their state rank, distribution, and the associated USEPA Level III ecoregions.

Nuisance and Invasive Plants

There are a large number of undesirable plant species that are considered nuisance and invasive plants. Noxious weeds are typically non-native species that have been introduced into an ecosystem inadvertently; however, on occasion native species can be considered a noxious weed. Noxious weeds greatly affect agricultural areas, forest management, natural, and other open areas (GPO, 2011). The U.S. government has designated certain plant species as noxious weeds in accordance with the Plant Protection Act of 2000 (7 U.S.C. 7701 et seq.). As of September 2014, 112 federally recognized noxious weed species have been catalogued in the United States (88 terrestrial, 19 aquatic, and 5 parasitic) (USDA, 2015).

South Carolina does not maintain a list of regulated noxious weeds. The South Carolina Exotic Pest Plant Council (SCEPPC) with members from state agencies, private industry, and education; publishes a terrestrial invasive plant[73] list, which does not have any regulatory authority, "to identify and categorize plants that pose threats to natural areas in South Carolina." The list includes terrestrial plants that are categorized as described below (count of species included parenthetically) (SCEPPC, 2014a):

- Severe Threat (27 species): "Invasive exotic plant species which are known to pose a severe threat to the composition, structure, or function of natural areas of South Carolina."
- Significant Threat (27 species): "Invasive exotic plant species which are established in a natural areas, spreading independently, and causing significant damage to communities; but may not be as widespread or difficult to manage as "Severe Threat" species."
- Emergent Threat (12 species): "Invasive exotic plant species found in South Carolina or in adjacent states, in limited infestations with substantial management difficulties; or widespread with minor management difficulties."
- Alert (27 species): "Exotic plant species know to pose a severe threat to natural areas in adjacent states or in the southeast with a limited distribution in South Carolina or not currently recorded here."

Aquatic habitats are also infected by invasive species. SCDNR manages the state's aquatic nuisance species program. According to SCDNR, the biggest threats for aquatic invasive species

[72] S1 – "Critically Imperiled – Critically imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province" (SCDNR, 2014i).

[73] Invasive Plant: "Invasive species is defined as any plant species that occurs outside its area of origin and that has become established, can reproduce, and can spread without cultivation and causes harm" (SCEPPC, 2014b).

are hydrilla (*Hydrilla verticallata*), giant salvinia (*Salvinia molesta*), water hyacinth (*Eichhornia crassipes*), flathead catfish (*Pylodictis olivaris*), spotted bass (*Micropterus punctulatus*), Asian green mussel (*Perna viridis*), beach vitex (*Vitex rotundifolia*), and giant barnacle (*Megabalunus coccopoma*). (Rapport, 2007)

13.1.6.4. *Terrestrial Wildlife*

This section discusses the terrestrial wildlife species in South Carolina, divided among mammals,[74] birds,[75] reptiles[76] and amphibians,[77] and invertebrates.[78] Terrestrial wildlife consists of those species, and their habitats, that live predominantly on land. A discussion of non-native and/or invasive terrestrial wildlife species is also included within this section. Information regarding the types and location of native and non-native/invasive wildlife is useful for assessing the importance of any impacts to these resources or the habitats they occupy.

Mammals

South Carolina is home to over 100 mammalian species with the highest diversity found in the coastal plains and the mountains. The largest of this group is the rodents. SCDNR regulates the hunting of mammal species. Larger mammal species include bear *(Ursus americanus)* and deer *(Odocoileus virginianus)*. Smaller game includes squirrel *(Sciurus carolinensis)*, gray fox *(Urocyon cinereoargenteus)*, rabbit *(Leporidae)*, beaver *(Castor Canadensis)*, opossum *(Didelphimorphia)*, bobcat *(Lynx rufus)*, otter *(Lontra canadensis)*, and skunk *(Mephitis mephitis)* (SCDNR, 2015g) (SCDNR, 2015i). A number of threatened and endangered mammals are also located in South Carolina. Section 13.1.6.6, *Threatened and Endangered Species and Species of Conservation Concern*, identifies these protected species.

Birds

The number of native bird species documented in South Carolina varies according to the timing of the data collection effort, changes in bird taxonomy,[79] and the reporting organization's method for categorizing occurrence and determining native versus non-native status. Further, the diverse ecological communities found in South Carolina support a large variety of bird species. Over 390 species of birds have been documented in South Carolina. This includes both resident and migratory species (SCDNR, 2005a).

South Carolina is located within the Atlantic Flyway, which generally follows the Atlantic Coast and Appalachian Mountains. The Atlantic Flyway extends from the Arctic islands and coast of Greenland south to eastern Mexico and the Caribbean Sea. Large numbers of migratory birds

[74] Mammals: "Warm-blooded vertebrates that give birth to and nurse live young; have highly evolved skeletal structures; are covered with hair, either at maturity or at some stage of their embryonic development; and generally have two pairs of limbs, although some aquatic mammals have evolved without hind limbs" (USEPA, 2015d).
[75] Birds: "Warm-blooded vertebrates possessing feathers and belonging to the class Aves" (USEPA, 2015d).
[76] Reptiles: "Cold-blooded, air-breathing vertebrates belonging to the class Reptilia, usually covered with external scales or bony plates" (USEPA, 2015d).
[77] Amphibian: "A cold-blooded vertebrate that lives in water and on land. Amphibians' aquatic, gill-breathing larval stage is typically followed by a terrestrial, lung-breathing adult stage" (USEPA, 2015d).
[78] Invertebrates: "Animals without backbones: e.g., insects, spiders, crayfish, worms, snails, mussels, clams, etc." (USEPA, 2015d).
[79] Taxonomy: "A formal representation of relationships between items in a hierarchical structure" (USEPA, 2013c).

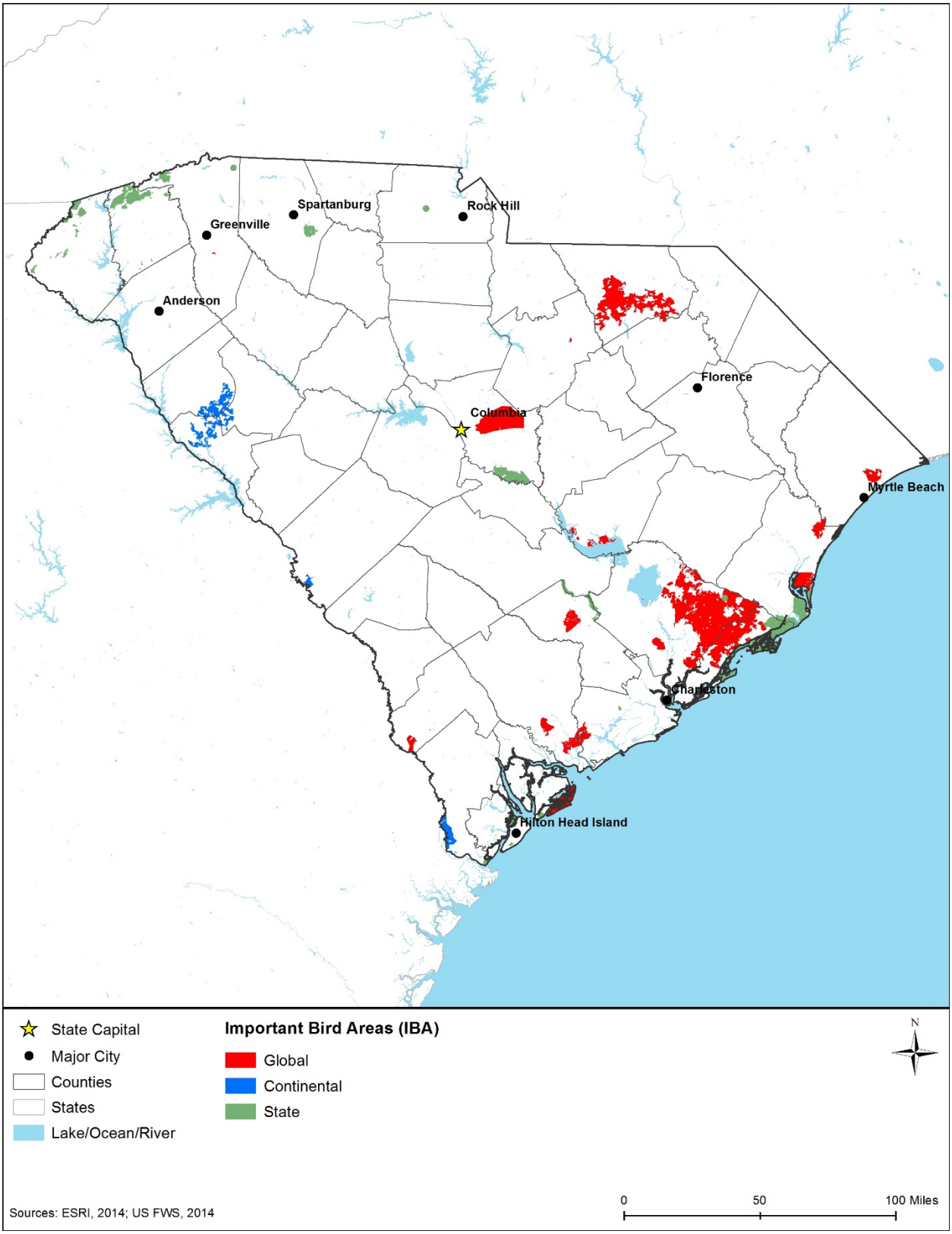


Figure 13.1.6-2: Important Bird Areas in South Carolina

utilize these flyways and other migration corridors and pathways throughout the state each year during their annual migrations northward in the spring and southward in the fall. The Migratory Bird Treaty Act (MBTA) makes it "illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations" (USFWS, 2013). The USFWS is responsible for enforcing the MBTA and maintaining the list of protected species. The migratory bird species protected under the MBTA are listed in 50 CFR 10.13 (USFWS, 2013). Bald eagles (*Haliaeetus leucocephalus*) are protected under the Bald and Golden Eagle Protection Act. Golden eagles are rarely seen and are a transient species in South Carolina (SCDNR, 2015c).

According to the Audubon Society, 49 Important Bird Areas (IBAs) have been identified in South Carolina, including (17 global[80] IBAs and 25 state[81] IBAs) (Audubon Society of South Carolina, 2015) (Figure 13.1.6-2). These IBAs are located throughout the state, although the largest concentrations are located along South Carolina's Atlantic Coast. The IBA program is an international bird conservation initiative with a goal of identifying the most important places for birds, and to conserve these areas. These IBAs link global and continental bird conservation priorities to local sites that provide critical habitat for native bird populations.

A number of threatened and endangered birds are located in South Carolina; Section 13.1.6.6, Threatened and Endangered Species and Species of Special Concern identifies these protected species.

Reptiles and Amphibians

There are over 142 species of reptiles and amphibians, such as sea turtles, snakes, and salamanders, occur in South Carolina, one of the most diverse assemblages in the United States (SCDNR, 2005a). South Carolina snake species include five venomous snakes from the pit viper family and one species from the cobra family (the coral snake) (SCDNR, 2016c). South Carolina's has a diverse group of amphibian species. "The Southern Coastal Plain supports more frog species (25) than any other place in North America" (SCDNR, 2014j). The American alligator (*Alligator mississippiensis*) is also native to South Carolina and is common along the coast. Populations of the American alligator have rebounded over the past few years. "The SCDNR instituted a hunting season in 2008" (SCDNR, 2015h).

A number of threatened and endangered reptiles and amphibians are located in South Carolina; Section 13.1.6.6, Threatened and Endangered Species and Species of Special Concern, identifies these protected species.

[80] Global IBAs include sites that meet at least one Global criteria (i.e., sites with significant numbers of globally threatened species, sites supporting 1% or greater population of a waterbird simultaneously) (Audubon Society of South Carolina, 2015).
[81] State IBAs include areas important to species only according to state-specific criteria (e.g., state-listed species) (Audubon Society of South Carolina, 2015).

Invertebrates

South Carolina is home to a variety of invertebrate species, including bees, hornets, wasps, butterflies, moths, beetles, flies, dragonflies, damselflies, spiders, mites, and nematodes. These invertebrates provide an abundant food source for mammals, birds, reptiles, amphibians, and other invertebrates. In the United States, one third of all agricultural output depends on pollinators.[82] In natural systems, the size and health of the pollinator population is linked to ecosystem health, with a direct relationship between pollinator diversity and plant diversity. "As a group, native pollinators are threatened by habitat loss, pesticides, disease, and parasites" (NRCS, 2009).

Invasive Wildlife Species

Exotic wildlife species are regulated and a permit must be obtained from SCDNR prior to importing a wildlife species that is not normally domesticated in South Carolina. Invasive wildlife species are important to consider when proposing a project since project activities may result in conditions that favor the growth and spread of invasive wildlife populations. These situations may result from directly altering the landscape or habitat to a condition that is more favorable for an invasive species, or by altering the landscape or habitat to a condition that is less favorable for a native species.

Invasive insects pose a large threat to South Carolina's forest and agricultural resources. Species such as the southern pine beetle (*Dendroctonus frontalis*), Asian gypsy moth (*Lymantria dispar*), and Asian longhorned beetle (*Anoplophora glabripennis*) have caused widespread damage within South Carolina (South Carolina Forestry Commission, 2016). A known invasive beetle, native to Asia, the emerald ash borer (Agrilus planipennis), has killed "tens of millions of ash trees." Though not confirmed in South Carolina, the beetle has seen in surrounding states (e.g., Georgia, North Carolina) (USDA, 2016a). Currently, federal quarantines are in place that restrict the transport of plant materials with the potential to contain the emerald ash borer (USDA, 2015b).

Other common terrestrial invasive species in South Carolina include European starlings (*Sturnus vulgaris*) and House sparrows (*Passer domesticus*), which are aggressive, non-native birds that out compete native secondary cavity nesters[83] for breeding opportunities and will often kill nesting native species (USDA, 2016b) (USFS, 2014). Wild pigs *(Sus scrofa)* occur in every county of the state and are known to compete with native wildlife species for food and habitat, damage plants, agricultural crops, and threaten livestock (SCDNR, 2016a).

13.1.6.5. *Fisheries and Aquatic Habitat*

This section discusses the aquatic wildlife species in South Carolina, including marine mammals and reptiles, fresh and saltwater fish, and invertebrates. A summary of non-native and/or invasive aquatic species is also presented. Some distinctive features of the South Carolina landscape with regard to aquatic wildlife are the small, high-gradient Blue Ridge streams, large,

[82] Pollinators: "Animals or insects that transfer pollen from plant to plant" (USEPA, 2015d).

[83] Cavity nesters excavate nesting holes, use cavities resulting from decay (natural cavities), or use holes created by other species in dead or deteriorating trees. The majority of cavity-nesting birds are insectivorous. (USFS, 1977)

fertile Piedmont rivers, and estuarine and saltwater marshes of the coast. These variable conditions provide habitat for a diverse array of aquatic organisms. Both essential fish habitat (EFH) identified by the Magnuson-Stevens Fishery Conservation and Management Act and critical habitat for threatened and endangered aquatic species, as defined by the Endangered Species Act (ESA), exist within the aquatic communities of South Carolina and are discussed in Section 13.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) identifies and protects those fish habitats that are necessary for spawning, breeding, feeding, or growth to maturity. These habitats are termed "Essential Fish Habitat" or EFH. NOAA provides an online mapping application and website to provide the public a means to obtain illustrative representations of EFH (NOAA, 2015d) (NOAA, 2015e). This tool is used to identify the existing conditions for a project location to identify sensitive resources.[84] South Carolina Appendix A, Table A-2 presents a summary of EFH for both Mid-Atlantic and South Atlantic species of the South Carolina coast.

Under the Magnuson-Stevens Act, National Marine Fisheries Service also considers a second, more limited habitat designation for each species in addition to EFH. Habitat Areas of Particular Concern (HAPC) are described as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. In general, HAPCs include high value intertidal and estuarine habitats, offshore areas of high habitat value or vertical relief, and habitats used for migration, spawning, and rearing of fish and shellfish. HAPCs are not afforded any additional regulatory protection under the Magnuson-Stevens Act; however, federal actions with potential adverse impacts to HAPC will be more carefully scrutinized during the consultation process and will be subject to more stringent EFH conservation recommendations (NOAA, 2010). Table 13.1.6-3 presents a summary of HAPC along or near the South Carolina coast.

Marine Mammals

Manatees, whales, and dolphins are found periodically in the waters surrounding South Carolina's barrier islands. Bottlenose dolphins are the most common near shore marine mammal in South Carolina. Female North Atlantic Right whales with calves are known to frequent in shore areas near South Carolina. South Carolina's threatened and endangered aquatic mammals are discussed further in Section 13.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

[84] NOAA's Essential Fish Habitat Mapper v 3.0 was used to identify "EFH areas of particular concern" and "EFH areas protected from fishing." As of July 2016, the procedure to use this interactive tool is as follows: 1) Visit http://www.habitat.noaa.gov/protection/efh/habitatmapper.html. 2) Select "EFH Mapper" under Useful Links. 3) After closing the opening tutorial, select the "Region" of interest from the drop-down menu. 4) Select the species under "Essential Fish Habitat" to view the areas in the selected region protected for the various life states (i.e., eggs, larvae, juvenile, adult, or all).

Marine Reptiles

Five of the world's seven species of sea turtles are found in South Carolina's coastal waters, and all five species are known to nest on South Carolina's coasts. The loggerhead turtle (*Caretta caretta*) is the most common nesting sea turtle found in South Carolina (SCDNR, 2015d). The five sea turtle species found in South Carolina are state and federally protected; protected sea turtle species are discussed in Section 13.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Table 13.1.6-3. Habitat Areas of Particular Concern for South Carolina

Species	Description of EFH - HAPC
Tilefish	Offshore
Coastal Migratory Pelagics	Sandy shoals of Capes Lookout, Cape Fear, and Cape Hatteras from shore to the ends of the respective shoals, but shoreward of the Gulf stream; The Charleston Bump and Hurl Rocks in South Carolina; Pelagic *Sargassum*; and Atlantic coast estuaries with high numbers of Spanish mackerel and cobia based on abundance data from the ELMR Program. Estuaries meeting this criteria for cobia include Broad River, South Carolina.
Coral, Coral Reef and live/ hardbottom habitat	Hurl Rocks and The Charleston Bump.
Dolphin/Wahoo	Offshore (The Charleston Bump Complex and Georgetown Hole in South Carolina).
Snapper/Grouper	Medium to high profile offshore hard bottoms where spawning normally occurs; localities of known or likely periodic spawning aggregations; nearshore hard bottom areas; The Charleston Bump in South Carolina); mangrove habitat; seagrass habitat; oyster/shell habitat; all coastal inlets; all state-designated nursery habitats of particular importance to snapper grouper; pelagic and benthic *Sargassum*; all hermatypic coral habitats and reefs; and Council-designated Artificial Reef Special Management Zones (SMZs).
Shrimp	All coastal inlets, all state-designated nursery habitats of particular importance to shrimp, and state-identified overwintering areas.
Red Drum	All coastal inlets, all state-designated nursery habitats of particular importance to red drum; documented sites of spawning aggregations in North Carolina, South Carolina, Georgia, and Florida; other spawning areas identified in the future; and habitats identified for submerged aquatic vegetation.
Spiny Lobster	None

Source: (NOAA, 2015e)

Fish

Freshwater Fish

South Carolina is home to more than 146 species of freshwater fish (SCDNR, 2005a). South Carolina's diverse fish fauna is largely due to the myriad of aquatic habitats that can be found throughout the State including "small, high-gradient Blue Ridge streams; large, fertile Piedmont rivers; and the "blackwater" streams and bays of the coastal plain" (SCDNR, 2016b). The types of fish found in South Carolina's waters range from largemouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilis*), blue catfish (*Ictalurus furcatus*), rainbow trout (*Oncorhynchus mykiss*), chain pickerel (*Esox niger*), American shad (*Alosa sapidissima*), spotted sucker

(*Minytrema melanops*), longnose gar (*Lepisosteus osseus*), and Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*). Twenty-seven species are considered native to South Carolina.

Saltwater Fish

South Carolina's nearshore waters are home to a large number of saltwater fish species. Some of the more common inshore marine species in South Carolina include Atlantic croaker (*Micropogonias undulatus*), black drum (*Pogonias cromis*), red drum (*Sciaenops ocellatus*), sheepshead (*Archosargus probatocephalus*), spot (*Leiostomus xanthurus*), and spotted seatrout (*Cynoscion nebulosus*). Off shore marine species include grouper, snapper, porgy, seabass, grunt, jacks, mackerel, and tuna. Shark species are also known to exist in the waters off South Carolina's coast. South Carolina's protected fish species are identified in Section 13.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Shellfish and Other Invertebrates

South Carolina protected shellfish and other invertebrates are identified in Section 13.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Invasive Aquatic Species

As previously discussed, South Carolina regulates exotic wildlife species and the SCDNR must be contacted regarding any species not normally domesticated in South Carolina. Potentially invasive aquatic plant examples include: *hydrilla*, water hyacinth *(Eichhornia crassipes)*, and common reed *(Phragmites australis)*. The South Carolina Invasive Species Task Force has identified the following species as known invasive aquatic animal species: green mussel (*Perna viridis*), charrua mussel (*Mytella charruana*), isopod *(Synidotea laevidorsalis)*, titan acorn barnacle (*Megabalanmus coccopoma*), spiny hands crab *(Charybdis hellerii)*, green porcelain crab (*Petrolisthes armatus*), and red lionfish (*Pterois volitans*). In addition to causing ecological issues, the invasion of these species can also bring new parasites and/or diseases that could potentially affect human health (SCDNR, 2008).

13.1.6.6. Threatened and Endangered Species and Species of Conservation Concern

The USFWS is responsible for administering the ESA (16 U.S.C. §1531 et seq.) in South Carolina. The USFWS has identified 25 federally endangered and 12 federally threatened species known to occur in South Carolina (USFWS, 2016a). Of these 37 federally listed species, four of them have designated critical habitat as shown in Figure 13.1.6-3 below.[85] The 37 federally listed species include three mammals, four reptiles, six birds, one fish, one amphibian, one invertebrate, 21 plants, and are discussed in detail under the following sections. (USFWS, 2015c) (USFWS, 2016a) There are no candidate species[4] are identified by USFWS as occurring within the state (USFWS 2015). Federal land management agencies maintain lists of species of concern for their landholdings; these lists are not discussed below as they are maintained

[85] Critical habitat includes "the specific areas (i) within the geographic area occupied by a species, at the time it is listed, on which are found those physical or biological features (I) essential to conserve the species and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by the species at the time it is listed upon determination that such areas are essential to conserve the species" (16 U.S.C §1532(5)(A)).

independently from the ESA. For future site-specific analysis on those lands, consultation with the appropriate land management agency might be required.

Mammals

Two federally listed endangered and one threatened mammal are known to occur in South Carolina (Table 13.1.6-4). These species include one marine mammal and two terrestrial mammals. The northern long-eared bat *(Myotis septentrionalis)* occurs in the northwestern portions of the state, and the red wolf *(Canis rufus)* occurs in forested areas throughout the state. The West Indian manatee (*Trichechus manatus*) can be found in the coastal waters and estuaries along South Carolina's coast. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in South Carolina is provided below.

Table 13.1.6-4 Federally Listed Mammal Species of South Carolina

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Marine Mammals				
West Indian Manatee	*Trichechus manatus*	E	No	Coastal waters, estuaries, and warm water outfalls
Terrestrial Mammals				
Northern Long-eared Bat	*Myotis septentrionalis*	T	No	Trees and snags, caves, and abandoned mines; found throughout the state.
Red Wolf	*Canis rufus*	E	No	Forested areas

[a] E = Endangered, T = Threatened
Source: (USFWS, 2015c) (USFWS, 2016a)

Terrestrial Mammals

Northern Long-eared Bat. The threatened northern long-eared bat (*Myotis septentrionalis*) is a medium-sized brown furred, insectivorous bat. This bat is medium-sized, reaching a length of 3 to 3.7 inches, with long ears relative to other members of the genus *Myotis* (USFWS, 2015d). The northern long-eared bat was listed as endangered in 2013 (78 FR 72058 72059, Dec. 02, 2013) and was relisted as threatened in 2015 (80 FR 17973 18033, April 2, 2015). In the U.S., its range includes most of the eastern and north central states (USFWS, 2015e). In South Carolina, the northern long-eared bat is known or believed to occur in 10 counties in the northwestern portion of the state (USFWS, 2015e).

This species hibernates during winter in caves and mines that exhibit constant temperatures and high humidity, which do not have air currents. In the summer, they roost singly or in colonies beneath bark, or in crevices or cracks of both live and dead trees. Although mating occurs in the fall, fertilization occurs following hibernation, from which pregnant females then migrate to summer areas where they roost in small colonies (USFWS, 2015d).

White Nose Syndrome is the leading cause for the decline of this species. The numbers of northern long-eared bats in hibernacula has decreased by 99 percent in the northeast United

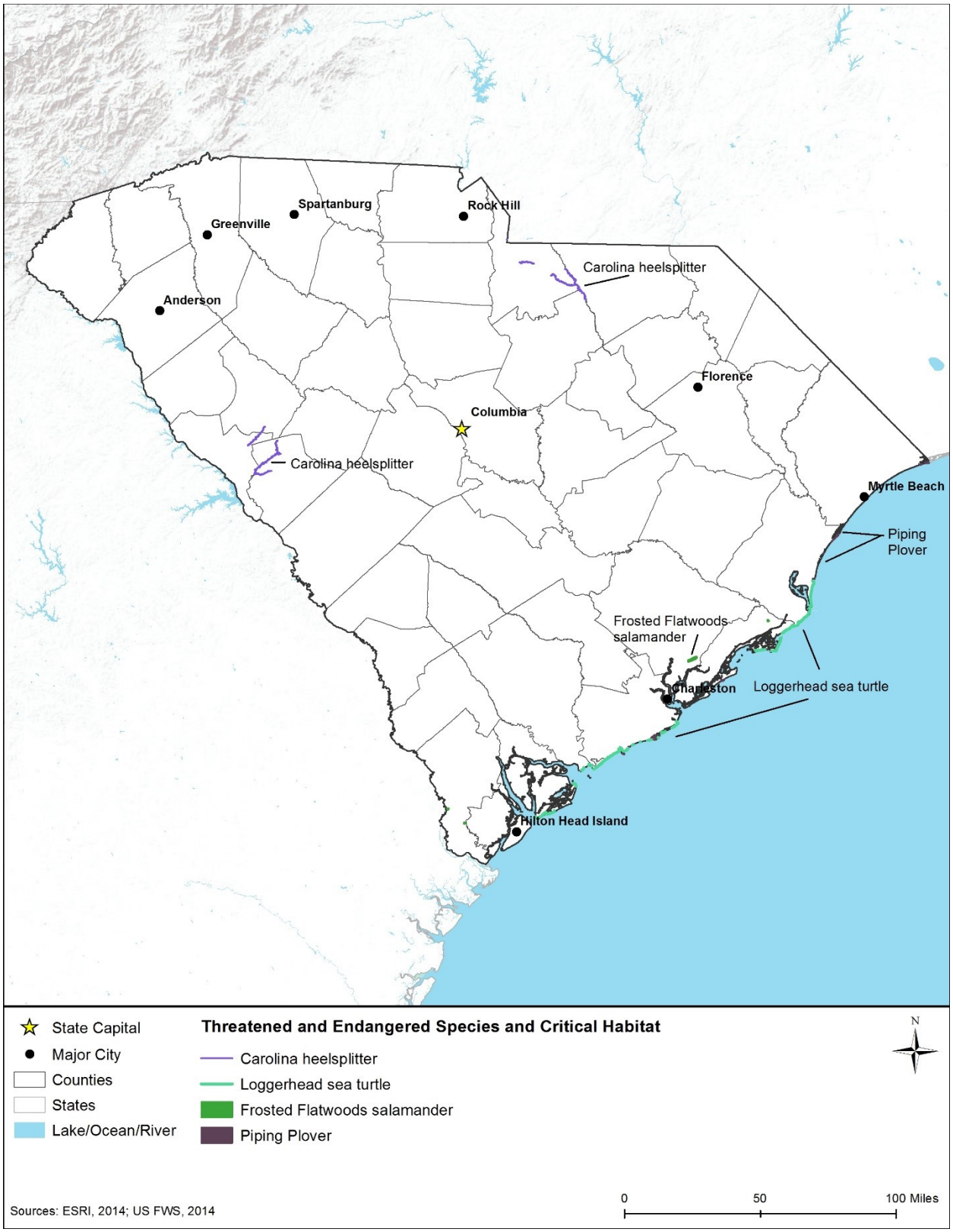


Figure 13.1.6-3: ESA Designated Critical Habitat in South Carolina

States (USFWS, 2015e). Other threats include temperature or air flow impacts to their hibernating habitat, forest management practices that are incompatible with this species' habitat needs, habitat fragmentation, and wind farm operations (USFWS, 2015d).

Red Wolf. The endangered red wolf (*Canis rufus*) is a mostly brown and buff colored, with reddish fur behind the ears and along the neck and legs. The red wolf is intermediate in size compared to wolves and coyotes, standing about 26 inches tall and weighing 45 to 80 pounds (USFWS, 2016e). The red wolf was listed as endangered in 1967 (32 FR 4001, March 11, 1967). In the U.S., its historic range includes Florida, North Carolina, and South Carolina (USFWS, 2016e). Presently, there are 250 to 275 red wolves in the U.S., with approximately 200 in captivity including two young males at the Sewee Center for observation and education in South Carolina (USFWS, 2015f). The only wild population of red wolves is found in the eastern counties of North Carolina with over 50 wolves (USFWS, 2016b). Bulls Island was an experimental release site, although all individuals were relocated in 2005 (USFWS, 2015f).

Red wolves are social animals, living in packs of five to eight animals. Dens are often found near stream banks, sand knolls, shallow depressions in the ground, holes near downed logs, and forest debris piles. Red wolves mate yearly in February and March, and pups are born in April and May. Red wolves are carnivores, with a varying diet of deer, rodents, and other smaller mammals. (USFWS, 2016c)

The red wolf's historic decline resulted from harassment and habitat fragmentation, which reduced numbers to near-extinction. Human-caused mortality and increased habitat fragmentation from development continue to threaten the red wolf. Coyotes directly compete with the red wolf for resources and habitat, introduce disease, and hybridize with red wolves. (USFWS, 2016c)

Marine Mammals

West Indian Manatee. The West Indian Manatee averages 9 feet in length and weigh about 1,000 pounds (USFWS, 2015g). The manatee was listed as endangered in 1967 (32 FR 4001, March 11, 1967). The West Indian manatee is also protected under the Marine Mammal Protection Act (MMPA). The manatee has a large, seal-shaped body with flippers and a large tail, and are usually gray in color (USFWS, 2015g). Manatees found in mainland U.S. waters are recognized as a separate subspecies known as the Florida manatee (*Trichechus manatus latirostris*) (USFWS, 2001a).

West Indian manatees are found in tropical and subtropical coastal and river waters along the southeast U.S. coast, the Caribbean coast of Central, and South America, and locally throughout the West Indies. During summer, manatees may be commonly found along South Carolina's eight coastal counties where appropriate water depths (3 to 6 feet) are present (USFWS, 2015g). "Shallow grass beds with ready access to deep channels are preferred feeding areas in coastal and riverine habitats. Manatees often use secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, cavorting, mating, and calving" (USFWS, 2001a). Threats to West Indian manatees include mortality or serious injury from boat strikes, habitat loss from decreased availability of warm-water refuges, and

coastal development. Other human-related threats include mortality from tide gates and dredges, habitat destruction, and entanglement in fishing gear (USFWS, 2001a).

Birds

Three endangered and three threatened avian species are federally listed and known to occur in South Carolina as summarized in Table 13.1.6-5. The piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa*) are primarily coastal birds found on beach communities during their annual migrations. The red-cockaded woodpecker (*Picoides borealis*), wood stork (*Mycteria Americana*), and Bachman's Warbler (*Vermivora bachmanii*). Kirtland's warbler (*Setophaga kirtlandii*) are woodland birds migrating to various specific parts of the state for foraging and nesting. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in South Carolina is provided below.

Table 13.1.6-5: Federally Listed Bird Species of South Carolina

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Bachman's Warbler,	*Vermivora bachmanii*	E	No	Primarily breeds in seasonally swamp forest with standing water.
Kirtland's Warbler,	*Setophaga kirtlandii*	E	No	Nests in dense young Jack Pine Forests along the Atlantic coast.
Piping Plover	*Charadrius melodus*	T	Yes along barrier islands.	Intertidal zone of ocean beaches, ocean washover areas, mudflats, sand flats, wrack lines, and the shorelines of coastal ponds, lagoons, and salt marshes; found along the coast of South Carolina.
Red-cockaded Woodpecker, entire	*Picoides borealis*	E	No	Mature pine forests; found in south-central and southern South Carolina.
Red Knot	*Calidris canutus rufa*	T	No	Intertidal marines, estuaries, and bays; found along the coast of South Carolina.
Wood Stork	*Mycteria americana*	T	No	Primarily feed in fresh and brackish wetlands and nest in cypress or other wooded swamps.

[a] E – Endangered, T – Threatened

Sources: (USFWS, 2015c) (USFWS, 2016a)

Bachman's Warbler. The Bachman's warbler is a small songbird; it is approximately 10-11 cm in length and has a short tail. It was first listed as endangered in 1967 (32 FR 4001 March 11, 1967). The Bachman warbler uses the southeastern United States as its breeding habitat and then spends its winters in Cuba. The bird is known only in Charleston County in South Carolina. (USFWS, 2015q)

Bachman's warbler breed in forested wetland habitat with an understory of palmetto. Nests are built low to the ground with an average of three to four eggs (USFWS, 2015r). This species is threatened due to the loss of breeding and wintering habitats as a result of habitat destruction from human disturbances.

Kirtland's Warbler. The Kirtland's warbler is a small songbird that grows about six inches in length. It was first listed as endangered in 1967 (32 FR 4001 March 11, 1967). The Kirtland's warbler nests in the northern part of the United States. The Kirtland's warbler passes through South Carolina during its migration to their wintering grounds in the Bahamas. It is known to exist in six counties along the coast during this migration. (USFWS, 2015s)

They prefer to nest in dense young jack pine forests found in the northern parts of the United States. The pine forests have to be at the right height (5 to 20 feet) and mixed with low-growing vegetation to allow the right amount of sunlight to come through. Current threats to this species include the loss of nesting habitat and nest parasitism by brown-headed cowbirds. (USFWS, 1985)

Piping Plover. The piping plover is a small, pale brown-colored migratory shorebird, measuring approximately 7.25 inches in length with a wingspan up to 15 inches and weighs between 1.5 to 2.3 ounces (USFWS, 1996). It was first listed as endangered in 1985 for the Great Lakes watershed of both the United States and Canada, and as threatened in the remainder of its range in the U.S. (50 FR 50726 50734, December 11, 1985). Regionally, the piping plover occurs in the Northern Great Plains, along the Atlantic Coast, and in the Great Lakes Area within the U.S. (USFWS, 2001b). Barrier islands along South Carolina coasts are a major wintering area for this species. Critical habitat for the wintering birds has been designated in South Carolina along the beaches of coastal barrier islands, including Waites Island – North and South, Murrels Inlet/Huntington Beach, Litchfield, North Inlet, North Santee Bay Inlet, Cape Romain, Bull Island, Stono Inlet, Seabrook Island, Deveaux Bank, Otter Island, Harbor Island, Caper's Island, and Hilton Head (USFWS, 2015t).

"Feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sand flats, wrack lines,[86] and the shorelines of coastal ponds, lagoons, and salt marshes" (Vinelli, 2000). They feed on worms, fly larvae, beetles, crustaceans, and other marine macroinvertebrates (USFWS, 1996). The preferred habitat are wide, open, sandy beaches with little vegetation. This species nests in small creeks or wetlands and create shallow nest lined with pebbles or broken shells. The female would lay an average of two to four eggs and both female and male care for them until eggs hatch (USFWS, 1996) (USFWS, 2001b). Piping plovers breed in three geographic regions of North America, composed of two separate subspecies. Those breeding on the Atlantic Coast of the U.S. and Canada are of the subspecies *C. m. melodus*, whereas the other subspecies, *C. m. circumcinctus*, includes two distinct populations, one which breeds on the Northern Great Plains of the U.S. and Canada, and the other which breeds on the Great Lakes (USFWS, 2015u). Current threats to this species include habitat loss and degradation, human disturbance, pets, predation, flooding from coastal storms, and environmental contaminants (USFWS, 1996) (USFWS, 2001b).

Red-cockaded Woodpecker. The red-cockaded woodpecker is a small black and white woodpecker that grows approximately seven inches with a wingspan of about 15 inches. It is characterized by its black cap and white cheek patches (USFWS, 2015v). The red-cockaded

[86] Wrack line: A "debris line or water mark" showing evidence of the mean high tidal along shorelines or flood events along a river/stream bank (CT DEEP, 2015).

woodpecker was listed as endangered in 1970 under early endangered species legislation (35 FR 16047 16048 October 13, 1970). Regionally, this species occurs in open pine forests in the southeast from Virginia south to Florida and west to Oklahoma and Texas. In South Carolina, the red-cockaded woodpecker is known to occur in 33 counties, including the Carolina Sandhills National Wildlife Refuge (USFWS, 2015w) (USFWS, 2015h).

The preferred habitat for the red-cockaded woodpecker is mature pine forests, with the preferred pine species being the longleaf pines (*Pinus palustris*). This species forages on pine trunks, branches, and flakes away bark in search of insects. Its diet is primarily composed of insects, including beetles, ants, spiders, and other insects found on pine trees, with occasional wild fruits and pine seeds. Current threats to the red-cockaded woodpecker include the availability of nesting and foraging habitat, habitat fragmentation, and fire suppression activites (USFWS, 2003).

Red Knot. The red knot is a medium-sized shorebird; it is approximately 9 inches in length with a wingspan up to 20 inches, making it among the largest of the small sandpipers (USFWS, 2005). It was federally listed as a threatened species in 2014 (79 FR 73705 73748, December 11, 2014). The red knot migrates annually from its breeding grounds above the Arctic Circle to the tip of South America where it winters. During spring and fall migration, the red knot travels in "non-stop segments of 1,500 miles and more, ending at stop sites called "staging areas." Some have been documented to fly more than 9,300 miles from south to north every spring and return south in autumn (USFWS, 2005) (USFWS, 2014b). The species is known from the five coastal South Carolina counties (USFWS, 2015x).

Red Knot Photo credit: USFWS

The preferred habitat is intertidal marines, estuaries, and bays. Mussel beds are important food sources for the red knot. The red knots mostly eat mussels and other mollusks all year; however, during migration season they also eat "juvenile clams and mussels and horseshoe crab eggs" (USFWS, 2005). Knots can be found on any South Carolina barrier beach, but the Cape Romain region is the most important area in South Carolina for shore birds (SCDNR, 2005b). Current threats to the red knot include sea level rise; coastal development; shoreline stabilization; dredging; reduced food availability at their migration stopovers; and disturbance by humans, dogs, vehicles, and climate change (USFWS, 2014b).

Wood Stork. "Wood storks are large, long-legged wading bird, about 50 inches tall, with a wingspan of 60 to 65 inches. The plumage is white except for black primaries and secondaries and a short black tail. The head and neck are largely unfeathered and dark gray in color. The bill is black, thick at the base, and slightly decurved. Immature birds are dingy gray and have a yellowish bill" (USFWS, 2015y). The bird was federally listed as a threatened species in 1984 (49 FR 7332 7335, February 28, 1984). The wood stork is the only stork regularly occurring in the United States. "The breeding range of the species extends from the southeastern United States south through Mexico and Central America, Cuba and Hispaniola and through South America to western Ecuador, eastern Peru, Bolivia, and northern Argentina" (USFWS, 1997). The species is known or believed to occur in 28 counties in South Carolina (USFWS, 2015y).

Wood Stork Photo credit: USFWS

The preferred habitat includes a variety of freshwater and estuarine wetlands for nesting, feeding, and roosting. Freshwater colony sites must remain inundated throughout the nesting cycle to protect against predation and abandonment. Foraging sites occur in shallow, open water where prey concentrations are high, such as freshwater marshes, roadside and agricultural ditches, narrow tidal creeks or shallow tidal pools, managed impoundments, and depressions in cypress heads or swamp sloughs (USFWS, 1997). Originally, the wood stork came to South Carolina as a post nesting foraging area. However, in 1981 the first nesting in South Carolina was recorded and populations have grown to at least 14 sites (SCDNR, 2005c). Following the breeding season, wood storks disperse towards North Carolina, Tennessee, and Arkansas (USFWS, 1997).

Current threats to the wood stork include loss of feeding habitat, water level manipulations affecting drainage, predation, and/or lack of nest tree regeneration, human disturbance, and pesticides/chemical pollutants (USFWS, 1997).

Fish

One endangered fish species is federally listed and known to occur in South Carolina, as summarized in Table 13.1.6-6. The shortnose sturgeon (*Acipenser brevirostrum*) is found in coastal plain rivers in south and east South Carolina. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in South Carolina is provided below.

Table 13.1.6-6: Federally Listed Fish Species of South Carolina

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Shortnose Sturgeon	*Acipenser brevirostrum*	E	No	Nearshore marine, estuarine, and riverine habitats in South Carolina, found in coastal rivers.

[a] E = Endangered
Sources: (USFWS, 2015c) (USFWS, 2016a)

Shortnose Sturgeon. The shortnose sturgeon is the smallest of the three eastern North American sturgeon species, averaging approximately 4.5 feet in length and weighing up to 50 pounds. The shortnose sturgeon are long-lived fishes with lifespans of 30 to 67 years and are among the most primitive of the bony fishes (NOAA, 2014c). This species was listed as endangered in 1967 (32 FR 4001, March 11, 1967). In South Carolina, it is found in the Waccamaw-Pee Dee, Santee, Cooper, ACE Basin (Ashepoo, Combahee, and Edisto Rivers), Winyah Bay (Black River) and Savannah river basins (USFWS, 2015z).

The preferred habitats are nearshore marine, estuarine, and riverine habitats. Adult shortnose sturgeon feed on large crustaceans and mollusks, while juvenile sturgeon feed on small crustaceans and benthic insects. Females of this species can live up to 67 years and males approximately 30 years. This species spawns upstream in freshwater and then moves downstream and offshore to marine environments along the continental shelf. Historically, the shortnose sturgeon was not sought after by the commercial fishing industry, but was often taken incidentally during attempts for Atlantic sturgeon. Current threats to this species include pollution, habitat modifications, construction of dams, and dredging (NOAA, 2014c).

Reptiles

Three endangered and two threatened reptile species are federally listed and known to occur in South Carolina as summarized in Table 13.1.6-7. All five sea turtles, green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricate*), Kemp's Ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*), are found along the coast of South Carolina. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in South Carolina is provided below.

Table 13.1.6-7. Federally Listed Reptile Species of South Carolina

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Marine Reptiles				
Green Sea Turtle	Chelonia mydas	T	No	Warm, shallow, coastal waters of reefs, lagoons, inlets, and bays with submerged aquatic vegetation

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	No	Warm, shallow, coastal waters of reefs, lagoons, inlets, and bays with submerged aquatic vegetation; migrates through South Carolina's coastal waters.
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	No	Muddy or sandy bottoms where prey items can be found, in waters rarely greater than 160 feet deep.
Leatherback Sea Turtle	*Dermochelys coriacea*	E	No	Coastal waters and the open sea environment; rarely nests in South Carolina.
Loggerhead Sea Turtle (Northwest Atlantic DPS)	*Caretta caretta*	T	Yes, critical habitat has been designated along South Carolina's barrier islands.	Open sea environment and inshore area such as salt marshes, creeks, bays, and lagoons; nests on South Carolina's barrier island beaches.

[a] E = Endangered, T = Threatened
Sources: (USFWS, 2015c) (USFWS, 2016a)

Marine Reptiles

Green Sea Turtle. The green sea turtle is "the largest of all of the hard-shelled sea turtles" (NOAA, 2016b). It was listed as threatened in 2016 (81 FR 20057 20090, May 6, 2016) (NOAA, 2016a). "Their top shell is smooth with shades of black, gray, green, brown, and yellow; their bottom shell is yellowish white." The adults grow to approximately 3 feet and weight between 300-350 pounds. The green sea turtle is found throughout all of the major oceans of the world, but "generally found in tropical and subtropical water along continental coasts and islands between 30 degree North and 30 degree South" (NOAA, 2016b). Critical habitat includes the "waters surrounding the island of Culebra, Puerto Rico" and the island's outlying Keys (USFWS, 2016f).

This species "are the only marine turtles to exclusively eat plants" (NOAA, 2016b). "They feed primarily on seagrasses and algae" (NOAA, 2016b). Nesting season typically occurs between June and September, with females laying eggs in 2 to 4 year cycles (NOAA, 2016b). Current threats to the green sea turtle include "harvest of eggs and adults, incidental capture in fishing gear, fibropapillomatosis (disease)," "loss or degradation of nesting habitat, disorientation of hatchlings by beachfront lighting; nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and incidental take from channel dredging and commercial fishing operations" (NOAA, 2016b) (USFWS, 2016f).

Hawksbill Sea Turtle. The endangered hawksbill sea turtle is one of the smaller sea turtles. It was listed as endangered in 1970 (35 FR 8491 8498, June 2, 1970). They have four scales on the top of their head, which are unusual for sea turtles. Adults range in size from 30 to 35 inches and weigh 100 to 150 pounds (although they can weigh as much as 300 pounds). Its upper shell is dark brown with yellow, orange, or red streaks and a yellow under shell. The hawksbill is found throughout all tropical waters (NOAA, 2014a) (USFWS, 2015i). Hawksbills are rare in the waters off South Carolina and are not known to nest in South Carolina (SCDNR, 2015d). NMFS

has designated the waters surrounding Culebra, Mona, and Monito Islands, Puerto Rico, as critical habitat necessary for the continued survival and recovery of hawksbill turtles (63 FR 46693 46701 September 2, 1998), but no critical habitat is located in South Carolina (USFWS, 2015j).

This species prefers warm, shallow, coastal waters of reefs, lagoons, inlets, and bays with submerged aquatic vegetation. As an omnivore, the hawksbill sea turtles feed primarily on sponges, algae, and invertebrates, and is often associated with the coral reef community. Nesting for these turtles occurs on remote beaches in the Gulf of Mexico and the Caribbean Sea in two to three year cycles, where females will lay between 140 to 200 eggs. (USFWS, 2015i)

Current threats to the hawksbill sea turtle include accidental capture in fishing lines, vessel strikes, contaminants, oil spills, disease, habitat loss of coral reef communities, and commercial exploitation. Outside of the U.S., a current threat is the harvest of their meat and eggs, which was the historic threat to this species causing their decline. (NOAA, 2014a)

Kemp's Ridley Sea Turtle. The endangered Kemp's Ridley sea turtle is considered the smallest sea turtle species and the most endangered. These sea turtles can grow to more than 2 feet in length and weigh up to 100 pounds (NOAA, 2015g) (USFWS, 2015k). The Kemp's Ridley sea turtle was first federally listed in 1970 (35 FR 18319 18322, December 2, 1970) under the Endangered Species Conservation Act (USFWS, 2015l). In the U.S., their range includes the Gulf of Mexico and the U.S. Atlantic seaboard, from New England to Florida. They prefer "nearshore habitats characterized by muddy or sandy bottoms where their prey items can be found," in waters rarely greater than 160 feet deep. They feed mostly on crabs, but also consume "jellyfish, fish, and an array of mollusks" (NOAA, 2015g) (USFWS, 2015k).

Kemp's Ridley sea turtle gather in large groups in Tamaulipas, Mexico where approximately 95 percent of this species' breeding occurs. Nesting occurs as early as April and into July. Some males migrate yearly between breeding and feeding grounds, whereas other remain near breeding grounds throughout the year. Hatchlings drift with the currents or float with plant material rafts for approximately two years (NOAA, 2015i). In South Carolina, juvenile Kemp's Ridley sea turtles are common in estuaries during the months of April through October (SCDNR, 2015d).

Historically, harvesting of the turtles eggs during their nesting was the main cause for the decline of this species while current threats to this species includes the inadvertent capture in fishing gear, human activity on beaches, and pollution (USFWS, 2015k). Kemp's Ridley turtles in South Carolina waters are most likely susceptible to the same hazards as other species including direct harvest of adults and eggs, incidental capture and drowning in the shrimp trawl fishery, collision with recreational and commercial boats, fishing line entanglements, and habitat loss (SCDNR, 2015d).

Leatherback Sea Turtle. The endangered leatherback sea turtle is the deepest-diving and most wide-ranging sea turtle growing 4 to 8 feet long and weighing 500 to 2,000 pounds (USFWS, 2015m). The leatherback sea turtle was listed as endangered in 1970 (35 FR 8491 8498, June 2, 1970) (USFWS, 2015n). The leatherback sea turtle is capable of tolerating a wide range of water temperatures; it has the widest global distribution of all reptiles. Regionally, this species is

known to occur in the Atlantic, Pacific, and Indian Oceans. The occurrence in the United States is rare for the Atlantic population, with the most significant location within the east coast being in southeastern Florida (USFWS, 2015m) (NOAA, 2015j). USFWS has designated Sandy Point Beach on St. Croix as critical habitat necessary for the continued survival and recovery of leatherback sea turtles, but no critical habitat is located in South Carolina (USFWS, 2015n).

The preferred habitat for this species includes open oceans but can also occur in coastal waters. The leatherback sea turtle diet consists of jellyfish, salps,[87] and other soft-bodied animals. This species will forage in both coastal waters and the open sea environment (NOAA, 2015j). For reproduction, the female leatherback sea turtles nest at 2 to 3 year intervals during the months of March to July. Creation of a nesting site occurs during the night and each turtle will nest up to 11 times per season (USFWS, 2015m). Leatherbacks are found along the South Carolina coast during annual migrations in the fall and spring. Current major threats to the species include natural and human-caused impacts to nesting sites, sand mining, coastal development (and associated artificial lighting) harvesting of their eggs, predation, incidental capture in fishing gear, climate change, and consumption of plastics (NOAA, 2015j).

Loggerhead Sea Turtle. The threatened loggerhead sea turtle (*Caretta caretta*) is a smaller sea turtle that can grow to an average length of three feet and weight of 250 pounds. This species has a reddish-brown carapace and flippers, and is characterized by its large head (USFWS, 2015o). The loggerhead sea turtle was initially listed as threatened throughout its range in 1978 (43 FR 32800 32811, July 28, 1978), and by 2011 nine different distinct populations segments were listed. Four segments were listed as threatened and five as endangered. The Northwest Atlantic Ocean population remained listed as threatened (76 FR 58868 58952, September 22, 2011). Nesting by the loggerhead sea turtle occurs from Texas to Virginia along the southeastern coast of the U.S. (USFWS, 2008a). Loggerheads are found throughout the marine and estuarine waters of South Carolina during the warm months of spring, summer, and fall. Loggerheads are South Carolina's primary nesting sea turtle, laying eggs on the beaches of every barrier island during the summer nesting season (SCDNR, 2015e). Open beaches are the preferred location for nesting along the coast and coral reefs and rocky places are the preferred feeding areas for the loggerhead sea turtles (NOAA, 2014b). Critical habitat has been designated in South Carolina along the beaches of coastal barrier islands including North Island, San Island, South Island, Cedar Island, Murphy Island, Cape Island, Lighthouse Island, Raccoon Key, Folly Island, Kiawah Island, Seabrook Island, Botany Bay Island, Interlude Beach, Edingsville Beach, Edisto Beach, Pine Island, Otter Island, Harbor Island, Little Capers Island, St. Phillips Island, and Bay Point Island (USFWS, 2015p).

The preferred habitat for the loggerhead sea turtle is the open sea environment, but they also occur in inshore area such as salt marshes, creeks, bays, and lagoons. Current threats to the loggerhead sea turtle include incidental captures in fishing gear, direct harvesting of eggs, marine pollution, watercraft strikes, disease, and loss or degradation of habitats. (NOAA, 2014b) (USFWS, 2015o)

[87] Salps: "A community-forming animal that look like a gelatinous barrel", "which float through the water column throughout the world's ocean, capturing prey like plankton" (NOAA, 2014d).

Amphibians

One threatened amphibian species is federally listed and known to occur in South Carolina as summarized in Table13.1.6-8. The frosted flatwoods salamander *(Ambystoma cingulatumis*) may be found in forests of southeastern South Carolina. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in South Carolina is provided below.

Table13.1.6-8: Federally Listed Amphibian Species of South Carolina

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Frosted Flatwoods Salamander	*Ambystoma cingulatum*	T	No	Breeds in isolated pond cypress dominated depressions generally within pine forests. A relatively open canopy resulting from seasonal prescribed burns is necessary to maintain appropriate vegetation.

[a] T = Threatened
Source: (USFWS, 2015c) (USFWS, 2016a)

Frosted Flatwoods Salamander. "The flatwoods salamander is medium-sized, reaching an adult length of 5 inches (13 centimeters). Body color ranges from silvery gray to black, with the back heavily mottled with a variable gray cross-band pattern" (USFWS, 1999). The species was listed as threatened in 1999 (64 FR 15691 15704, April 1, 1999). Its range includes coastal plain areas Florida, Georgia, and South Carolina. In South Carolina, frosted flatwoods salamander is known or believed to occur in five counties in the southeastern portion of the state (USFWS, 2015aa). USFWS has designated critical habitat necessary for the continued survival and recovery of the frosted flatwoods salamander in over 1100 acres in South Carolina including Jasper County, Charleston County, and Berkeley County (USFWS, 2015aa).

Preferred habitat of the frosted flatwoods salamander includes historically longleaf pine and wiregrass flatwoods and savannas in the lower southeastern Coastal Plain. Adults are terrestrial and live underground most of the year. They breed in relatively small, isolated ephemeral ponds where the larvae develop until metamorphosis. "Post-metamorphic salamanders migrate out of the ponds and into the uplands where they live until they move back to ponds to breed as adults" (USFWS, 2009).

Threats to the frosted flatwoods salamander include destruction and modification of the pine flatwoods habitat (including fire suppression) and disease/predation (USFWS, 2009). In South Carolina, conversion of wetland habitats for other uses including agriculture has altered the drainage patterns required for aquatic breeding (SCDNR, 2005d).

Invertebrates

There is one endangered invertebrate species that are federally listed and known to occur in South Carolina as summarized in Table 13.1.6-9. The Carolina heelsplitter *(Lasmigona decorate)* is located central South Carolina. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in South Carolina is provided below.

Table 13.1.6-9. Federally Listed Invertebrate Species of South Carolina

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Carolina Heelsplitter	*Lasmigona decorata*	E	Yes critical habitat has been designated in central South Carolina	Freshwater streams and rivers

[a] E = Endangered
Source: (USFWS, 2015c) (USFWS, 2016a)

Carolina Heelsplitter. The Carolina heelsplitter is a freshwater mussel that has an ovate trapezoidal shaped shell. "The outer surface of the shell is yellowish, brownish or greenish in color" (SCDNR, 2005e). The species was listed as endangered in 1993 (58 FR 34926 34932 June 30, 1993). Critical habitat has been designated for the Carolina heelsplitter in the northeastern part of South Carolina along Gills Creek, Flat Creek, Lynches River, Mountain Creek, Turkey Creek, Beaverdam Creek, and Cuffytown Creek (USFWS, 2002).

Carolina heelsplitter prefers cool, clean, shallow, and heavily shaded streams. "Like other freshwater mussels, the Carolina heelsplitter feeds by filtering food particles from the water column" (SCDNR, 2005d). Several factors have led to the decline of the Carolina heelsplitter. Pollution from wastewater treatment facilities and increased siltation from stormwater runoff are a threat to their habitat (SCDNR, 2005d). In addition, habitat alteration caused by human disturbance has also lead to the decline of the Carolina heelsplitter (USFWS, 2002).

Plants

Fifteen endangered and six threatened plant species are federally listed and known to occur in South Carolina as summarized in Table 13.1.6-10. The 21 plant species listed all have different ranges throughout the state of South Carolina that range from the Appalachian Mountains in the north to the coastal plain in the south. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in South Carolina is provided below.

Table 13.1.6-10. Federally Listed Plant Species of South Carolina

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
American Chaffseed	*Schwalbea americana*	E	No	Successional habitats; found in 12 counties in South Carolina.
Bunched Arrowhead	*Sagittaria fasciculata*	E	No	Undisturbed deciduous woodlands with slow flowing spring waters. Found only in one county in South Carolina.
Black Spored Quillwort	*Isoetes melanospora*	E	No	Eroded depressions formed on flat-to-doming granitic outcrops; known from one county in South Carolina.
Canby's Dropwort	*Oxypolis canbyi*	E	No	Open and sparse wetlands; known from 21 counties across.

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Dwarf-flowered Heartleaf	*Hexastylis naniflora*	T	No	Along bluffs and adjacent slopes, in boggy areas next to streams and creek heads, and along the slopes of nearby hillsides and ravines, known in five counties of South Carolina.
Harperella	*Ptilimnium nodosum*	E	No	Shallow ponds in hilly terrain and along gravelly stream-banks of swift moving water; found in three counties in South Carolina.
Little Amphianthus	*Amphianthus pusillus*	T	No	Eroded depressions formed on granitic outcrops; known from three counties.
Miccosukee Gooseberry	*Ribes echinellum*	T	No	Mixed hardwood or beech-magnolia forests on slopes and in bottomlands of central South Carolina.
Michaux's Sumac	*Rhus michauxii*	E	No	Successional habitats with sandy or rocky open woods. Known from one county.
Mountain Sweet Pitcher-plant	*Sarracenia rubra* ssp. *Jonesii*	E	No	Bogs and wetlands of mountainous regions in western South Carolina.
Persistent Trillium	*Trillium persistens*	E	No	Deciduous or conifer-deciduous woods within ravines or gorges; species is known in one county in northern South Carolina.
Pondberry	*Lindera melissifolia*	E	No	Seasonally flooded wetlands, sandy sinks, pond margins, and swampy depressions; in South Carolina, the species is known from 10 counties.
Relict Trillum	*Trillium reliquum*	E	No	Hardwood forests. Known in two counties.
Rock Gnome Lichen	*Gymnoderma lineare*	E	No	Vertical slopes with humid conditions. Known only in one county.
Rough-leaved Loosestrife	*Lysimachia asperulaefolia*	E	No	Grass shrub areas on moist soils. Found in two counties.
Schweinitz's Sunflower	*Helianthus schweinitzii*	E	No	Open clearings with poor soils. Found in two counties.
Seabeach Amaranth	*Amaranthus pumilu*	T	No	Dunes on the barrier islands of the Atlantic Ocean. Five Counties in South Carolina.
Small Whorled Pogonia	*Isotria medeoloides*	T	No	Hardwood stands that include beech, birch, maple, oak, hemlock, and hickory; found in two counties.
Smooth Coneflower	*Echinacea laevigata*	E	No	Open woods, glades, cedar barrens, dry limestone bluffs, and roadsides; known from nine counties.

Common Name	Scientific Name	Federal Status [a]	Critical Habitat in South Carolina	Habitat Description
Swamp Pink	*Helonias bullata*	T	No	Forested wetlands; in South Carolina, known only from Greenville County.
White Irisette	*Sisyrinchium dochotomum*	E	No	Mid-elevation slopes characterized by open, dry-to-moderate-moisture oak hickory forests; known in Greenville County.

[a] E = Endangered, T = Threatened
Source: (USFWS, 2015c) (USFWS, 2016a)

American Chaffseed. "A perennial member of the figwort family, American chaffseed grows from 12 to 24 inches high. The stems are unbranched or branched only at the base. The large, purplish-yellow, tubular flowers are 1 to 1.5 inches long and form a spike-like cluster" (USFWS, 2014c). The American chaffseed was listed as endangered in 1992 (57 FR 44703 44708, September 29, 1992). The American chaffseed is a coastal plain species that ranges throughout the Atlantic and Gulf coasts (USFWS, 2014c). In 2008, 53 known extent sites were recorded in this range. In South Carolina, the species is known or believed to occur in 12 counties in South Carolina (USFWS, 2015ab).

Suitable habitat for this species consists of successional habitats such as "pine flatwoods, fire-maintained savannas, and ecotonal[88] areas between peaty wetlands and xeric (dry) sandy soils, bog borders, and other open grass-sedge systems." "The American chaffseed occurs in sandy (sandy peat, sandy loam), acidic, and seasonally moist to dry soils…[and]…species-rich plant communities where grasses, sedges, and savanna dicots are numerous." The American chaffseed is dependent on fire and fluctuating water tables to maintain crucial conditions that it requires. Threats to the American chaffseed are collecting, loss of habitat from residential development and natural vegetation succession. (USFWS, 2014c)

Bunched Arrowhead. The bunched arrowhead (*Sagittaria fasciculate)* is a small herbaceous plant growing 15-16 inches tall. "Emergent leaves are broad and tapered at the tip and up to 12 inches long and one to two inches wide." The white flowers begin blooming in mid-May and continue through July. The fruits mature a few weeks after flowering (USFWS, 2011g). The bunched arrowhead was listed as endangered in 1979 (FR 43700-43701, July 25, 1979). The species is known or believed to occur in Greenville County in South Carolina (USFWS, 2015ac).

Bunched arrowheads occupy seepages in bogs that have a continuous flow of cool clean water. It prefers shady areas with sandy loam soils. Threats to this species include habitat destruction from the development of lands for residential and agricultural purposes and invasive non-native species. (USFWS, 2011g) (NCSU, 2016)

Black Spored Quillwort. The black spored quillwort (*Isoetes melanospora*) is a "rooted perennial with hollow, finely septate,[89] linear leaves (sporophyllis) which are spirally arranged."

[88] Ecotonal: A transition area between two adjacent ecological communities (Merriam Webster Dictionary, 2016).
[89] Septate: This describes leaf blades with cross-sectional venation that span adjacent parallel veins. (Hilty, 2015)

"Leaves are typically less than 7 centimeters (2.75 inches) long, but may extend up to 15 cm (6 inches) in length. The subterranean bases of the leaves are enlarged and overlapping. The leaf bases emanate from the upper portion of a short, squat, corm-like stem, which in this species is bibbed and typically somewhat shreddy"[90] (USFWS, 1993a). The mature megaspores are unique among Southeastern quillworts in that they are gray when dry, black when wet (USFWS, 1993a). The black spored quillwort was listed as endangered in 1988 (53 FR 3560 3565, February 5, 1988). The species is only known or believe to occur in Lancaster County, South Carolina (USFWS, 2015ad).

Suitable habitat for this species is "restricted to eroded depressions or (rarely) quarry pools formed on flat-to-doming granitic (either granite or granite-gneiss) outcrops." The species is found in "depressions which have an intact rim restricting drainage, and with an accumulation of a few centimeters of mineral soil." Threats to the black spored quillwort include destruction of habitat due to quarrying activities, disturbance by farm animals, dumping on rock outcrops, vehicular traffic, recreational impacts (foot traffic, littering, and fire building on rock outcrops), hybridization, and extreme cold (USFWS, 1993a).

Canby's Dropwort. Canby's dropwort (*Oxypolis canbyi*) is a perennial herb that grows to heights between 2.6 and 3.9 feet. The plant's stems are thin and stiff, holding slender leaves and extending up to small, five-petal white flower clusters "fringed with red to pink" (USFWS, 2011a). The species was federally listed as an endangered plant species in 1986 (51 FR 6690 6693, February 25, 1986). The species' range extends along Atlantic coastal states from Delaware to Georgia; in South Carolina, the species known or believed to occur 21 counties within the central part of the state (USFWS, 2015ae).

Habitat for Canby's dropwort includes open ponds, swamps, and sloughs, ultimately uninhibited by intensive canopy cover and on wet soils for a majority of the year. Wetland areas located near coastal regions with sandy or muddy upper soil layers provide adequate habitat for the species. Habitat loss, hydrologic alterations, environmental degradation from herbicides, and insect predation are all current threats to the species' survival (USFWS, 2011a).

Dwarf-flowered Heartleaf. The Dwarf-flowered heartleaf (*Hexastylis naniflora)* is a low growing herbaceous plant in the birthwort family. The plant has green heart shaped leaves. The jug-shaped flowers are usually beige to dark brown or purple and appear from mid-March to early June" (USFWS, 2011b). The species was listed as a threatened plant species in 1989 (54 FR 14964-14967 April 14, 1989). This species is known in the upper piedmont region of both North Carolina and South Carolina. In South Carolina is it known to occur in five counties (USFWS, 2015c).

Dwarf-flowered heartleaf typically grows on slopes adjacent to streams in moist acidic soils. The species is threatened by habitat loss and degradation resulting from land conversion to residential and agricultural uses (USFWS, 2011b).

Harperella. Harperella (*Ptilimnium nodosum*), or pond harperella, is a perennial herb that grows between six inches and three feet tall. Its thin stalks have quill-like leaves and end in small white

[90] Shreddy: This describes a loose and flaky consistency (DCNR, 2014).

flowers that typically have five petals each (USFWS, 2015af). The species was listed as endangered in 1988 (53 FR 37978 37982, September 28, 1988). Harperella's range reaches down the east coast from Maryland down to Georgia and into Oklahoma (USFWS, 2015ag). In South Carolina, harperella is known or believed to exist in three counties in the south central portion of the state (USFWS, 2015ag).

Habitat for pond harperella consists of shallow ponds in hilly terrain and along gravelly stream-banks of swift moving water. Threats to harperella consist of water changes in flow, depth, and quality, along with human factors such as damming, hydrologic alterations, and development. Habitat destruction, either through overwhelming water coverage or through severe dehydration, can detrimentally impact the species' (USFWS, 2015af).

Little Amphianthus. The little amphianthus (*Amphianthus pusillus*) is "a small, aquatic annual with very short (to ca. 6 mm) (0.25 inch), leafy, rooted, submerged stems that produce flowers and one or more threadlike scapes. The tip of each scape bears two small, ovate to lanceolate, oppositely arranged bracts. The scapes elongate as necessary (to ca. 15 cm (6 inches)) to permit the bracts to float upon the surface of the water. A single small (to 4 mm (0.16 inch) long) long white to pale purplish flower is borne between the two bracts. Other flowers borne on the usually submerged short stem are similar to the emersed flowers. The fruit is a small, shallowly bilobed capsule" (USFWS, 1993a). The little amphianthus was listed as threatened in 1988 (53 FR 3560 3565, February 5, 1988). The species range includes Alabama, Georgia, and South Carolina; in South Carolina, the species is known or believed to occur in three counties in northern South Carolina (USFWS, 2015ah).

Suitable habitat for this species is "restricted to eroded depressions or (rarely) quarry pools formed on flat-to-doming granitic (either granite or granite-gneiss) outcrops" (USFWS, 1993c). The species is usually found in depressions that have been eroded in the granite with "an intact rim restricting drainage, and with an accumulation of a few centimeters of mineral soil." Threats to little amphianthus include destruction of habitat due to quarrying activities, disturbance by farm animals, dumping on rock outcrops, vehicular traffic, recreational impacts (foot traffic, littering, and fire building on rock outcrops), and extreme cold (USFWS, 1993a).

Michaux's Sumac. The Michaux's sumac (*Rhus michauxii*), part of the cashew family, is a densely hairy shrub with one to three-foot stems and evenly serrated, oblong leaflets. The species contains male and female small greenish-yellow to white flowers within the same plant, which flower in June and July and produce a red drupe[91] fruit in August through October (USFWS, 2015ai). Michaux's sumac was listed as endangered in 1989 (54 FR 39850 39857, September 28, 1989). This species is distributed throughout the Atlantic coastal plains in the southern U.S. In South Carolina, the species is known in only Kershaw County in the central part of the state (USFWS, 2016g).

Suitable habitat consists of sandy or rocky open woods and survives best in areas where some form of disturbance has occurred, such as wildfire or maintained clearings. The most critical

[91] Drupe: "A fleshly fruit" (Hilty, 2015).

threat to this species is low reproductive capacity, fire suppression, and habitat loss due to development (USFWS, 2015ai).

Persistent Trillium. The persistent trillium (*Trillium persistens*) is a "perennial herb with erect stems up to 12 inches (30 cm) tall." Leaves are "lance-shaped and dark green, in a whorl of three leaves at the top of the stem." The flower stalk rises "from the center of the whorl of leaves", and the flower has three petals, that are "delicate in texture with slightly wavy edges, white, turning pink-purple with age; 3 pale green sepals, slightly spreading, narrower than the petals, with bluntly pointed tips and pale edges; and 6 straight stamens with white stalks (filaments) and yellow pollen sacs (anthers)" (Chafin, 2009). The persistent trillium was listed as endangered in 1978 (43 FR 17910 17916, May 27, 1978). The species is restricted to the Tallulah-Tugaloo River system in northeast Georgia and western South Carolina; in South Carolina, the species is only known or believed to occur in Oconee County (USFWS, 1984) (USFWS, 2015aj).

Suitable habitat for this species consists of deciduous or conifer-deciduous woods with a well-developed overstory within ravines or gorges, commonly under or near rhododendron, with well-decomposed litter and/or loose loam (USFWS, 1984). Threats to the species include impoundments, logging, wildfires, and recreational access (USFWS, 1984).

Pondberry. The pondberry (*Lindera melissifolia*) "is a deciduous shrub that grows to approximately 2 meters (6 feet) tall, and spreads vegetatively by stolons.[92] Pale yellow flowers appear in the spring before the leaves emerge. The oval-shaped fruits are 0.5 inch (12 millimeter) long, and turn from green during the summer to bright red in the fall" (USFWS, 2015as). Leaves are aromatic with a rounded leaf base. "Shrubs usually are sparsely branched, with fewer branches on smaller plants." Plants are dioecious[93] and "produce clusters of small, yellow flowers in early spring prior to leaf development, from buds on branches produced from the growth during the preceding year. Immature fruits are drupes, green, and ripen to red by fall" (USFWS, 2015ak). Pondberry was listed as endangered in 1986 (51 FR 27495 27500, July 31, 1986). The species is known or believed to occur in Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina; in South Carolina, the species is known or believed to occur in ten counties in the Coastal Plains region of the state (USFWS, 2015ak).

Suitable habitat for this species includes "seasonally flooded wetlands, sandy sinks, pond margins," and swampy depressions. Threats to the species include "alteration or destruction of its habitat through land-clearing, drainage modification, timber harvesting," and disturbance from domestic animals (USFWS, 1993b).

Relict Trillium. The relict trillium (*Trillium reliquum*) "is distinguished from other sessile-flowered members of the genus by its decumbent or S-curved stems, distinctively shaped anthers,[94] and the color and shape of its leaves. The flowers appear in early spring and are

[92] Stolon: Above ground roots or modified stems "that can produce new plantlets some distance away from the mother plant" (Hilty, 2015).
[93] Dioecious: "Male and female flowers are produced on separate plants" (USFWS, 2015as).
[94] Anther: "Anthers bear the pollen of the flowers; they are located at the tip of the stamens (male reproductive organs). The anthers of a flower are often powdery yellow or orange in appearance (from the grains of pollen)" (Hilty, 2015).

greenish to brownish purple or occasionally pure yellow in color. The fruit is an oval-shaped, berry-like capsule that matures in early summer" (USFWS, 1991a). The relict trillium was listed as endangered in 1988 (53 FR 10879 10884, April 4, 1988). The species occurs primarily in undisturbed moist hardwood forests in limited portions of Alabama, Georgia, and South Carolina; in South Carolina, the species is known from two counties in the western region of the state (USFWS, 1991a) (USFWS, 2015al).

Suitable habitat for this species includes "moist hardwood forests that have had little or no disturbance in the recent past. The soils on which it grows vary from rocky clays to alluvial[95] sands, but all exhibit a high organic matter content in the upper soil layer. Most sites appear to be free from the influence of fire, both in the recent and distant past" (USFWS, 1991a). Relict trillium does occur on less than optimum sites, such as power and sewer line rights-of-way, and can apparently become reestablished after intensive disturbance to the habitat, such as agricultural activity (USFWS, 1991a).

Threats to the species include "loss or alteration of habitat resulting from residential development. Most populations are adjacent to rapidly expanding urban areas, and the direct impacts of construction activities associated with an expanding population are significant. In addition, activities such as road construction; power transmission line construction; and gas, water and sewer line installation all may have indirect or direct impacts." " Logging of areas occupied by the species constitutes a significant threat, as does conversion or use of the sites for pine monoculture, pastures, or row crop agriculture" (USFWS, 1991a).

Rock Gnome Lichen. The rock gnome lichen (*Lysimachia asperulaefolia*) occurs in dense colonies recognized by thin squamules[96] that protrude from a rock surface. The squamules are generally blue-grey on the top, white on the bottom and fade to black underneath (USFWS, 2011c). The rock gnome lichen was listed as an endangered plant in 1995 (60 FR 3557 3562 January 18, 1995). The lichen is found in the higher elevations of the southern Appalachian Mountains of North Carolina, South Carolina, Virginia, and Tennessee. In South Carolina, this species can be found only in Greenville County (USFWS, 2015am).

The rock gnome lichen is found growing on vertical rock faces at higher elevations in humid environments. It needs a moderate amount of light but cannot tolerate high level of solar intensity. The rock gnome lichen is threatened by human disturbances including recreational and residential development. Another threat is from invasive insects that attack the trees that provide the necessary shade for the rock gnome lichen to grow. (USFWS, 2011c)

Rough-Leaved Loosestrife. Rough-leaved loosestrife (*Lysmachia asperulaefolia*) is a perennial herb that grows 11 to 23 inches in height with yellow flowers (USFWS, 2011d). The species was listed as an endangered plant in 1987 (52 FR 22585 22589 July 13, 1987). The rough-leaved loosestrife is found in the coastal plains and sandhills regions of North Carolina and

[95] Alluvial: "Deposits of clay, silt, sand, gravel, or other particulate material that has been deposited by a stream or other body of running water in a streambed, on a flood plain, on a delta, or at the base of a mountain" (USGS, 2015e).

[96] Squamules: small lobed, leaf-like shaped "lichen structures that are attached to their substrate by one end, like a shingle; several of these structures will comprise a lichen" (USFS, 2016).

South Carolina (USFWS, 2011d). In South Carolina, it can be found in Darlington and Richland counties (USFWS, 2016h).

The rough-leaved loosestrife can be found in grass shrub areas that are located between areas of long leaved pine uplands and pond pine pocosins[97] on moist to seasonally saturated sands. The plant is found to thrive in areas that area maintained by fires. Threats to this species include habitat loss from human activities, which include fire suppression, wetlands drainage, and residential and commercial development. (USFWS, 2011d)

Schweinitz's Sunflower. Schweinitz's sunflower (*Helianthus schweinitzii*) is a perennial sunflower that grows about 6.5 feet in height (but has been known to grow up to 16 feet) and produces small yellow flowers. The leaves are on the opposites sides of the lower parts of the stem and begin to alternate on the upper parts (USFWS, 2011e). The Schweinitz's sunflower was listed as an endangered plant in 1991 (56 FR 21087 21091 May 7, 1991*)*. The sunflower is found in the upper Piedmont regions of North Carolina and South Carolina. In South Carolina, the Schweinitz's sunflower is found in two counties, Lancaster and York (USFWS, 2015ao).

The Schweinitz's sunflower can be found in open areas with poor soils, typically thin clays. This species "occurs in full to partial sun." Threats to this species include "habitat destruction, fire suppression, alteration of native habitat, roadside and utility right of way maintenance, industrial development, mining, encroachment by exotic species, highway construction and improvement," and commercial and residential development. (USFWS, 2011e)

Seabeach Amaranth. Seabeach amaranth (*Amaranthus pumilus*) is an annual dune plant with pinkish-red or red stems and rounded stems. This species branches into clumps, which often reaches 30 cm in diameter (USFWS, 2011f). Seabeach amaranth was listed as a threatened plant in 1993 (58 FR 18035 18042 April 7, 1993*)*. The plant is found along the Atlantic Coast from New York to South Carolina. In South Carolina, seabeach amaranth can be found in three counties along the coastal barrier islands (USFWS, 2015ap).

Seabeach amaranth occurs in barrier islands along the coast of the eastern United States. This species needs an extensive area of barrier island and beaches and does not do well when competition is introduced. Threats to this species include "construction of beach stabilization structures, beach erosion and tidal inundation, beach grooming, pedestrian traffic, herbivory by insects and feral animals and, in certain circumstances, by off-road vehicles" (USFWS, 2011f).

Small Whorled Pogonia. The small whorled pogonia is a member of the orchid family, which grows between 10 to 14 inches in height with greenish yellow flowers (USFWS, 2008b). The small whorled pogonia was federally listed as endangered in 1982 (47 FR 39827 39831, September 9, 1982) and in 1994 was reclassified as threatened (59 FR 50852 50857, October 6, 1994). Regionally this species is known to occur in sparse distributions from Maine south to Georgia and as far west as Illinois (USFWS, 2015aq). In South Carolina, the small whorled pogonia is known from two counties in the northern part of the state (USFWS, 2015aq).

[97] Pocosin: A shrub bog "that is dominated by broadleaved evergreen shrub vegetation" and "occur chiefly in the Carolinas and Georgia" (Sharitz & Gibbons, 1982).

The small whorled pogonia occurs "in older hardwood stands of beech, birch, maple, oak, hemlock, and hickory that have an open understory," preferring acidic soils along small streams that have a thick layer of litter (USFWS, 2008b). One distinct feature of this species is that it can remain dormant underground for multiple years before reappearing (USFWS, 1992). Current threats to small whorled pogonia include habitat loss due to urban expansion recreational activities, and forestry practices (USFWS, 2008b).

Smooth Coneflower. The smooth coneflower (*Echinacea laevigata*) is a perennial herb in the aster family that grows up to 3.3 feet from a vertical rootstock with basal leaves that may reach eight inches in length. The plant produces solitary flowers that are pink-purple and droop. Flowering occurs in late May through July and fruits develop in the summer months (USFWS, 2015ar). The smooth coneflower was listed as endangered in 1992 (57 FR 46340 46344, October 8, 1992). The distribution of the smooth coneflower is currently in Virginia, North Carolina, South Carolina, and Georgia, although it historically also occurred regionally throughout the southern U.S.; in South Carolina, it is known from nine counties spread out through the northern and central part of the state (USFWS, 2015ar) (USFWS, 2016d).

The habitat of the smooth coneflower includes open woods, glades, cedar barrens, dry limestone bluffs, and roadsides. Optimal sites include soils rich in calcium and magnesium, and abundant sunlight. Threats to the species include fire suppression and habitat loss from development, collection, and roadside maintenance activities (USFWS, 2015ar).

Swamp Pink. The swamp pink (*Helonias bullata*) is an obligate wetland species[98] in the lily family with fragrant pink wildflowers. Leaves are evergreen lance shaped that form circular clusters that lay flat on the ground. Flowers grow on one to three feet tall stalks in clusters of 30 to 50 individual small pink flowers with blue anthers (USFWS, 2015at). The swamp pink was federally listed as threatened in 1988 (53 FR 35076 35080, September 9, 1988). The swamp pink is known or believed to occur on the coastal plains of three states (Delaware, New Jersey, and Maryland) and isolated spots of the southern Appalachian Mountains; within South Carolina the species is known only from Greenville County in the extreme northern part of the state (USFWS, 2015at).

Suitable habitats for the swamp pink consist of shaded forested wetland areas. Threats include human development that changes the physical and hydraulic conditions of the wetlands and invasive species (USFWS, 2015at).

White Irisette. The white irisette (*Sisyrinchium dichotomum*) is a perennial herb found on open, mid-elevation slopes in areas with partial sun such as woodland edges and roadsides (USFWS, 1995). This species was listed as endangered in 1991 (56 FR 46752-48755, September 26, 1991) (USFWS, 1991b). An individual white irisette is a cluster of as many as 10 or more winged stems emerging from fibrous roots. The plant grows to 10 to 16 inches high; flowers have 3-inch white petals (USFWS, 1995) (USFWS, 2011h). This species is believed or known in to occur in Greenville County, South Carolina (USFWS, 2015av).

[98] Obligate wetland species: Almost always occur in wetlands. With few exceptions, these plants are found in standing water or seasonally saturated soils (14 or more consecutive days) near the surface.

Suitable habitat for this species consists of dry to moderate moisture oak-hickory forests, found in shallow soils and over rocky, steep terrain. The white irisette depends on regular natural disturbances, and is indirectly affected by the extinction of local populations of elk and bison as well as fire suppression. Human disturbances, such as residential development, road constructions, and herbicide use threaten the plant. (USFWS, 2015av) (USFWS, 2011h)

13.1.7. Land Use, Recreation, and Airspace

13.1.7.1. Definition of the Resource

The following summarizes major land uses, recreational venues, and airspace considerations in South Carolina, characterizing existing, baseline conditions for use in evaluating the potential environmental consequences resulting from implementing the Proposed Action or Alternatives.

Land Use and Recreation

Land use is defined as "the arrangements, activities, and inputs people undertake in a certain land cover type to produce, change, or maintain it" (Di Gregorio & Jansen, 1998). A land use designation can include one or more pieces of land, and multiple land uses may occur on the same piece of land. Land use also includes the physical cover, observed on the ground or remote sensing and mapping, on the earth's surface; land cover includes vegetation and manmade development (USGS, 2012d).

Recreational uses are activities in which residents and visitors participate. They include outdoor activities, such as hiking, fishing, boating, athletic events (e.g., golf), and other attractions (e.g., historic monuments and cultural sites) or indoor activities, such as museums and historic sites. Recreational resources can include trails, lakes, forests, beaches, recreational facilities, museums, historic sites, and other areas/facilities. Federal, state, county, or local governments typically manage recreational resources.

Descriptions of land uses are presented in three primary categories: forest and woodland, agricultural, and developed. Descriptions of land ownership are presented in four main categories: private, federal, state, and tribal. Descriptions of recreational opportunities are presented in a regional fashion, highlighting areas of recreational significance within four identified regions.

Airspace

Airspace is generally defined as the space lying above the earth, above a certain area of land or water, or above a nation and the territories that it controls, including territorial waters (Merriam Webster Dictionary, 2015a). Airspace is a finite resource that can be defined vertically and horizontally, as well as temporally, when discussing it in relation to aircraft activities. Airspace management addresses how and in what airspace aircraft fly. Air flight safety considers aircraft flight risks, such as aircraft mishaps and bird/animal-aircraft strikes. The Federal Aviation Administration (FAA) is charged with the safe and efficient use of the nation's airspace and has established criteria and limits to its use.

The FAA operates a network of airport towers, air route traffic control centers, and flight service stations. The FAA also develops air traffic rules, assigns use of airspace, and controls air traffic in U.S. airspace. "The Air Traffic Organization (ATO) is the operational arm of the FAA responsible for providing safe and efficient air navigation services to approximately 30.2 million square miles of airspace. This represents more than 17 percent of the world's airspace and includes all of the U.S. and large portions of the Atlantic and Pacific Oceans and the Gulf of Mexico" (FAA, 2014). The ATO is comprised of Service Units (organizations) that support the operational requirements.

The FAA Air Traffic Services Unit (the Unit) manages the National Airspace System (NAS) and international airspace assigned to U.S. control and is responsible for ensuring efficient use, security, and safety of the nation's airspace. FAA field and regional offices (e.g., Aircraft Certification Offices, Airports Regional Offices, Flight Standards District Offices [FSDOs], Regional Offices & Aeronautical Center, etc.) assist in regulating civil aviation to promote safety, and develop and carry out programs that control aircraft noise and other environmental effects (e.g., air pollutants) attributed from civil aviation (FAA, 2015d). The FAA works with state aviation officials and airport planners, military airspace managers, and other organizations in deciding how best to use airspace.

13.1.7.2. Specific Regulatory Considerations

Appendix C, Environmental Laws and Regulations, summarizes numerous federal environmental laws and regulations that, to one degree or another, may affect land use in South Carolina. However, local county, city, and village laws and regulations govern most site-specific land use controls and requirements. Furthermore, many land use controls and requirements are implemented and enforced under the umbrella of land use planning, often with the help and support of state authorities.

Because federal laws govern the Nation's airspace, there are no specific South Carolina state laws that would alter the existing conditions relating to airspace for this PEIS. There are state statutes that address aviation in the South Carolina – Code of Laws, Title 55 – Aeronautics (South Carolina Legislature, 2015).

13.1.7.3. Land Use and Ownership

For the purposes of this analysis, South Carolina has been classified into primary land use groups based on coverage type as forest and woodlands, agricultural, and developed land. Land ownership within South Carolina has been classified into four main categories: private, federal, state, and tribal.

Land Use

Table 13.1.7-1 identifies the major land uses by coverage type in South Carolina. Forest and woodlands is comprised of the largest portion of land use with 62 percent of South Carolina's total land occupied by this category (Table 13.1.7-1 and Figure 13.1.7-1). Agriculture is the second largest area of land use with 17 percent of the total land area. Developed areas account for approximately 8 percent of the total land area. The remaining percentage of land includes

public land, surface water, and other land covers, shown in Figure 13.1.7-1, that are not associated with specific land uses (USGS, 2012b).

Table 13.1.7-1: Major Land Uses in South Carolina by Coverage Type

Land Use	Square Miles	Percent of Land
Forest and Woodland	18,583	62%
Agricultural Land	5,111	17%
Developed Land	2,516	8%

Source: (USGS, 2012b)

Forest and Woodland

Forest and woodland areas can be found throughout the state, many of them interspersed with, and adjacent to, agricultural areas. The largest concentrations of forest are in the Sumter and Francis Marion National Forests. Other large concentrations exist within South Carolina's five state forests. Section 13.1.6 presents additional information about terrestrial vegetation.

State Forests

South Carolina state forests are comprised of five units, totaling 91,859 acres (Table 13.1.7-2). Land uses within the state forests include recreation, wildlife management, forest management, water management, education, and other preservation type uses.

Table 13.1.7-2: South Carolina State Forests

State Forest	Acres
Sand Hills	46,836
Manchester	28,675
Harbison	2,137
Poe Creek	1,806
Wee Tee	12,405
Total	**91,859**

Source: (South Carolina Forestry Commission, 2015)

Private Forest and Woodland

Private forestlands indirectly provide some public benefit, including forest products, wildlife habitat, jobs, scenic beauty, and outdoor recreation opportunities. Scattered throughout the state, forests and woodlands on private lands often border agricultural fields, suburban neighborhoods, and state forests. For additional information regarding forest and woodland areas, see Section 13.1.6, Biological Resources and Section 13.1.8, Visual Resources.

Agricultural Land

Agricultural land exists in every region of the state, with the largest concentrations in the central and northeastern areas of the state (Figure 13.1.7-1). Approximately 16 percent, or 5,111 square miles, is classified as agricultural land in South Carolina. In 2012, there were 25,266 farms in South Carolina and most were owned and operated by small, family businesses, with the average farm size of less than 100 acres (U.S. Department of Agriculture 2012). Some of the state's largest agricultural uses include tobacco, cotton soybeans, corn, and hay. Other agricultural uses include livestock for dairy and meat, goats, sheep and hogs.

Developed Land

Developed land in South Carolina tends to be concentrated within major metropolitan areas and surrounding cities, towns, and suburbs (Figure 13.1.7-1). Although only eight percent of South Carolina land is developed, these areas are highly utilized for residential, commercial, industrial, recreational, and government purposes. Table 13.1.7-3 lists the top five developed metropolitan areas within the state and their associated population estimates, and Figure 13.1.7-1 shows where these areas are located within the Developed land use category.

Table 13.1.7-3: Top Five Developed Metropolitan Areas

Metropolitan Area	Population Estimate
Columbia	549,777
Charleston/North Charleston	548,404
Greenville	400,492
Myrtle Beach/Socastee (SC/NC)	195,025
Spartanburg	180,786
Total Population of Metro Areas	**1,874,484**
Total State Population	**4,832,482**

Source: (U.S. Census Bureau, 2015a)

Land Ownership

Land ownership within South Carolina has been classified into four main categories: private, federal, state, and tribal.

The majority of land in South Carolina is privately owned, with most of this land falling under the land use categories of agricultural, forest and woodland, and developed (Figure 13.1.7-2).[99] Highly developed, urban, metropolitan areas transition into suburban, agriculture, and woodland areas, which then transition into more wild and remote areas. Private land exists in all regions of the state.

Federal Land

The federal government manages 1,802.3 square miles of South Carolina land with a variety of land types and uses, including national parks, monuments, historic sites, military bases, and national forests (Figure 13.1.7-3).[100] Table 13.1.7-4 identifies the federal agencies managing the majority of federal lands throughout the state (Table 13.1.7-4 and Figure 13.1.7-2). There may

[99] Land ownership data were retrieved from the Protected Areas Database of the United States (PAD-US), produced by USGS (http://gapanalysis.usgs.gov/padus/). This dataset categorizes lands across the U.S. by conservation, land management, planning, recreation, and ownership, as well as other uses. It is an extensive data set that contains large quantities of information relevant to the Proposed Action. The data was queried to show Owner and used USGS' PAD-US ownership symbolization for consistency. The PADUS 1.3 geodatabase was downloaded in the summer of 2015, and used consistently throughout all these maps for each state and D.C.

[100] Recreational area data was retrieved from the Protected Areas Database of the United States (PAD-US), produced by USGS (http://gapanalysis.usgs.gov/padus/). This dataset categorizes lands across the U.S. by conservation, land management, planning, recreation, and ownership, as well as other uses. It is an extensive data set that contains large quantities of information relevant to the Proposed Action. The data was queried to show the Primary Designation Type of area. To show these in the map, recognizable symbols (e.g., varying shades of green for National Parks and Forests) were used as PAD-US does not have a standard symbolization for recreational resources. The PADUS 1.3 geodatabase was downloaded in the summer of 2015, and used consistently throughout all these maps for each state and D.C.

be other federal lands, but they are not shown on the map due to their small size relative to the entire state. Some federal agencies only have small areas of federal lands scattered throughout the state.[101] (USGS, 2014i)

Table 13.1.7-4: Federal Land in South Carolina

Agency	Square Miles	Representative Type
NPS	47.6	National Parks, National Monuments
USFWS	202.0	National Wildlife Refuges
Department of Defense	282.5	Military Forts, Naval and Marine Facilities, Air Force Base
Department of Energy	305.2	Nuclear Plant
US Forest Service	965.0	National Forests, Wilderness Areas
Total	**1,802.3**	

Source: (USGS, 2014i)

- The NPS manages 47.6 square miles consisting of 6 official designated NPS units, including the Congaree National Park, the Cowpens National Battlefield, Fort Sumter National Monument, Kings Mountain Military Park, Charles Pinckney Historic Site, and the Ninety Six National Historic Site;
- The USFWS owns and manages 202 square miles consisting of eight NWRs in South Carolina, which include Carolina Sandhills NWR, Santee NWR, Waccamaw NWR, Cape Romain NWR, Ace Basin NWR, Pinckney Island NWR, Savannah NWR, and Tybee NWR;
- The Department of Defense owns and manages 282.5 square miles used for military and air force bases, marine air stations, naval shipyards, and naval weapons stations;
- The Department of Energy owns and manages 305.2 square miles consisting of the Savannah River Nuclear Plant; and
- The Forest Service (USFS) owns and manages 965 square miles set aside as the Sumter and Francis Marion National Forests. (USGS, 2014i)

[101] Not all federal agency land is depicted in Figure 13.1.7-4 given the small size of some of the land acreage.

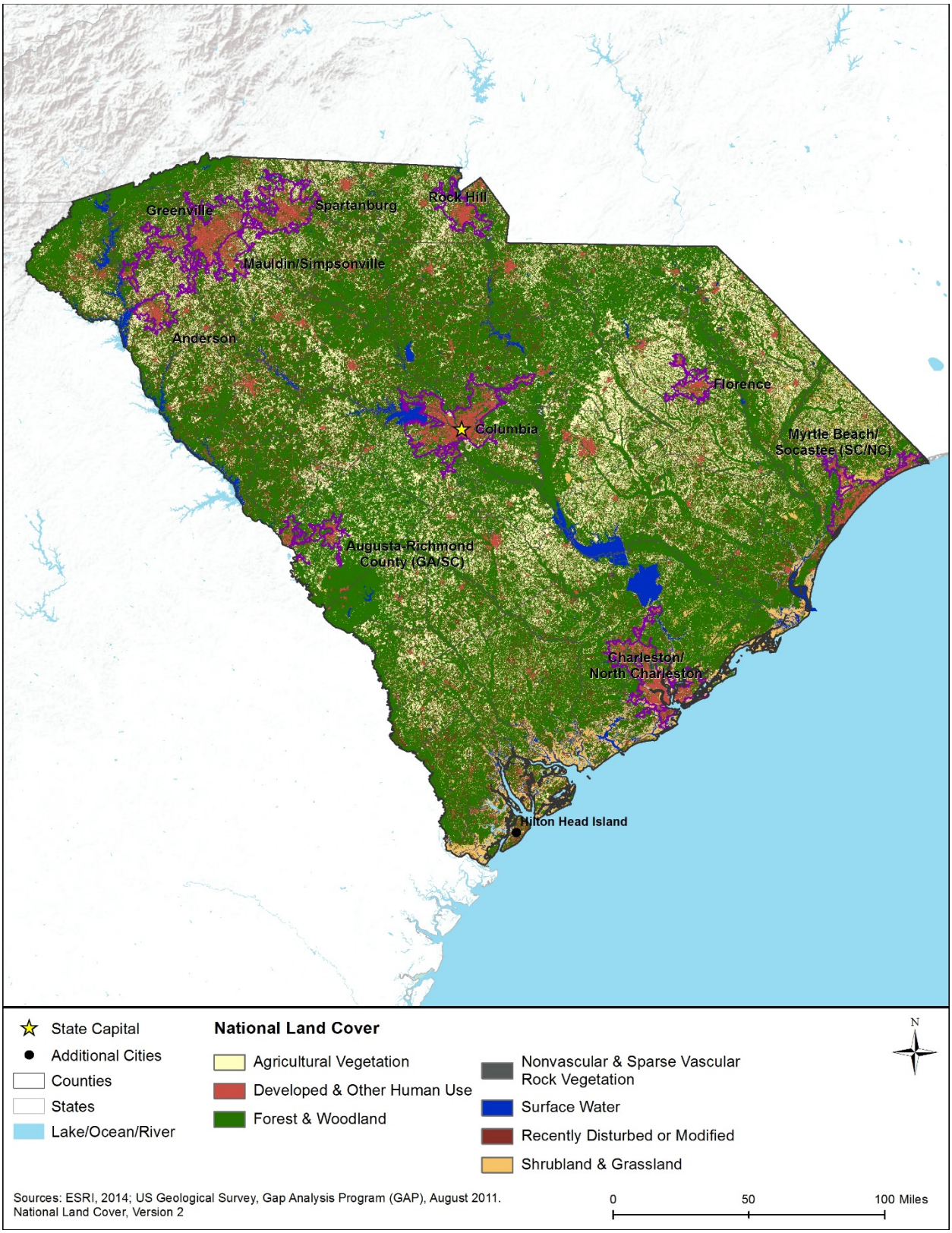


Figure 13.1.7-1: Major Land Use Distribution by Coverage Type

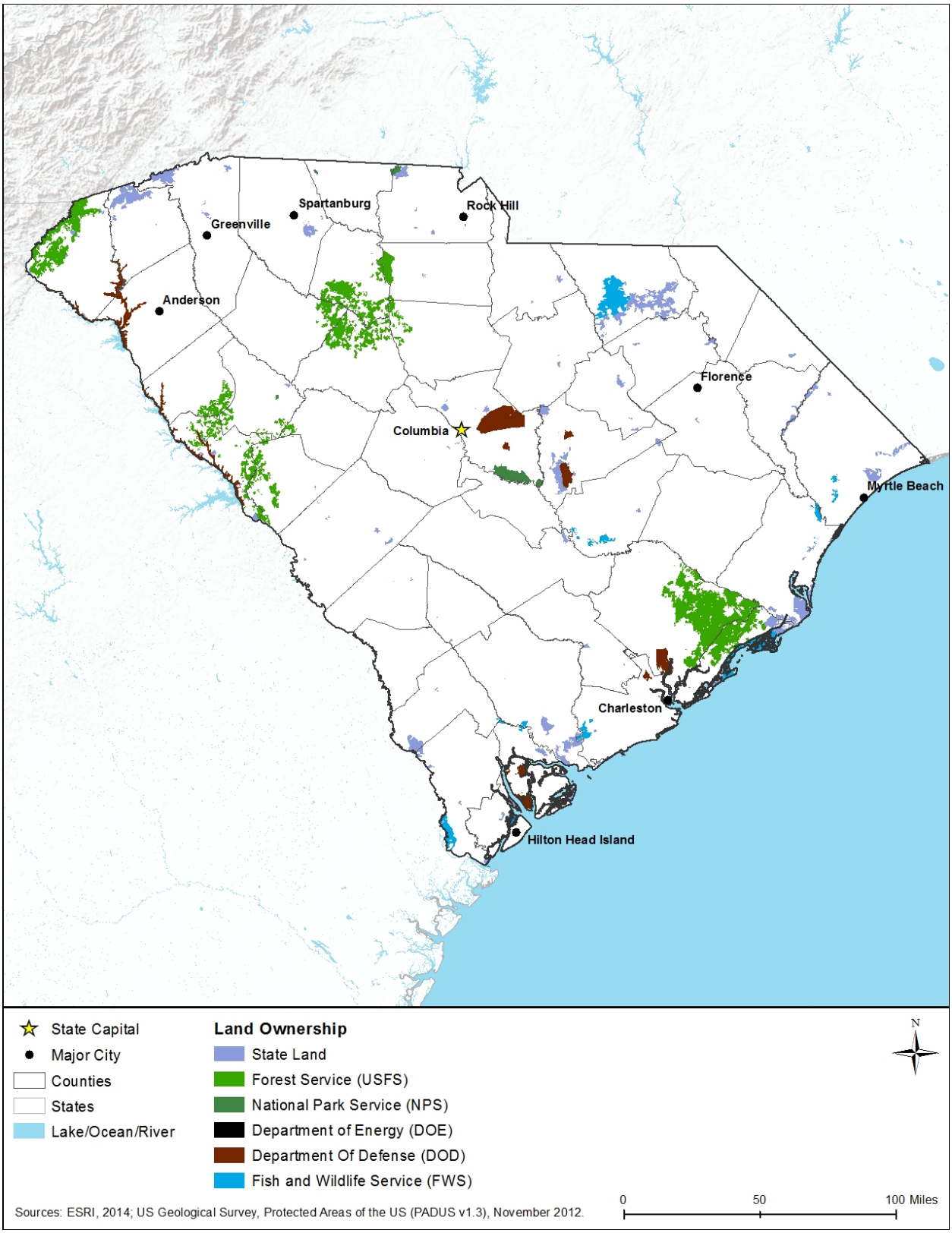


Figure 13.1.7-2: Land Ownership Distribution

State Land[102]

The South Carolina state government owns approximately 505.2 square miles of land comprised of state forests, historic sites, state offices, state parks, and wildlife areas. Six state agencies are responsible for managing state lands (Table 13.1.7-5).

Table 13.1.7-5: State Land in South Carolina

Agency	Square Miles[103]	Type
State Cultural Affairs	152.3	Cultural and Historic Sites
State Department of Land	121.6	State Forest
State Department of Natural Resources	8.3	Preservation Land
State Fish and Wildlife	131.6	State Wildlife Management Areas
State Land Board	1.8	Miscellaneous
State Parks & Recreation	89.6	State Parks, State Forests

Source: (USGS, 2014i)

Tribal Land

No land in South Carolina is held in trust by the federal or state government on behalf of a American Indian tribe or tribes as permanent tribal homelands. South Carolina does not have any federally recognized tribes in the state, and the Bureau of Indian Affairs does not manage any land in the state (U.S. Census Bureau, 2014).[104] For additional information on American Indian tribes in South Carolina, see Section 13.1.11, Cultural Resources.

13.1.7.4. Recreation

South Carolina consists of mountains in the northwest and ocean coastline on the east. The state is known for recreational activities along the coastline, with resort cities popular for golf courses. On the community level, towns, cities, and counties provide an assortment of indoor and outdoor recreational facilities, including athletic fields and courts, playgrounds, picnicking areas, and lake, river, or beach access points. Availability of community-level facilities is typically commensurate to the population's needs.

This section discusses recreational opportunities available at various locations throughout Illinois. For information on visual resources, see Section 13.1.8, Visual Resources, and for information on the historical significance of locations, see Section 13.1.11, Cultural Resources.

[102] State land use data for tables and narrative text were derived from specific state sources and may not correspond directly with USGS data that was used for developing maps and figures.
[103] Acres are not additive due to overlapping boundaries of the State Forests, State Parks and Recreation Areas, and Wildlife Management Areas.
[104] Although the Bureau of Indian Affairs "manages" American Indian lands, the Bureau of Indian Affairs is different than other land management agencies as the lands are held in trust and are sovereign nations.

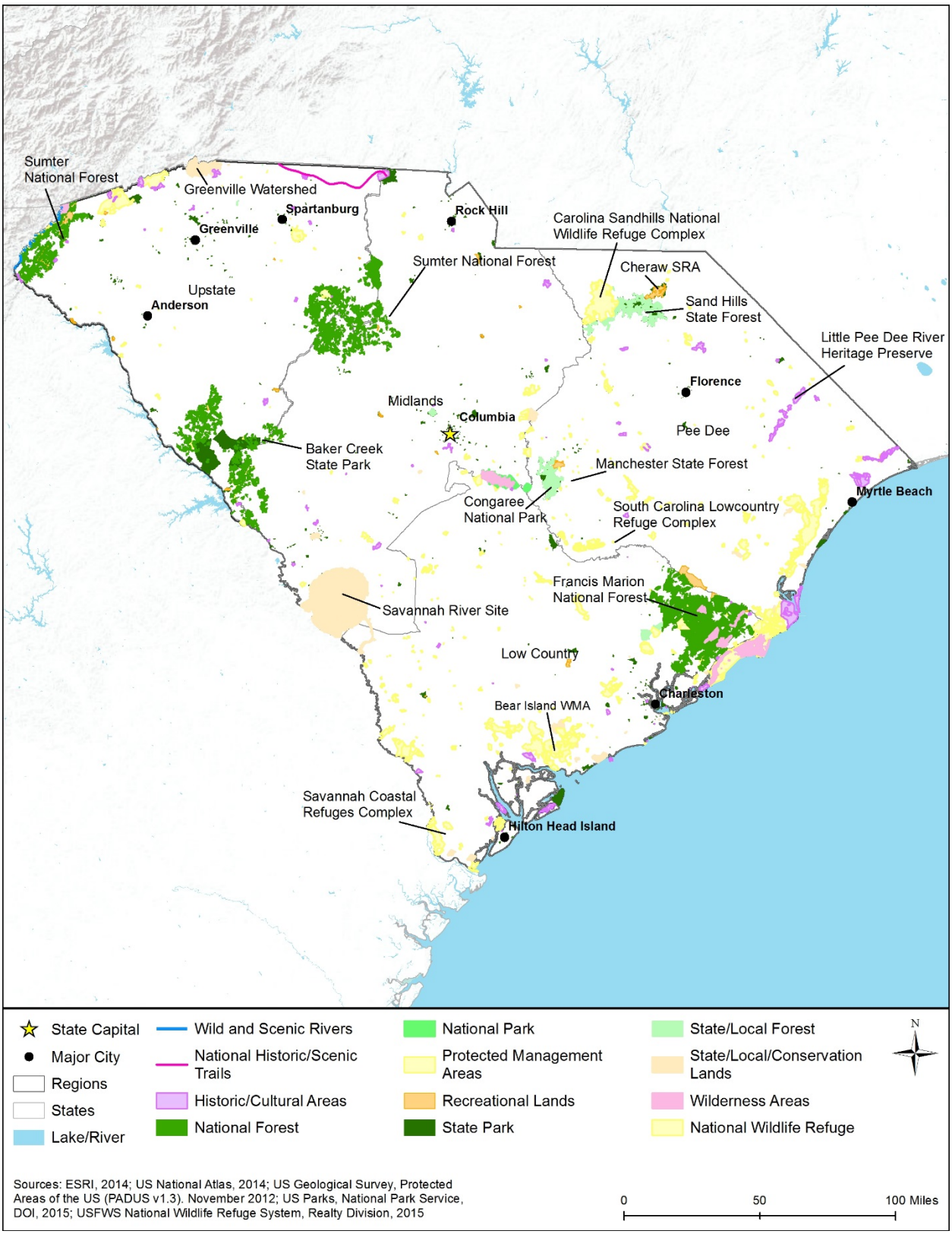


Figure 13.1.7-3: South Carolina Recreation Resources

Upstate Region

In the northwestern portion of the state, the Upstate Region is bordered by North Carolina to the north and Georgia to the west (see Figure 13.1.7-3). This region primarily consists of the Blue Ridge Mountains.

The Chattooga River, a Wild and Scenic River, flows through the Sumter National Forest; the river is popular for kayaking, canoeing, tubing, and rafting (USFS, 2015a). Recreational activities within the forest include hiking, horseback riding, and other trail use; camping and picnicking; fishing, swimming, boating, and other water activities; and target shooting and licensed, seasonal big game and game bird hunting. (USFS, 2015b)

Midlands

South Carolina's Midlands is in the center of the state, bordered to the north by North Carolina, and by Georgia to the west (see Figure 13.1.7-3). Geographically, this region is the midpoint between the mountainous Upstate and the sandy hills of the Lowcountry.

Congaree National Park is known for both hiking and kayak trails, including the Congaree River Blue Trail, a 50-mile designated recreational kayak and canoe trail. Other activities within the park include fishing, non-motorized boating, and camping. (NPS, 2015b) Kings Mountain National Military Park, commemorating a battle in the Revolutionary War, has a visitor's center, hosts interpretive programs, hiking trails, and a backcountry campsite (NPS, 2015c).

Pee Dee

The Pee Dee Region, in northeastern South Carolina, is bordered to the north by North Carolina and the west by the Atlantic Ocean (see Figure 13.1.7-3). The shoreline is mainly resorts and beachfront towns, while Pee Dee River cuts through the interior of the region and defines much of the landscape.

Approximately 16.1 million tourists visited Myrtle Beach in 2013 (Myrtle Beach Chamber of Commerce, 2015). Myrtle Beach is a large boardwalk city visited for attractions including a fishing pier, arcades, amusement parks, and entertainment venues (South Carolina Department of Parks, Recreation, and Tourism, 2015a).

Lowcountry

South Carolina's Lowcountry is in the southern part of the state, with the Atlantic Ocean on the east and Georgia on the west (see Figure 13.1.7-3). The region is known for sandy soils and small hills. The shore consists of a series of beach towns with beaches on both bay-side and ocean-side. On the coast, islands and towns are known for boardwalk and water activities. Hilton Head Island, in particular, is popular for its golf courses. (South Carolina Department of Parks, Recreation, and Tourism, 2015b)

The Francis Marion National Forest contains recreational places including the I'on Swamp Interpretive Trail and the Sewee Shell Ring Interpretive Trail. Recreational activities within the forest include hiking, horseback riding, and other trail use; camping and picnicking; fishing,

boating, and other water activities; and target shooting and licensed, seasonal big game and game bird hunting. (USFS, 2015b)

The South Carolina Lowcountry Refuges Complex consists of four National Wildlife Refuges: Santee, E.F. Hollings ACE, Cape Romain, and Waccamaw National Wildlife Refuges. Within these refuges, recreational activities are available, including hiking, wildlife viewing, birdwatching, photography, and other trail use; fishing, and licensed, seasonal hunting. (USFWS, 2015aw)

13.1.7.5. Airspace

The FAA uses the NAS to provide for aviation safety. The NAS includes Special Use Airspace (SUA) consisting of Restricted Areas, Warning Areas, and Military Operation Areas (MOAs). The FAA controls the use of the NAS with various procedures and practices (such as established flight rules and regulations, airspace management actions, and air traffic control procedures) to ensure the safety of aircraft and protection of the public.

Airspace Categories

There are two categories of airspace or airspace areas:

1) **Regulatory airspace** consists of controlled airspace (Class A, B, C, D, and E airspace areas in descending order of restrictive operating rules), and restricted and prohibited areas.
2) **Non-regulatory airspace** consists of MOAs, warning areas, alert areas, and controlled firing areas.

Within each of these two categories, there are four types of airspace: controlled, uncontrolled, special use, and other airspace. The categories and types of airspace are dictated by the complexity or density of aircraft movements, the nature of the operations conducted within the airspace, the level of safety required, and the national and public interest. Figure 13.1.7-4 depicts the different classifications and dimensions for controlled airspace. Air Traffic Control (ATC)[105] service is based on the airspace classification (FAA, 2008).

[105] ATC – Approved authority service to provide safe, orderly, and expeditious flow of air traffic operations (FAA, 2015e).

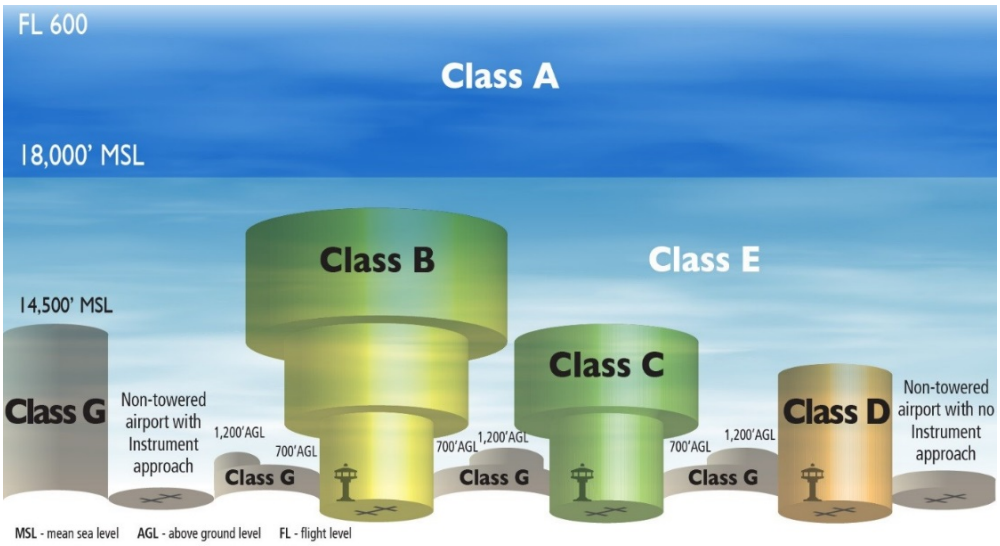


Figure 13.1.7-4: National Air Space Classification Profile

Source: Derived from (FAA, 2008)

Controlled Airspace

- **Class A:** Airspace from 18,000 feet to 60,000 feet Mean Sea Level (MSL).[106] Includes the airspace over waters off the U.S. coastlines (48 contiguous States and Alaska) within 12 Nautical Miles (NM). All operations must be conducted under Instrument Flight Rules (IFR).[107]
- **Class B:** Airspace from the surface up to 10,000 feet MSL near the busiest airports with heavy traffic operations. The airspace is tailored to the specific airport in several layers. An ATC clearance is required for all aircraft to operate in this area.
- **Class C:** Airspace from the surface to 4,000 feet above the airport elevation surrounding the airport. Applies to airports with an operational control tower, serviced by a radar approach control, and certain number of IFR operations or total number of passengers boarding aircrafts. Airspace is tailored in layers, but usually extends out to 10 NM from 1,200 feet to 4,000 feet above the airport elevation. Entering Class C airspace requires radio contact with the controlling ATC authority, and an ATC clearance is ultimately required for landing.
- **Class D:** Airspace from the surface to 2,500 feet above the airport elevation surrounding airports with an operational control tower. Airspace area is tailored. Aircraft entering the airspace must establish and maintain radio contact with the controlling ATC.
- **Class E:** Controlled airspace not designated as Class A, B, C, or D. Class E airspace extends upward from the surface or a designated altitude to the overlying or adjacent controlled airspace (FAA, 2008).

[106] MSL – The average level of for the surface of the ocean; "The height of the surface of the sea midway between the average high and low tides" (Merriam Webster Dictionary, 2015b).
[107] IFR – Rules for the conduct of flights under instrument meteorological conditions (FAA, 2015e).

Uncontrolled Airspace

Class G: No specific definition. Refers generally to airspace not designated as Class A, B, C, D, or E. Class G airspace is from the surface to the base of Class E airspace.

Special Use Airspace

SUA designates specific airspace that confines or imposes limitations on aircraft activities (See Table 13.1.7-6).

Table 13.1.7-6: SUA Designations

SUA Type	Definition
Prohibited Areas	"Airspace of defined dimensions identified by an area on the surface of the earth within which the flight of aircraft is prohibited. Such areas are established for security or other reasons associated with the national welfare. These areas are published in the Federal Register and are depicted on aeronautical charts."
Restricted Areas	"Airspace identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Activities within these areas must be confined because of their nature or limitations imposed upon aircraft operations that are not a part of those activities or both. Restricted areas denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. Penetration of restricted areas without authorization from the using or controlling agency may be extremely hazardous to the aircraft and its occupants. Restricted areas are published in the Federal Register and constitute 14 CFR Part 73."
Warning Areas	"Airspace of defined dimensions, extending from three NM from the U.S. coast, which contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn non-participating pilots of the potential danger. A warning area may be located over domestic or international waters or both."
MOAs	"Airspace of defined vertical and lateral limits established for separating certain military activities (e.g., air combat maneuvers, air intercepts, testing, etc.) from IFR traffic. Whenever an MOA is in use, non-participating IFR traffic may be cleared through a MOA if IFR separation can be provided by ATC. Otherwise, ATC will reroute or restrict nonparticipating IFR traffic."
Alert Areas	"Depicted on aeronautical charts to inform non-participating pilots of areas that may contain a high volume of pilot training or an unusual type of aerial activity. Pilots should be particularly alert when flying in these areas. All activity within an alert area must be conducted in accordance with CFRs, without waiver, and pilots of participating aircraft and pilots transiting the area are responsible for collision avoidance."
Controlled Firing Areas (CFAs)	"Activities that, if not conducted in a controlled environment, could be hazardous to nonparticipating aircraft. The distinguishing feature of the CFA, as compared to other special use airspace, is that its activities are suspended immediately when spotter aircraft, radar, or ground lookout positions indicate an aircraft might be approaching the area. There is no need to chart CFAs since they do not cause a nonparticipating aircraft to change its flight path."
National Security Areas (NSA)	"Airspace of defined vertical and lateral dimensions established at locations where there is a requirement for increased security and safety of ground facilities. Pilots are requested to voluntarily avoid flying through the depicted NSA. When it is necessary to provide a greater level of security and safety, flight in NSAs may be temporarily prohibited by regulation under the provisions of 14 CFR Section 99.7. Regulatory prohibitions are issued by System Operations, System Operations Airspace and Aeronautical Information Manual (AIM) Office, Airspace and Rules, and disseminated via Notices to Airmen (NOTAM). Inquiries about NSAs should be directed to Airspace and Rules."

Sources: (FAA, 2015e) (FAA, 2008)

Other Airspace Areas

Other airspace areas, explained in Table 13.1.7-7, include Airport Advisory, Military Training Routes (MTRs), Temporary Flight Restrictions (TFRs), Parachute Jump Aircraft Operations, published Visual Flight Rules (VFR) and IFRs, and Terminal Radar Service Areas.

Table 13.1.7-7: Other Airspace Designations

Type	Definition
Airport Advisory	There are three types: • Local Airport Advisory – Operated within 10 statute (5,280 feet/mile) miles of an airport where there is a Flight Service Station (FSS) located on an airport, but no operational control tower. The FSS advises the arriving and departing aircraft on particular conditions. • Remote Airport Advisory – Operated within 10 statute miles for specific high activity airports with no operational control tower. • Remote Airport Information Service – Used for short-term special events.
MTRs	MTRs are for use by the military for training, specifically low level combat tactics where low altitudes and high speed are needed.
TFRs	TFRs are established to: • Protect people and property from a hazard; • Provide safety for disaster relief aircraft during operations; • Avoid unsafe aircraft congestion associated with an incident or public interest event; • Protect the U.S. President, Vice President, and other public figures; • Provide safety for space operations; and • Protect in Hawaii declared national disasters for humanitarian reasons. Only those TFRs annotated with an ending date and time of "permanent" are included in this Draft PEIS, since it indicates a longer, standing condition of the airspace. Other TFRs are typically a shorter duration of for a one-time specific event.
Parachute Jump Aircraft Operations	Parachute jump area procedures are in 14 CFR Part 105, while the U.S. parachute jump areas are contained in the regional Airport/Facility Directory.
Published VFRs and IRs	These are established routes for moving around and through complex airspace, like Class B airspace. VFRs are procedures used to conduct flights under visual conditions. IFRs are procedures used to conduct flights with instruments and meteorological conditions.
Terminal Radar Service Areas	Airspace areas that are not one of the established U.S. airspace classes. These areas provide additional radar services to pilots.

Sources: (FAA, 2015e) (FAA, 2008)

Aerial System Considerations

Unmanned Aircraft Systems

Unmanned Aircraft Systems (UASs) are widely used by the military, private entities, public service, educational institutions, federal/state/local governments, and other agencies. The FAA's Unmanned Aircraft Systems Integration Office integrates UAS into the NAS. The *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap of*

2013 addresses the actions and considerations needed to integrate UAS into the NAS "without reducing existing capacity, decreasing safety, negatively impacting current operators, or increasing the risk to airspace users or persons and property on the ground any more than the integration of comparable new and novel technologies" (FAA, 2013 First Edition).

UAS at airports is a complex operational challenge with the need to separate UAS flight operations from mainstream air traffic. Separation can be achieved with specific UAS launch windows, special airports, or off-airport locations that allow the UAS to easily launch and recover. Special aviation procedures are applied to UAS flights. There must be the capability of Sense and Avoid (SAA) and Control and Communication (C2) during UAS operations. An Unmanned Aircraft (UA) must be able to see (or sense) other aircraft in the area and avoid the aircraft through corrected flight path changes. General equipment and operational requirements can include aircraft anti-collision lights, an altitude encoding transponder, cameras, sensors, and collision avoidance maneuvers. The C2 of the UA occurs with the pilot/operator, the UAS control station, and ATC. Research efforts, a component of the FAA's UAS roadmap, continue to mature the technology for both SAA and C2 capabilities.

Balloons

Moored balloons and unmanned free balloons cannot be operated in a prohibited or restricted area unless approval is obtained from the controlling agency. Balloons also cannot be operated if they pose a hazard to people and their property.

Obstructions to Airspace Considerations

The Airports Division of the FAA is responsible for the evaluation and analysis of proposed construction or alterations on airports. The FAA Air Traffic Office is responsible for determining obstructions to air navigation as a result of construction off airports that may affect the safe and efficient use of navigable airspace and the operation of planned or existing air navigation and communication facilities. Such facilities include air navigation aids, communication equipment, airports, federal airways, instrument approach or departure procedures, and approved off-airway routes. An Obstruction Evaluation and Airport Airspace Analysis (OE/AAA) is required when there is the potential for airport construction/alteration of a facility that may impinge upon the NAS. Per 14 CFR Part 77.9, the FAA is to be notified about construction or alterations when:

- "Any construction or alteration exceeding 200 ft. aboveground level;
- Any construction or alteration:
  - within 20,000 ft. of a public use or military airport which exceeds a 100:1 surface from any point on the runway of each airport with its longest runway more than 3,200 ft.;
  - within 10,000 ft. of a public use or military airport which exceeds a 50:1 surface from any point on the runway of each airport with its longest runway no more than 3,200 ft.; and
  - within 5,000 ft. of a public use heliport which exceeds a 25:1 surface.

- Any highway, railroad, or other traverse way whose prescribed adjusted height would exceed the above noted standards:
  - When requested by the FAA and
  - Any construction or alteration located on a public use airport or heliport regardless of height or location" (FAA, 2015f).

Construction or alternative facilities (such as towers) that are subject to FCC licensing requirements are also required to have an OE/AAA performed by the FAA Airport Division.

South Carolina Airspace

The South Carolina Aeronautics Commission is a state agency comprised of two departments, flight and airport development, that provides both air transportation and airport development services. The Commission's mission is to "foster air and economic development by overseeing the safety and development of the state's public use airports, by providing safe and reliable air transportation for state government and business prospects; and by providing aviation education opportunities." (South Carolina Aeronautics, 2011a) The Commission "is responsible for the collection, maintenance, and dissemination of airport data through a physical inspection of all proposed, active, closed, and abandoned aircraft landing facilities open to public use. This program includes:

- Condition of all airfield facilities (ex: lights, pavements, hangars, terminal buildings);
- Evaluation of flight approach surfaces per FAA PART 77 standards; and
- Submitting and verifying data uploaded to the FAA facilities directory and approach manuals distributed every 56 days (South Carolina Aeronautics, 2011b).

There is one FAA FSDO in South Carolina located in West Columbia (FAA, 2015d).

South Carolina airports are classified as those included in the State Aviation System Plan (SASP) and those that are not part of the SASP. The SASP addresses the strategic planning and future development for the state's airport system, as well as addressing key associated with their airports. (National Association of State Aviation Officials, 2015) Figure 13.1.7-5 presents the different aviation airports/facilities residing in South Carolina, while Figure 13.1.7-6 and Figure 13.1.7-7 presents the breakout by public and private airports/facilities. There are approximately 194 airports within South Carolina as presented in Table 13.1.7-8 and Figures 13.1.7-5 through 13.1.7-7 (USDOT, 2015a).

Table 13.1.7-8: Type and Number of South Carolina Airports/Facilities

Type of Airport or Facility	Public	Private
Airport	66	90
Heliport	0	32
Seaplane	0	2
Ultralight	0	3
Balloonport	0	0
Gliderport	0	1
Total	**66**	**128**

Source: (USDOT, 2015b)

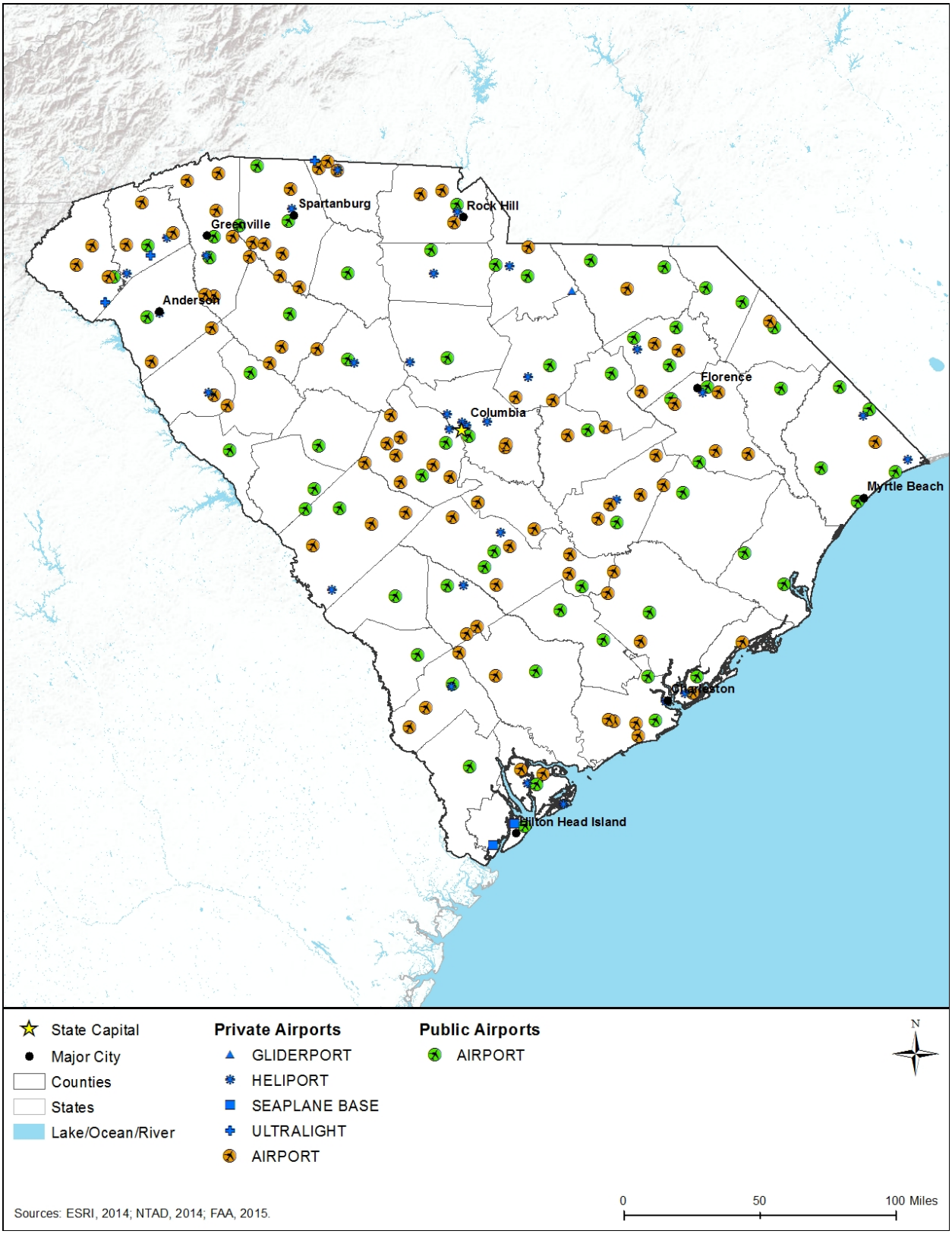


Figure 13.1.7-5: Composite of South Carolina Airports/Facilities

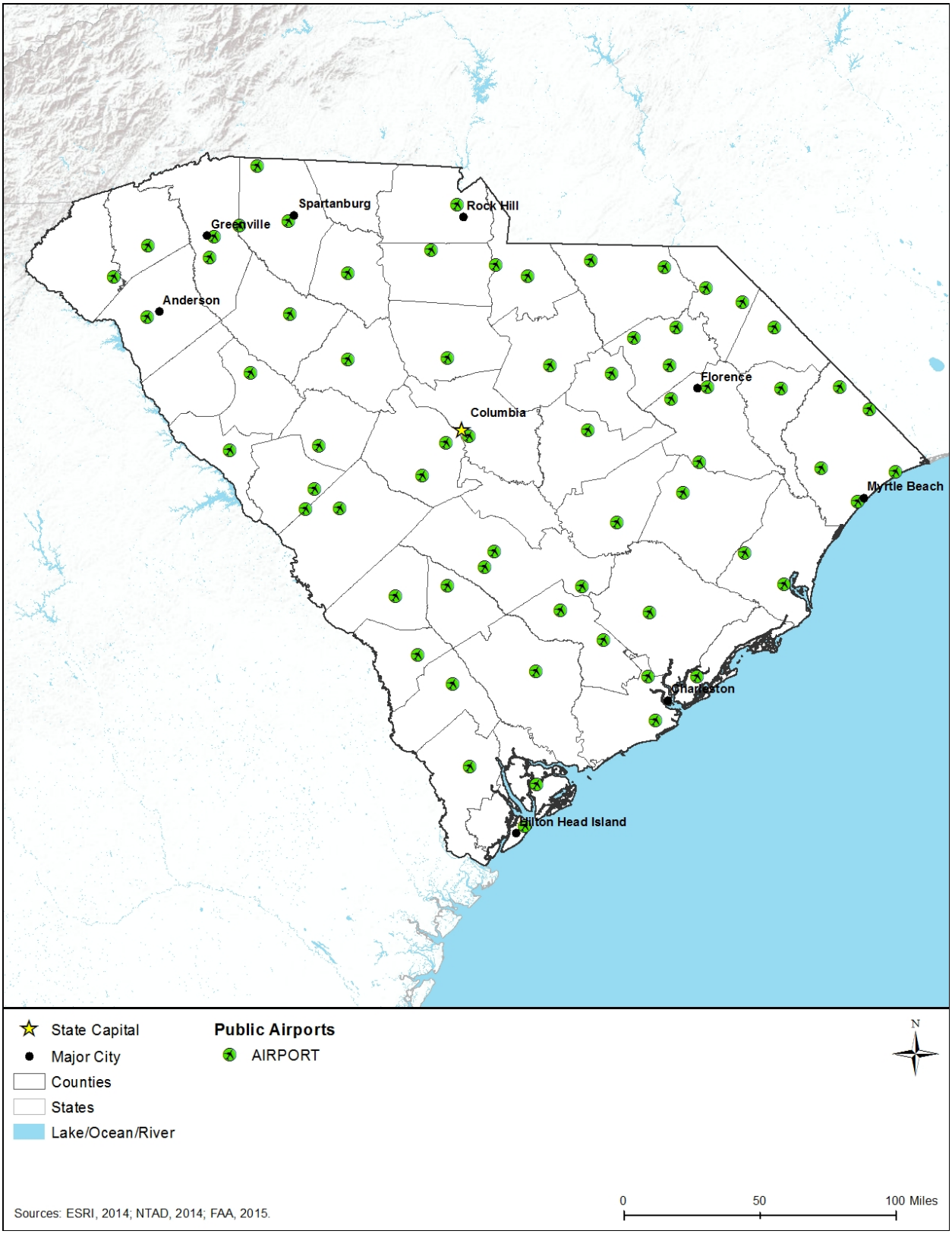


Figure 13.1.7-6: Public South Carolina Airports/Facilities

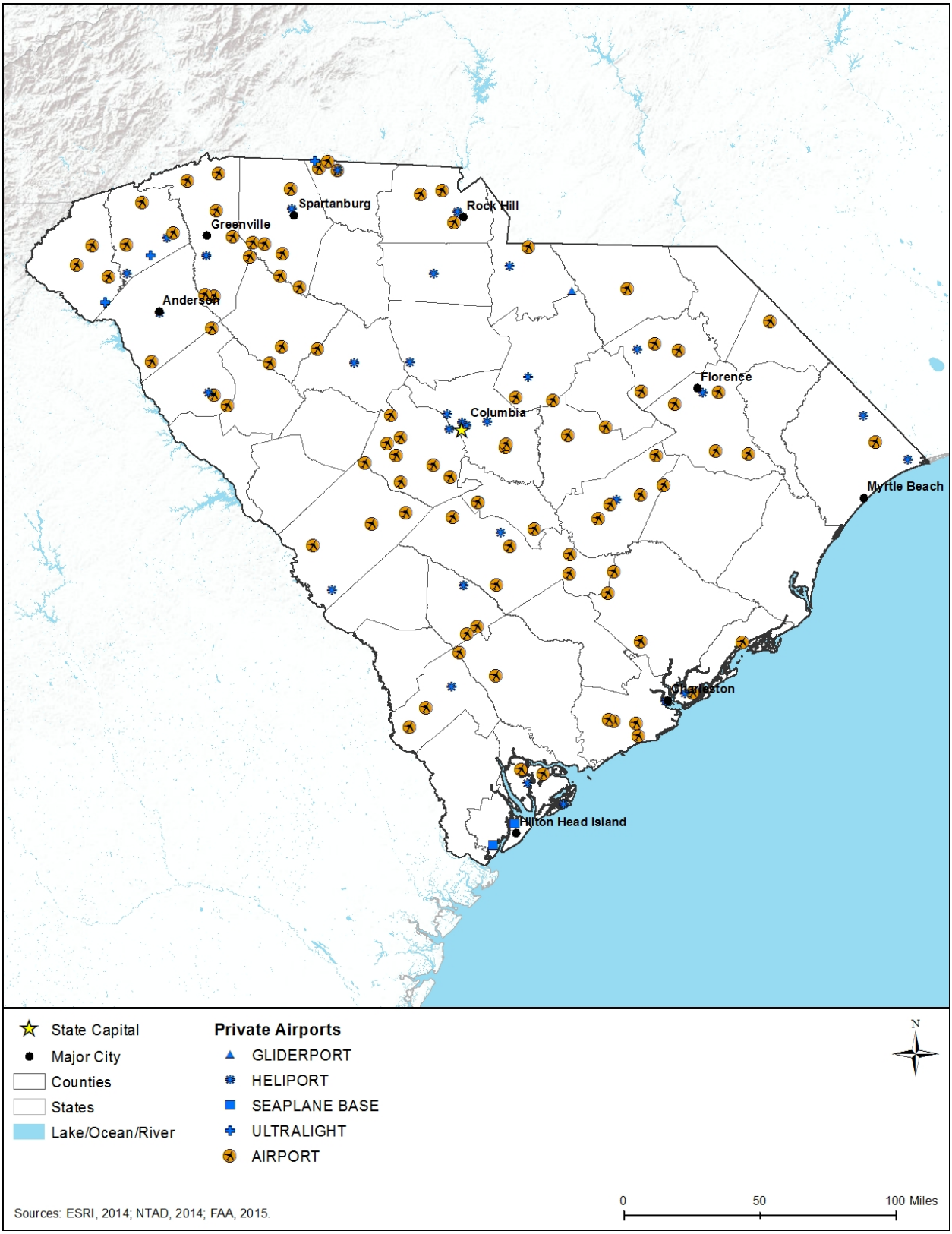


Figure 13.1.7-7: Private South Carolina Airports/Facilities

There are Class C and Class D controlled airports in South Carolina as follows:

- Four Class C:
  - Charleston Air Force Base (AFB)/International;
  - Columbia Metropolitan;
  - Greenville-Spartanburg, Greer;
  - Myrtle Beach International; and
  - Shaw AFB, Sumter.
- Twelve Class D:
  - Beaufort Marine Corps Air Station (MCAS)/Merritt Field, Beaufort;
  - Mc Entire Air National Guard, Eastover;
  - Florence Regional;
  - Greenville Downtown;
  - Greenville, Donaldson Center Airport, Greenville;
  - Hilton Head;
  - North Air Force Auxiliary, North;
  - Grand Strand, North Myrtle Beach; and
  - Shaw AFB, Sumter (FAA, 2015g).

SUAs (i.e., five restricted areas, ten MOAs, and one NSA) located in South Carolina are as follows:

- Fort Jackson (Restricted):
  - R-6001A – Surface to 3,200 feet MSL; and
  - R-6001B – 3,200 feet MSL to FL 230.
- Poinsett-Sumter (Restricted):
  - R-6002A – Surface to, but not including, 13,000 feet MSL;
  - R-6002B – 13,000 feet MSL to, but not including, FL 180; and
  - R-6002C – FL 180 to FL 230 (FAA, 2015h).

The ten MOAs for South Carolina are as follows:

- Beaufort:
  - 1 – 100 feet AGL to 10,000 feet MSL; Excluding airspace 3,000 feet MSL and below in the following area: Beginning at lat. 32°10’56”N., long. 80°37’39”W.; to lat. 32°16’01”N., long. 80°47’39”W.; to lat. 32°20’30”N., long. 80°41’10”W.; thence clockwise via a 7.5 NM arc centered at lat. 32°13’01”N., long. 80°41’59”W.; to lat.

32°13’21”N., long. 80°33’09”W.; thence southwest three NM from and parallel to the U. S. coast to the point of beginning;

- 2 – 100 feet AGL to 7,000 feet MSL; Excluding airspace 3,000 feet MSL and below in the following area: Beginning at lat. 32°20’30”N., long. 80°41’10”W.; to lat. 32°16’01”N., long. 80°47’39”W.; to lat. 32°16’57”N., long. 80°49’31”W.; thence clockwise via a 7.5 NM arc centered at lat. 32°13’01”N., long. 80°41’59”W.; to the point of beginning; and
- 3 – 100 feet AGL to 2,000 feet MSL.

- Gamecock:
  - A – 7,000 feet MSL to, but not including, FL 180;
  - B – 10,000 feet MSL to, but not including, FL 180;
  - C – 100 feet AGL to 10,000 feet MSL; Excluding the airspace 1,500 feet AGL and below within a three NM radius of Hemingway-Stucky and Andrews Airports, South Carolina;
  - D – 10,000 feet MSL to, but not including, FL 180; and
  - I – 100 feet AGL to 6,000 feet MSL.
- Poinsett – 300 feet AGL to 2,500 feet MSL; Excluding the airspace 1,500 feet AGL and below within: 1. A 2 NM ARC centered at lat. 33°36’30”N., long. 80°21’15”W.2. A one NM ARC centered at lat. 33°44’25”N., long. 80°27’50”W.
- W-74 – Surface to 10,000 feet MSL; Excluding airspace 3,000 feet MSL and below in the following area: Beginning at lat. 32°13’21”N., long. 80°33’09”W.; thence clockwise via a 7.5 NM arc centered at lat. 32°13’01”N., long. 80°41’59”W.; to lat. 32°09’23”N., long. 80°34’26”W.; to lat. 32°10’56”N., long. 80°37’39”W.; Thence three NM from and parallel to the U. S. coast to the point of beginning. (FAA, 2015h)

The SUAs for South Carolina are presented in Figure 13.1.7-8. There are no TFRs in South Carolina (Figure 13.1.7-8) (FAA, 2015i). There is a National Security Area (NSA 0001 – Surface to 2,000 feet MSL)[108] located around Aiken (See Figure 13.1.7-8) (FAA, 2015h). The restrictions associated with this NSA, when active, may impact the airspace in the area. MTRs in Louisiana, presented in Figure 13.1.7-9, consist of eleven Visual Routes, nine Instrument Routes, and two Slow Routes.

UAS Considerations

The National Park Service (NPS) signed a policy memorandum on June 24, 2014 that “directs superintendents nationwide to prohibit launching, landing, or operating unmanned aircraft on lands or waters administered by the NPS” (NPS, 2014b). There are six national parks in South Carolina that that must comply with this agency directive. (NPS, 2015n).

[108] National Security Area (NSA) consists of defined vertical and lateral dimensions in the airspace where there is increased security of ground facilities. Pilots are expected to voluntarily avoid flying through the NSA. Additional security levels may result in further restrictions of the NSA, which FAA Headquarters would issue and disseminate with a NOTAM. (FHWA, 2014)

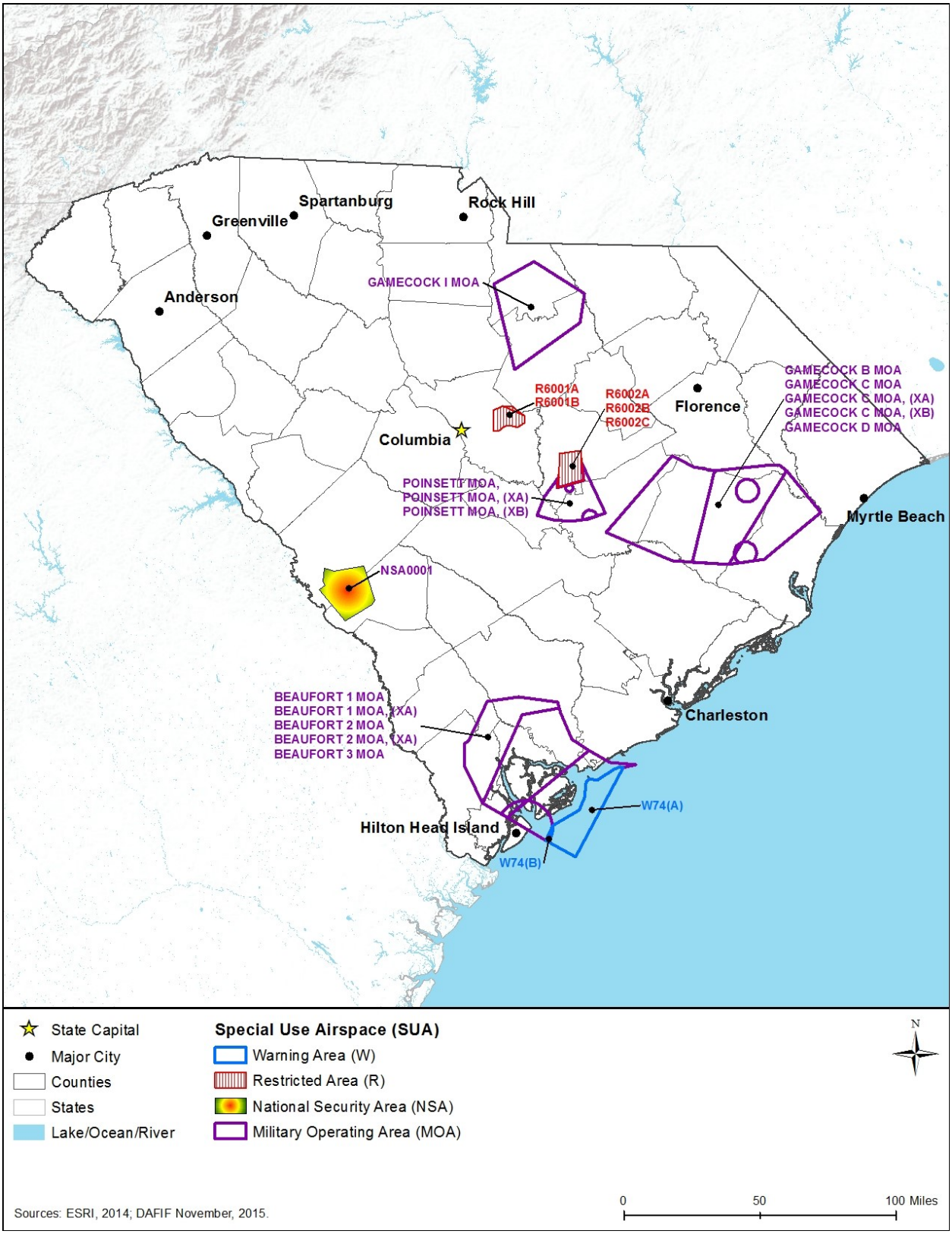


Figure 13.1.7-8: SUAs in South Carolina

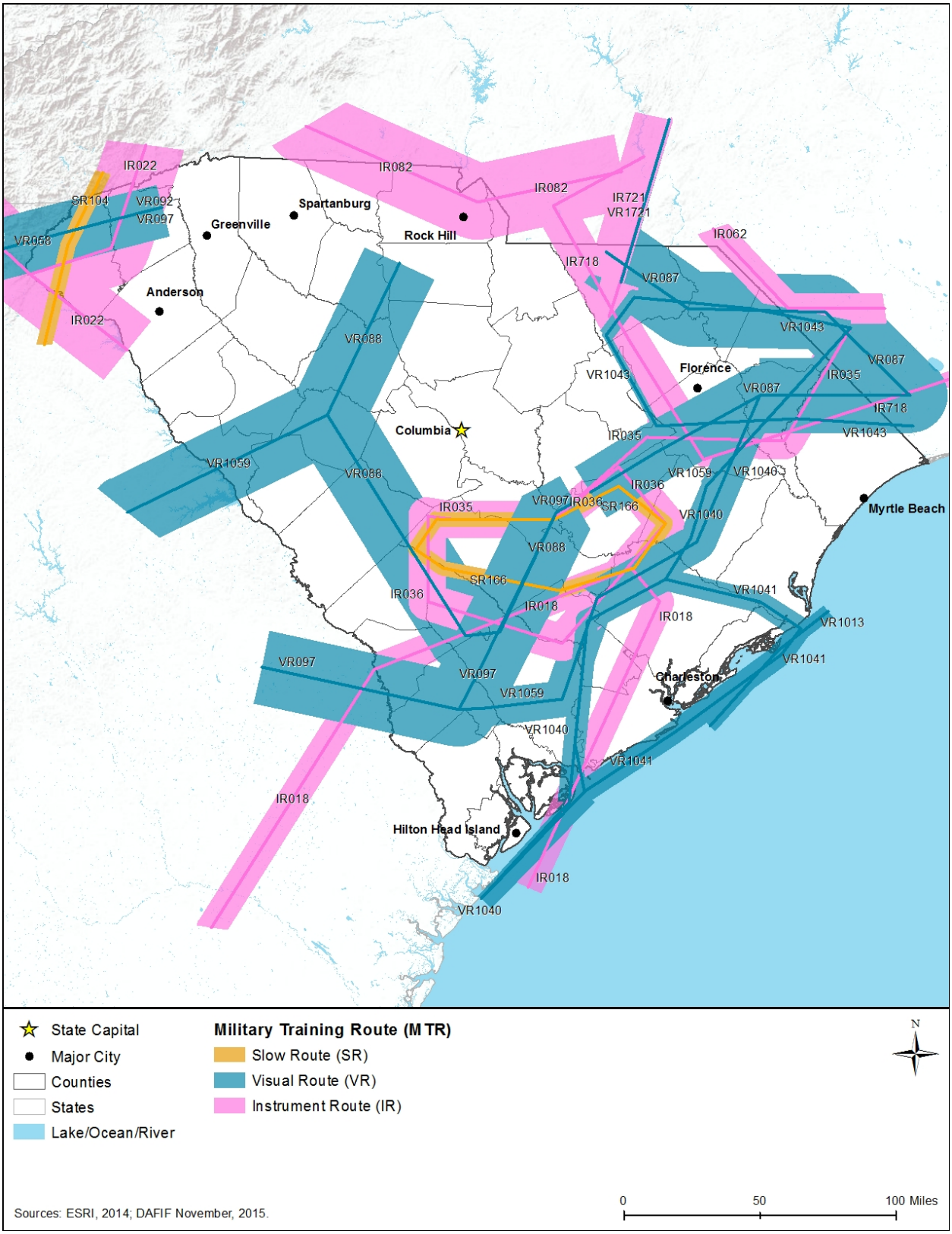


Figure 13.1.7-9: MTRs in South Carolina

Obstructions to Airspace Considerations

Several references in the South Carolina Code of Laws address airspace hazards. As defined in the South Carolina Code, Title 55, Chapter 9 South Carolina Airports Act (F), Section 55-9-250, an airport hazard "is a condition, occurrence or activity that endangers the lives and property of users of an airport and of occupants of land and other persons in its vicinity, and also, if of the obstruction type, in effect reduces the size of the area available for the landing, taking off and maneuvering of aircraft, thus tending to destroy or impair the utility of the airport and the public investment in it. (South Carolina Legislature, 2015) Section 55-9-300 through 55-9-340 of this chapter addresses zoning and regulation as it pertains to regulate structures affecting airspace within the State. (South Carolina Legislature, 2015)

13.1.8. Visual Resources

13.1.8.1. Definition of the Resource

Visual resources influence the human experience of a landscape. Various aspects combine to create visual resources, such as color, contrast, texture, line, and form. Features (e.g., mountain ranges, city skylines, ocean views, unique geological formations, rivers) and constructed landmarks (e.g., bridges, memorials, cultural resources, or statues) are considered visual resources. For some, cityscapes are valued visual resources, whereas others prefer natural areas. While many aspects of visual resources are subjective, evaluating potential impacts on the character and continuity of the landscape is a consideration when evaluating proposed actions for NEPA and NHPA compliance. The federal government does not have a definition of what constitutes a visual resource; therefore, this PEIS will use the general definition of visual resources used by the Bureau of Land Management, "the visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features)" (BLM, 1984).

13.1.8.2. Specific Regulatory Considerations

Table 13.1.8-1 presents state and local laws and regulations that relate to visual resources.

Table 13.1.8-1: Relevant South Carolina Visual Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Protection of State Owned or Leased Historic Properties, SC Code of Laws 60-12-10 thru 60-12-90	State Historic Preservation Office (SHPO)	Establishes a review process for projects involving historic properties owned or leased by the State of South Carolina that are listed in the National Register of Historic Places.
Department of Parks, Recreation and Tourism, SC Code of Laws 51-1-60 thru 51-1-90	Department of Parks, Recreation and Tourism	Establishes the duty of developing a coordinated plan to preserve the state's historical heritage by "acquiring and owning, recognizing, marking and publicizing areas, sites, buildings and other landmarks and items of national and statewide historical interest and significance to the history of our State."
Heritage Trust Program, SC Code of Laws 51-17-10 to 51-17-150	SCDNR	Creates the Heritage Trust program to inventory, evaluate, and protect the elements considered the most outstanding representatives of the state's natural and cultural heritage.

State Law/Regulation	Regulatory Agency	Applicability
South Carolina Local Government Comprehensive Planning Enabling Act, SC Code of Laws 6-29-310 thru 6-29-1640	Local Governments	Allows local governments to adopt zoning laws to protect historic properties and develop local government comprehensive plans, including the cultural resources element "which considers historic buildings and structures, commercial districts, residential districts, unique, natural, or scenic resources, archaeological, and other cultural resources."
Department of Natural Resources, SC Code of Laws Title 48, 49, and 50	SCDNR	Establishes the responsibilities of SCDNR to serve as the principal advocate for and steward of South Carolina's natural resources, including the state scenic rivers program.

In addition to the state laws and regulations, local zoning laws may apply related to visual resources. Viewsheds and scenic vistas are increasingly important to the state's towns, cities, and villages as they look at the future planning of their municipalities.

13.1.8.3. Character and Visual Quality of the Existing Landscape

South Carolina has a wide range of visual resources. There are many well-known historic cities in South Carolina, including Charleston, Beaufort, and Mount Pleasant. Although the urban areas of South Carolina frequently come to mind, the majority of the state is characterized as forested, agricultural, or undeveloped (Figure 13.1.7-1 in Section 13.1.7, Land Use, Recreation and Airspace).

South Carolina has four distinct regions: the Sea Islands, Atlantic Coastal Plain, Piedmont Plateau, and Blue Ridge Mountains. There are hundreds of islands along South Carolina's Atlantic coast, including Hilton Head Island and Kiawah Island. Over half of the state is flat coastal plains, with swamps near the coast and rivers throughout, including the Edisto, Great Pee Dee, Santee, and Savannah Rivers. The coastal plain also has sandy hills where it meets the Piedmont Plateau, where rolling hills have elevations around 1,000 feet above sea level. The Blue Ridge Mountains stretch across the northwestern edge of the state, with the highest point at Sassafras Mountain at 3,560 feet.

Forest and woodlands are the most prevalent visual resource in the state, occupying 58 percent of South Carolina's total land (Figure 13.1.7-1 in Section 13.1.7, Land Use, Recreation, and Air Space) (USGS, 2012b). Visual resources within forested areas are generally comprised of continuous, natural looking cover with gradual transitions of line and color. They are typically characterized by the lack of disturbance or disruption of the landscape. Agricultural lands are the second most dominant landscape in the state, with 16 percent of the total land area. These areas generally have some abrupt lines and colors between crops and pastures, few tall structures (aside from grain silos and some trees), and no urban development. Developed areas account for approximately 8 percent of the total land area (USGS, 2012b). One aspect of importance for visual resources is to maintain the character of the area. For example, in a farm community, keeping the character of the town consistent with farm-style houses, barns, and silos would be key in maintaining the character of the community. In a more metropolitan area, there may be many different visual styles within each neighborhood, but keeping the character of the neighborhood is important to maintain if new development were to occur.

While the state and many municipalities have some regulation of scenic and visual resources, not all scenic areas within the state have been identified or have policy or regulations for management or protection by the state. The areas listed below have some measure of management, significance, or protection through state or federal policy, as well as being identified as a visually significant area.

13.1.8.4. Visually Important Historic Properties and Cultural Resources

Visual and aesthetic qualities of historic properties can contribute to the overall importance of a particular site. Such qualities relate to the integrity of the appearance and setting of these properties or resources. Viewsheds (the natural and manmade environment visible from one or more viewing points) can also contribute to the significance of historic properties or cultural resources (NASA, 2013). Viewsheds containing historic properties and cultural resources may be considered important because of their presence in the landscape. Figure 13.1.8-1 shows areas that are included in the National Register of Historic Places (NRHP) that may be considered visually sensitive. In South Carolina, there are 1,511 NRHP listed sites, which include 76 National Historic Landmarks, 2 National Battlefields, 2 National Historic Sites, 1 National Monument, and over 170 historic districts. Some State Historic Sites, State Heritage Areas, and State Historic Districts may also be included in the NRHP, whereas others are not designated at this time.

The Secretary of the Interior's Standards for the Treatment of Historic Properties addresses four aspects: preservation, rehabilitation, restoration, and reconstruction, whereas *The Guidelines for the Treatment of Cultural Landscapes*, both authored by the NPS, provides guidance for applying protections to all aspects of the historic and cultural landscape, such as forests, gardens, trails, structures, ponds, and farming areas, to meet the Standards (NPS 1995). The Standards "require retention of the greatest amount of historic fabric, including the landscape's historic form, features, and details as they have evolved over time," which directly protects historic properties and the visual resources therein (NPS 1995).

National Heritage Areas

National Heritage Areas (NHAs) are "places where natural, cultural, and historic resources combine to form a cohesive, nationally important landscape" (NPS, 2011). These areas help tell the history of the United States. Based on this criteria, NHAs in South Carolina may contain scenic or aesthetic areas considered visual resources or visually sensitive. There are two NHAs in South Carolina: South Carolina National Heritage Corridor and Gullah/Geechee Cultural Heritage Corridor (Figure 13.1.8-1). The South Carolina National Heritage Corridor is 240 miles with four distinct regions between Charleston and the Blue Ridge Mountains, "that tell the story of the Old South - a story of plantations and cotton fields, kindred spirits and conflict, and hardships and prosperity" (NPS, 2015d). The Gullah/Geechee Cultural Heritage Corridor extends from Wilmington, North Carolina to St. Augustine, Florida and encompasses the areas of the southeast where descendants of West and Central African slaves amalgamated their African traditions with American culture (NPS, 2015e).

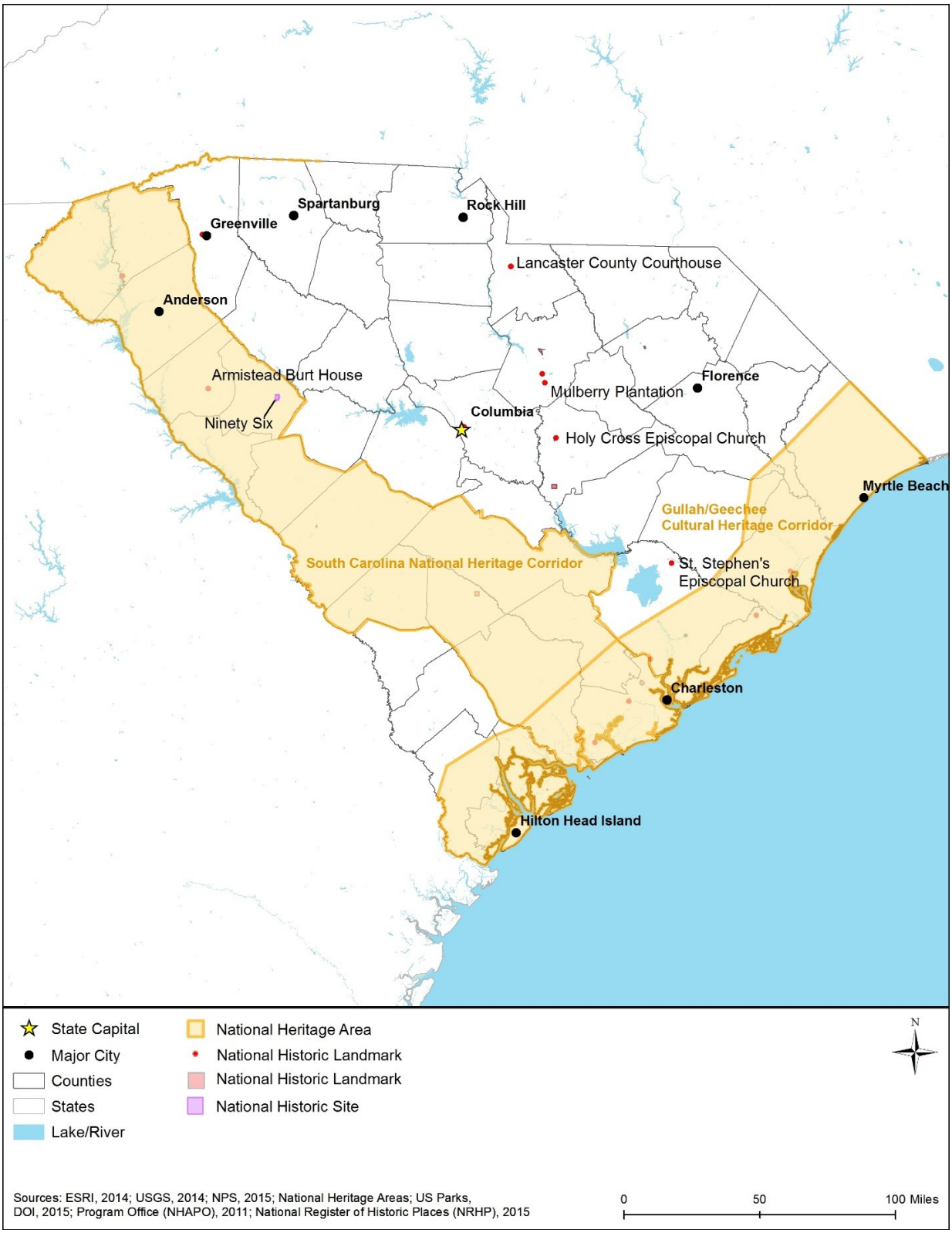


Figure 13.1.8-1: Representative Sample of Some Historic and Cultural Resources that May be Visually Sensitive

National Historic Landmarks

National Historic Landmarks (NHLs) are defined as "nationally significant historic places designated by the U.S. Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States" (NPS, 2015f). NHLs may include "historic buildings, sites, structures, objects, and districts" (NPS, 2016). Other types of historic properties include battlefields and canals. The importance of NHL-designated properties can be attributed to scenic or aesthetic qualities, among other attributes, that may be considered visual resources or visually sensitive at these sites. In South Carolina, there are 76 NHLs, including sites such as the Beaufort and Charleston Historic Districts, Fort Hill (John C. Calhoun House), South Carolina State House, and several churches and plantations (Figure 13.1.8-1) (NPS, 2015g). By comparison, there are over 2,500 NHLs in the United States, with approximately 3percent of these located in South Carolina (NPS, 2015o). Figure 13.1.8-1 provides a representative sample of some historic and cultural resources that may be visually sensitive.

National Battlefields

The general title national battlefield includes national battlefield, national battlefield park, national battlefield site, and national military park. South Carolina has one national battlefield park and one national military park, which are areas associated with American military history (NPS, 2003). Cowpens National Battlefield "commemorates the place where Daniel Morgan and his army turned the flanks of Banastre Tarleton's British Army" using the double envelopment military tactic (NPS, 2015h). Kings Mountain National Military Park preserves the site of an "important American victory during the Revolutionary War" (NPS, 2015h). These sites may contain aesthetic and scenic values associated with history and are identified on the map in Figure 13.1.8-1.

National Historic Sites and Historical Parks

South Carolina has two National Historic Sites and Historical Parks, which are preserved by the NPS to "commemorate persons, events, and activities important in the nation's history." (NPS, 2003). Parks are generally larger in size and complexity than sites (NPS, 2003). The two national historic sites (NHS) in South Carolina are Charles Pinckney NHS and Ninety Six NHS. Charles Pinckney was a principal author and signer of the United States Constitution and the site preserves his coastal plantation. The Ninety Six NHS marks the site of two Revolutionary War battles, Cherokee Indian land, and two towns and a trading post established by early settlers (NPS, 2015h). These sites may contain aesthetic and scenic values associated with history and are identified on the map in Figure 13.1.8-1.

National Monuments

South Carolina has one National Monument, which is "intended to preserve at least one nationally significant resource" (NPS, 2003). A national monument is usually smaller than a national park and lacks its diversity of attractions (NPS, 2003). Fort Sumter National Monument marks the site of the beginning of the Civil War on April 12, 1861, when the Confederate Army attacked this Federal fort (NPS, 2015h). These sites may contain aesthetic and scenic values associated with history and are identified on the map in Figure 13.1.8-1.

State Historic Sites and Parks

The South Carolina State Park Service manages 8 State Historic Sites and other special state parks that preserve the state's history in the Revolutionary and Civil Wars, historic homes and plantations, and American Indian and African American heritage. These sites may contain aesthetic and scenic values associated with history and are identified on the map in Figure 13.1.8-1 and Table 13.1.8-2.

Table 13.1.8-2: South Carolina State Historic Sites

Charles Towne Landing State Historic Site	Oconee Station
Colonial Dorchester	Redcliffe Plantation
Hampton Plantation	Rivers Bridge
Musgrove Mill	Rose Hill

Source: (South Carolina State Parks, 2015a)

13.1.8.5. Parks and Recreation Areas

U.S. National Park System

National Parks areas and National Forests, owned and managed by the NPS and the USFS respectively, contain natural, historic, cultural, visual, ecological, and recreational resources of significance to the nation and are maintained for the public's use. In South Carolina, there are 2 National Battlefields, 2 National Historic Sites, 2 National Heritage Areas, 1 National Monument, and 1 National Historic Trail (NPS, 2015h). Table 13.1.8-3 identifies the NPS units located in South Carolina.

Table 13.1.8-3: South Carolina National Park Service Areas

Charles Pinckney NHS	Kings Mountain National Military Park
Cowpens National Battlefield	Ninety Six NHS[a]
Gullah/Geechee Cultural Heritage Corridor	Overmountain Victory National Historic Trail
Fort Sumter National Monument	South Carolina National Heritage Corridor

[a] Also an NHL
Source: (NPS, 2015h)

Congaree National Park (Figure 13.1.8-2) is "the largest intact expanse of old growth bottomland hardwood forest remaining in the southeastern United States" (NPS, 2015i). The Congaree and Wateree Rivers flow through the park, supporting the biodiversity of this ecosystem.

National Forests

The USFS manages two National Forests in South Carolina (Figure 13.1.8-3).[109] The Francis Marion and Sumter National Forests are 629,000 acres in four ranger districts used for timber

[109] The natural areas data were retrieved from the Protected Areas Database of the United States (PAD-US), produced by USGS (http://gapanalysis.usgs.gov/padus/). This dataset categorizes lands across the U.S. by conservation, land management, planning, recreation, and ownership, as well as other uses. It is an extensive data set that contains large quantities of information relevant to the Proposed Action. The data was queried and further combined by the Primary Designation Type into classifications that fit the multiple types of land applicable for Natural Areas. For this map, recognizable symbols (e.g., varying shades of green for National Parks and Forests) were used as PAD-US does not have a standard symbolization for natural areas. The PADUS 1.3 geodatabase was downloaded in the summer of 2015, and used consistently throughout all these maps for each state and D.C.

and wood production, habitat for wildlife and fish, wilderness area management, and recreation (USFS, 2015c). The Savannah River Site is 170,000 acres of natural resources protected by the USFS and Department of Energy (DOE). DOE's Savannah River Site is not open to the public because it is an "industrial complex that processes and stores nuclear materials in support of national defense" (USFS, 2015d).

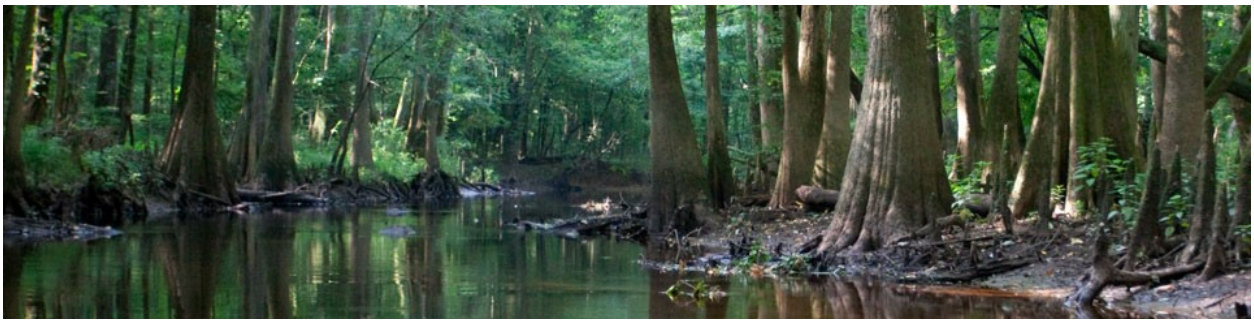


Figure 13.1.8-2: Congaree National Park

Source: (NPS, 2015i)

U.S. Army Corps of Engineers Recreation Areas

There are three U.S. Army Corps of Engineers (USACE) recreation areas within South Carolina, Hartwell Lake, J. Strom Thurmond Lake, and Richard B. Russell Lake (Figure 13.1.8-3) (USACE, 2015). These lakes are specifically managed by the USACE for scenic and aesthetic qualities in their planning guidance in addition to managing risks for floods (USACE, 1997).

Federal and State Trails

The National Trails System Act (16 USC 1241-1251, as amended) defines National Historic Trails as "extended trails which follow as closely as possible and practicable the original trails or routes of travel of national historic significance" (NPS, 2012a). There is one National Historic Trail in South Carolina. The Overmountain Victory National Historic Trail (Figure 13.1.8-3) stretches 330 miles through Virginia, Tennessee, North and South Carolina, with 87 miles of walkable pathways, and marks the route of the Kings Mountain campaign of 1780 (NPS, 2015h).

In addition to National Scenic and Historic Trails, the National Trails System Act authorized the designation of National Recreational Trails near urban areas by either the Secretaries of the Interior or Agriculture, depending upon the ownership of the designated land (American Trails, 2015). In South Carolina there are 17 National Recreation Trails administered by the NPS, USFS, local and state governments, and private and non-profit organizations (National Recreation Trails, 2015).

State Parks

State parks contain natural, historic, cultural, and/or recreational resources of significance to South Carolina residents and visitors. The South Carolina State Park Service manages 47 state parks in South Carolina, with over 80,000 acres of land, most of which contain scenic or aesthetic areas considered to be visual resources or visually sensitive (Figure 13.1.8-3) (South Carolina State Parks, 2015b).

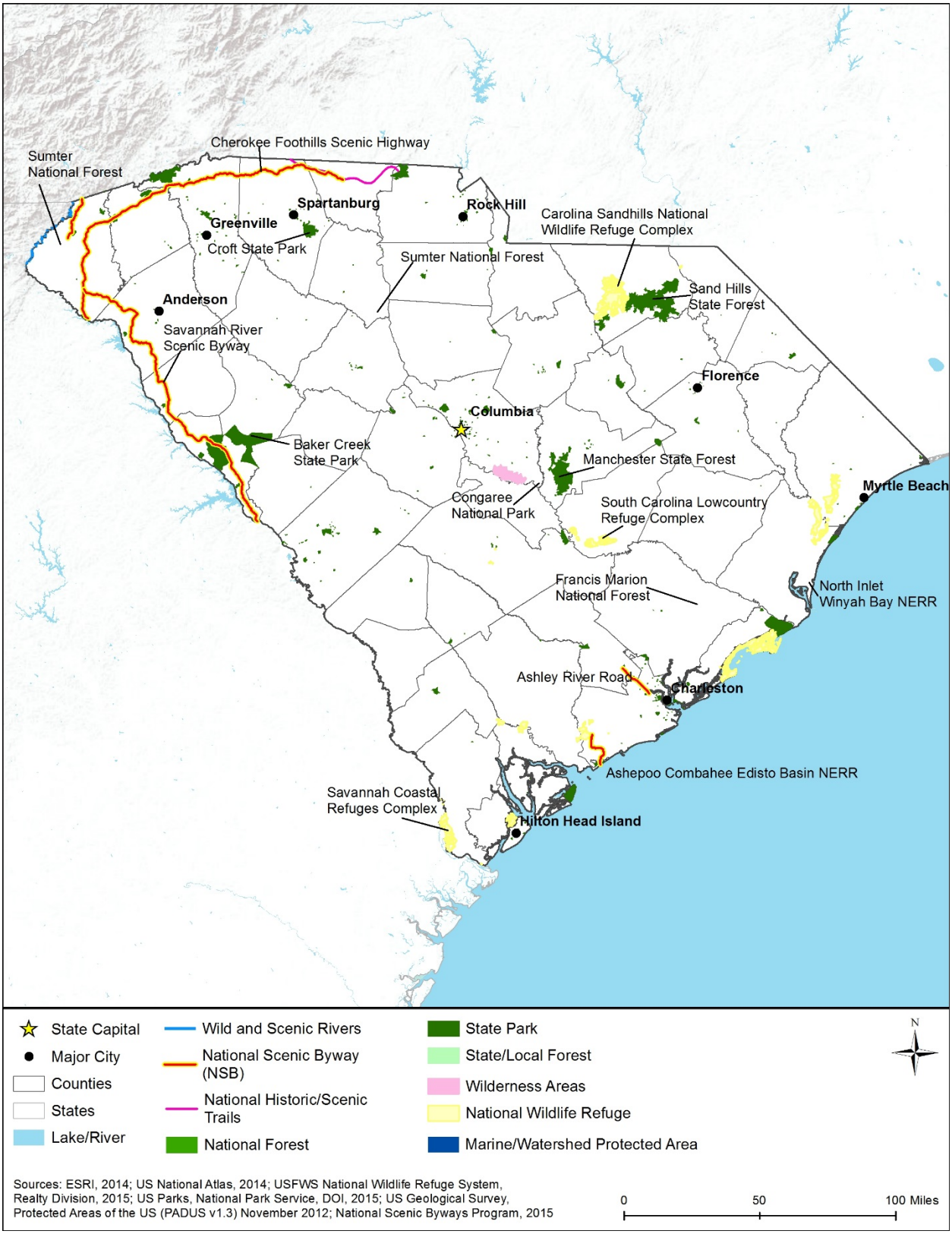


Figure 13.1.8-3: Natural Areas that May be Visually Sensitive

State Forests

The South Carolina Forestry Commission manages five state forests: Sand Hills (46,838 acres), Manchester (28,675 acres), Harbison (2,137 acres), Poe Creek (2,498 acres), and Wee Tee (12,403 acres) (Figure 13.1.8-3) (South Carolina Forestry Commission, 2015). The State Forest System maintains aesthetics and wildlife habitats for South Carolinians, and creates natural reserves. Visual resources other than a variety of tree species include wildlife habitats and lake and river vistas.

State Trails

The South Carolina Department of Parks, Recreation & Tourism manages the State Trails Program in partnership with public and private agencies and interested citizens (South Carolina State Trails Program, 2008). The program fosters a statewide network of trails and greenways, including national recreation, national forest, state park, and historic trail routes. These trails may contain aesthetic and scenic values associated with natural resources and history and are identified on the map in Figure 13.1.8-3.

13.1.8.6. Natural Areas

National Wilderness Areas

In 1964 Congress enacted the Wilderness Act of 1964 to "establish a National Wilderness Preservation System for the permanent good of the whole people" to provide "clean air, water, and habitat critical for rare and endangered plants and animals" (Wilderness.net, 2015a). This Act defined wilderness as land untouched by man and primarily affected only by the "forces of nature" and as that which "may also contain ecological, geological, or other features of scientific, education, scenic, or historical value" (Wilderness.net, 2015b). A designation as a National Wilderness Area is the highest level of conservation protection given by Congress to federal lands. Over 106 million acres of federal public lands have been designated as wilderness areas. Twenty-five percent of these federal lands are in 47 national parks (44 million acres) and part of the National Park System. Other designated wilderness areas are managed by the U.S. Forest Service, Bureau of Land Management, and U.S. Fish and Wildlife Service (NPS, 2015j).

South Carolina is home to 7 federally managed Wilderness Areas as shown in Table 13.1.8-4 and Figure 13.1.8-3 (Wilderness.net, 2015c).

Table 13.1.8-4: South Carolina National Wilderness Areas

Cape Romain Wilderness	Little Wambaw Swamp Wilderness
Congaree National Park Wilderness	Wambaw Creek Wilderness
Ellicott Rock Wilderness	Wambaw Swamp Wilderness
Hell Hole Bay Wilderness	

Source: (Wilderness.net, 2015c)

Rivers Designated as National or State Wild, Scenic or Recreational

National Wild, Scenic, or Recreational Rivers are those rivers designated by Congress or the Secretary of the Interior in accordance with the Wild and Scenic Rivers Act of 1968 (16 USC

1271-1287). These rivers have outstanding natural, cultural, and recreational values, including potential visual resources. A portion of only one river, the Chattooga River (41.9 miles), has been designated as wild and scenic (Figure 13.1.8-3) (National Wild and Scenic Rivers System, 2015b).

The SCDNR manages the Scenic Rivers program, which protects South Carolina's natural and cultural heritage of the state's rivers. The South Carolina Scenic Rivers Act of 1989 states that the program has the purpose of protecting "unique or outstanding scenic, recreational, geologic, botanical, fish, wildlife, historic or cultural values" of selected rivers or river segments in the state (SCDNR, 2015f). South Carolina has nine scenic rivers as shown in Figure 13.1.8-3 and Table 13.1.8-5.

Table 13.1.8-5: South Carolina State Scenic Rivers

Scenic River	Miles
Ashley River	24 miles
Black River	75 miles
Broad River	15 miles
Catawba River	30 miles
Great Pee Dee River	70 miles
Little Pee Dee River	14 miles
Little Pee Dee River of Dillon County	48 miles
Saluda River	10 miles
Middle Saluda River	5 miles
Lynches River	102 miles

Source: (SCDNR, 2015f)

National Wildlife Refuges

NWRs are a network of lands and waters managed by the USFWS. These lands and waters are "set aside for the conservation, management and, where appropriate, restoration of fish, wildlife, and plant resources and their habitats" (USFWS, 2015ax). There are eight NWRs in South Carolina as shown in Figure 13.1.8-3 and Table 13.1.8-6 (USFWS, 2015ay).

Cape Romain NWR (Figure 13.1.8-4) extends 22 miles along South Carolina's Atlantic coast and encompasses 66,306 acres of barrier islands, salt marshes, tidal creeks, long sandy beaches, and two lighthouses (USFWS, 2015au).

Table 13.1.8-6: South Carolina National Wildlife Refuges

Cape Romain NWR	Santee NWR
Carolina Sandhills NWR	Savannah NWR
Ernest F. Hollings ACE Basin NWR	Tybee NWR
Pinckney Island NWR	Waccamaw NWR

Source: (USFWS, 2015ay)

Figure 13.1.8-4: Cape Romain NWR

Source: (USFWS, 2015an)

State Wildlife Management Areas and Heritage Preserves

The SCDNR manages public lands through two distinct programs, the Heritage Trust Program and Wildlife Management Areas Program. The Heritage Trust Program was created to "conserve those natural features and cultural resources that are quickly disappearing as the state's population increases in size" (SCDNR, 2014k). More than 83,000 acres have been protected as Heritage Preserves. The Wildlife Management Area (WMA) Program provides hunting opportunities, as well as wildlife conservation and management. SCDNR manages over 50 WMAs in cooperation with private landowners and the U.S. Forest Service, covering over 1.1 million acres of land. For additional information on wildlife refuges and management areas, see Section 13.1.6.4., Wildlife.

National Natural Landmarks

NNLs are sites designated by the U.S. Secretary of the Interior that "contain outstanding biological and/or geological resources, regardless of land ownership, and are selected for their outstanding condition, illustrative value, rarity, diversity, and value to science and education" (NPS, 2014a). These landmarks may be considered visual resources or visually sensitive. There are 6 NNLs in South Carolina as shown in Table 13.1.8-7 and Figure 13.1.8-3 (NPS, 2012d). Flat Creek Natural Area and 40 Acre Rock (Figure 13.1.8-5) is located within the Forty Acre Rock Heritage Preserve, and "contains the largest remaining undisturbed granitic flat-rock outcrop in the Carolina Piedmont" (NPS, 2012b).

Table 13.1.8-7: South Carolina National Natural Landmarks

Congaree River Swamp	John de la Howe Forest
Flat Creek Natural Area and 40 Acre Rock	St. Phillips Island
Francis Beidler Forest	Stevens Creek Natural Area

Source: (NPS, 2012c)

Figure 13.1.8-5: Flat Creek Natural Area and 40 Acre Rock

Source: (NPS, 2012b)

13.1.8.7. Additional Areas

State and National Scenic Byways

National Scenic Byways are resources designated specifically for scenic or aesthetic areas or qualities which would be considered visual resources or visually sensitive. South Carolina has only four designated National Scenic Byways (see Figure 13.1.8-3 and Figure 13.1.7-1 in Section 13.1.7 Land Use, Recreation, and Airspace) (FHWA, 2015b) (FHWA, 2015c):

- Ashley River Road: 11 miles in southeast South Carolina. "The Ashley River Road passes by three national historic landmarks -- Saint Andrew's Episcopal Church, Drayton Hall, and Middleton Place -- as it traverses a National Register Historic District that traces the history of European and African settlement, commerce and industry from their colonial origins to the present."
- Cherokee Foothills Scenic Highway: 112 miles in northwest South Carolina. "Looming majestically beyond the low Piedmont hills, the Blue Ridge escarpment thrills the mountain lover's soul. The Cherokees called these heights the "Great Blue Hills of God." Following an ancient Cherokee path, this beautiful two-lane road arcs through peach orchards and villages, past Cowpens National Battlefield and over Lake Keowee."
- Edisto Island National Scenic Byway: 16.8 miles in southeast South Carolina. "For a variety of views from the sparkling waters of Edisto Bay to the green foliage native to the South, drive the Edisto Island Scenic Byway on SC 174."
- Savannah River Scenic Byway: 110 miles in western South Carolina. "The Savannah River Scenic Byway affords scenic views, glimpses of life in the rural South and opportunities to experience southern hospitality. Whether receiving a casual lesson on barbecue traditions, fishing tips or stories about the state's role in the Revolutionary and Civil Wars, you'll feel welcome."

Similar to National Scenic Byways, the South Carolina Department of Transportation administers South Carolina's state scenic byways in partnership with the South Carolina Scenic Highways Committee. There are 17 state scenic byways covering over 205 miles throughout

South Carolina as shown in Figure 13.1.8-3 and Table 13.1.8-8 (South Carolina Scenic Byways, 2015).

Table 13.1.8-8: South Carolina State Scenic Byways

Scenic Byway	Miles
Bohicket Road	10 miles
Cowpens National Battlefield	9 miles
Edisto Beach	3 miles
Falling Waters	13 miles
Fort Johnson Road	4.5 miles
Hilton Head	8 miles
Hilton Head Island	22 miles
Long Point Road	2 miles
Mathis Ferry Road	3 miles
May River	11 miles
McTeer Bridge & Causeways	3 miles
Old Sheldon Church Road	7 miles
Plantersville	12 miles
Riverland Drive	5 miles
SC 170	8 miles
US 21 (Sea Island)	19 miles
Western York	66 miles

Source: (South Carolina Scenic Byways, 2015)

13.1.9. Socioeconomics

13.1.9.1. Definition of the Resource

NEPA requires consideration of socioeconomics; specifically, Section 102(A) of NEPA requires federal agencies to "insure the integrated use of the natural and social sciences…in planning and in decision making" (42 USC § 4332(A)). Socioeconomics refers to a broad, social science-based approach to understanding a region's social and economic conditions. It typically includes population, demographic descriptors, economic activity indicators, housing characteristics, property values, and public revenues and expenditures (BLM, 2005). When applicable, it includes qualitative factors such as community cohesion. Socioeconomics provides important context for analysis of FirstNet projects, and in addition, FirstNet projects may affect the socioeconomic conditions of a region.

The choice of socioeconomic topics and depth of their treatment depends on the relevance of potential topics to the types of federal actions under consideration. FirstNet's mission is to provide public safety broadband and interoperable emergency communications coverage throughout the nation. Relevant socioeconomic topics include population density and growth, economic activity, housing, property values, and state and local taxes.

The financial arrangements for deployment and operation of the FirstNet network may have socioeconomic implications. Section 1.1 frames some of the public expenditure and public

revenue considerations specific to FirstNet; however, this is not intended to be either descriptive or prescriptive of FirstNet's financial model or anticipated total expenditures and revenues associated with the deployment of the Nationwide Public Safety Broadband Network (NPSBN). This socioeconomics section provides some additional, broad context, including data and discussion of state and local government revenue sources that FirstNet may affect.

Environmental justice is a related topic that specifically addresses the presence of minority populations (defined by race and Hispanic ethnicity) and low-income populations, in order to give special attention to potential impacts on those populations, per Executive Order 12898. This PEIS addresses environmental justice in a separate section (Section 13.1.10). This PEIS also addresses the following topics, sometimes included within socioeconomics, in separate sections: Land Use, Recreation and Airspace (Section 13.1.7), infrastructure (Section 13.1.1), and aesthetic considerations (Section 13.1.8).

Wherever possible, this section draws on nationwide datasets from federal sources such as the U.S. Census Bureau (Census Bureau) and U.S. Bureau of Labor Statistics (BLS). This ensures consistency of data and analyses across the states examined in this PEIS. In all cases, this section uses the most recent data available for each geography at the time of writing. At the county, state, region, and United States levels, the data are typically for 2013 or 2014. For smaller geographic areas, this section uses data from the Census Bureau's American Community Survey (ACS). The ACS is the Census Bureau's flagship demographic estimates program for years other than the decennial census years. This PEIS uses the 2009-2013 ACS, which are based on surveys (population samples) taken across that five-year period; thus, it is not appropriate to attribute its data values to a specific year. It is a valuable source because it provides the most accurate and consistent socioeconomic data across the nation at the sub-county level. (U.S. Census Bureau, 2016)[110]

[110] For U.S. Census Bureau sources, a URL (see references section) that begins with "http://factfinder.census.gov" indicates that the American FactFinder (AFF) interactive tool can be used to retrieve the original source data via the following procedure. If the reference's URL begins with "http://dataferrett.census.gov," significant socioeconomic expertise is required to navigate this interactive tool to the specific data. However, the data can usually be found using AFF. As of May 24, 2016, the AFF procedure is as follows: 1) Go to http://factfinder.census.gov. 2) Select "Advanced Search," then "Show Me All." 3) Select from "Topics" choices, select "Dataset," then select the dataset indicated in the reference; e.g., "American Community Survey, 2013 1-Year Estimates" or "2012 Census of Governments." Click "Close." Note: ACS is the abbreviation in the AFF for the American Community Survey. SF is the abbreviation used with the 2000 and 2010 "Summary Files." For references to the "2009-2013 5-Year Summary File," choose "2013 ACS 5-year estimates" in the AFF. 4) Click the "Geographies" box. Under "Select a geographic type," choose the appropriate type; e.g., "United States – 010" or "State – 040" or "..... County – 050" then select the desired area or areas of interest. Click "Add to Your Selections," then "Close." For Population Concentration data, select "Urban Area - 400" as the geographic type, then select 2010 under "Select a version" and then choose the desired area or areas. Alternatively, do not choose a version, and select "All Urban Areas within United States." Regional values cannot be viewed in the AFF because the regions for this PEIS do not match Census Bureau regions. All regional values were developed by downloading state data and using the most mathematically appropriate calculations (e.g., sums of state values, weighted averages, etc.) for the specific data. 5) In "Refine your search results," type the table number indicated in the reference; e.g., "DP04" or "LGF001." The dialogue box should auto-populate with the name of the table(s) to allow the user to select the table number/name. Click "Go." 6) In the resulting window, click the desired table under "Table, File, or Document Title" to view the results. If multiple geographies were selected, it is often easiest to view the data by clicking the "Download" button above the on-screen data table. Choose the desired comma-delimited format or presentation-ready format (includes a Microsoft Excel option). In some cases, the structure of the resulting file may be easier to work with under one format or another. Note that in most cases, the on-screen or downloaded data contains additional parameters besides those used in the FirstNet PEIS report table. Readers must locate the FirstNet PEIS-specific data within the Census Bureau tables. Additionally, the data contained in the FirstNet tables may incorporate data from multiple sources and may not be readily available in one table on the Census site.

The remainder of this section addresses the following subjects: regulatory considerations specific to socioeconomics in the state, communities and populations, economic activity, housing, property values, and taxes.

13.1.9.2. Specific Regulatory Considerations

Research for this section did not identify any specific state, local, or tribal laws or regulations that are directly relevant to socioeconomics for this PEIS.

13.1.9.3. Communities and Populations

This section discusses the population and major communities of South Carolina (SC) and it includes the following topics:

- Recent and projected statewide population growth,
- Current distribution of the population across the state, and
- Identification of the largest population concentrations in the state.

Statewide Population and Population Growth

Table 13.1.9-1 presents the 2014 population and population density of South Carolina in comparison to the South region[111] and the nation. The estimated population of South Carolina in 2014 was 4,832,482. The population density was 161 persons per square mile (sq. mi.), which was considerably higher than the population density of the region (114 persons/sq. mi.) and the nation (90 persons/sq. mi.). In 2014, South Carolina was the 24th largest state by population among the 50 states and the District of Columbia, 40th largest by land area, and had the 20th greatest population density. (U.S. Census Bureau, 2015d) (U.S. Census Bureau, 2015e)

Table 13.1.9-1: Land Area, Population, and Population Density of South Carolina

Geography	Land Area (sq. mi.)	Estimated Population 2014	Population Density 2014 (persons/sq. mi.)
South Carolina	30,109	4,832,482	154
South Region	914,471	104,109,977	114
United States	3,531,905	318,857,056	90

Sources: (U.S. Census Bureau, 2015d) (U.S. Census Bureau, 2015e)

Population growth is an important subject for this PEIS given FirstNet's mission. Table 13.1.9-2 presents the population growth trends of South Carolina from 2000 to 2014 in comparison to the South region and the nation. The state's annual growth decreased, from 1.43 percent to 1.10 percent, in the 2010 to 2014 period compared to 2000 to 2010. The growth rate of South Carolina in the 2010 to 2014 period was somewhat lower than the rate of the region (1.14 percent) and was considerably higher than the nation's rate (0.81 percent).

[111] The South region is comprised of the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas. Throughout the socioeconomics section, figures for the South region represent the sum of the values for all states in the region, or an average for the region based on summing the component parameters. For instance, the population density of the South region is the sum of the populations of all its states, divided by the sum of the land areas of all its states.

Table 13.1.9-2: Recent Population Growth of South Carolina

Geography	Population			Numerical Population Change		Rate of Population Change (AARC)[a]	
	2000	2010	2014 (estimated)	2000 to 2010	2010 to 2014	2000 to 2010	2010 to 2014
South Carolina	4,012,012	4,625,364	4,832,482	613,352	207,118	1.43%	1.10%
South Region	86,516,862	99,487,696	104,109,977	12,970,834	4,622,281	1.41%	1.14%
United States	281,421,906	308,745,538	318,857,056	27,323,632	10,111,518	0.93%	0.81%

Sources: (U.S. Census Bureau, 2015y) (U.S. Census Bureau, 2015d)

AARC = Average Annual Rate of Change (compound growth rate)

Demographers prepare future population projections using various population growth modeling methodologies. For this nationwide PEIS, it is important to use population projections that apply the same methodology across the nation. It is also useful to consider projections that use different methodologies, since no methodology is a perfect predictor of the future. The Census Bureau does not prepare population projections for the states. Therefore, Table 13.1.9-3 presents projections of the 2030 population from two sources that are national in scope and use different methodologies: the University of Virginia's Weldon Cooper Center for Public Service and ProximityOne, a private sector demographic and economic data and analysis service (ProximityOne, 2015) (University of Virginia Weldon Cooper Center, 2015). The table provides figures for numerical change, percentage change, and annual growth rate based on averaging the projections from the two sources. The average projection indicates South Carolina's population will increase by approximately 758,000 people, or 15.7 percent, from 2014 to 2030. This reflects an average annual projected growth rate of 0.91 percent, which is somewhat lower than the historical growth rate from 2010 to 2014 of 1.10 percent. The projected growth rate of the state is similar to that of the region (0.97 percent) and higher than the projected growth rate of the nation (0.80 percent).

Table 13.1.9-3: Projected Population Growth of South Carolina

Geography	Population 2014 (estimated)	Projected 2030 Population			Change Based on Average Projection		
		UVA Weldon Cooper Center Projection	Proximity One Projection	Average Projection	Numerical Change 2014 to 2030	Percent Change 2014 to 2030	Rate of Change (AARC)[a] 2014 to 2030
South Carolina	4,832,482	5,587,991	5,593,128	5,590,560	758,078	15.7%	0.91%
South Region	104,109,977	122,323,551	120,794,020	121,558,786	17,448,809	16.8%	0.97%
United States	318,857,056	360,978,449	363,686,916	362,332,683	43,475,627	13.6%	0.80%

Sources: (ProximityOne, 2015) (University of Virginia Weldon Cooper Center, 2015) (U.S. Census Bureau, 2015d)

[a] AARC = Average Annual Rate of Change (compound growth rate)

Population Distribution and Communities

Figure 13.1.9-1 presents the distribution and relative density of the population of South Carolina. Each brown dot represents 500 people, and massing of dots indicates areas of higher population

density – therefore, areas that are solid in color are particularly high in population density. The map uses ACS estimates based on samples taken from 2009 to 2013 (U.S. Census Bureau, 2015f). This map also presents the 10 largest population concentrations in the state, outlined in purple. These population concentrations reflect contiguous, densely developed areas as defined by the Census Bureau based on the 2010 census (U.S. Census Bureau, 2012) (U.S. Census Bureau, 2015g). These population concentrations often include multiple incorporated areas as well as some unincorporated areas.

Other groupings of brown dots on the map represent additional, but smaller, population concentrations. The map shows that South Carolina has several smaller population centers. Dispersed dots indicate dispersed population across the less densely settled areas of the state.

Table 13.1.9-4 provides the populations of the 10 largest population concentrations in South Carolina, based on the 2010 census. It also shows the changes in population for these areas between the 2000 and 2010 censuses.[112] In 2010, the two largest population concentrations were the Columbia and Charleston/North Charleston areas, which had 549,777 and 548,404 people, respectively. The state had no other population concentrations over 500,000. The smallest of these 10 population concentrations was the Anderson area, with a 2010 population of 75,702 people. The fastest growing area, by average annual rate of change from 2000 to 2010, was the South Carolina portion of the Myrtle Beach/Socastee area, with an annual growth rate of 4.72 percent. The Mauldin/Simpsonville and Rock Hill areas also had growth rates slightly over 4 percent. All but one of the areas (Anderson) experienced annual population growth rates over 1.0 percent during this period.

Table 13.1.9-4 also shows that the top 10 population concentrations in South Carolina accounted for over 51.2 percent of the state's population in 2010. Further, population growth in the 10 areas from 2000 to 2010 amounted to 95.1 percent of the entire state's growth.

Table 13.1.9-4: Population of the 10 Largest Population Concentrations in South Carolina

Area	Population				Population Change 2000 to 2010	
	2000	2010	2009–2013	Rank in 2010	Numerical Change	Rate (AARC) [a]
Anderson	70,436	75,702	77,366	10	5,266	0.72%
Augusta-Richmond County (GA/SC) (SC Portion)	85,581	103,504	105,073	8	17,923	1.92%
Charleston/North Charleston	423,410	548,404	567,077	2	124,994	2.62%
Columbia	420,537	549,777	558,210	1	129,240	2.72%
Florence	67,314	89,557	93,120	9	22,243	2.90%
Greenville	302,194	400,492	404,963	3	98,298	2.86%

[112] Census Bureau boundaries for these areas are not fixed. Area changes from 2000 to 2010 may include accretion of newly developed areas into the population concentration, Census Bureau classification of a subarea as no longer qualifying as a concentrated population due to population losses, and reclassification by the Census Bureau of a subarea into a different population concentration. Thus, population change from 2000 to 2010 reflects change within the constant area and change as the overall area boundary changes. Differences in boundaries in some cases introduce anomalies in comparing the 2000 and 2010 populations and in calculation of the growth rate presented in the table.

Area	Population				Population Change 2000 to 2010	
	2000	2010	2009–2013	Rank in 2010	Numerical Change	Rate (AARC) [a]
Mauldin/Simpsonville	77,831	120,577	124,583	6	42,746	4.47%
Myrtle Beach/Socastee (SC/NC) (SC Portion)	122,984	195,025	199,352	4	72,041	4.72%
Rock Hill	70,007	104,996	106,325	7	34,989	4.14%
Spartanburg	145,058	180,786	181,590	5	35,728	2.23%
Total for Top 10 Population Concentrations	**1,785,352**	**2,368,820**	**2,417,659**	**NA**	**583,468**	**2.87%**
South Carolina (statewide)	**4,012,012**	**4,625,364**	**4,679,602**	**NA**	**613,352**	**1.43%**
Top 10 Total as Percentage of State	**44.5%**	**51.2%**	**51.7%**	**NA**	**95.1%**	**NA**

Sources: (U.S. Census Bureau, 2012) (U.S. Census Bureau, 2015h) (U.S. Census Bureau, 2015i)
[a] AARC = Average Annual Rate of Change (compound growth rate)

13.1.9.4. Economic Activity, Housing, Property Values, and Government Revenues

This section addresses other socioeconomic topics that are potentially relevant to FirstNet. These topics include:

- Economic activity;
- Housing;
- Property values; and
- Government revenues.

Social institutions – educational, family, political, public service, military, and religious – are present throughout the state. The institutions most relevant to FirstNet projects are public services such as medical and EMS, and facilities. This PEIS addresses public services in Section 13.1.1, Infrastructure. Project-level NEPA analyses may need to examine other institutions, depending on specific locations and specific types of actions.

Economic Activity

Table 13.1.9-5 compares several economic indicators for South Carolina to the South region and the nation. The table presents two indicators of income[113] – per capita and median household – as income is a good measure of general economic health of a region.

[113] The Census Bureau defines income as follows: "'Total income' is the sum of the amounts reported separately for wage or salary income; net self-employment income; interest, dividends, or net rental or royalty income or income from estates and trusts; Social Security or Railroad Retirement income; Supplemental Security Income (SSI); public assistance or welfare payments; retirement, survivor, or disability pensions; and all other income. Receipts from the following sources are not included as income: capital gains, money received from the sale of property (unless the recipient was engaged in the business of selling such property); the value of income "in kind" from food stamps, public housing subsidies, medical care, employer contributions for individuals, etc.; withdrawal of bank deposits; money borrowed; tax refunds; exchange of money between relatives living in the same household; gifts and lump-sum inheritances, insurance payments, and other types of lump-sum receipts." (U.S. Census Bureau, 2015o)

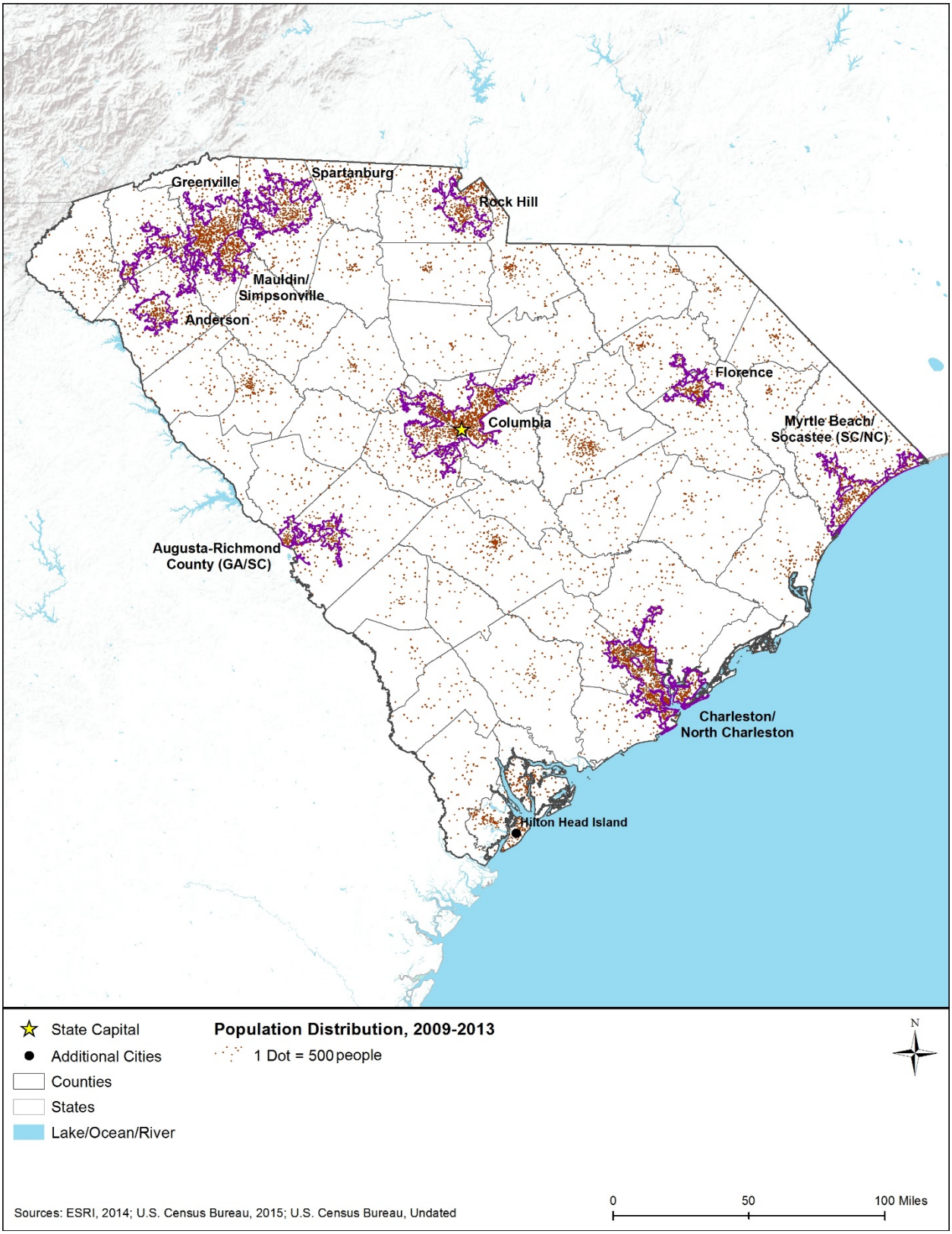


Figure 13.1.9-1: Population Distribution in South Carolina, 2009–2013

Per capita income is total income divided by the total population. As a mathematical average, the very high incomes of a relatively small number of people tend to bias per capita income figures upwards. Nonetheless, per capita income is useful as an indicator of the relative income level across two or more areas. As shown in Table 13.1.9-5, the per capita income in South Carolina in 2013 ($23,687) was $1,324 lower than that of the region ($25,011), and $4,497 lower than that of the nation ($28,184).

Household income is a useful measure, and often used instead of family income, because in modern society there are many single-person households and households composed of non-related individuals. Median household income (MHI) is the income at which half of all households have higher income, and half have lower income. Table 13.1.9-5 shows that in 2013, the MHI in South Carolina ($44,310) was $2,252 lower than that of the region ($46,562), and 7,940 lower that of the nation ($52,250).

Employment status is a key socioeconomic parameter because employment is essential to the income of a large portion of the adult population. The federal government calculates the unemployment rate as the number of unemployed individuals who are looking for work divided by the total number of individuals in the labor force. Table 13.1.9-5 compares the unemployment rate in South Carolina to the South region and the nation. In 2014, South Carolina's statewide unemployment rate of 6.4 percent was slightly higher than the rate for the region (6.1 percent) and the nation (6.2 percent).[114]

Table 13.1.9-5: Selected Economic Indicators for South Carolina

Geography	Per Capita Income 2013	Median Household Income 2013	Average Annual Unemployment Rate 2014
South Carolina	$23,687	$44,163	6.4%
South Region	$25,011	$46,562	6.1%
United States	$28,184	$52,250	6.2%

Sources: (BLS, 2015a) (U.S. Census Bureau, 2015j) (U.S. Census Bureau, 2015k) (U.S. Census Bureau, 2015l)

Figure 13.1.9-2 and Figure 13.1.9-3 show how MHI in 2013 (U.S. Census Bureau, 2015j) and unemployment in 2014 (BLS, 2015a) varied by county across the state. These maps also incorporate the same population concentration data as Figure 13.1.9-1 (U.S. Census Bureau, 2012) (U.S. Census Bureau, 2015g). Following these two maps, Table 13.1.9-6 presents MHI and unemployment for the 10 largest population concentrations in the state. The table reflects survey data taken from 2009 to 2013. Thus, its figures are not directly comparable to those on the maps. Nonetheless, both the maps and the table help portray differences in income and unemployment across South Carolina.

Figure 13.1.9-2 shows that the majority of counties in South Carolina had MHI levels below the national average. Only a few counties, located around the Columbia, Charleston/North Charleston, Hilton Head, and Rock Hill areas, had MHI levels above the national average. Table

[114] The timeframe for unemployment rates can change quarterly.

13.1.9-6 shows that MHI levels in the 10 population concentrations ranged from $36,989 in the Anderson area to $66,528 in the Mauldin/Simpsonville area. Five areas had MHI above the state average ($44,779) and five had MHI below that level.

Figure 13.1.9-3 presents variations in the 2014 unemployment rate across the state, by county. It shows that counties with unemployment rates below the national average (that is, better employment performance) were distributed around the Columbia, Charleston/North Charleston, Hilton Head, Greenville, and Anderson areas. The highest unemployment rates were generally in the counties located in the central portions of the state. Table 13.1.9-6 shows that 2009–2013 unemployment rates varied across the 10 areas. Only two areas (Anderson and Florence) had unemployment rates that exceeded the state average (11.4 percent). This indicates that unemployment in South Carolina generally was higher outside the top population concentrations than within them. Note that the lowest and highest unemployment rates were in the same two areas that had the highest and lowest median household incomes, respectively, as described in the previous paragraph.

Detailed employment data provides useful insights into the nature of a local, state, or national economy. Table 13.1.9-7 provides figures on employment percentages by type of worker and by industry based on surveys conducted in 2013 by the Census Bureau. By class of worker (type of worker: private industry, government, self-employed, etc.), the percentage of private wage and salary workers in South Carolina was slightly lower than the percentage for the South region and the nation. The percentage of government workers was higher than the percentages for the region and the nation. The percentage of self-employed workers was slightly lower than the percentages for the region and the nation.

By industry, South Carolina has a mixed economic base and some notable figures in the table are as follows. South Carolina in 2013 had a considerably higher percentage of persons working in “manufacturing” than did the region and nation. The state had a somewhat higher percentage of persons working in “arts, entertainment, and recreation, and accommodation and food services” than did the region and nation. It had a somewhat lower percentage of persons working in “professional, scientific, management, administrative, and waste management services” than did the region and nation. It also had a lower percentage of workers in “agriculture, forestry, fishing and hunting, and mining” than the region or nation. The percentages for the remaining industries were within one percentage point of the regional and national values.

Table 13.1.9-6: Selected Economic Indicators for the 10 Largest Population Concentrations in South Carolina, 2009–2013

Area	Median Household Income	Average Annual Unemployment Rate
Anderson	$36,989	12.8%
Augusta-Richmond County (GA/SC) (SC Portion)	$45,770	10.6%
Charleston/North Charleston	$52,725	10.1%
Columbia	$51,212	10.1%
Florence	$43,104	12.3%

Area	Median Household Income	Average Annual Unemployment Rate
Greenville	$42,280	10.2%
Mauldin/Simpsonville	$66,528	7.8%
Myrtle Beach/Socastee (SC/NC) (SC Portion)	$43,058	11.1%
Rock Hill	$47,806	11.2%
Spartanburg	$42,453	10.3%
South Carolina (statewide)	$44,779	11.4%

Source: (U.S. Census Bureau, 2015m)

Table 13.1.9-7: Employment by Class of Worker and by Industry, 2013

Class of Worker and Industry	South Carolina	South Region	United States
Civilian Employed Population 16 Years and Over	2,080,718	45,145,155	145,128,676
Percentage by Class of Worker			
Private wage and salary workers	78.6%	79.4%	79.7%
Government workers	16.1%	14.5%	14.1%
Self-employed in own not incorporated business workers	5.1%	5.9%	6.0%
Unpaid family workers	0.1%	0.2%	0.2%
Percentage by Industry			
Agriculture, forestry, fishing and hunting, and mining	1.0%	2.4%	2.0%
Construction	6.1%	6.9%	6.2%
Manufacturing	13.7%	9.9%	10.5%
Wholesale trade	2.5%	2.8%	2.7%
Retail trade	11.9%	12.1%	11.6%
Transportation and warehousing, and utilities	4.4%	5.2%	4.9%
Information	2.0%	1.9%	2.1%
Finance and insurance, and real estate and rental and leasing	5.7%	6.3%	6.6%
Professional, scientific, management, administrative, and waste management services	9.5%	10.5%	11.1%
Educational services, and health care and social assistance	22.0%	22.0%	23.0%
Arts, entertainment, and recreation, and accommodation and food services	11.3%	9.9%	9.7%
Other services, except public administration	5.3%	5.2%	5.0%
Public administration	4.7%	4.8%	4.7%

Source: (U.S. Census Bureau, 2015n)

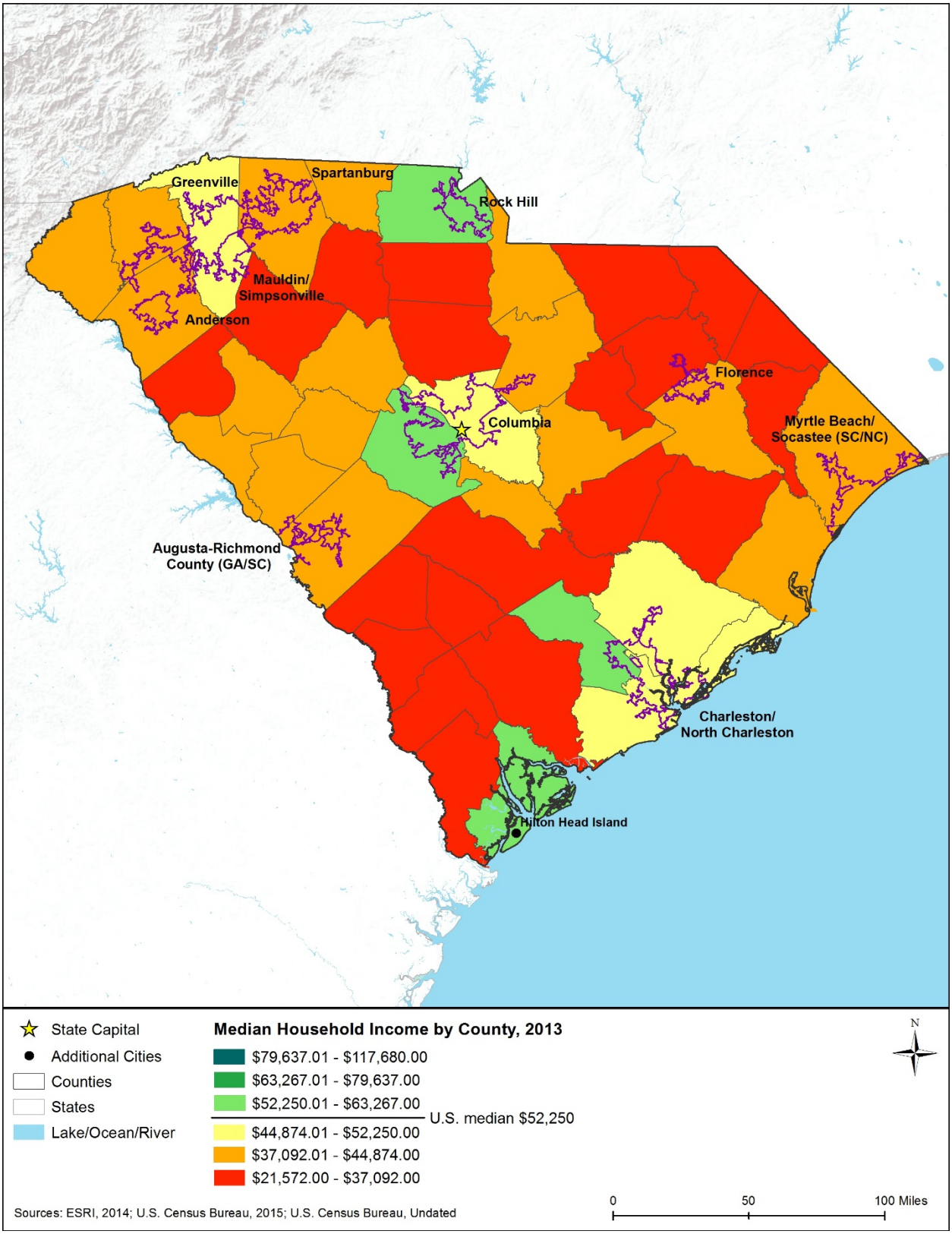


Figure 13.1.9-2: Median Household Income in South Carolina, by County, 2013

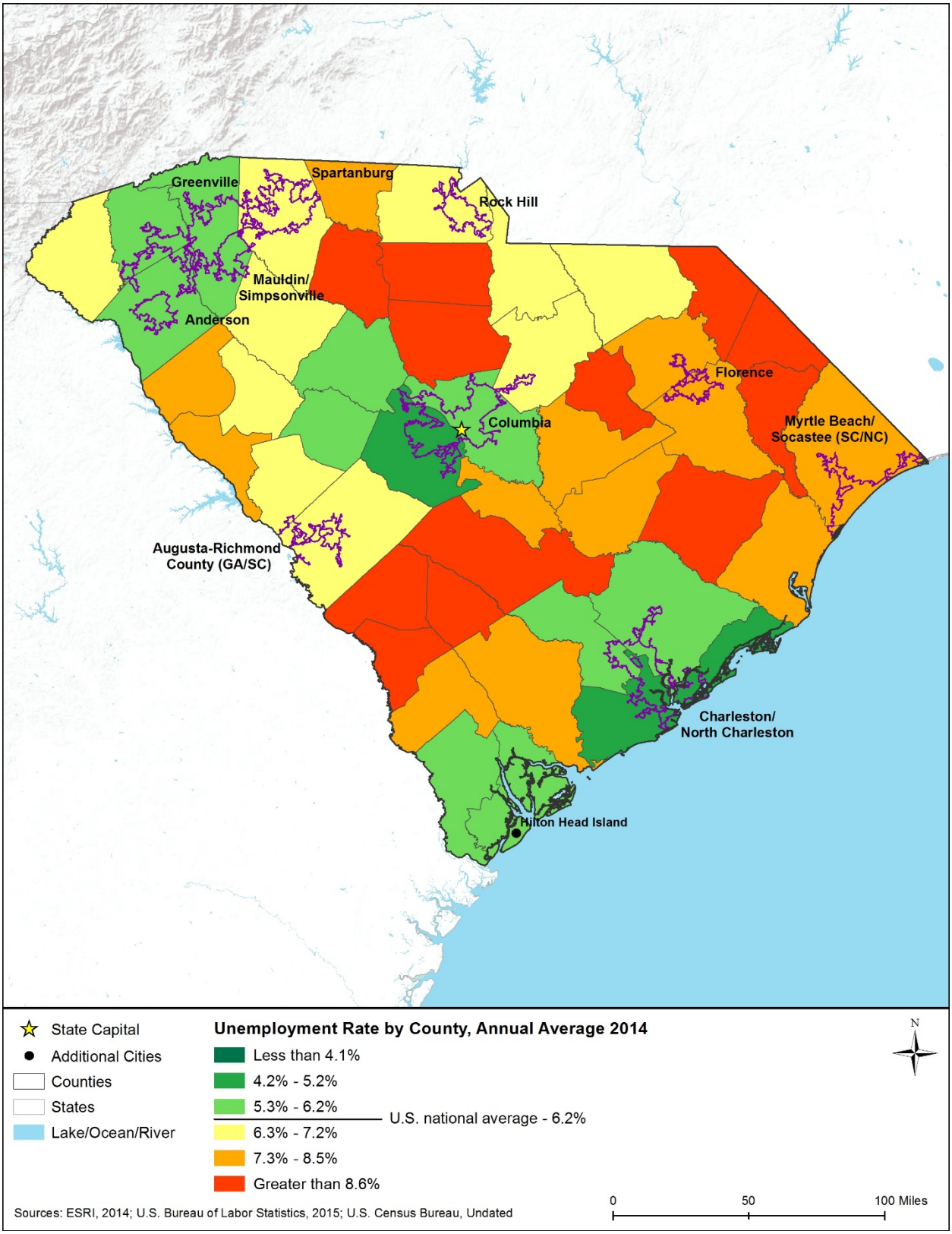


Figure 13.1.9-3: Unemployment Rates in South Carolina, by County, 2014

Table 13.1.9-8 presents employment shares for selected industries for the 10 largest population concentrations in the state. The table reflects survey data taken by the Census Bureau from 2009 to 2013. Thus, its figures for the state are slightly different from those in Table 13.1.9-7 for 2013.

Table 13.1.9-8: Employment by Selected Industries for the 10 Largest Population Concentrations in South Carolina, 2009–2013

Area	Construction	Transportation and Warehousing, and Utilities	Information	Professional, Scientific, Management, Administrative and Waste Management Services
Anderson	5.7%	3.2%	1.6%	7.7%
Augusta-Richmond County (GA/SC) (SC Portion)	6.1%	5.4%	1.9%	12.0%
Charleston/North Charleston	6.7%	4.8%	2.2%	12.3%
Columbia	5.0%	4.0%	2.2%	10.1%
Florence	3.5%	4.4%	1.4%	8.7%
Greenville	7.3%	3.6%	1.9%	10.3%
Mauldin/Simpsonville	4.9%	3.5%	1.7%	12.7%
Myrtle Beach/Socastee (SC/NC) (SC Portion)	7.9%	2.4%	1.5%	10.0%
Rock Hill	6.0%	5.2%	2.3%	9.2%
Spartanburg	4.6%	3.9%	1.8%	8.2%
South Carolina (statewide)	6.6%	4.6%	1.8%	9.5%

Source: (U.S. Census Bureau, 2015m)

Housing

The housing stock is an important socioeconomic component of communities. The type, availability, and cost of housing in an area reflect economic conditions and affect quality of life. Table 13.1.9-9 compares South Carolina to the South region and nation on several common housing indicators.

As shown in Table 13.1.9-9, in 2013, South Carolina had a slightly lower percentage of housing units that were occupied (83.1 percent) than the region (85.2 percent) or nation (87.6 percent). Of the occupied units, South Carolina had a higher percentage of owner-occupied units (68.2 percent) than the region (64.6 percent) and the nation (63.5 percent). The percentage of detached single-unit housing (also known as single-family homes) in 2013 (62.5 percent) was lower in South Carolina than in the region (63.8 percent) and somewhat higher than in the nation (61.5 percent). The homeowner vacancy rate in South Carolina (2.2 percent) matched the rate for the region and was slightly higher than the nation's rate (1.9 percent). This rate reflects "vacant units that are 'for sale only'" (U.S. Census Bureau, 2015o). The vacancy rate among rental units was higher in South Carolina (10.5 percent) than in the region (8.5 percent) and the nation (6.5 percent).

Table 13.1.9-9: Selected Housing Indicators for South Carolina, 2013

Geography	Total Housing Units	Housing Occupancy & Tenure				Units in Structure
		Occupied Housing	Owner-Occupied	Homeowner Vacancy Rate	Rental Vacancy Rate	1-Unit, Detached
South Carolina	2,158,784	83.1%	68.2%	2.2%	10.5%	62.5%
South Region	44,126,724	85.2%	64.6%	2.2%	8.5%	63.8%
United States	132,808,137	87.6%	63.5%	1.9%	6.5%	61.5%

Source: (U.S. Census Bureau, 2015p)

Table 13.1.9-10 provides housing indicators for the largest population concentrations in the state by survey data taken from 2009 to 2013. Thus, its figures are not directly comparable to the more recent data in the previous table. However, it does present variation in these indicators for population concentrations across the state and compared to the state average for the 2009 to 2013 period.

Table 13.1.9-10: Selected Housing Indicators for the 10 Largest Population Concentrations in South Carolina, 2009–2013.

Area	Total Housing Units	Housing Occupancy & Tenure				Units in Structure
		Occupied Housing	Owner-Occupied	Homeowner Vacancy Rate	Rental Vacancy Rate	1-Unit, Detached
Anderson	35,335	87.1%	63.1%	3.0%	9.9%	67.3%
Augusta-Richmond County (GA/SC) (SC Portion)	46,968	88.7%	69.2%	1.8%	5.7%	69.0%
Charleston/North Charleston	245,362	88.2%	61.7%	3.1%	11.3%	60.6%
Columbia	235,948	89.5%	63.9%	2.7%	9.5%	66.3%
Florence	40,699	88.0%	62.0%	2.7%	9.5%	66.2%
Greenville	175,620	88.3%	61.8%	3.0%	8.4%	63.7%
Mauldin/Simpsonville	48,758	93.1%	76.4%	1.9%	8.1%	75.6%
Myrtle Beach/Socastee (SC/NC) (SC Portion)	153,254	55.7%	66.7%	4.1%	41.3%	42.1%
Rock Hill	44,978	90.3%	63.8%	2.0%	6.9%	65.9%
Spartanburg	79,061	87.4%	65.7%	3.5%	12.0%	68.2%
South Carolina (statewide)	2,143,464	83.1%	69.1%	2.6%	12.2%	62.3%

Source: (U.S. Census Bureau, 2015q)

Property Values

Property values have important relationships to both the wealth and affordability of communities. Table 13.1.9-11 provides indicators of residential property values for South Carolina and compares these values to values for the South region and nation. The figures on

median value of owner-occupied units are from the Census Bureau's ACS, based on owner estimates of how much their property (housing unit and land) would sell for if it were for sale (U.S. Census Bureau, 2015o).

The table shows that the median value of owner-occupied units in South Carolina in 2013 ($139,200) was higher than the corresponding values for the South region ($137,752) and considerably lower than the nation's value ($173,900).

Table 13.1.9-11: Residential Property Values in South Carolina, 2013

Geography	Median Value of Owner-Occupied Units
South Carolina	$139,200
South Region	$137,752
United States	$173,900

Source: (U.S. Census Bureau, 2015p)

Table 13.1.9-12 presents residential property values for the largest population concentrations in the state. The table reflects survey data taken from 2009 to 2013. Thus, its figures are not directly comparable to the more recent data in the previous table. However, it does show variation in property values for population concentrations across the state and compared to the state average for the 2009 to 2013 period. The median property value for these 10 communities ranged from $123,200 in the Anderson area to $191,500 in the Charleston/North Charleston area; the statewide value was $137,400. The lowest property value was in the area – Anderson – that had the lowest median household income (Table 13.1.9-6).

Table 13.1.9-12: Residential Property Values for the 10 Largest Population Concentrations in South Carolina, 2009–2013

Area	Median Value of Owner-Occupied Units
Anderson	$123,200
Augusta-Richmond County (GA/SC) (SC Portion)	$134,300
Charleston/North Charleston	$191,500
Columbia	$148,400
Florence	$129,900
Greenville	$140,000
Mauldin/Simpsonville	$172,600
Myrtle Beach/Socastee (SC/NC) (SC Portion)	$170,600
Rock Hill	$147,900
Spartanburg	$123,300
South Carolina (statewide)	$137,400

Source: (U.S. Census Bureau, 2015q)

Government Revenues

State and local governments obtain revenues from many sources. FirstNet projects may affect flows of revenue sources between different levels of government due to program financing and

intergovernmental agreements for system development and operation. Public utility taxes are a subcategory of selective sales taxes that includes taxes on providers of land and mobile telephone, telegraph, cable, and internet services (U.S. Census Bureau, 2006). These service providers may obtain new taxable revenues from operation of components of the public safety broadband network. These revenue streams are typically highly localized and therefore are best considered in the deployment phase of FirstNet.

Table 13.1.9-13 presents total and selected state and local government revenue sources as reported by the Census Bureau's 2012 Census of Governments. It provides both total dollar figures (in millions of dollars) and figures per capita (in dollars), based on total population for each geography. The per capita figures are particularly useful in comparing the importance of certain revenue sources in the state relative to other states in the region and the nation. State and local governments may obtain some additional revenues related to telecommunications infrastructure. General and selective sales taxes may change, reflecting expenditures during system development and maintenance.

Table 13.1.9-13 shows that the state government in South Carolina received more total revenue in 2012 on a per capita basis than its counterpart governments in the region, but less than its counterpart governments in the nation. South Carolina local governments received less total revenue per capita in 2012 than their counterparts in the region and the nation. South Carolina state and local governments had lower levels per capita of intergovernmental revenues[115] from the federal government than their counterparts in the region and nation. The state government in South Carolina obtained minimal revenue from property taxes. Local governments in South Carolina obtained lower levels of property taxes, per capita, than local governments in the region and nation. State and local governments in South Carolina reported lower revenue from general sales taxes than their counterparts in the region and nation. State and local governments in South Carolina also reported lower revenue from selective sales taxes, and public utilities taxes specifically, than their counterparts in the region and nation. Individual income tax revenue, on a per capita basis, was higher for the South Carolina state government than for its counterpart governments in the region, and lower when compared to counterpart governments in the nation. The state government in South Carolina reported lower levels of corporate income tax revenues, on a per capita basis, than its counterparts in the region and nation. Local governments in South Carolina reported no revenue from individual or corporate income taxes.

Table 13.1.9-13: State and Local Government Revenues, Selected Sources, 2012

Type of Revenue	South Carolina		Region		United States	
	State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount
Total Revenue ($M)	$26,106	$19,364	$524,374	$449,683	$1,907,027	$1,615,194
Per capita	$5,527	$4,099	$5,148	$4,414	$6,075	$5,145
Intergovernmental from Federal ($M)	$6,893	$440	$160,706	$18,171	$514,139	$70,360

[115] Intergovernmental revenues are those revenues received by one level of government from another level of government, such as shared taxes, grants, or loans and advances (U.S. Census Bureau, 2006).

Type of Revenue	South Carolina		Region		United States	
	State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount
Per capita	$1,459	$93	$1,578	$178	$1,638	$224
Intergovernmental from State ($M)	$0	$4,853	$0	$115,088	$0	$469,147
Per capita	$0	$1,027	$0	$1,130	$0	$1,495
Intergovernmental from Local ($M)	$434	$0	$2,815	$0	$19,518	$0
Per capita	$92	$0	$28	$0	$62	$0
Property Taxes ($M)	$9	$4,874	$2,073	$109,687	$13,111	$432,989
Per capita	$2	$1,032	$20	$1,077	$42	$1,379
General Sales Taxes ($M)	$2,926	$374	$82,651	$25,836	$245,446	$69,350
Per capita	$619	$79	$811	$254	$782	$221
Selective Sales Taxes ($M)	$1,272	$279	$41,447	$9,394	$133,098	$28,553
Per capita	$269	$59	$407	$92	$424	$91
Public Utilities Taxes ($M)	$46	$70	$5,101	$4,745	$14,564	$14,105
Per capita	$10	$15	$50	$47	$46	$45
Individual Income Taxes ($M)	$3,097	$0	$38,637	$1,226	$280,693	$26,642
Per capita	$656	$0	$379	$12	$894	$85
Corporate Income Taxes ($M)	$253	$0	$8,099	$114	$41,821	$7,210
Per capita	$54	$0	$80	$1	$133	$23

Sources: (U.S. Census Bureau, 2015r) (U.S. Census Bureau, 2015s)

Note: This table does not include all sources of government revenue. Summation of the specific source rows does not equal total revenue.

13.1.10. Environmental Justice

13.1.10.1. Definition of the Resource

EO 12898,[116] *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, issued in 1994, sets out principles of environmental justice and requirements that federal agencies should follow to comply with the EO. The fundamental principle of environmental justice as stated in the EO is, "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (USEPA, 2016e). Under the EO, each federal agency must "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Executive Office of the President, 1994). In response to the EO, the Department of Commerce developed an Environmental Justice Strategy in 1995, and published an updated strategy in 2013 (DOC, 2013).

In 1997, the Council on Environmental Quality (CEQ) issued *Environmental Justice: Guidance under the National Environmental Policy Act (NEPA)* to assist federal agencies in meeting the

[116] See https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice.

requirements of the EO (CEQ, 1997). Additionally, the USEPA's Office of Environmental Justice (USEPA, 2015a) offers guidance on Environmental Justice issues and provides an "environmental justice screening and mapping tool," EJSCREEN (USEPA, 2015f).

The CEQ guidance provides several important definitions and clarifications that this PEIS utilizes:

- Minority populations consist of "Individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic";
- Low-income populations consist of individuals living in poverty, as defined by the U.S. Census Bureau (Census Bureau); and
- Environmental effects include social and economic effects. Specifically, "Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment" (CEQ, 1997).

13.1.10.2. Specific Regulatory Considerations

The South Carolina legislature passed House Bill 3933 (SC Legislature, 2016) in June 2007 to form an environmental justice advisory committee to the DHEC (South Carolina Environmental Justice Advisory Committee, 2009). The Advisory Committee, consisting of three (3) universities and 13 state agencies, was established and tasked with "identifying existing practices at state agencies regarding environmental justice issues, which affect economic development and revitalization projects in this state, and to make recommendations" (South Carolina Environmental Justice Advisory Committee, 2009).

The Advisory Committee adopted a new definition of environmental justice for the state:

> Environmental Justice is defined within South Carolina as the fair treatment and meaningful involvement of people of all races, cultures, and income with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations and policies in working toward increasing prosperity of all South Carolinians (South Carolina Environmental Justice Advisory Committee, 2009).

The Committee created the "South Carolina Environmental Justice Revitalization Commission, and established four subcommittees (i.e., Health, Revitalization and Reuse, Policy, and Education and Awareness) to have discussions and make recommendations. The South Carolina Environmental Justice Advisory Committee provided a Final Report in December 2009, which included reports and recommendations from the four subcommittees. The Policy Subcommittee prepared a Draft Environmental Justice Policy (also included in the final report) for state agencies to refer to when assisting citizens and communities in addressing environmental justice issues and concerns. (South Carolina Environmental Justice Advisory Committee, 2009)

13.1.10.3. Environmental Setting: Minority and Low-Income Populations

Table 13.1.10-1 presents 2013 data on the composition of South Carolina's population by race and by Hispanic origin. The state's population has a considerably higher percentage of individuals who identify as Black/African American (27.6 percent) than the populations of the South region (18.4 percent) and the nation (12.6 percent). The state's population has lower percentages of individuals who identify as Asian (1.4 percent), or Some Other Race (1.5 percent) than the populations of the South region and the nation. Those percentages are, for Asian, 2.6 percent for the South region and 5.1 percent for the nation; and for Some Other Race, 3.3 percent and 4.7 percent, respectively. The state's population of persons identifying as White (67.2 percent) is lower than that of the South region (72.3 percent) and the nation (73.7 percent).

The percentage of the population in South Carolina that identifies as Hispanic (5.3 percent) is considerably lower than in the South region (18.8 percent) and the nation (17.1 percent). Hispanic origin is a different category than race; persons of any race may identify as also being of Hispanic origin. The category All Minorities consists of all persons who consider themselves Hispanic or of any race other than White. South Carolina's All Minorities population percentage (36.2 percent) is lower than that of the South region (42.3 percent) or the nation (37.6 percent).

Table 13.1.10-2 presents the percentage of the population living in poverty in 2013, for the state, region, and nation. The figure for South Carolina (18.6 percent) is somewhat higher than that for the South region (18.2 percent) and considerably higher when compared to the nation's (15.8 percent).

Table 13.1.10-1: Population by Race and Hispanic Status, 2013

Geography	Total Population (estimated)	Race							Hispanic	All Minorities[a]
		White	Black/ African Am	Am. Indian/ Alaska Native	Asian	Native Hawaiian /Pacific Islander	Some Other Race	Two or More Races		
South Carolina	4,774,839	67.2%	27.6%	0.3%	1.4%	0.1%	1.5%	1.9%	5.3%	36.2%
South Region	102,853,019	72.3%	18.4%	0.9%	2.6%	0.1%	3.3%	2.4%	18.8%	42.3%
United States	316,128,839	73.7%	12.6%	0.8%	5.1%	0.2%	4.7%	3.0%	17.1%	37.6%

Source: (U.S. Census Bureau, 2015t)

[a] "All Minorities" is defined as all persons who consider themselves Hispanic or of any race other than White. Because some Hispanics identify as both Hispanic and of a non-White race, "All Minorities" is less than the sum of Hispanics and non-White races.

Table 13.1.10-2: Percentage of Population (Individuals) in Poverty, 2013

Geography	Percent Below Poverty Level
South Carolina	18.6%
South Region	18.2%
United States	15.8%

Source: (U.S. Census Bureau, 2015u)

13.1.10.4. Environmental Justice Screening Results

Analysis of environmental justice in a NEPA document typically begins by identifying potential environmental justice populations in the project area. Appendix D, Environmental Justice Methodology, presents the methodology used in this PEIS to screen each state for the presence of potential environmental justice populations. The methodology builds on CEQ guidance and best practices used for environmental justice analysis. It uses data at the census-block group level; block groups are the smallest geographic units for which regularly updated socioeconomic data are readily available at the time of writing.

Figure 13.1.10-1 visually portrays the results of the environmental justice population screening analysis for South Carolina. The analysis used block group data from the Census Bureau's American Community Survey 2009-2013 5-Year Estimates (U.S. Census Bureau, 2015f) (U.S. Census Bureau, 2015v) (U.S. Census Bureau, 2015w) (U.S. Census Bureau, 2015x) and Census Bureau urban classification data (U.S. Census Bureau, 2012) (U.S. Census Bureau, 2015g).

Figure 13.1.10-1 shows that South Carolina has a high proportion of areas with high potential for environmental justice populations. High potential areas are particularly prevalent in the southern two-thirds of the state. High and moderate potential areas occur both within and outside of the 10 largest population concentrations.

It is important to understand how the data behind Figure 13.1.10-1 affect the visual impact of this map. Block groups have similar populations (hundreds to a few thousand individuals) regardless of population density. In sparsely populated areas, a single block group may cover tens or even hundreds of square miles, while in densely populated areas, block groups each cover much less than a single square mile. Thus, while large portions of the state outside the areas defined as large population concentrations show moderate or high potential for environmental justice populations, these low density areas reflect modest numbers of minority or low-income individuals compared to the potential environmental justice populations within densely populated areas. The overall effect of this relative density phenomenon is that the map visually shows large areas of the state having environmental justice potential, but this over-represents the presence of environmental justice populations.

It is also very important to note that Figure 13.1.10-1 does not definitively identify environmental justice populations. It indicates degrees of likelihood of the presence of populations of potential concern from an environmental justice perspective. Two caveats are important. First, environmental justice communities are often highly localized. Block group data may under- or over-represent the presence of these localized communities. For instance, in the large block groups in sparsely populated regions of the state, the data may represent dispersed individuals of minority or low-income status rather than discrete, place-based communities. Second, the definition of the moderate potential category draws a wide net for potential environmental justice populations. As discussed in Appendix D, the definition includes some commonly used thresholds for environmental justice screening that tend to over-identify environmental justice potential. Before FirstNet deploys projects, additional site-specific analyses to identify specific, localized environmental justice populations may be warranted. Such analyses could tier-off the methodology of this PEIS.

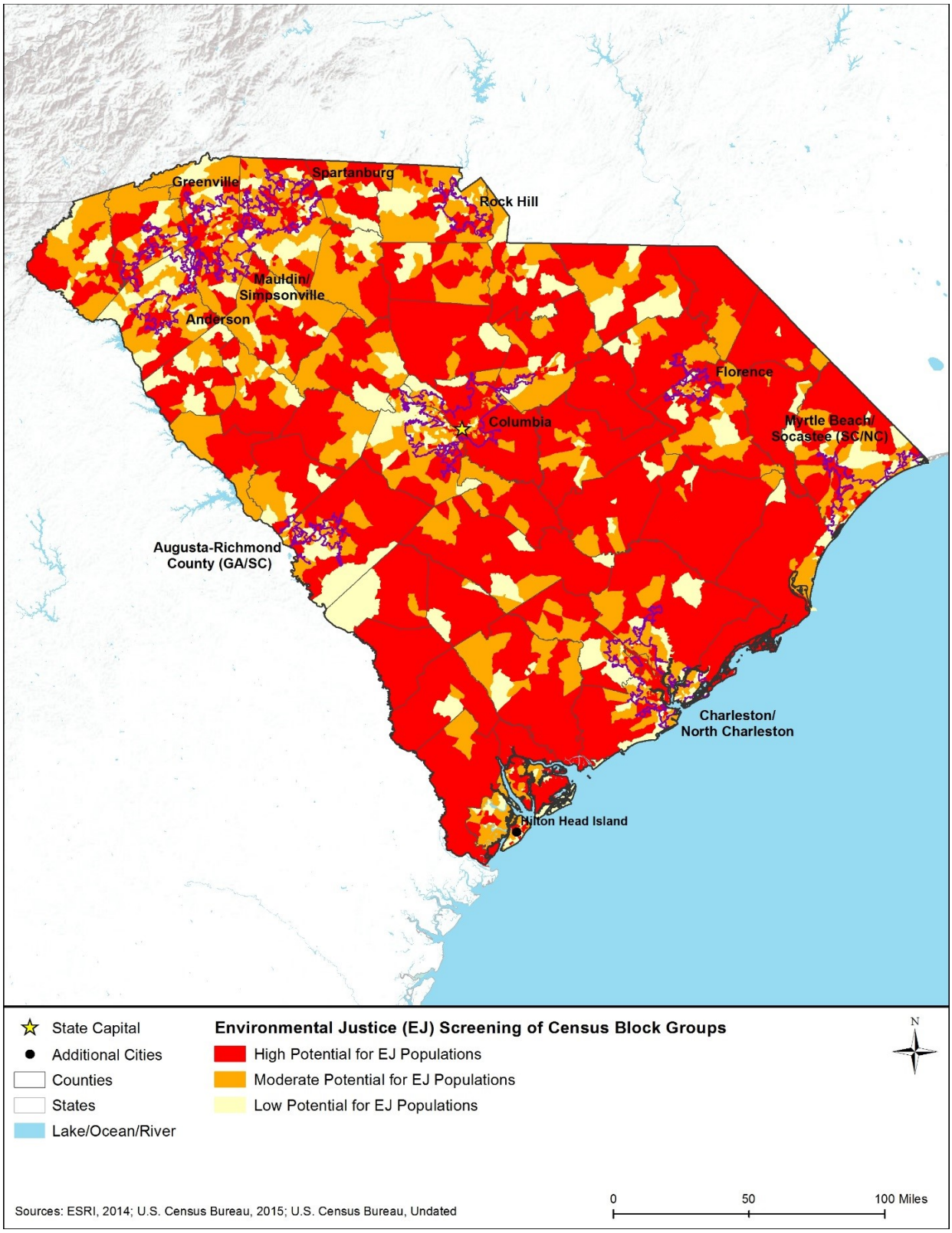


Figure 13.1.10-1 Potential for Environmental Justice Populations in South Carolina, 2009–2013

This map also does not indicate whether FirstNet projects would have actual impacts on environmental justice populations. An environmental justice effect on minority or low-income populations only occurs if the effect is harmful, significant (according to significance criteria), and "appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group" (CEQ, 1997). The Environmental Consequences section (Section 13.2) addresses the potential for disproportionately high and adverse environmental or human health impacts on environmental justice populations.

13.1.11. Cultural Resources

13.1.11.1. Definition of Resource

For the purposes of this PEIS, Cultural Resources are defined as:

> Natural or manmade structures, objects, features, locations with scientific, historic, and cultural value, including those with traditional religious or cultural importance and any prehistoric or historic district, site, or building included in, or eligible for inclusion in, the National Register of Historic Places (NRHP).

This definition is consistent with the how cultural resources are defined in the:

- The statutory language and implementing regulations for Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), formerly 16 USC 470a(d)(6)(A) (now 54 USC 306131(b)) and 36 CFR 800.16(l)(1);
- The statutory language and Implementing regulations for the Archaeological Resources Protection Act of 1979 (ARPA), 16 USC 470cc(c) and 43 CFR 7.3(a);
- The statutory language and implementing regulations for the Native American Graves Protection and Repatriation Act (NAGPRA), 25 USC 3001(3)(D) and 43 CFR 10.2(d);
- NPS program support of public and private efforts to identify, evaluate, and protect America's historic and archeological resources (NPS, 2015k); and
- Advisory Council on Historic Preservation's (ACHP) guidance for protection and preservation of sites and artifacts with traditional religious and cultural importance to Indian tribes or Native Hawaiian organizations (Advisory Council on Historic Preservation, 2004).

13.1.11.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of the NEPA and other applicable laws and regulations. Applicable federal laws and regulations that apply to Cultural Resources, such as the NHPA (detailed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders), the American Indian Religious Freedom Act (AIRFA), ARPA, and NAGPRA and Appendix C, Environmental Laws and Regulations, summarizes these pertinent federal laws.

South Carolina has state laws and regulations that parallel both NEPA and the NHPA (refer to Table 13.1.11-1). However, federal laws and regulations supersede these state laws and regulations. While federal agencies may take into account compatible state laws and regulations,

their actions that are subject to federal environmental review under NEPA and NHPA are not subject to compliance with such state laws and regulations.

Table 13.1.11-1: Relevant South Carolina Cultural Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Heritage Trust Program, SC Code of Laws 51-17-10 to 51-17-150	SCDNR	Creates the Heritage Trust program to inventory, evaluate, and protect the elements considered the most outstanding representatives of the state's natural and cultural heritage.
Protection of State Owned or Leased Historic Properties, SC Code of Laws 60-12-10 thru 60-12-90	State Historic Preservation Office (SHPO)	Establishes a review process for projects involving historic properties owned or leased by South Carolina, which are listed in the National Register of Historic Places (NRHP).

13.1.11.3. Cultural Setting

Human beings have inhabited the South Carolina region for more than 13,500 years. The majority of evidence of South Carolina's early human habitation comes from the study of archeological sites of pre-European contact and historic populations. In addition to the hundreds of archaeological sites listed in the state's inventory, there are 113 archaeological sites in South Carolina listed on the NRHP: 52 are historic, 45 are prehistoric, 14 have both historic and prehistoric provenience, and two are shipwrecks (NPS, 2014d). Archaeologists typically divide large study areas into regions. South Carolina is within two major physiographic regions: the Atlantic Plain (Coastal Plain Province) and the Appalachian Highlands (Piedmont and Blue Ridge Provinces). The locations of these regions and provinces are presented in Figure 13.1.3-1 of this document and their general characteristics summarized in the subsequent sections.

Most archeological evidence in South Carolina is found in relatively shallow deposits on the surface, or within one to two feet of the surface. However, in some cases, natural factors have buried sites beneath multiple layers of sediment or organic materials, such as in floodplain deposits found along streams and rivers or peat deposits in wetlands. These alluvial deposits can range 1-10 feet below the current surface, with older sites typically in the deeper sediments. Disturbed ground, including urban areas, may contain archaeological resources in deeper or shallower strata than undisturbed areas.

The following sections provide additional detail about South Carolina's prehistoric periods (approximately 11500 B.C. to A.D. 1500) and the historic period since European colonization in the 1500s. There is some overlap between the prehistoric period and the historic period, as American Indians continued to carry on their traditional way of life in parts of South Carolina after European contact. Section 13.1.11.4 presents an overview of the initial human habitation in South Carolina and the cultural development that occurred before European contact. Section 13.1.11.5 discusses the federally recognized American Indian Tribes with a cultural affiliation to the state. Section 13.1.11.6 provides a current list of significant archaeological sites in South Carolina and tools that the state has developed to ensure their preservation. Section 13.1.11.7 documents the historic context of the state since European contact, and Section 13.1.11.8 summarizes the architectural context of the state during the historic period.

13.1.11.4. Prehistoric Setting

Archaeologists divide South Carolina's prehistoric past into four periods: Paleoindian Period (11500 - 8000 B.C.), Archaic Period (8000 - 1000 B.C.), Woodland Period (1000 B.C. - A.D. 900), and Late Prehistoric Period (A.D. 900 - 1500). Figure 13.1.11-1 shows a timeline representing these periods of early human habitation of present day South Carolina. South Carolina is part of the Atlantic Plain and Appalachian Highlands archaeological culture of North America. Evidence of human occupation is prevalent in each of South Carolina's physiographic regions. Due to advancements in archaeological techniques and the association of newly discovered artifacts with similar ones previously assigned to a particular range of the archaeological record, the dates associated with a particular phase in North American human development continue to become increasingly accurate (Pauketat, 2012; Haynes, Donahue, Jull, & Zabel, 1984; Haynes, Johnson, & Stafford, 1999).

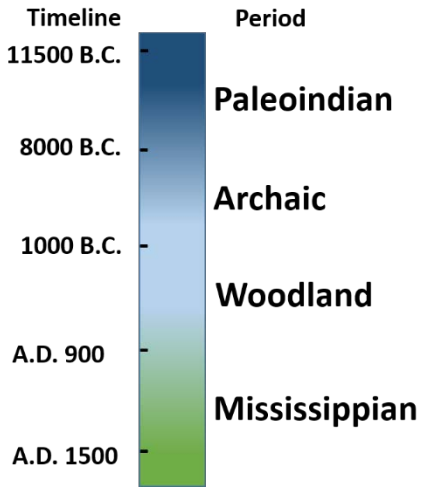


Figure 13.1.11-1: Timeline of Prehistoric Human Occupation

Source: (Institute of Maritime History, 2015)

Paleoindian Period (11500 – 8000 B.C.)

The Paleoindian Period represents the earliest human habitation of the South Carolina region. The earliest people lived in small groups of nomadic hunters and gatherers that used chipped-stone tools, including the "fluted javelin head" arrow and spear points (referred to as the Clovis or Folsom fluted point). Studies show that that such technology was prevalent in northeastern Asia, the Arabian Peninsula, and Spain prior to human arrival into North America (Charpentier, Inizan, & Feblot-Augustins, 2002). During the Paleoindian Period, many large mammals that are now extinct, such as giant bison, mammoths, saber-toothed tigers and mastodons, were being hunted (Kane, Sharon; Keeton, Richard, 1994). As the environment changed and the large animals decreased in numbers, the people began to exploit various other plant and animal species with other technologies.

Most of the oldest known evidence of human settlement in South Carolina comes from the discovery of durable stone projectile points. Artifacts from the Paleoindian Period are unevenly

distributed throughout South Carolina and vary in accordance with geographic and topographic factors. In a study of 11,257 projectile points discovered across the United States dating from the Paleoindian period, 317 are from South Carolina. The majority of the fluted points documented in the United States are from east of the Mississippi River. By the end of the Paleoindian Period, all of present-day South Carolina was populated by Paleoindians (Anderson & Faught, 1998).

Archaic Period (8000 – 1000 B.C.)

During the Archaic Period, the climate of South Caroline became warmer and large game previously exploited during the Paleoindian Period was becoming extinct, likely from a combination of environmental changes and human hunting. The hunters-gathers of this period began to rely increasingly on fish, small game, and a wider range of plants for subsistence. Later in the Archaic Period, the use of pottery in some areas of South Carolina made it easier to store food for future use, and populations increased while adapting to a warmer climate. (Kane, Sharon; Keeton, Richard, 1994)

Data from South Carolina's Collectors Survey have enabled development of robust spatial models that show a decrease in range of human activity within the Savannah River Valley during the Archaic Period. From the model results, archaeologists conclude that bands of people became more localized with the emergence of village habitation. Correspondingly, toolmaking also becoming more localized (Sassaman, Hanson, T, & Charles, 1988).

During the Middle Archaic Period, in certain parts of the American Southeast, including South Carolina, tools were being manufactured for non-subsistence purposes. It is common for archaeologists to find "biface caches"[117] that were intended for mortuary offerings or trade. Typically, these sites are not large, and do not lend themselves to the understanding of the scale and intensity of their production. However, the frequency of sites in the Savannah River Valley provide enough data for archaeologists to understand reasonably well the scale of tool production across the region. Unfinished bifaces are referred to as "preforms," because they were manufactured with the intent of trade or ceremonial purposes to be completed later. The Pen Point site in the Upper Coastal Plain of South Carolina contained 200-300 manufactured preforms. Archeologists have determined that the materials were probably manufactured in a single production event and were likely meant for exchange (Sassaman, 1994).

The lifestyle of Archaic Period people began to change around 5,000 years ago, with the early cultivation and domestication of plants, which became an important supplement to the diet of the hunter-gatherer culture that was expanding throughout the region. People began to settle into semi-permanent camps that they occupied depending upon the season and the availability of resources in an area. As populations continued to increase during the Archaic Period, the

[117] "Such caches consist of purposefully hidden ('cached,' usually buried) groups of large, well-made, percussion-shaped, symmetrical bifaces. Cache bifaces typically have no evidence of use, resharpening, notching, or other evidence of specific function. Most are well suited for being turned into large knives or very large spear and dart points, but they were left in an unfinished state. Such artifacts are sometimes called 'trade blanks' or 'quarry blanks,' but the biface caching pattern is more than mere trade in tool-making stock" (Sassaman, Production for Exchange in the Mid-Holocene Southeast: a Savannah River Valley Example, 1994).

development of pottery for food storage and ceremonial purposes began about 3,000 years ago (Cabak, Sassaman, E, & Gillam, 1998).

Woodland Period (1000 B.C. – A.D. 900)

During the early part of the Woodland Period, people primarily lived in seasonal camps much like during the late Archaic, and the climate was much like the current conditions in South Carolina. Although the people continued to hunt deer and bison during this period, they became very successful at harvesting fish and clams. Shellfishing began during the Woodland Period as is evident from number of coastal shell midden sites documented throughout the state (Claassen, 1986). Corn, beans, and squash were cultivated. The advent of the bow and arrow enabled more efficient hunting, warfare, and possibly fishing (University of South Carolina, 2013) (Kane, Sharon; Keeton, Richard, 1994).

By the Middle Woodland period, societies were more sedentary and semi-permanent villages were established, although some groups migrated seasonally to maximize food exploitation strategies. Pottery manufacturing became widespread throughout the region, which is an indicator that people were beginning to realize the benefits of settling within a more permeant or semi-permanent locale. (University of South Carolina, 2013), (Kane, Sharon; Keeton, Richard, 1994)

The practice of mound building for ceremonial purposes was prevalent in South Carolina during the Middle and Late Woodland Periods and required an extraordinary amount of coordinated labor. The builders used wicker baskets and clay pots to move large amounts of soil for the construction of large earthen mounds. The construction of both burial and ceremonial mounds became more elaborate throughout the Woodland and into the Mississippian Period. (University of South Carolina, 2013)

The practice of constructing large shell rings (ring or arch-shaped ridges made from shellfish remains) within coastal regions of the state is a phenomenon known by archaeologists for some time. The theories associated with this practice include ceremonial, recreational, or exploitative (e.g., fish traps) purposes. Recent research suggests that these were actually habitation sites in which the rings are discarded kitchen refuse, and developed their shape and stature over time. All the shell rings discovered in South Atlantic Coast region are on estuaries and tidal creeks and "occupy high ground immediately adjoining salt marshes or occasionally are isolated in salt marshes a few hundred feet offshore" (Stalter, Leyva, & Kincaid, 1999).

Mississippian Period (A.D. 900 – 1500)

Prehistoric populations continued to increase in South Carolina during the Mississippian Period as more communities became sedentary and permanent, year-round occupation of a place more common. There is widespread evidence of gardening and the tools associated with gardening. Common crops continued to be corn, beans, and squash that were cultivated and harvested as a group effort by the entire community. Hunting and fishing remained important parts of the subsistence strategy of the area's Mississippian cultures. (Kane, Sharon; Keeton, Richard, 1994)

Trade between the various populations throughout the region became a significant part of the cultural makeup. The mound building culture continued to remain a dominate force in the region, and permanent villages and towns developed around mound complexes. Elaborate tools, jewelry, and ceremonial objects were crafted by artisans and became a symbol of status among the elite. (Kane, Sharon; Keeton, Richard, 1994)

Between 1970 and 1985, extensive archeological research was conducted on the Mississippian cultures along the Savannah River Valley. Before 1970, most research concerned the ceremonial centers of Irene, Hollywood, Rembert, Chauga, Tugalo, and Estatoe, and results were reported based on site-specific archaeological investigations. By 1985, archaeologists conducting fieldwork along the Savannah River Valley had developed a detailed chronological sequence of socio-political, settlement patterns and subsistence evolution of the Mississippian Period culture (Anderson, Hally, & Rudolph, 1986). It is now believed that the transition from the Woodland to the Mississippian Period "was a shift from small, widely dispersed sites to larger nucleated settlements near floodplains, and the emergence of political ceremonial centers" (Anderson, Hally, & Rudolph, 1986).

Throughout he Mississippian Period there was a continuing increase in dependence on agriculture for both substance and wealth. The formation of hierarchical political systems, known as chiefdoms, continued to expand and dominate the socio-political structure of the Mississippian societies within the Savannah River Valley and throughout the region (Anderson, Hally, & Rudolph, 1986).

13.1.11.5. Federally Recognized Tribes of South Carolina

According to the Bureau of Indian Affairs and the National Conference of State Legislators, the Catawba Indian Nation is the only federally recognized Tribe in South Carolina (National Conference of State Legislators, 2015; GPO, 2015). The general location of the Catawba Indian Nation is shown in Figure 13.1.11-2. The other tribes depicted in the figure are general locations of tribes known to have existed in this region of the United States, but are not officially federally recognized.

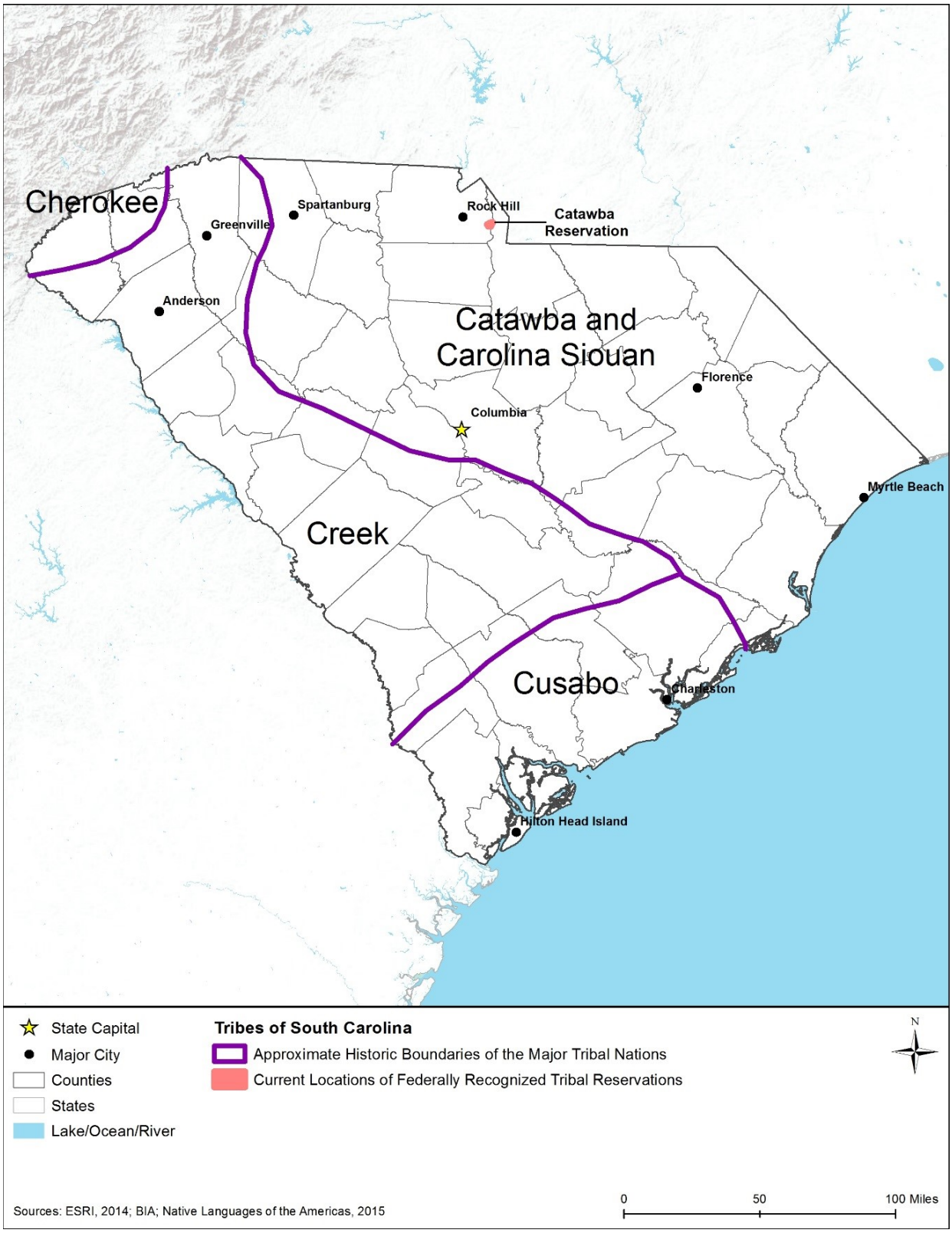


Figure 13.1.11-2: Federally Recognized Tribes in South Carolina

13.1.11.6. Significant Archaeological Sites of South Carolina

As previously mentioned in Section 13.1.11.3 there are 113 archaeological sites in South Carolina listed on the NRHP. Table 13.1.11-2 lists the names of the sites, the city they are closest to, and type of site. The list includes both prehistoric and historic archaeological sites. The number of archaeological sites may increase with the discovery of new sites. (NPS, 2014c).

South Carolina State Cultural Resources Database and Tools

South Carolina State Historic Preservation Office (SHPO)

The South Carolina State Historic Preservation Office promotes and aids in the preservation of the state's historic and prehistoric cultural resources. The SHPO manages several preservation programs, awards grants and tax incentives, and maintains South Carolina's site register and historic survey.

South Carolina Institute of Archaeology and Anthropology (SCIAA)

The South Carolina Institute of Archaeology and Anthropology is a state funded organization within the University of South Carolina's College of Arts and Sciences. The SCIAA hosts the Office of the State Archaeologist and acts as research center and cultural resource management agency. The Institute also maintains ArchSite, South Carolina's GIS database for cultural resources. There are two levels of access granted to the system, public and professional. The public version provides information about sites but not locational data. (University of South Carolina, 2013).

Table 13.1.11-2 Archaeological Sites on the NRHP in South Carolina

Closest City	Site Name	Type of Site
Allendale	Red Bluff Flint Quarries	Historic - Aboriginal
Awendaw	Sewee Mound	Prehistoric
Bamberg	Cal Smoak Site	Prehistoric
Beaufort	Charlesfort--Santa Elena Site	Historic, Military
Beaufort	Fort Lyttelton Site	Historic, Military
Beaufort	Laurel Bay Plantation	Historic
Beech Island	Fort Moore-Savano Town Site	Historic - Aboriginal, Military
Bluffton	Altamaha Town	Historic - Aboriginal
Camden	Adamson Mounds Site	Prehistoric
Camden	Belmont Neck Site --38KE06	Historic, Prehistoric
Camden	McDowell Site	Prehistoric
Cayce	Congarees Site	Historic - Aboriginal, Military
Cayce	Manning Archeological Site	Historic - Aboriginal, Prehistoric
Cayce	SAM Site	Historic - Aboriginal, Prehistoric
Cayce	Taylor Site	Prehistoric

Closest City	Site Name	Type of Site
Charleston	Ashley Hall Plantation	Prehistoric
Charleston	Fort Pemberton Site	Historic, Military
Charleston	Lighthouse Point Shell Ring (38CH12)	Prehistoric
Charleston	Site of Old Charles Towne	Historic - Aboriginal, Prehistoric, Military
Chester	McCollum Mound	Historic - Aboriginal, Prehistoric
Columbia	Brown's Ferry Vessel	Shipwreck
Columbia	Nipper Creek(38RD18)	Prehistoric
Cross Anchor	Musgrove's Mill Historic Battle Site	Military
Edgefield	Pottersville	Historic
Edisto	Fig Island Site	Prehistoric
Edisto Island	Grimball, Paul, House Ruins	Historic
Edisto Island	Spanish Mount Point	Historic - Aboriginal, Prehistoric
Edisto Island	Townsend's, Hephzibah Jenkins, Tabby Oven Ruins	Historic
Florence	Stockade, The	Historic, Military
Folly Beach	Folly North Site--38CH1213	Historic, Military
Fort Motte	Fort Motte Battle Site	Historic, Military
Frogmore	Lands End Road Tabby Ruins	Historic
Frogmore	St. Helenaville Archaeological Site (38BU931)	Historic
Gaffney	Archeological Site 38CK1	Prehistoric
Gaffney	Archeological Site 38CK44	Prehistoric
Gaffney	Archeological Site 38CK45	Prehistoric
Gaffney	Coopersville Ironworks Site (38CK2) and Susan Furnace Site (38CK67)	Historic, Prehistoric
Gaffney	Cowpens Furnace Site (38CK73)	Historic
Gaffney	Ellen Furnace Site (38CK68)	Historic
Gaffney	Nesbitt's Limestone Quarry (38CK69)	Historic
Georgetown	Minim Island Shell Midden (38GE46)	Historic, Prehistoric
Heath Springs	Battle of Hanging Rock Historic Site	Military
Hilton Head	Skull Creek	Prehistoric
Hilton Head Island	Fish Haul Archaeological Site (38BU805)	Historic, Prehistoric
Hilton Head Island	Green's Shell Enclosure	Prehistoric
Hilton Head Island	Sea Pines	Prehistoric
Hilton Head Island	SS William Lawrence Shipwreck Site	Shipwreck
Hopkins	Big Lake Cattle Mound	Historic
Hopkins	Brady's Cattle Mound	Historic
Hopkins	Cattle Mound #6	Historic
Hopkins	Cook's Lake Cattle Mound	Historic
Hopkins	Cooner's Cattle Mound	Historic
Hopkins	Dead River Cattle Mound	Historic

Closest City	Site Name	Type of Site
Hopkins	Dead River Dike	Historic
Hopkins	Northwest Boundary Dike	Historic
Hopkins	Southwest Boundary Dike	Historic
Jackson	Silver Bluff	Historic - Aboriginal, Military
Johnson's Landing	Lawton Mounds	Historic - Aboriginal, Prehistoric
Johnsonville	Snow's Island	Historic, Military
Johnsonville	Snow's Island (Boundary Increase)	Historic, Military
Kiawah Island	Bass Pond Site	Prehistoric
Kings Creek	King's Creek Furnace Site (38CK71)	Historic
Kirksey	Trapp and Chandler Pottery Site (38GN169)	Historic
Laurel Bay	Chester Field	Prehistoric
Lockhart	McCollum Fish Weir	Historic - Aboriginal, Prehistoric
Madens	Lindley's Fort Site	Historic, Military
Martin	Allendale Chert Quarries Archeological District	Prehistoric
McBee	Kirkley, Evy, Site	Prehistoric
McCormick	Dorn Gold Mine	Historic
Mount Pleasant	Auld Mound	Prehistoric
Mount Pleasant	Buzzard's Island Site	Prehistoric
Mount Pleasant	Pritchard, Paul, Shipyard	Historic, Military
Mt. Pleasant	Long Point Plantation (38CH321)	Historic
Murrell's Inlet	Richmond Hill Plantation Archeological Sites	Historic
Orangeburg	Mack, Alan, Site (38OR67)	Prehistoric
Pacolet	Archeological Site 38SP11	Prehistoric
Pacolet	Archeological Site 38SP12	Prehistoric
Pacolet	Archeological Site 38SP13	Prehistoric
Pacolet	Archeological Site 38SP17	Prehistoric
Pacolet	Archeological Site 38SP18	Prehistoric
Pacolet	Archeological Site 38SP19	Prehistoric
Pacolet	Archeological Site 38SP20	Prehistoric
Pacolet	Archeological Site 38SP21	Prehistoric
Pacolet	Archeological Site 38SP23	Prehistoric
Pacolet	Archeological Site 38SP52	Prehistoric
Pacolet	Archeological Site 38SP53	Prehistoric
Pacolet	Archeological Site 38SP54	Prehistoric
Pacolet	Archeological Site 38SP57	Prehistoric
Peeples	Fennell Hill	Prehistoric
Pelham	Pelham Mills Site (38GR165)	Historic
Port Royal	Camp Saxton Site	Historic
Port Royal	Fort Frederick	Prehistoric, Military
Port Royal	Hasell Point Site	Prehistoric

Closest City	Site Name	Type of Site
Ridgeland	Honey Hill--Boyd's Neck Battlefield	Historic, Military
Ridgeland	White Hall Plantation House Ruins and Oak Avenue	Historic
Rockville	Hanckel Mound	Prehistoric
Rockville	Horse Island	Prehistoric
Saluda	Saluda Old Town Site	Historic - Aboriginal, Prehistoric
Shady Grove Church	Thicketty Mountain Ore Pits (38CK74)	Historic
Sheldon	Pocosobo Town	Historic - Aboriginal
Smyrna	Jackson's Furnace Site (38YK217)	Historic
St. Helena Island	Indian Hill Site	Prehistoric
St. Matthews	Buyck's Bluff Archeological Site	Prehistoric
St. Matthews	Prehistoric Indian Village	Prehistoric
St. Stephen	Keller Site	Historic - Aboriginal, Prehistoric
Stallsville	Newington Plantation	Historic
Summerton	Santee Indian Mound and Fort Watson	Prehistoric
Tradesville	Buford's Massacre Site	Military
Troy	Long Cane Massacre Site	Historic
Union	Battle of Blackstock's Historic Site	Military
Waterloo	Rosemont Plantation	Historic
Winnsboro	Blair Mound	Prehistoric
Winnsboro	McMeekin Rock Shelter	Prehistoric

Source: (NPS, 2015l)

13.1.11.7. Historic Context

Two Spanish mariners, Francisco Gordillo and Pedro de Quejo, were the first European explorers to reach South Carolina, discovering Santa Elena (later Saint Helena and now Parris Island) in 1521 (NPS, 1988). Then both the French (1562-1563) and Spanish (1566-1587) established successive forts there followed by others exploring parts of South Carolina, although the first permanent settlement was not established until 1670 by the English near what is now Charleston (South Carolina State Library, 2016). Designated "Carolina" for the Latin name for the English King Charles II, the colony was divided into South and North Carolina in 1710. European settlers established rice and indigo plantations in coastal areas and African slaves were brought in in large numbers for labor, making up the majority of the colony's population by 1720 (South Carolina State Library, 2016).

By the American Revolution, South Carolina was among the richer English colonies in North America. The area saw more Revolutionary War battles than any other state, including "major engagements at Sullivan's Island, Camden, Kings Mountain, and Cowpens" (South Carolina State Library, 2016). South Carolina entered the Union on May 23, 1788 as the 8th state to ratify the Constitution.

Columbia was established by the state legislature in 1786 as a central location for the state capital, somewhat reducing the political power of the low country plantation owners (South Carolina State Library, 2016). The invention of the cotton gin by Eli Whitney in 1794 lead to a shift in agriculture, making the seed removal from cotton less labor intensive and more profitable and leading to its expansion as a crop, especially in the "upcountry" (interior) areas of the state.

South Carolina became the first state to secede from the Union on December 20, 1860, and the Civil War started when Confederate troops fired on Fort Sumter, located in the Charleston Harbor, on April 12-13, 1861. The state suffered greatly during the war: losing on-fifth of its white male population, having much of the port city of Charleston destroyed by siege and also blockaded from maritime commerce, and Union troops under General Sherman's command burned plantations and a large portion of the city of Columbia in 1865 (South Carolina State Library, 2016). Reconstruction in the state lasted through 1877, and South Carolina was the only state where African-Americans held a majority in the state legislature during this period (White-Perry, 2010). White conservatives retook control of the state government following the withdrawal of Federal troops in 1877, but the plantation system that contributed greatly to the state's wealth was defunct (South Carolina State Library, 2016).

The state began to recover economically in the early 20th century with an increase in industrial production, beginning with textiles (South Carolina State Library, 2016). The entry of the U.S. into World War I lead to the establishment of Fort Jackson, near Columbia, in 1917; by January 1918, the installation had over 42,000 soldiers and over 1,500 buildings had been constructed there in a six-month period (U.S. Army, 2015). More than 166,000 South Carolinians served during World War II, with a loss of life totaling over 3,400 (U.S. War Department, 1946).

South Carolina has 1,511 NRHP listed sites, as well as 76 NHLs (NPS, 2014d). South Carolina contains two NHAs, the South Carolina National Heritage Corridor and a portion of the Gullah/Geechee Heritage Corridor (NPS, 2015m). Figure 13.1.11-2 shows the location of NHA and NRHP sites within South Carolina.[118]

13.1.11.8. Architectural Context

Following the earthen and log forts of the 16th century French and Spanish attempts at colonization, the first buildings associated with permanent European settlements in South Carolina were made of lumber and brick and were located on English coastal plantations and in the urban environment of Charles Town (Charleston). The typical planation featured a plantation (farm) house, along with numerous auxiliary structures and outbuildings. Common early forms of rural residential structures included the I-house, the central-passage four-over-four house, and smaller double-pen cottages (NPS, 1988). The early architecture of Charleston was distinctly English; some structures were stone or half-timbered, although the colonial Lord Proprietors favored brick construction (Poston, 1997). The construction of St. Phillip's Church in 1722 was the start of high-style architecture in Charleston, and the architecture of the plantations in the countryside shifted from unadorned to formal Georgian style – notable examples include Ashley Hall, The Oaks, and Drayton Hall, which was completed in 1742 (Poston, 1997).

[118] See Section 13.1.3 for a more in-depth discussion of additional historic resources as they relate to recreational resources.

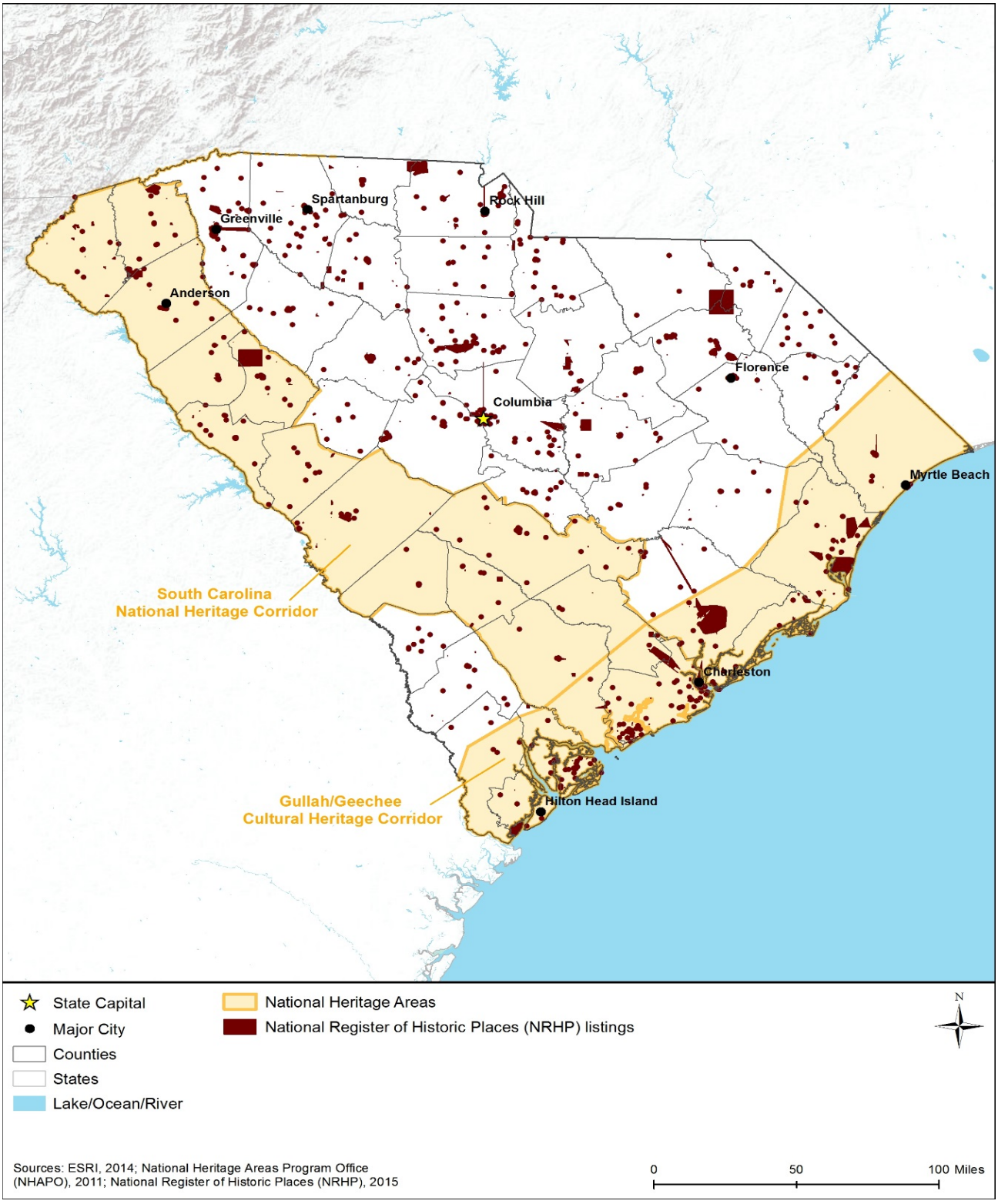


Figure 13.1.11-3: National Heritage Areas and National Register of Historic Places Sites in South Carolina

In the early 19th Century, new architectural styles began to appear in the state, including Neoclassical and English Regency (Late Georgian). Both the Duncan House and William Mason Smith House in Charleston are examples from this early national period, and are indicative of the wealth in the state from exports of rice and cotton (Poston, 1997). Revival styles became more popular in the second half of the 19th century, with various Victorian styles appearing later in the century. In Columbia, the McDuffie's Antiques building is an example of a Greek Revival commercial structure, and the Ensor-Keenan House is the city's only remaining example of the Italianate style. (NPS, 1979)

The vernacular bungalow house type that was common throughout the southeast dominated early 20th century rural residences. More formal styles of residential architecture, generally found in urban areas, progressed from International Style (starting in the mid-1920s), through Modern Style (1930s), and into Neo-Eclectic, starting in the 1960s (South Carolina Department of Archives and History, 2016). Forms for housing in the middle part of the century were generally minimal traditional and ranch houses.

Figure 13.1.11-4: Representative Architectural Styles of South Carolina

- Top Left – Charles H. Drayton House (Charleston, SC) – (Historic American Buildings Survey, 1977)
- Top Middle – Drayton Hall (Charleston, SC) –(Highsmith, 2006)
- Right – South Carolina Capitol (Columbia, SC) – (Historic American Buildings Survey, 1933)
- Bottom Left – Fort Sumter (Charleston, SC) – (Detroit Publishing Company, 1901)
- Bottom Middle – U.S. Customs House (Charleston, SC) – (Detroit Publishing Company, 1900)

13.1.12. Air Quality

13.1.12.1. Definition of the Resource

The type determines air quality in a geographic area and amount of pollutants emitted into the atmosphere, the size and topography[119] of the area, and the prevailing weather and climate conditions. The levels of pollutants and pollutant concentrations in the atmosphere are typically expressed in units of parts per million (ppm)[120] or micrograms per cubic meter ($\mu g/m^3$) determined over various periods of time (averaging time).[121] This section discusses the existing air quality in South Carolina. The USEPA designates areas within the United States as attainment,[122] nonattainment,[123] maintenance,[124] or unclassifiable[125] depending on the concentration of air pollution relative to ambient air quality standards. Information is presented regarding national and state ambient air quality standards and nonattainment areas that would be potentially more sensitive to impacts from implementation of the Proposed Action or alternatives.

13.1.12.2. Specific Regulatory Considerations

National and State Ambient Air Quality Standards

The Clean Air Act (CAA) establishes National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: Carbon monoxide (CO), lead, oxides of nitrogen (NO_2), particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), and oxides of sulfur (SO_2). The NAAQS establish various standards, either primary[126] or secondary,[127] for each pollutant with varying averaging times. Standards with short averaging times (e.g., 1-hour, 8-hour, and 24-hour) were developed to prevent the acute health effects from short-term exposure at high concentrations. Longer averaging periods (e.g., 3 months or annual) are intended to prevent chronic health effects from long-term exposure. A description of the NAAQS is presented in Appendix E.

In addition to the NAAQS, there are standards for hazardous air pollutants (HAP), which are those typically associated with specific industrial processes such as chromium electroplating (hexavalent chromium), dry cleaning (perchloroethylene), and solvent degreasing (halogenated solvents) (USEPA, 2016c). HAPs can have severe adverse impacts on human health and the environment, including increased risk of cancer, reproductive issues, or birth defects. HAPs are

[119] Topography: The unique features and shapes of the land (e.g., valleys and mountains).
[120] Equivalent to 1 milligram per liter (mg/L).
[121] Averaging Time: "The period over which data are averaged and used to verify proper operation of the pollution control approach or compliance with the emissions limitation or standard" (USEPA, 2015p).
[122] Attainment areas: Any area that meets the national primary or secondary ambient air quality standard for the pollutant (USEPA, 2015q).
[123] Nonattainment areas: Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant (USEPA, 2015q).
[124] Maintenance areas: An area that was previously nonattainment, but has met the national primary or secondary ambient air quality standards for the pollutant, and has been designated as attainment (USEPA, 2015q).
[125] Unclassifiable areas: Any area that cannot be classified on the basis of available information as meeting the national primary or secondary air quality standard for a pollutant (USEPA, 2015q).
[126] Primary standard: The primary standard is set to provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly (USEPA, 2014c).
[127] Secondary standards: The secondary standard is set to provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (USEPA, 2014c).

federally regulated under the CAA via the National Emission Standards for Hazardous Air Pollutants (NESHAPs). USEPA developed the NESHAPs for sources and source categories emitting HAPs that pose a risk to human health. Appendix E presents a list of federally regulated HAPs.

The SCDHEC adopted the NAAQS and does not maintain any state-only standards (SCDHEC, 2015e).

Title V Operating Permits/State Operating Permits

South Carolina has authorization to issue CAA Title V operating permits on behalf of the USEPA, as outlined in 40 CFR 70. The Title V program refers to Title V of the CAA that governs permitting requirements for major industrial air pollution sources and consolidates all CAA requirements for the facility into one permit (USEPA, 2015g). The overall goal of the Title V program is to "reduce violations of air pollution laws and improve enforcement of those laws" (USEPA, 2015g). South Carolina Regulation 61-62.70 (Title V Operating Permit Program) describes the applicability of Title V operating permits (SCDHEC, 2015l). South Carolina requires Title V operating permits for any major source if it emits or has the potential to emit pollutants in excess of the major source thresholds (see Table 13.1.12-1). The permit issued to a facility contains both state and federal portions and incorporates a reporting schedule. (USEPA, 2014a)

Table 13.1.12-1: Major Air Pollutant Source Thresholds

Pollutant	TPY[a]
Any Pollutant	100 Tons per Year
Single HAP	10 Tons per Year
Total/Cumulative HAPs	**25 Tons per Year**

Source: (USEPA, 2014a)

[a] Sources in nonattainment areas will have lower thresholds for some criteria pollutants depending on the classification of the nonattainment area.

In addition to Title V operating permits, the SCDHEC issues Registration permits and General permits. The SCDHEC may issue Registration permits under Regulation 61-62. Section II.I (Registration permits) for specific stationary sources with an uncontrolled potential to emit less than the maximum threshold for major sources. The SCDHEC may also issue General permits under Regulation 62.70.6.d (General permits) for similar sources including facilities that have similar operations, and limits their air emissions below the major threshold required by the Title V program (see Table 13.1.12-1) (SCDHEC, 2015l).

Exempt Activities

South Carolina Regulation 61-62.2 (Definitions, and General Requirements) Section II F (Operating Permits) states that any source required to obtain an air quality construction permit must request an operating permit after construction and prior to operation of the air emissions source. Section II B (Exemptions from the Requirement to Obtain a Construction Permit) exempts the following sources from both construction and operating permits if they were constructed prior to February 11, 1971:

- "Natural gas boilers;
- Oil-fired boilers of 50 x 10^6 British thermal unit per hour (Btu/hr) rated input capacity or smaller; and
- Coal-fired boilers of 20 x 10^6 Btu/hr rated input capacity or smaller."

The following sources are exempt from both construction and operating permits as long as they are not required to obtain a permit from South Carolina Regulation 61-62.70 (Title V Operating Permit Program):

- "Boilers and space heaters of less than 1.5 x 10^6 Btu/hr rated input capacity which burn only virgin liquid fuels or virgin solid fuels and
- Boilers and space heaters of less than 10 x 10^6 Btu/hr rated input capacity which burn only virgin gas fuels…
- …Emergency power generators as described below:
- Generators of less than or equal to 150 kilowatt (kW) rated capacity;
- Generators of greater than 150 kW rated capacity designated for emergency use only, are operated a total of 500 hours per year or less for testing; and maintenance, and have a method to record the actual hours of use such as an hour meter.
- Sources emitting only steam, air, nitrogen, oxygen, carbon dioxide, or any physical combination of these;
- Sources with a total uncontrolled potential to emit (PTE) of less than five (5) tons per year each of particulates, sulfur dioxide, nitrogen oxides, and carbon monoxide; and a total uncontrolled PTE of less than 1000 pounds per month (lbs./month) of VOCs will not require construction permits…"

Temporary Emissions Sources Permits

The SCDHEC Bureau of Air Quality Exemptions List includes some temporary activities as being exempt from construction and operating permitting. The temporary replacement of boilers (same size/capacity or smaller) that remain onsite for 12 months or less are exempt only if they are used in place of a permanent boiler while maintenance is being performed. This exemption applies as long as the emissions from the temporary units do not exceed the emissions from the permanent boiler. In addition, temporary or portable generators that meet the USEPA's definition of a non-road engine are exempt from obtaining a construction and operating permit (SCDHEC, 2015g).

State Preconstruction Permits

South Carolina Regulation 61-62.1 Section II A.1.a (Construction Permits) requires any person planning to construct or add to a source of air contaminants, including the installation of any device to control air contaminant discharges, to obtain a construction permit from the SCDHEC prior to construction.

General Conformity

Established under Section 176(c)(4) of the CAA, "the General Conformity Rule ensures that the actions taken by federal agencies in nonattainment and maintenance areas do not interfere with a state's plans to meet national standards for air quality" outlined in the state implementation plan (SIP) (USEPA, 2013a). An action in designated nonattainment and maintenance areas would be evaluated for the emission of those particular pollutants under the General Conformity Rule through an applicability analysis. Pursuant to Title 40 CFR 93.153(d)(2) and (e), federal actions "in response to emergencies which are typically commenced on the order of hours or days after the emergency" and actions "which are part of part of a continuing response to emergency or disaster" that are taken up to 6 months after beginning response activities, will be exempt from any conformity determinations (GPO, 2010a).

The estimated pollutant emissions are compared to *de minimis*[128] levels. These values are the minimum thresholds for which a conformity determination must be performed (see Table 13.1.12-2). As a result, lower *de minimis* thresholds for VOCs and NO_X could apply depending on the attainment status of a county.

Table 13.1.12-2: *De Minimis* Levels

Pollutant	Area Type	TPY
Ozone (VOC or NO_X)	Serious Nonattainment	50
	Severe Nonattainment	25
	Extreme Nonattainment	10
	Other areas outside an OTR	100
Ozone (NO_X)	Maintenance	100
Ozone (VOC)	Maintenance outside an OTR	100
CO, SO_2, NO_2	All Nonattainment and Maintenance	100
PM_{10}	Serious Nonattainment	70
	Moderate Nonattainment and Maintenance	100
$PM_{2.5}$ (Direct Emissions) (SO_2) (NO_X (unless determined not to be a significant precursor)) (VOC or ammonia (if determined to be significant precursors))	All Nonattainment and Maintenance	100
Lead	All Nonattainment and Maintenance	25

Source: (GPO, 2010b)

If an action does not result in an emissions increase above the *de minimis* levels in Table 13.1.12-2, then a conformity determination is not required. If the applicability analysis shows that the total direct and indirect emissions are above the *de minimis* levels in Table 13.1.12-2, then the action must undergo a conformity determination. The federal agency must first show that the action would meet all SIP control requirements and that any new emissions would not

[128] *de minimis*: USEPA states that "40 CFR 93 § 153 defines de minimis levels, that is, the minimum threshold for which a conformity determination must be performed, for various criteria pollutants in various areas" (USEPA, 2016g).

cause a new violation of the NAAQS. To demonstrate conformity,[129] the agency would have to fulfill one or more of the following:

- Show any emissions increase is specifically identified and accounted for in the respective state's SIP;
- Receive acknowledgement from the state that any increase in emissions would not exceed the SIP emission budget;
- Receive acknowledgement from the state to revise the SIP and include emissions from the action;
- Show the emissions would be fully offset by implementing reductions from another source in the same area; and
- Conduct air quality modeling that demonstrates the emissions would not cause or contribute to new violations of the NAAQS, or increase the frequency or severity of any existing violations of the NAAQS (USEPA 2010).

State Implementation Plan Requirements

The South Carolina SIP is composed of many related actions to ensure ambient air concentrations of the six criteria pollutants comply with the NAAQS. South Carolina's SIP is a collection of separate actions taken for each of the pollutants. All of South Carolina's SIP actions are codified under 40 CFR Part 52 Subpart PP. More information on South Carolina's SIP is available on the SCDHEC SIP website, http://www.scdhec.gov/HomeAndEnvironment/Air/MostCommonPollutants/Ozone/StateImplementationPlan/.

13.1.12.3. Environmental Setting: Ambient Air Quality

Nonattainment Areas

The USEPA classifies areas as attainment, nonattainment, maintenance, or unclassifiable for six criteria pollutants. When evaluating an area's air quality against regulatory thresholds (i.e., permitting and general conformity), maintenance areas are often combined with nonattainment, while unclassifiable areas are combined with attainment areas. Figure 13.1.12-1 and Table 13.1.12-3, below, present the nonattainment areas in South Carolina as of January 30, 2015. The year(s) listed in the table for each pollutant indicate when USEPA promulgated the standard for that pollutant; note that, for $PM_{2.5}$, O_3, and SO_2, these standards listed are in effect. Table 13.1.12-3 contains a list of the counties and their respective current nonattainment status for each criteria pollutant. The year(s) listed in the table for each pollutant indicate when EPA promulgated the standard for that pollutant. Unlike Table 13.1.12-3, Figure 13.1.12-1 does not differentiate between standards for the same pollutant. Additionally, given that particulate matter is the criteria pollutant of concern, $PM_{10,}$ and $PM_{2.5}$ merge in the figure to count as a single pollutant.

[129] Conformity: Compliance with the State Implementation Plan.

Table 13.1.12-3: South Carolina Nonattainment and Maintenance Areas by Pollutant Standard and County

County	Pollutant and Year EPA Implanted Standard										
	CO	Lead		NO_2	PM_{10}	$PM_{2.5}$		O_3		SO_2	
	1971	1978	2008	1971	1987	1997	2006	1997	2008	1971	2010
York								M			
York (Charlotte-Rock Hill, NC-SC (SC portion))									X-5		

Source: (USEPA, 2015h)
X-1 = Nonattainment Area (Extreme)
X-2 = Nonattainment Area (Severe)
X-3 = Nonattainment Area (Serious)
X-4 = Nonattainment Area (Moderate)
X-5 = Nonattainment Area (Marginal)
X-6 = Nonattainment Area (Unclassified)
M = Maintenance Area

Air Quality Monitoring and Reporting

The SCDHEC measures air pollutants at 34 sites across the state as part of the National Air Monitoring Stations Network and the State and Local Air Monitoring Stations Network (SCDHEC, 2015h). Annual South Carolina State Ambient Air Quality Reports are prepared, containing pollutant data summarized by region (SCDHEC, 2015i). The SCDHEC reports real-time pollution levels of O_3.

Throughout 2012, O_3 measurements exceeded the federal standard of 0.075 ppm twelve times across nine counties in South Carolina including Abbeville, Anderson, Cherokee, Chesterfield, Darlington, Greenville, Richland, Spartanburg, and York. No other criteria pollutants exceed federal standards for the same period (SCDHEC, 2015i).

Air Quality Control Regions

USEPA classified all land in the United States as a Class I, Class II, or Class III Federal Air Quality Control Region (AQCR) (42 U.S.C. 7470). Class I areas include international parks, national wilderness areas which exceed 5,000 acres in size, national memorial parks which exceed 5,000 acres in size, and national parks which exceed 6,000 acres in size. Class I areas cannot be re-designated as Class II or Class III and are intended to maintain pristine air quality. Although USEPA developed the standards for a Class III AQCR, to date they have not actually classified any area as Class III. Therefore, any area that is not classified as a Class I area is, by default, automatically designated as a Class II AQCR (42 U.S.C. 7470).

- In a 1979 USEPA memorandum, the Assistant Administrator for Air, Noise, and Radiation (USEPA, 1979) advised USEPA Regional Offices to provide notice to the Federal Land Manager (FLM) of any facility subject to the Prevention of Significant Deterioration (PSD) permit requirements and within 100 kilometers[130] of a Class I area. "The EPA's policy is that FLMs should be notified by the Regional Office about any project that is within 100

[130] The memorandum and associated guidance use kilometers. 100 kilometers is equal to about 62 miles.

kilometers of a Class I area. For sources having the capability to affect air quality at greater distances, notification should also be considered for Class I areas beyond 100 kilometers" (Page, 2012). The 2005 USEPA guidelines for air quality modeling do not provide a precise modeling range for Class I areas.

- PSD applies to new major sources or major modifications at existing sources for pollutants where the source is in an attainment or unclassifiable area. An air quality analysis is required for sources subject to PSD requirements and generally consists of using a dispersion model to evaluate emission impacts to the area. "Historically, the EPA guidance for modeling air quality impacts under the PSD program has tended to focus more on the requirements for a Class II modeling analysis. Such guidance has provided that applicants need not model beyond the point of significant impact or the source or 50 kilometers[131] (the normal useful range of EPA-approved Gaussian plume models" (USEPA, 1992).

South Carolina has one Class I area: the Cape Romain Wilderness area. North Carolina has three Class I areas, the Shining Rock Wilderness, Linville Gorge Wilderness, and Joyce Kilmer-Slickrock Wilderness areas, where the 100-kilometer buffer intersects South Carolina counties. Tennessee has two Class I areas, the Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness areas, where the 100-kilometer buffer intersects South Carolina counties. South Carolina has one Class I area, the Wolf Island Wilderness area, where the 100-kilometer buffer intersects South Carolina counties. Any PSD-applicable action within these counties would require FLMs notification from the appropriate Regional Office. Figure 13.1.12-1 provides a map of South Carolina highlighting all relevant Class I areas and all areas within the 100-kilometer radiuses. The numbers next to each of the highlighted Class I areas in Figure 13.1.12-1 correspond to the numbers and Class I areas listed in Table 13.1.12-4.

Table 13.1.12-4: Relevant Federal Class I Areas

#[a]	Area	Acreage	State
1	Cape Romain Wilderness	28,000	SC
2	Shining Rock Wilderness	13,350	NC
3	Linville Gorge Wilderness	7,575	NC
4	Great Smoky Mountains NP	241,207	TN
5	Joyce Kilmer-Slickrock Wilderness	14,033	NC-TN
6	Wolf Island Wilderness	5,126	GA

Source: (USEPA, 2012b)

[a] The numbers correspond to the shaded regions in Figure 13.1.12-2.

[131] The memorandum and associated guidance use kilometers. 50 kilometers is equal to about 31 miles.

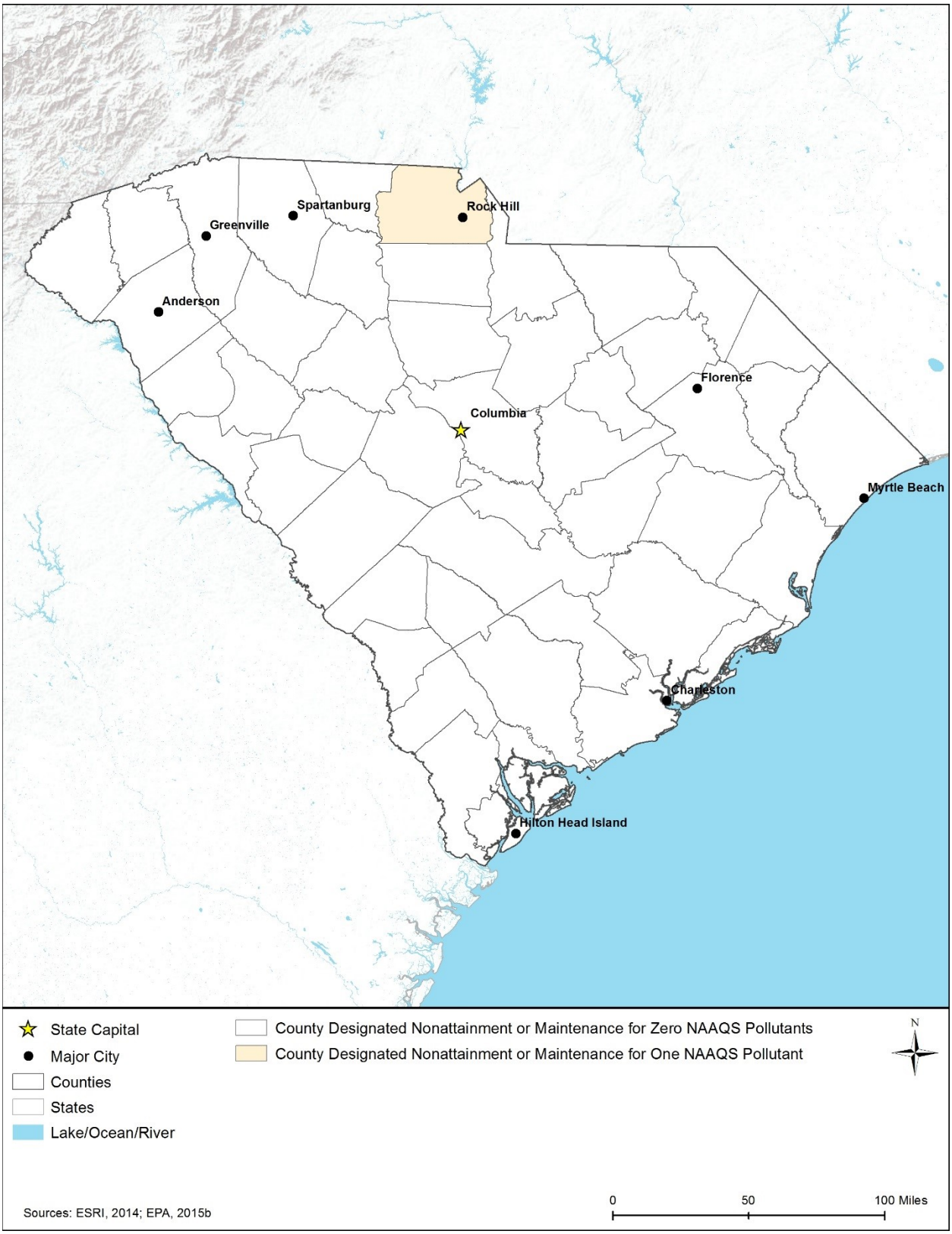


Figure 13.1.12-1: Nonattainment and Maintenance Counties in South Carolina

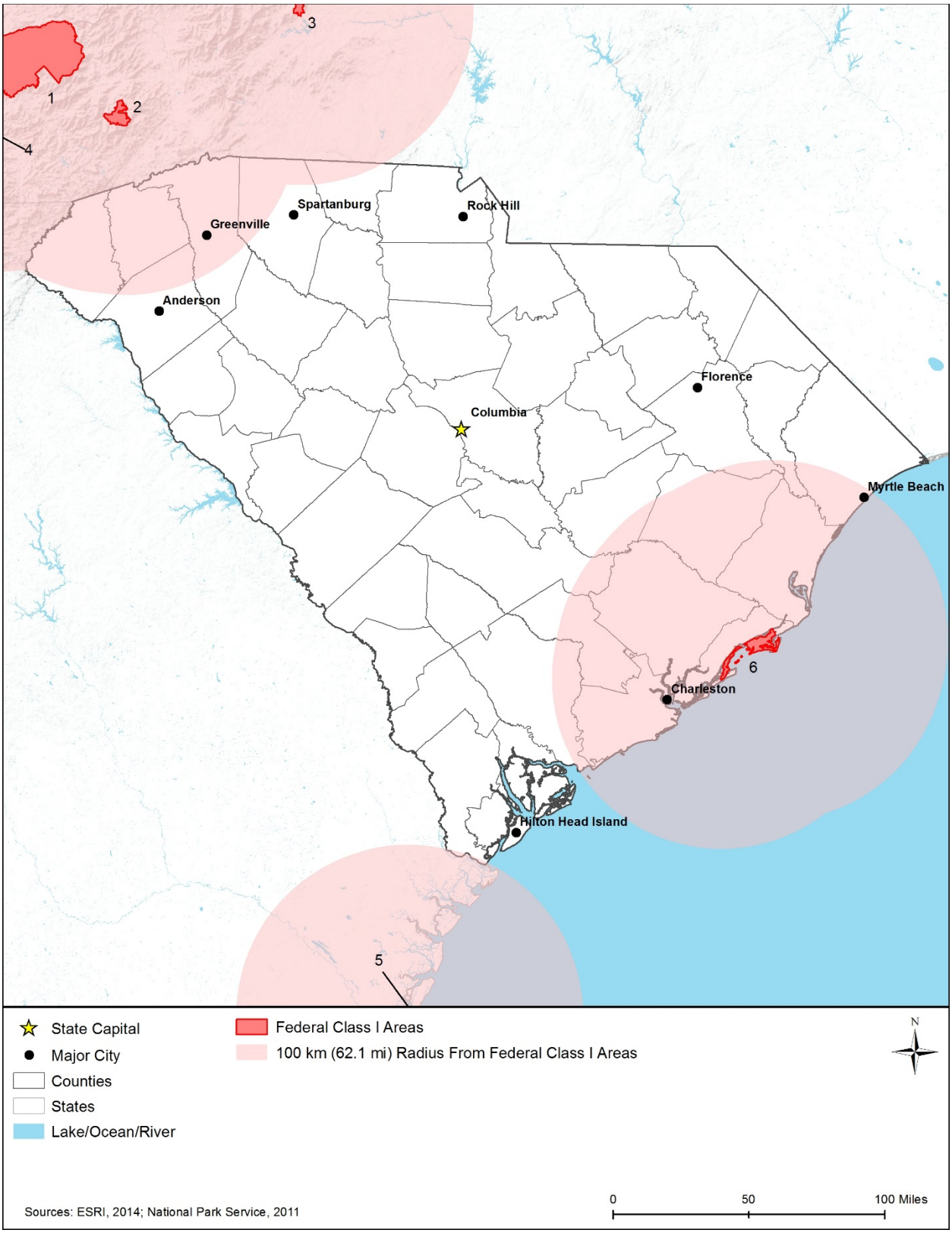


Figure 13.1.12-2: Federal Class I Areas with Implications for South Carolina

13.1.13. Noise

This section presents a discussion of a basic understanding of environmental noise, background/ambient noise levels, noise standards, and guidelines.

13.1.13.1. Definition of the Resource

Noise is a form of sound caused by pressure variations that the human ear can detect and is often defined as unwanted sound (USEPA, 2012c). Noise is one of the most common environmental issues that interferes with normal human activities and otherwise diminishes the quality of the human environment. Typical sources of noise that result in this type of interference in urban and suburban surroundings includes interstate and local roadway traffic, rail traffic, industrial activities, aircraft, and neighborhood sources like lawn mowers, leaf blowers, etc.

The effects of noise can be classified into three categories:

- Noise events that result in annoyance and nuisance;
- Interference with speech, sleep, and learning; and
- Physiological effects such as hearing loss and anxiety.

Fundamentals of Noise

For environmental noise analyses, a noise metric refers to the unit that quantitatively measures the effect of noise on the environment. The unit used to describe the intensity of sound is the decibel (dB). Audible sounds range from 0 dB ("threshold of hearing") to about 140 dB ("threshold of pain") (OSHA, 2016c). The vibration frequency characteristics of the sound, measured as sound wave cycles per second [Hertz (Hz)], determines the pitch of the sound (FTA, 2006). The normal audible frequency range is approximately 20 Hz to 20 kHz (FAA, 2015j). The A-weighted scale, denoted as dBA, approximates the range of human hearing by filtering out lower frequency noises, which are not as damaging as the higher frequencies. The dBA scale is used in most noise ordinances and standards (OSHA, 2016c).

Measurements and descriptions of noise (i.e., sounds) are based on various combinations of the following factors (FTA, 2006):

- The total sound energy radiated by a source, usually reported as a sound power level;
- The actual air pressure changes experienced at a particular location, usually measured as a sound pressure level (the frequency characteristics and sound pressure level combine to determine the loudness of a sound at a particular location);
- The duration of a sound; and
- The changes in frequency characteristics or pressure levels through time.

Figure 13.1.13-1 presents the sound levels of typical events that occur on a daily basis in the environment. For example, conversational speech is measured at about 55 to 60 dBA, whereas a band playing loud music may be as high as 120 dBA. (OSHA, 2013)

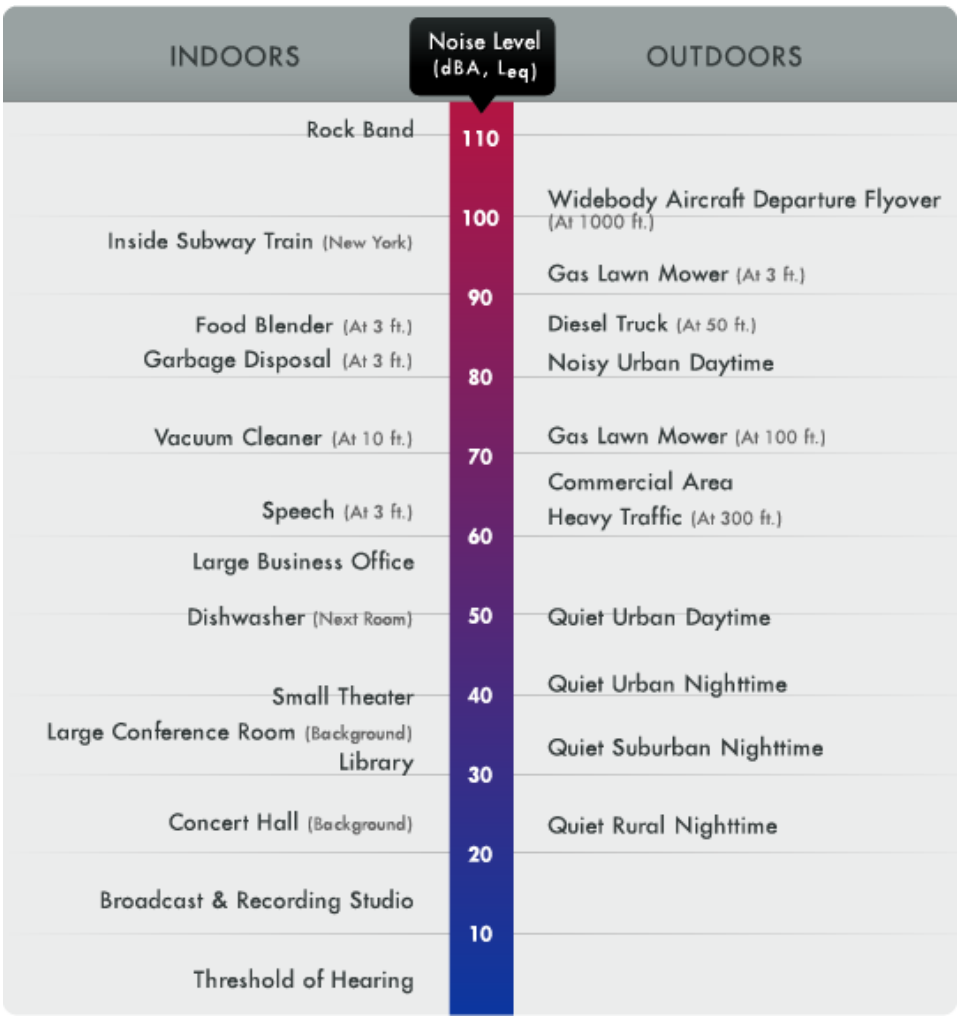


Figure 13.1.13-1: Sound Levels of Typical Sounds

Leq: Equivalent Continuous Sound Level

Source: (Sacramento County Airport System, 2015)
Prepared by: Booz Allen Hamilton

Because of the logarithmic unit of measurement, sound levels cannot be added or subtracted linearly. However, several methods of estimating sound levels can be useful in determining approximate sound levels. First, if two sounds of the same level are added, the sound level increases by approximately three dB (for example, 60 dB + 60 dB = 63 dB). Secondly, the sum of two sounds of a different level is slightly higher than the louder level (for example, 60 dB + 70 dB = 70.4 dB).

The changes in human response to changes in dB levels is categorized as follows (FTA, 2006):

- A 3-dB change in sound level is considered a barely noticeable difference;
- A 5-dB change in sound level will typically result in a noticeable community response; and
- A 10-dB change, which is generally considered a doubling of the sound level, almost certainly causing an adverse community response.

In general, ambient noise levels are higher during the day than at night and typically this difference is about 10 dB (USEPA, 1973). Ambient noise levels can differ considerably depending on whether the environment is urban, suburban, or rural.

13.1.13.2. Specific Regulatory Considerations

As identified in Appendix C, Environmental Laws and Regulations, the Noise Control Act of 1972, along with its subsequent amendments (e.g., Quiet Communities Act of 1978 [42 U.S.C. Parts 4901−4918]), delegates authority to the states to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Although no federal noise regulations exist, the USEPA has promulgated noise guidelines (USEPA, 1974). Similarly, most states have no quantitative noise-limit regulations.

South Carolina does not have any statewide noise laws that would apply to actions considered under the Proposed Action. There is a statewide noise law that exists in South Carolina addressing noise from the use of vehicles, motorboats, and trains. However, emergency vehicles are exempted from this law. Many cities and towns may have local noise ordinances to manage community noise levels. The noise limits specified in such ordinances are typically applied to define noise sources and specify a maximum permissible noise level. Large cities and towns, such as Charleston and Columbia, are likely to have different regulations than rural or suburban communities largely due to the population density and difference in ambient noise levels (FHWA, 2011).

13.1.13.3. Environmental Setting: Ambient Noise

The range and level of ambient noise in South Carolina varies widely based on the area and environment of the area. The population of South Carolina can choose to live and interact in areas that are large cities, rural communities, and national and state parks. Figure 13.1.13-1 illustrates noise values for typical community settings and events that are representative of what the population of South Carolina may experience on a day-to-day basis. These noise levels represent a wide range and are not specific to South Carolina. As such, this section describes the areas where the population of South Carolina can potentially be exposed to higher than average noise levels.

- **Urban Environments:** Urban areas are likely to have higher noise levels on a daily basis due to highway traffic (70 to 90 dBA), construction noise (90 to 120 dBA), and outdoor conversations (e.g., small/large groups of people) (60 to 90 dBA) (DOI, 2008). The areas that are likely to have the highest ambient noise levels in the state are: Charleston (and its neighboring boroughs and cities), Columbia, and Rock Hill.
- **Airports:** Areas surrounding airports tend to be more sensitive to noise due to aircraft operations that occur throughout the day. A jet engine aircraft can produce between 130 to 160 dBA in its direct proximity (FAA, 2007). However, commercial aircraft are most likely to emit noise levels between 70 to 100 dBA depending of the type of aircraft and associated engine (FAA, 2012a). This noise will be perceived differently based on the altitude of the aircraft and its distance to the point of measurement. Airport operations are primarily arrivals and departures of commercial aircraft but based on the type of airport can include

touch-and-go operations that are typical of general aviation airports and military airfields. The location of most commercial airports are in the proximity of urban communities; therefore, aircraft operations (arrivals/departures) can result in noise exposure in the surrounding areas to be at higher levels with the potential for increased noise levels during peak operation times (early morning and evenings), when there is an increase in air traffic. The noise levels in areas surrounding commercial airports can have significantly higher ambient noise levels than in other areas. In South Carolina, Charleston International Airport (CHS), Greenville-Spartanburg International Airport (GSP), and Myrtle Beach International Airport (MYR) have more than 303,000 annual operations combined (FAA, 2015b). These operations result in increased ambient noise levels in the surrounding communities. See Section 13.1.1, Public Safety Infrastructure, and Figure 13.1.7-4 for more information about airports in the state.

- **Highways:** Communities near major highways also experience higher than average noise levels when compared to areas that are not in close proximity to a highway (FHWA, 2015d). There are a number of major highways within the state that may contribute to higher ambient noise levels for residents living in those areas. The major highways in the state tend to have higher than average ambient noise levels on nearby receptors, ranging from 52 to 75 dBA (FHWA, 2015d). See Section 13.1.1, Public Safety Infrastructure, and Figure 13.1.13-1 for more information about the major highways in the state.
- **Railways:** Like highways, railways tend to have higher than average ambient noise levels for residents living in close proximity (FTA, 2006). Railroad operations can produce noise ranging from 70 dBA for an idling locomotive to 115 dBA when the locomotive engineer rings the horn while approaching a crossing (USDOT, 2015c). South Carolina has multiple rail corridors with high levels of commercial and commuter rail traffic. These major rail corridors include lines that extend mainly from Charleston and Columbia to other cities in South Carolina, Georgia, and North Carolina, such as CSX (SC Department of Commerce, 2008). See Section 13.1.1, Public Safety Infrastructure, and Figure 13.1.13-1 for more information about rail corridors in the state.
- **National and State Parks:** The majority of national and state parks are likely to have lower than average ambient noise levels given their size and location in wilderness areas. National and state parks, historic areas, and monuments are protected areas. These areas typically have lower noise levels, as low as 30 to 40 dBA (NPS, 2014e). South Carolina has six national parks and six NNLs (NPS, 2015h). Visitors to these areas expect lower ambient noise conditions than the surrounding urban areas. See Section 13.1.8, Visual Resources, for more information about national and state parks for South Carolina.

13.1.13.4. Sensitive Noise Receptors

Noise-sensitive receptors include residences, schools, medical facilities, places of worship, libraries, churches, nursing homes, concert halls, playgrounds, and parks. Sensitive noise receptors are typically areas where the intrusion of noise can disrupt the use of the environment. A quiet urban area usually has a typical noise level in the daytime of 50 dBA, and 40 dBA during the evening. Noise levels in remote wilderness and rural nighttime areas are usually 30 dBA

(BLM, 2014). Most cities, towns, and villages in South Carolina have at least one school, church, or park, in addition to likely having other noise-sensitive receptors. There are most likely thousands of sensitive receptors throughout the state of South Carolina.

13.1.14. Climate Change

13.1.14.1. Definition of the Resource

Climate change, according to the Intergovernmental Panel on Climate Change (IPCC), is defined as "…a change in the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or human activity" (IPCC, 2007).

Accelerated rates of climate change are linked to an increase in atmospheric concentrations of greenhouse gas (GHG) caused by emissions from human activities such as burning fossil fuels to generate electricity (USEPA, 2012d). The IPCC is now 95 percent certain that humans are the main cause of current global warming (IPCC, 2013). Human activities result in emissions of four main GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halocarbons (a group of gases containing fluorine, chlorine, or bromine) (IPCC, 2007). The common unit of measurement for GHGs is metric tons of CO_2-equivalent (MT CO_2e),[132] which equalizes for the different global warming potential of each type of GHG. Where this document references emissions of CO_2 only, the units are in million metric tons (MMT) CO_2. Where the document references emissions of multiple GHGs, the units are in MMT CO_2e.

The IPCC reports that "global concentrations of these four GHGs have increased significantly since 1750" where "atmospheric concentrations of CO_2 increased from 280 parts per million (ppm) of carbon in 1750 to 379 ppm of carbon in 2005" (IPCC, 2007). The atmospheric concentration of CH_4 and N_2O have increased from pre-industrial values of about 715 and 270 parts per billion (ppb) to 1774 and 319 ppb, respectively, in 2005 (IPCC, 2007). In addition, the IPCC reports that human activities are causing an increase in various hydrocarbons from near-zero pre-industrial concentrations (IPCC, 2007).

Both the GHG emissions effects of the Proposed Action and Alternatives, and the relationships of climate change effects to the Proposed Action and Alternatives, are considered in this PEIS (see Chapter 13, Environmental Consequences). Existing climate conditions in the project area are described first by state and sub-region, where appropriate, and then by future projected climate scenarios. The discussion focuses on the following climate change impacts: 1) temperature; 2) precipitation; 3) sea level; and 4) severe weather events (including tropical storms, tropical cyclones, and hurricanes).

[132] CO_2e refers to Carbon Dioxide Equivalent, "A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Carbon dioxide equivalents are commonly expressed as million metric tons of carbon dioxide equivalents ($MMTCO_2e$). The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP. $MMTCO_{2e}$ = (million metric tons of a gas) * (GWP of the gas)" (USEPA, 2015d).

13.1.14.2. Specific Regulatory Considerations

The pertinent federal laws relevant to the protection and management of climate change are summarized in Appendix C, Environmental Laws and Regulations. South Carolina has not established goals and regulations to reduce GHG emissions to combat climate change. However, the SCDNR published "Climate Change Impacts to Natural Resources in South Carolina," which begins to evaluate potential climate change impacts on South Carolina (SCDNR, 2013).

13.1.14.3. South Carolina Greenhouse Gas Emissions

Estimates of South Carolina's total GHG emissions vary. DOE's Energy Information Agency (EIA) collects and disseminates national-level emissions data on other GHGs such as CH_4 and nitrous oxide (NO_x), but not at the state level (EIA, 2011). The USEPA also collects and disseminates national-level GHG emissions data, but by economic sector, not by state (USEPA, 2015e). Individual states have developed their own GHG inventories, which are updated with different frequencies and trace GHGs in a variety of ways.

For the purposes of this PEIS, the EIA data on CO_2 emissions are used as the baseline metric to ensure consistency and comparability across the 50 states. However, if additional data sources on GHG emissions are available for a given state, including other GHGs such as CH_4, they are described and cited.

According to the EIA, South Carolina emitted a total of 69.2 MMT of CO_2 in 2013 with the transportation sector the largest emitter at 43 percent of total CO_2 emissions and electric power sector second at 41 percent (Table 13.2.14-1) (EIA, 2015c). Annual emissions between 1980 and 2013 are presented in Figure 13.1.14-1.

Between 1980 and 1983, South Carolina's annual CO_2 emissions declined from 55.3 MMT to 49.3 MMT, before increasing to a maximum of 89.1 MMT in 2004 from which they declined to their current levels. Increases and decreases took place across all sectors and fuel types. Transportation dominates the petroleum product emissions, and electric power dominates the coal emissions (EIA, 2015c) although more than half of South Carolina's electricity generation capacity is nuclear (EIA, 2015d). In 2013, South Carolina was ranked 28th among the states and the District of Columbia for total CO_2 emissions and 29th for per capita CO_2 emissions (EIA, 2015e).

Table 13.1.14-1: South Carolina CO_2 Emissions from Fossil Fuels by Fuel Type and Sector, 2013

Fuel Type (MMT)		Source (MMT)	
Coal	24.3	Residential	1.8
Petroleum Products	32.3	Commercial	1.7
Natural Gas	12.6	Industrial	7.9
		Transportation	29.5
		Electric Power	28.2
TOTAL	**69.2**	**TOTAL**	**69.2**

Source: (EIA, 2015c)

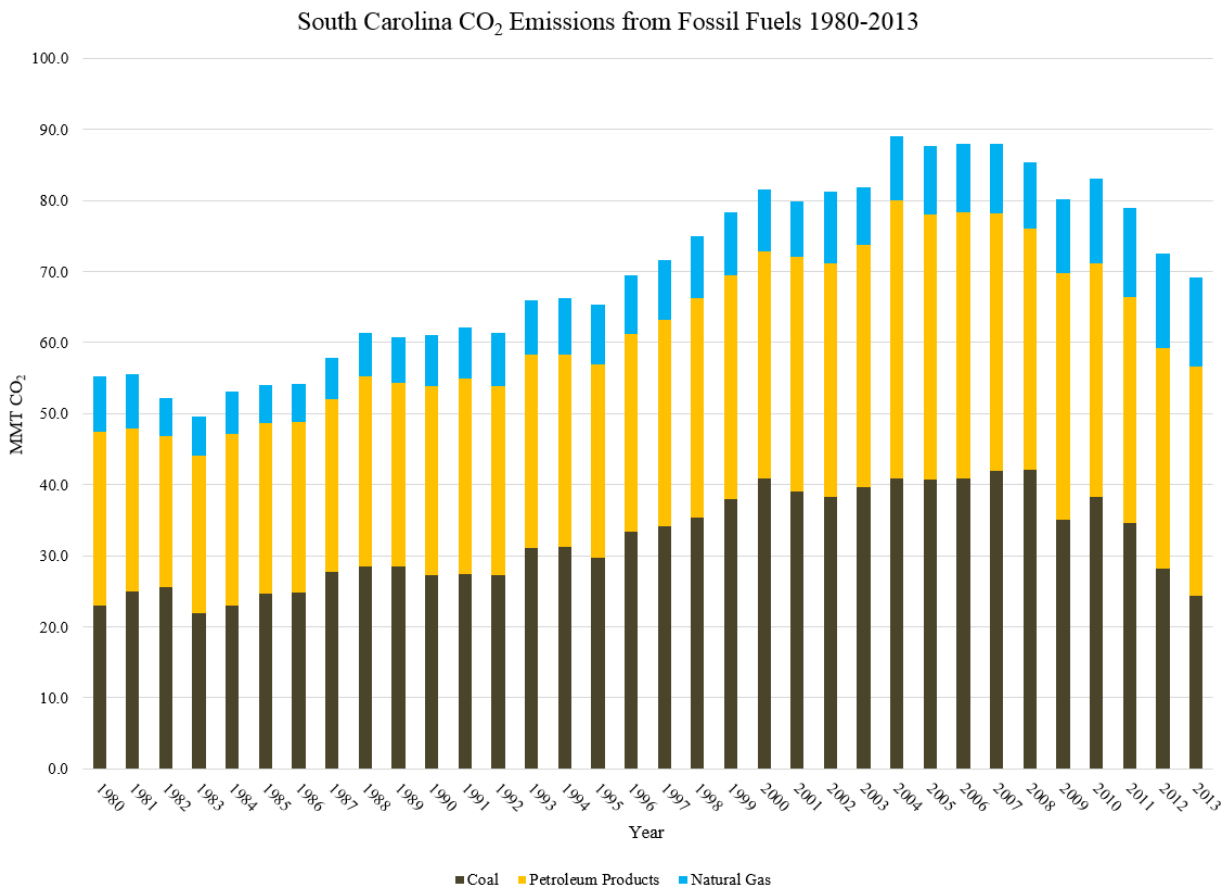


Figure 13.1.14-1: South Carolina CO_2 Emissions from Fossil Fuels by Fuel Type 1980-2013

Source: (EIA, 2015c)

South Carolina commissioned the Center for Climate Strategies to prepare GHG emissions inventory, which was completed in 2008 (CCS, 2008). The report includes estimates of emissions from 1990 to 2005, and projections to 2020. Greenhouse gas emissions in 1990 were estimated to be 67.2 MMT CO_2e, 87.8 MMT CO_2e in 2000, and 93.5 MMT CO_2e in 2005. For comparison, total U.S. GHG emissions were 7,379 MMTs CO_2e in 2005 (USEPA, 2014b).

The majority of South Carolina's GHG emissions are CO_2. These emissions are the result of fossil fuel combustion for the purpose of producing electricity, petroleum products used in the transportation sector. Other major GHGs emitted in South Carolina are CH_4 and N_2O from the agricultural and industrial sectors. The inventory also includes small amounts of hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6) and perfluorocarbons (PFCs). (CCS, 2008)

In the 1990s, South Carolina's economy and population grew, resulting in a significant increase in the transportation sector. In 2005, on-road automobile emissions accounted for 68 percent of emissions, a 34 percent increase from 2000. Vehicles powered by gasoline were responsible for 68 percent of transportation emissions while diesel contributed 24 percent. Between 1990 and 2005 all transportation related emissions increased annually by 2.3 percent. Within the same

time frame, the state's gross GHG emissions increased by 34 percent while the nation's transportation emissions grew 27 percent (CCS, 2008). Future projections for South Carolina GHG emissions in 2010 and 2020 were 102.2 MMT CO_2e and 125.4 MMT CO_2e, respectively (CCS, 2008).

13.1.14.4. Environmental Setting: Existing Climate

The National Weather Service defines climate as the "reoccurring average weather found in any particular place" (NWS, 2011a). The widely accepted division of the world into major climate categories is referred to as the Köppen-Geiger climate classification system. Climates within this system are classified based "upon general temperature profiles related to latitude" (NWS, 2011a). The first letter in each climate classification details the climate group. The Köppen-Geiger system further divides climates into smaller sub-categories based on precipitation and temperature patterns. The secondary level of classification details the seasonal precipitation, degree of aridity, and presence or absence of ice. The tertiary levels distinguish different monthly temperature characteristics (NWS, 2011b).

The entirety of South Carolina falls into climate group C. Climates classified as C are generally warm, with humid summers and mild winters. During winter months, the mean climate feature is the mid-latitude cyclone (NWS, 2011a) (NWS, 2011b). South Carolina has one sub-climate category, which is described in the following paragraphs.

Cfa – The Köppen-Geiger climate classification system classifies the entirety of South Carolina as Cfa. Cfa climates are generally warm, with humid summers and mild winters. In this climate classification zone, the secondary classification indicates year-round rainfall, but it is highly variable; thunderstorms are dominant during summer months. In this climate classification zone, the tertiary classification indicates mild, hot summers with an average temperature of warm months over 72 °F. Average temperatures of the coldest months are under 64 °F. (NWS, 2011a) (NWS, 2011b)

This section discusses the current state of South Carolina's climate with regard to air temperature, precipitation, sea level, and extreme weather events (e.g., tropical storms, tropical cyclones, and hurricanes) in the state's climate region, Cfa.

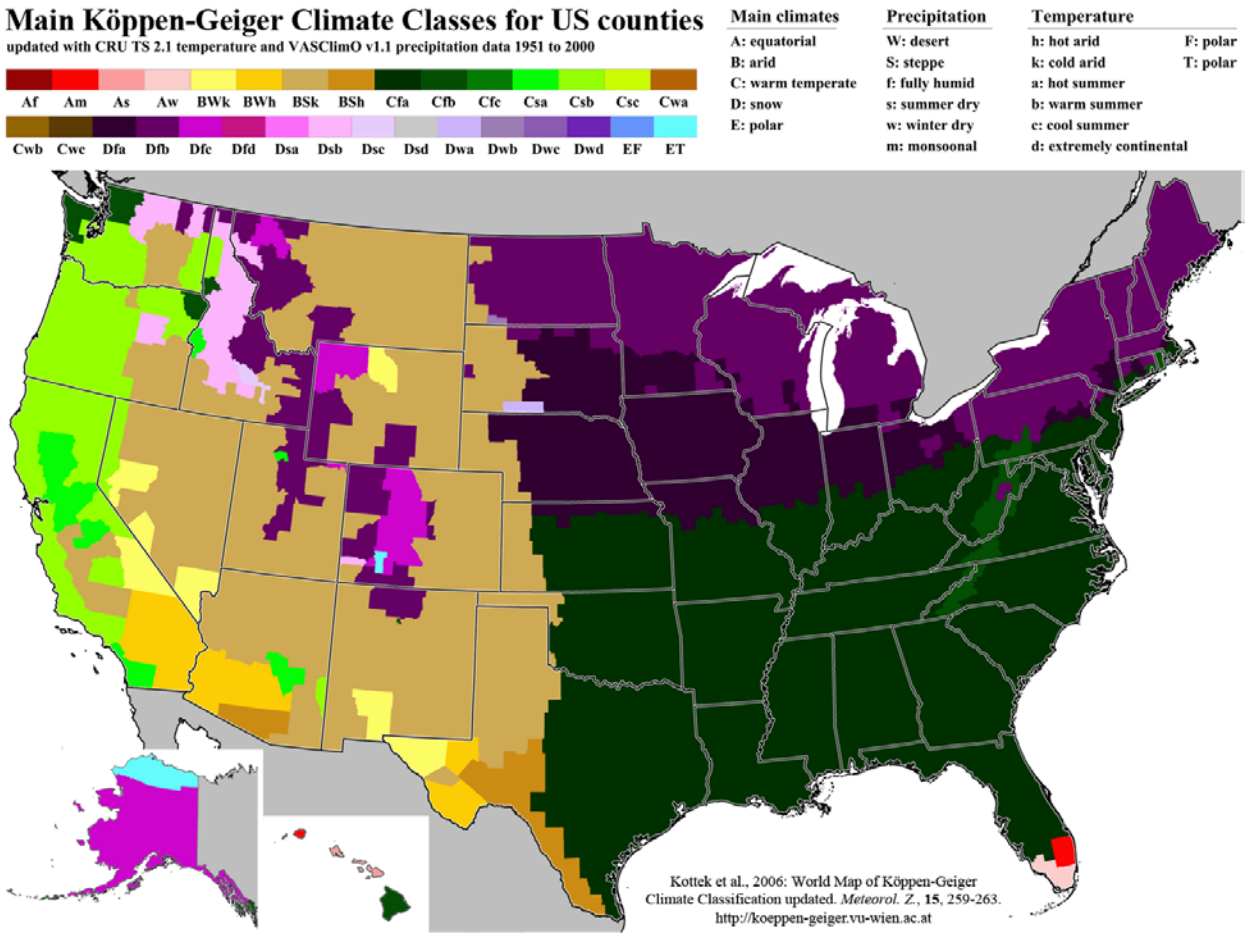


Figure 13.1.14-2: Köppen-Geiger Climate Classes for US Counties

Source: (Kottek, 2006)

Air Temperature

Although several factors play a role in South Carolina's climate, the two leading factors is the state's proximity to the Atlantic Ocean and the Appalachian Mountains. Average temperatures in South Carolina are "generally mild with the annual average fluctuating from the mid-50s in the mountains to the low 60s along the coast" (Mizzell, 2015).

Weather in South Carolina between October and April is largely controlled "by the characteristics of the air masses and frontal systems that move eastward or southeastward across the United States" (Mizzell, 2015). Summer months in South Carolina are hot and humid, with temperatures ranging from "the upper 60s in the mountains, to the mid-70s in the Low Country" (Mizzell, 2015). Maximum temperatures during summer months can reach 90 °F "an average of 55 days each year between the months of April and October" (Mizzell, 2015).

Cfa – Columbia, the capital of Louisiana, is located within the climate classification zone Cfa. The average annual temperature in Columbia is approximately 64.9 °F; 47.8 °F during winter months; 81.1 °F during summer months; 64.4 °F during spring months; and 65.7 °F during autumn months (NOAA, 2015h). Charleston, located in southern South Carolina along the coast,

is also within the climate classification zone Cfa. The average annual temperature in Charleston is approximately 65.9 °F; 50.2 °F during winter months; 80.7 °F during summer months; 65.2 °F during spring months; and 67.2 °F during autumn months. Greenwood, located in South Carolina's northwestern interior, is also within the climate classification zone Cfa. The average annual temperature in Greenwood is approximately 61.8 °F; 44.1 during winter months; 79.2 °F during summer months; 61.1 °F during spring months; and 62.6 °F during autumn months. (NOAA, 2015h)

Precipitation

On average, South Carolina receives approximately 47.9 inches of precipitation each year. Distribution of rainfall varies geographically, annually, and seasonally. During summer months, "the strengthening of high-pressure systems offshore keeps the state under the effects of tropical maritime air for extended periods" (Mizzell, 2015). This circulation strongly influences rainfall patterns throughout the state, "by transporting warm, moist air inland from the ocean" (Mizzell, 2015). During summer months in particular, warm air rises and forms localized thunderstorms, "resulting in a summer precipitation maximum" (Mizzell, 2015). The majority of rainfall in South Carolina falls during thunderstorms.

During summer months (June through August), average rainfall statewide is approximately 15.66 inches. Summer and early fall months also bring at least one tropical storm or hurricane. Tropical storms and hurricanes are common, due to the state's coastal orientation, "accounting for an average of 13 percent of all heavy rainfall events in the Southeast U.S." (Mizzell, 2015). Precipitation received between October and November is generally the lowest in the state. During winter months, precipitation is "generally caused almost entirely by the passage of the low-pressure and associated frontal systems" (Mizzell, 2015).

Cfa – Columbia, the capital of South Carolina, is within the climate classification zone Cfa. The average annual precipitation accumulation in Columbia is 45.40 inches; 10.48 inches during winter months; 15.03 inches during summer months; 9.54 inches during spring months; and 10.35 inches during autumn months. Charleston, in southern South Carolina along the coast, is also within the climate classification zone Cfa. The average annual precipitation accumulation in Charleston is 51.03 inches; 9.78 inches during winter months; 19.33 inches during summer months; 9.64 inches during spring months; and 12.28 inches during autumn months. Greenwood, in South Carolina's northwestern interior, is also within the climate classification zone Cfa. The average annual precipitation accumulation in Greenwood is approximately 44.60 inches; 12.35 inches during winter months; 11.14 inches during summer months; 10.93 inches during spring months; and 10.18 inches during autumn months. (NOAA, 2015h)

Sea Level

South Carolina has "187 miles of coastline, 2,876 miles of tidal shoreline, and 8 coastal counties" (SCDHEC, 2015j). Much of this shoreline is at risk for damage from strong winds, heavy rainfall, flooding, tropical storms, and hurricanes. Since 1900, global sea level has risen by approximately 8 inches (Climate Central, 2014a). As sea level continues to rise, the risks associated with living along the coast also rise. In Charleston, flooding averaged fewer than five

days per year between 1957 and 1963. However, in accordance with sea level rise and increasing precipitation, the city averaged more than 23 flooding days a year between 2007 and 2013. As sea level continues to rise, the risks associated with living along the coast also rise. Superstorm Sandy highlighted in 2012 the risks and vulnerabilities of living near unprotected tidal shoreline. (Climate Central, 2014a) (Climate Central, 2014b) (Slade, 2014)

Severe Weather Events

Tropical cyclones in South Carolina are infrequent, providing occasional influences in rainfall during summer and autumn months. "The major coastal impacts from tropical cyclones are storm surge, winds, precipitation, and tornadoes" (South Carolina State Climatology Office, 2015). By comparison, hurricanes are much more intense than tropical cyclones, as wind speeds regularly exceed 74 mph. These winds, in combination with low-pressure systems, "combine to result in significant ocean rise and wave action" (South Carolina State Climatology Office, 2015). This rise in water levels, known as storms surge, "plagues coastal inland and low-lying inland areas as these storms make landfall" (South Carolina State Climatology Office, 2015). Inland regions are affected by tropical cyclones, as strong, destructive winds move inward (South Carolina State Climatology Office, 2015).

South Carolina's deadliest hurricane occurred on August 27, 1893. This storm resulted in extensive flooding along the state's coast, winds exceeded 120 mph, and more than 2,000 people drowned. Monetary damages from this storms totaled $10 million (in 1893 dollars). More recently, on September 22, 1989, Hurricane Hugo crossed into the state near the Isle of Palms. During this storm, winds reached 138 mph, with wind gusts exceeding 160 mph. In total, damages from this storm exceeded $6 billion, 50 to 70,000 people were left homeless, and 26 people were killed. Major industries affected included the utilities, agriculture, timber, and commerce sectors. (South Carolina State Climatology Office, 2015)

Flooding is also common to South Carolina, with the majority of floods occurring during autumn and early spring months as coastal storms begin to intensify. Although the state employs significant flood control measures, flooding occurs several times each year in South Carolina. The state "can experience riverine flooding any month of the year," however, the majority of floods experienced are the result of tropical cyclones and/or hurricanes. (South Carolina State Climatology Office, 2015)

On January 1, 1987, a storm system brought strong winds and record high tides, causing over $25 million in damages to South Carolina's beachfront properties. In October 1990, the remnants of Hurricane Klaus and Tropical Storm Marco caused four deaths in Kershaw County when a dam broke, "sending water across a road trapping people in their vehicle" (South Carolina State Climatology Office, 2015). "As a result of the flooding, Aiken, Calhoun, Cherokee, Darlington, Edgefield, Florence, Kershaw, Lee, Orangeburg, Spartanburg, Sumter, and Union counties were declared federal disaster areas" (South Carolina State Climatology Office, 2015). During another historic flooding event, the remnants of Hurricane Floyd lead to approximately 15 to 20 inches of rainfall in some coastal areas of the state, causing record flooding along the Waccamaw River. In Horry County alone, over 1,700 homes were damaged or destroyed. In Murrell's Inlet, floodwaters of three feet were reported. The most extensive

flooding on record to occur in the state occurred in August 1908, when all of the major rivers in the state "rose from 9 to 22 feet above flood stage" (South Carolina State Climatology Office, 2015). In many locations, rainfall accumulation totals reached record highs of two to four times the normal amount of rainfall. South Carolina's deadliest flood occurred in June 1903, when 60 to 80 people drowned during a flash flooding event along the Pacolet River. (South Carolina State Climatology Office, 2015)

South Carolina ranks 23rd in the U.S. for "annual tornado frequency during the period 2000 – 2014" (South Carolina State Climatology Office, 2015). Between 1950 and 2014, South Carolina experienced 940 confirmed tornadoes, with an average of 15 tornadoes occurring each year. Between 1994 and 2014, "the annual average was 26 tornadoes per year" (South Carolina State Climatology Office, 2015). Although tornadoes can touch down during any month of the year, the majority of tornadoes strike during March, April, May, and September. (South Carolina State Climatology Office, 2015)

The state's deadliest tornado occurring on April 30, 1924, killing 77 people, injuring 778, and destroying 465 homes. During the state's second deadliest tornado on March 28, 1984, 15 people were killed and 448 were injured, with damages amounting to over $100 million. More recently, in September 2004, the remnants of Tropical Storm Frances "triggered a record 47 tornadoes as it tracked up the spine of the Appalachians" (South Carolina State Climatology Office, 2015). Sumter County experienced the most extensive damage, with three deaths and over $1.7 million in damages. In total, this tornado outbreak injured 13 people and caused over $2.77 million in total statewide damages. (South Carolina State Library, 2015)

13.1.15. Human Health and Safety

13.1.15.1. Definition of the Resource

The existing environment for health and safety is defined by occupational and environmental hazards likely to be encountered during the deployment, operation, and maintenance of towers, antennas, cables, utilities, and other equipment and infrastructure at existing and potential FirstNet telecommunication sites. There are two human populations of interest within the existing environment of health and safety, (1) telecommunication occupational workers and (2) the public near telecommunication sites. Each of these populations could experience different degrees of exposure to hazards as a result of their relative access to FirstNet telecommunication sites and their function throughout the deployment of the FirstNet telecommunication network infrastructure.

The health and safety issues reviewed in this section include occupational safety for telecommunications workers, contaminated sites, and manmade or natural disaster sites. This section does not evaluate the health and safety risks associated with radio frequency (RF) radiation or vehicle traffic. Vehicle traffic and the transportation of hazardous materials and wastes are evaluated in Section 13.1.1, Infrastructure.

13.1.15.2. Specific Regulatory Considerations

Federal organizations, such as OSHA, USEPA, the U.S. Department of Health and Human Services, and others protect human health and the environment. In South Carolina, the South

Carolina Department of Labor, Licensing & Regulation (SCDLLR), and the SCDHEC regulates waste and environmental pollution, as well as public health. Federal OSH regulations apply to workers through either OSHA, or stricter state-specific plans that must be approved by OSHA. OSHA enforces occupational safety regulations at the state level by SCOSH and at the federal level.

Federal laws relevant to protect occupational and public health and safety are summarized in Section 1.8, Overview of Relevant Federal Laws and Executive Orders and Appendix C, Environmental Laws and Regulations. Table 13.2.15-1 below summarizes the major South Carolina laws relevant to the state's occupational health and safety, hazardous materials, and hazardous waste management programs.

Table 13.1.15-1: Relevant South Carolina Human Health and Safety Laws and Regulation

State Law/Regulation	Regulatory Agency	Applicability
South Carolina Code of Laws: Title 41, Chapter 15	SCDLLR	Outlines the South Carolina Occupational Safety and Health State Plan.
South Carolina Code of Laws: Title 44, Chapter 56, Article 7	SCDHEC	Allows for the redevelopment or return to use of sites whose redevelopment is complicated by environmental contamination.
South Carolina Code of Laws: Title 48, Chapter 20	SCDHEC, South Carolina Mining Council	Details state mining and reclamation standards to provide for the safety of workers and the public.

13.1.15.3. Environmental Setting: Existing Telecommunication Sites

There are many inherent health and safety hazards at telecommunication sites. Telecommunication site work is performed indoors, below ground level, on building roofs, over water bodies, and on communication towers. Tasks may also be performed at dangerous heights, while operating heavy equipment, on energized equipment near underground and overhead utilities, and while using hazardous materials, such as flammable gases and liquids. Because telecommunication workers are often required to perform work outside, heat and cold exposure, precipitation, and lightning strikes also present hazard and risks depending on the task, occupational competency, and work-site monitoring (OSHA, 2016a). A summary description of the health and safety hazards present in the telecommunication occupational work environment is listed below.

Working from height, overhead work, and slips, trips, or falls – At tower and building-mount sites, workers regularly climb structures using fixed ladders or step bolts to heights up to 2,000 feet above the ground's surface (OSHA, 2015b). In addition to tower climbing hazards, telecommunication workers have restricted workspace on rooftops or work from bucket trucks parked on uneven ground. Cumulatively, these conditions present fall and injury hazards to telecommunication workers, and the public who may be observing the work or transiting the area (International Finance Corporation, 2007).

Trenches and confined spaces – Installation of underground utilities, building foundations, and work in utility manholes[133] are examples of when confined space work is necessary. Installation of telecommunication activities involves laying conduit and in small trenches (generally 6 to 12 inches in width). Confined space work can involve poor atmospheric conditions, requiring ventilation and rescue equipment. Additionally, when inside a confined space, worker movement is restricted and may prevent a rapid escape or interfere with proper work posture and ergonomics. (OSHA, 2016b)

Heavy equipment and machinery – New and replacement facility deployment and maintenance can involve the use of heavy equipment and machinery. During the lifecycle of a telecommunication site, heavy equipment such as bulldozers, backhoes, dump trucks, cement trucks, and cranes are used to prepare the ground, transport materials, and soil, and raise large sections of towers and antennas. Telecommunication workers may be exposed to the additional site traffic and often work near heavy equipment to direct the equipment drivers and to accomplish work objectives. Accessory machinery such as motorized pulley systems, hydraulic metal shears, and air driven tools present additional health and safety risks as telecommunication work sites. These pieces of machinery can potentially sever skin and bone, or cause other significant musculoskeletal injuries to the operator. (OSHA, 2016b)

Energized equipment and existing utilities – Electrical shock from energized equipment and utilities is an elevated risk at telecommunication sites due to the amount of electrical energy required for powering communication equipment and broadcasting towers. Telecommunication cables are often co-located with underground and overhead utilities, which can further increase occupational risk during earth-breaking and aerial work (International Finance Corporation, 2007).

Optical fiber safety – Optical fiber cable installation and repair presents additional risks to telecommunications workers, including potential eye or tissue damage, through ingestion, inhalation, or other contact with glass fiber shards. The shards are generated during termination and splicing activities, and can penetrate exposed skin (International Finance Corporation, 2007). Additionally, fusion splicing (to join optical fibers) in confined spaces or other environments with the potential for flammable gas accumulation presents risk of fire or explosion (Fiber Optic Association, 2010).

Noise – Sources of excess noise at telecommunication sites include heavy equipment operation, electrical power generators and other small engine equipment, air compressors, electrical and pneumatic power tools, and road vehicles, such a diesel engine work trucks. The cumulative noise environment has the potential to exceed the OSHA acceptable level of 85 dB per 8-hour time weighted average (see Section 13.1.13, Noise) (OSHA, 2002). Fugitive noise may emanate beyond the telecommunication work site and impact the public living in the vicinity, observing the work, or transiting through the area. (OSHA, 2016b)

[133] Manholes may be used for telecommunications activities, especially in cities and urban areas, depending on the location of other utilities. In cities, power, water, and telecommunication lines are often co-located; if access is through a manhole in the street, that access will be used.

Hazardous materials and hazardous waste – Work at telecommunication sites may require the storage and use of hazardous materials such as fuel sources for backup power generators and compressed gases used for welding and metal cutting (new towers only). In some cases, telecommunication sites require use of potentially hazardous products (e.g., herbicides). Secondary hazardous materials (e.g., exhaust fumes) may be a greater health risk than the primary hazardous material (e.g., diesel fuel). Furthermore, the use of hazardous materials creates down-stream potential to generate hazardous waste. While it is unlikely that any FirstNet activities would involve the generation or storage of hazardous waste, older existing telecommunication structures and sites could have hazardous materials present, such as lead-based paint on outdoor structures or asbestos tiles and insulation in equipment sheds. The public, unless a telecommunication work site allows unrestricted access, are typically shielded from hazardous materials and hazardous wastes that are components of telecommunication site work. (OSHA, 2016b)

Aquatic environments – Installation of telecommunication lines may include laying, burying, or boring lines under wetlands and waterways, including lakes, rivers, ponds, and streams. Workers responsible for these activities operate heavy equipment from soft shorelines, boats, barges, and other unstable surfaces. There is potential for equipment and personnel falls, as well as drowning in waterbodies. Wet work conditions also increase risks of electric shock and hypothermia. (OSHA, 2016b)

Outdoor elements – Weather conditions have the potential to quickly and drastically reduce safety, and increase hazards at telecommunication work sites. Excessive heat and cold conditions impact judgement, motor skills, hydration, and in extreme cases may lead to hyper- or hypothermia. Precipitation, such as rain, ice, and snow, create slippery climbing conditions and wet or muddy ground conditions. Lightning strikes are risks to telecommunication workers climbing towers or working on top of buildings. (OSHA, 2016b)

Telecommunication Worker Occupational Health and Safety

The U.S. Department of Labor, BLS uses established industry and occupational codes to classify telecommunications workers. For industry classifications, BLS uses the North American Industry Classification System (NAICS) codes, which identify the telecommunications industry (NAICS code 517XX) as being within the information industry (NAICS code 51). For occupational classifications, BLS uses the Standard Occupational Classification (SOC) system to identify workers as belonging to one of 840 occupations. Telecommunications occupations are identified as either telecommunication equipment installers and repairers, except line installers (SOC code 49-2022), or telecommunication line installers and repairers (SOC code 49-9052). Both occupations are reported under the installation, maintenance and repair occupations (SOC code 49-0000).

As of May 2014, there were 3,270 telecommunication equipment installers and repairers and, 1,560 telecommunication line installers and repairers (Figure 13.1.15-1) working in South Carolina (BLS, 2015b). In 2013, the most recent data available, South Carolina had 1.1 cases of nonfatal injuries per 100 full-time workers in the telecommunications industry (BLS, 2015c). By

comparison, there were 1.9 nonfatal occupational injury cases nationwide in both 2012 and 2013 per 100 full-time workers in the telecommunications industry (BLS, 2013a).

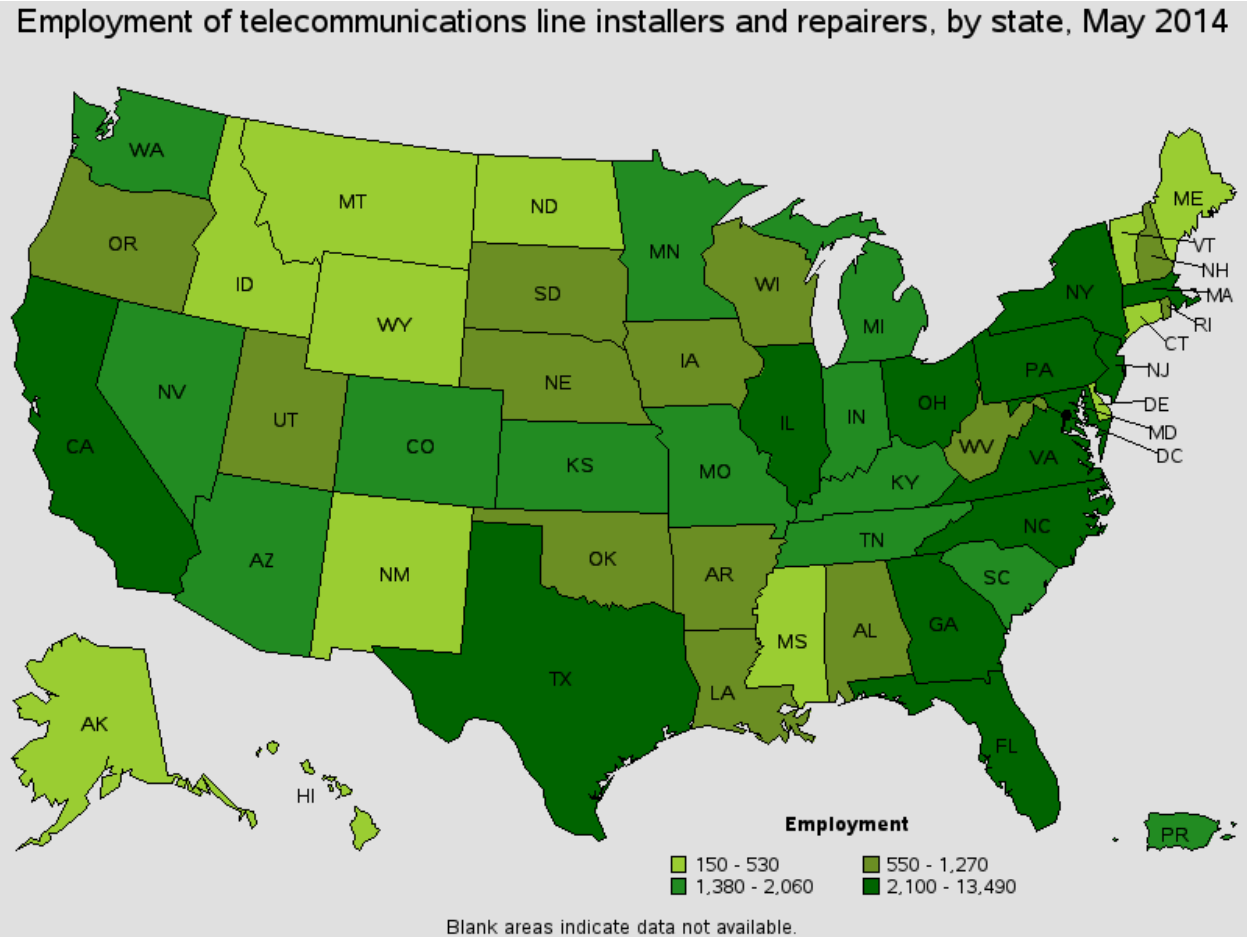


Figure 13.1.15-1: Number of Telecommunication Line Installers and Repairers Employed per State, May 2014

Source: (BLS, 2015d)

Nationwide in 2013, there were 18 fatalities reported across the telecommunications industry (5 due to violence and other injuries by persons or animals; 3 due to transportation incidents; and 7 due to slips, trips, or falls), with an hours-based fatal injury rate of 7.9 per 100,000 full-time equivalent workers (BLS, 2013b). This represents 45 percent of the broader information industry fatalities (40 total), and less than 1 percent of total occupational fatalities (4,585 total). By comparison, between 2003 and 2014, South Carolina had one occupational fatality within the telecommunications industry (NAICS code 517XX) in 2011 (BLS, 2015e).

Public Health and Safety

The public is unlikely to encounter occupational hazards at telecommunication sites, due to limited access. Among the public, trespassers entering telecommunication sites would be at the greatest risk for exposure to health and safety hazards. SCDHEC maintains the South Carolina

Environmental Public Health Tracking information system, to make environmental health data available and to help respond to potential public health problems from environmental exposures (SCDHEC, 2014c). Public health data is also reported at the federal level through the Centers for Disease Control and Prevention Wide-ranging Online Data for Epidemiologic Research (WONDER). While the WONDER database cannot be searched for cases specific to telecommunication sites, many available injury categories are consistent with risks present at telecommunication sites. For example, between 1999 and 2013, there were 131 fatalities due to a fall from, out of, or through a building or structure; 32 fatalities due to exposure to electric transmission lines; and 31 fatalities due to being caught, crushed, jammed or pinched in or between objects in South Carolina (Centers for Disease Control and Prevention, 2015).

13.1.15.4. Environmental Setting: Contaminated Properties and Abandoned Mine Lands at or near Telecommunication Sites

Existing and surrounding land uses, including landfills or redeveloped brownfields, near telecommunication sites have the potential to impact human health and safety. Furthermore, undocumented environmental practices of telecommunication site occupants, including practices before current environmental laws, could result in environmental contamination, affecting the quality of soil, sediments, groundwater, surface water, and air.

Contaminated property is typically classified by the federal environmental remediation or cleanup programs that govern them, such as sites administered through the Superfund Program[134] or listed on the National Priorities List (NPL), as well as the Resource Conservation and Recovery Act (RCRA) Corrective Action sites and Brownfields. These regulated cleanup sites are known to contain environmental contaminants at concentrations exceeding acceptable human health exposure thresholds. Contact with high concentrations of contaminated media can result in adverse health effects, such as dermatitis, pulmonary and cardiovascular events, organ disease, central nervous system disruption, birth defects, and cancer. It generally requires extended periods of exposure over a lifetime for the most severe health effects to occur.

The SCDHEC Division of Site Assessment, Remediation, and Revitalization is responsible for cleaning up or overseeing assessment, remediation, and cleanup of Superfund sites in South Carolina (SCDHEC, 2014d). As of September 2015, South Carolina had 54 RCRA Corrective Action sites[135], 255 brownfields, and 26 proposed or final Superfund/NPL sites (USEPA, 2015i). Based on a November 2015 search of USEPA's Cleanups in My Community (CIMC) database, there are three Superfund site in South Carolina where groundwater migration is not under control (Leonard Chemical Company near Catawba, SC; Parris Island Marine Corps Recruit Depot near Parris Island; and the Savannah River Site near Aiken, SC) (USEPA, 2015j).

[134] The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) enacted in 1980, commonly referred to as the Superfund Program, governs abandoned hazardous waste sites, and collects a tax on chemical and petroleum industries. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986; see Appendix C, Environmental Laws and Regulations (USEPA, 2011).

[135] Data gathered using the U.S. Environmental Protection Agency's CIMC search on November 13, 2015, for all sites in the State of South Carolina, where cleanup type equals 'RCRA Hazardous Waste – Corrective Action,' and excludes sites where cleanup phase equals 'Construction Complete' (i.e., no longer active).

SCDHEC's Brownfield Program oversees brownfield cleanup and redevelopment by non-responsible parties, and the Voluntary Cleanup Program (VCP) allows responsible parties the flexibility to report and clean up a property following specific standards (SCDHEC, 2014e). One example of a brownfield site is the Seaco site, in Columbia, SC. The site was used as a fertilizer manufacturing plant until 1949, when Seaco, Inc. purchased it for use as an asphalt emulsion plant. The site was later purchased by AA Properties-Commerce Tuller, Inc. and Associated Asphalt Columbia, LLC who planned to expand asphalt production at the facility (SCDHEC, 2014f). These companies entered into Voluntary Cleanup Contracts (VCCs) with SCDHEC, which requires them to conduct environmental testing and remediation at the sites in exchange for liability protection from existing contamination at the site (SCDHEC, 2014g).

In addition to contaminated properties, certain industrial facilities are permitted to release toxic chemicals into the air, water, or land. One such program is the Toxics Release Inventory (TRI), administered by the USEPA under the Emergency Planning and Community Right to Know Act (EPCRA) of 1986. The Toxic Release Inventory database is a measure of the industrial nature of an area and the over-all chemical use, and can be used to track trends in releases over time. The "releases" do not necessarily equate to chemical exposure by humans or necessarily constitute to quantifiable health risks because the releases include all wastes generated by a facility – the majority of which are disposed of via managed, regulated processes that minimize human exposure and related health risks (e.g., in properly permitted landfills or through recycling facilities). As of September 2015, South Carolina had 516 TRI reporting facilities. The identification of a TRI facility does not necessarily indicate that the facility is actively releasing to the environment; the majority of TRI reports involve permitted disposal facilities. According to the USEPA, in 2013, the most recent data available, South Carolina released 49.7M pounds of toxic chemicals through onsite and offsite disposal, transfer, or other releases, largely from the chemical and paper industries. This accounted for 1.21 percent of nationwide TRI releases, ranking South Carolina 14 of 56 U.S. states and territories based on total releases per square mile. (USEPA, 2015k)

Another USEPA program is the NPDES, which regulates the quality of stormwater and sewer discharge from industrial and manufacturing facilities. Permitted discharge facilities are potential sources of toxic constituents that are harmful to human health or the environment. As of November 12, 2015, South Carolina had 169 permitted major discharge facilities registered with the USEPA Integrated Compliance Information System. (USEPA, 2015l)

The National Institutes of Health (NIH), U.S. National Library of Medicine, provides an online mapping tool called TOXMAP, which allows users to "visually explore data from the USEPA's TRI and Superfund Program" (National Institutes of Health, 2015a). Figure 13.1.15-2 provides an overview of potentially hazardous sites in South Carolina.

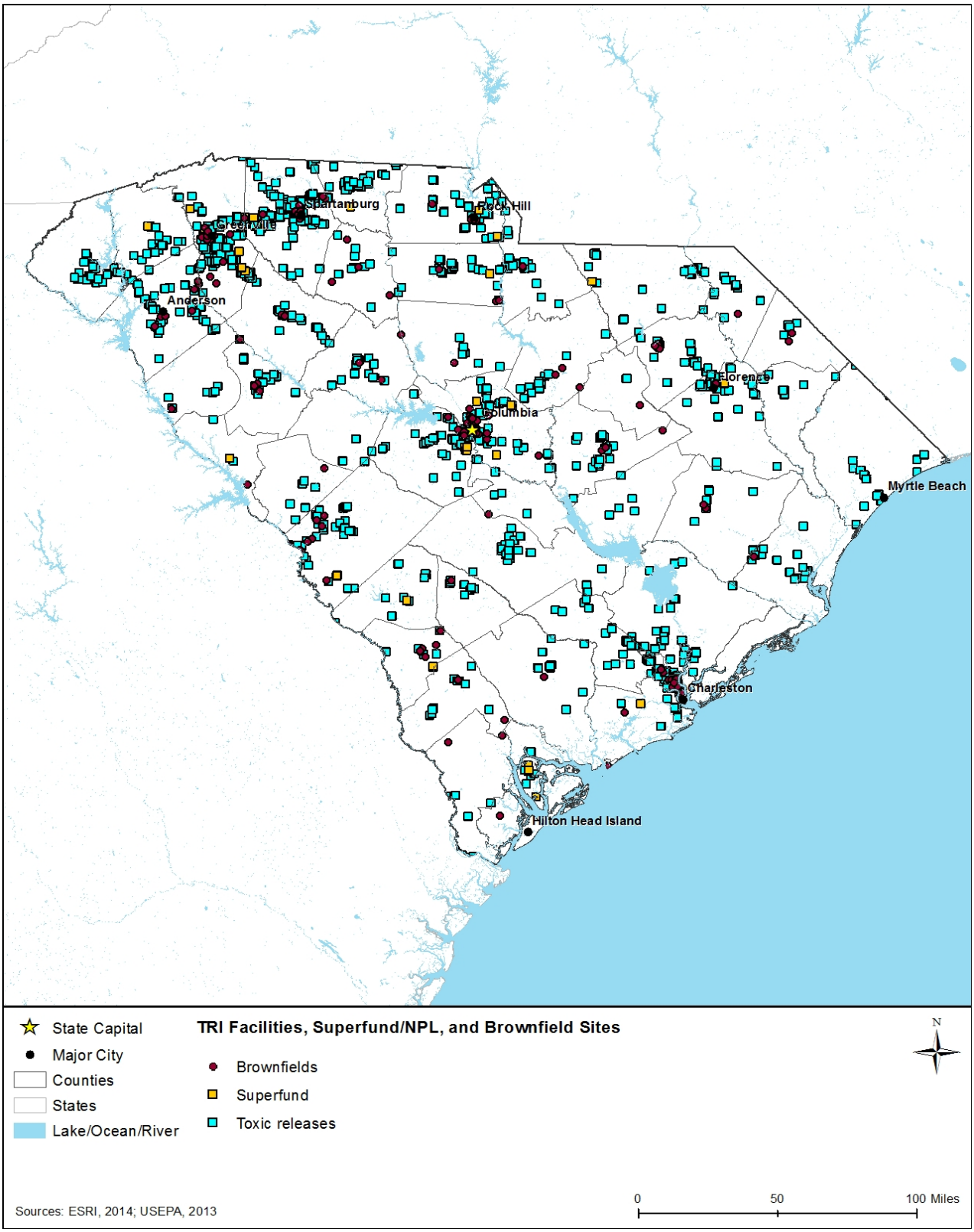


Figure 13.1.15-2: TOXMAP Superfund/NPL and TRI Facilities in South Carolina (2013)

In addition to hazardous waste contamination, another health and safety hazard includes surface and subterranean mines. Health and safety hazards at active mines and abandoned mine lands (AML) include falling into open shafts, cave-ins from unstable rock and decayed support, deadly gases and lack of oxygen inside the mine, unused explosives and toxic chemicals, horizontal and vertical openings, high walls, and open pits (Federal Mining Dialogue, 2015). As of May 2015, there were no high priority AMLs (sites posing health and safety hazards) in South Carolina (DOI, 2015).

Telecommunication Worker Occupational Health and Safety

Telecommunications sites may be on or near contaminated land, industrial discharge facilities, or sites presenting additional hazards. Occupational exposure to contaminated environmental media can occur during activities like soil excavating, trenching, other earthwork, and working over water bodies. Indoor air quality may also be impacted from vapor intrusion infiltrating indoors from contaminated soil or groundwater that are present beneath a building's foundation. As of October 2015, there are two USEPA-regulated telecommunications sites in South Carolina (Bellsouth Telecommunications in Greenville, SC; and Rock Hill Telephone Company in Rock Hill, SC) (USEPA, 2015m). Sites such as these are regulated under one or more environmental programs including NPDES compliance, Superfund/NPL status, and TRI releases.

According to BLS data, South Carolina had 12 fatalities within the installation, maintenance, and repair occupations (SOC code 49-0000) between 2003 and 2014 from exposure to "harmful substances or environments," although these were not specific to telecommunications (BLS, 2015e). By comparison, the BLS reported three fatalities in 2011 and three fatalities[136] in 2014 nationwide within the telecommunications industry (NAICS code 517), due to exposure to harmful substances or environments (BLS, 2015f). In 2014, BLS also reported four fatalities within the telecommunications line installers and repairers occupation (SOC code 49-9052), and no fatalities within the telecommunications equipment installers and repairers occupation (SOC code 49-2022) due to exposure to harmful substances or environments (BLS, 2014).

Public Health and Safety

As described earlier, access to telecommunication sites is nearly always restricted to occupational workers. Although site access control is one of the major reasons telecommunication sites present an inherent low risk to non-occupational workers, the public could be potentially exposed to contaminants and other hazards in a variety of ways. One example would be if occupational workers disturb contaminated soil while digging, causing hazardous chemicals to mix with an underlying groundwater drinking water sources. If a contaminant enters a drinking water source, the surrounding community could inadvertently ingest or absorb the contaminant when using that source of water for drinking, cooking, bathing, and swimming. By trespassing on a restricted property, a trespasser may come in contact with contaminated soil or surface water, or by inhaling harmful vapors. SCDHEC partners with the Centers for Disease Control and Prevention, National Environmental Public Health Tracking

[136] BLS Census of Fatal Occupational Injuries data for 2014 is for preliminary reporting only. Final data is expected to be released in spring 2016 (BLS, 2015g).

Network to provide health, exposure, and hazard information, including known chemical contaminants, chronic diseases, and conditions based on geography. (SCDHEC, 2014h)

Spotlight on South Carolina Superfund Sites: Savannah River Site

The Savannah River Site (SRS) is a Department of Energy (DOE) facility near Aiken, SC, which formerly produced plutonium and tritium for nuclear weapons. Improper disposal practices resulted in extensive contamination at the site by radioactive wastes from nuclear material production, including pits, piles, landfills, and groundwater contamination. As of November 2015, DOE has cleaned up 324 of the 515 waste areas at the SRS (Figure 13.1.15-3). The USEPA and SCDHEC provide regulatory oversight to the DOE, and cleanup completion is planned for 2031. (USEPA, 2015r)

The Agency for Toxic Substances and Disease Registry (ATSDR) has identified "No apparent public health hazard" to the surrounding community. This means that people may be exposed to contaminated media, but the exposure is not enough to present a human health hazard. The ATSDR has recommended that the SCDHEC and DOE continue to monitor groundwater along the boundary of the SRS, and contaminants in the Savannah River. (Agency for Toxic Substances and Disease Registry, 2007)

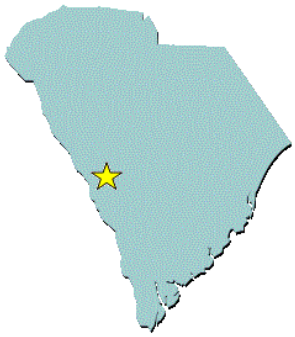


Figure 13.1.15-3 Former Disposal Area after Final Closure in 2006

Source: (DOE, 2006)

13.1.15.5. Environmental Setting: Natural & Manmade Disaster Sites

Natural and manmade disaster events can create health and safety risks, as well as present unique hazards, to telecommunication workers and the public. Telecommunications, including public safety communications, can be unavailable (temporarily or permanently) during disaster events. Examples of manmade disasters are train derailments, refinery fires, or other incident involving the release of hazardous constituents. A common example of a natural disaster is flooding. Floodwaters damage transportation infrastructure (roads, railways, etc.) and utility lines (sewer, water, electric power, broadband, natural gas lines, etc.). Hazardous chemicals and sanitary wastes often contaminate floodwaters, which can cause headaches, skin rashes, dizziness, nausea, excitability, weakness, fatigue, and disease to exposed workers (OSHA, 2003).

Physical hazards may also be present at disaster sites, such as downed utility lines, debris blockage or road washout conditions, which increases exposure risks to telecommunication workers. Climbing and working from tower structures damaged by wind increases the risk of slips, trips, or falls. During natural and manmade disasters, access to the telecommunication sites can be obstructed by debris.

Telecommunication Worker Occupational Health and Safety

Telecommunication workers are often called upon to provide support to natural and manmade disaster response efforts because of the critical need to restore and maintain telecommunication capabilities. The need to enter disaster areas as part of the recovery effort exposes telecommunication workers to elevated risks because chemical, biological, and physical hazards might not have not been fully identified or assessed. Transportation infrastructure and utilities in the affected areas are often compromised and present unknown chemical and biologic hazards. Correspondingly, if telecommunication workers are injured during response and repair operations, their rescue and treatment might over-extend first responder staff and medical facilities that are delivering care to victims of the initial incident.

Spotlight on South Carolina Manmade Disaster Sites: Graniteville Train Derailment

On January 6, 2005, a northbound freight train was accidentally diverted onto an industry track where it derailed after colliding with a parked train in Graniteville, SC. Three of the derailed cars contained pressurized chlorine gas (Figure 13.1.15-4), which released into the atmosphere, killing the train engineer and eight other people in the area. Chlorine gas is heavier than air, which allows it to spread along the ground over a large area, where inhalation can cause asphyxiation. About 75 people near the crash were hospitalized, and 5,400 people were evacuated. (National Transportation Safety Board, 2005a) Chlorine releases are particularly dangerous, because asphyxiation risk might not be immediately apparent or understood by first responders, resulting in causalities of occupational works or the public.

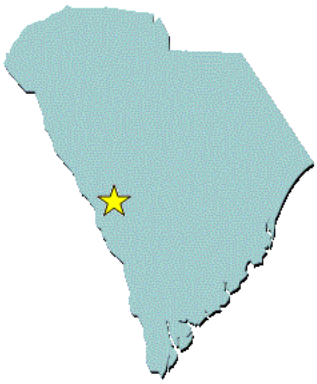


Figure 13.1.15-4 Train Wreck and Chlorine Release in Graniteville, SC

Source: (National Transportation Safety Board, 2005b)

Currently, SCDHEC and BLS do not report data specific to injuries or fatalities among telecommunication workers responding to natural or manmade disasters. However, the National Response Center (NRC), managed by the U.S. Coast Guard, compiles reports for oil spills, chemical releases, or other maritime security incidents and contains incident reports related to occupational health and safety. Of the 205 NRC-reported incidents for South Carolina in 2015 with known causes, only 10 were attributed to natural disaster (floods and natural phenomenon), while the majority (195) were attributed to manmade disasters (equipment failure and operator error) (U.S. Coast Guard, 2015a). According to the NRC, several incidents occurred due to severe flooding in October 2015, which involved a discharge of hazardous materials. One incident involved an underground storage tank, which was dislodged and ruptured by flooding near Columbia, SC, spilling the entire contents into the floodwaters (U.S. Coast Guard, 2015b). Hazardous material releases such as this present unique, hazardous challenges to telecommunication workers during natural or manmade disasters.

Public Health and Safety

Hazards present during natural and manmade disasters are often far-reaching, affecting large geographic areas and affecting all populations living within the area. Similar to telecommunication workers, the public faces risks during these types of disasters, such as compromised transportation infrastructure and utilities, potential for exposure to unknown chemical and biologic hazards, and inadequate medical support. In 2014, South Carolina experienced 7 fatalities (2 due to flooding, 1 due to heat, 2 due to winter weather, and 2 due to unknown causes) and 12 weather-related injuries (NWS, 2015).

13.2. ENVIRONMENTAL CONSEQUENCES

This section describes the potential environmental impacts, beneficial or adverse, resulting from the Proposed Action and Alternatives. As this is a programmatic evaluation, site- and project-specific issues are not assessed. The specific deployment activity and where the deployment will take place will be determined based on location-specific conditions and the results of site-specific environmental reviews.

At the programmatic level, the categories of impacts have been defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Each resource area identifies the range of possible impacts on resources for the Proposed Action and Alternatives, including the No Action Alternative. The No Action provides a comparison to describe the effects of environmental resources of the existing conditions to the proposed Alternatives.

NEPA requires agencies to assess the potential direct and indirect impacts each alternative could have on the existing environment (as characterized earlier in this section). Direct impacts are those impacts that are caused by the Proposed Action and occur at the same time and place, such as soil disturbance. Indirect impacts are those impacts related to the Proposed Action but result from an intermediate step or process, such as changes in surface water quality because of soil erosion.

For each resource, the potential impact is assessed in terms of context of the action and the intensity of the potential impact, per CEQ regulations (40 CFR §1508.27). Context refers to the timing, duration, and where the impact could potentially occur (i.e., local vs. national; pristine vs. disturbed; common species vs. protected species). In terms of duration of potential impact, context is described as short or long term. Intensity refers to the magnitude or severity of the effect as either beneficial or adverse. Resource-specific significance rating criteria are provided at the beginning of each resource area section.

13.2.1. Infrastructure

13.2.1.1. Introduction

This section describes potential impacts to infrastructure in South Carolina associated with construction, deployment, and operation of the Proposed Action and Alternatives. Chapter 16, Best Management Practices (BMPs) and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partners would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.1.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on infrastructure were evaluated using the significance criteria presented in Table 13.2.1-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to infrastructure addressed in this section are presented as a range of possible impacts.

Table 13.2.1-1: Impact Significance Rating Criteria for Infrastructure

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Transportation system capacity and safety	Magnitude or Intensity	Creation of substantial traffic congestion/delay and/or a substantial increase in transportation incidents (e.g., crashes, derailments).	Effect that is potentially significant, but with mitigation is less than significant.	Minimal change in traffic congestion/delay and/or transportation incidents (e.g., crashes, derailments).	No effect on traffic congestion or delay, or transportation incidents.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Persisting indefinitely.		Short-term effects will be noticeable for up to the entire construction phase or a portion of the operational phase.	NA
Capacity of local health, public safety, and emergency response services	Magnitude or Intensity	Impacted individuals or communities cannot access health care and/or emergency services, or access is delayed, due to the project activities.	Effect is potentially significant, but with mitigation is less than significant.	Minor delays to access to care and emergency services that do not impact health outcomes.	No impacts on access to care or emergency services.
	Geographic Extent	Regional impacts observed (“regional” assumed to be at least a county or county-equivalent geographical extent, could extend to state).		Impacts only at a local/neighborhood level.	NA
	Duration or Frequency	Duration is constant during construction and deployment phase.		Rare event during construction and deployment phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Modifies existing public safety response, physical infrastructure, telecommunication practices, or level of service in a manner that directly affects public safety communication capabilities and response times	Magnitude or Intensity	Substantial adverse changes in public safety response times and the ability to communicate effectively with and between public safety entities.	Effect that is potentially significant, but with mitigation is less than significant.	Minimal change in the ability to communicate with and between public safety entities.	No perceptible change in existing response times or the ability to communicate with and between public safety entities.
	Geographic Extent	Local/City, County/Region, or State/Territory.		Local/City, County/Region, or State/Territory.	Local/City, County/Region, or State/Territory.
	Duration or Frequency	Permanent or perpetual change in emergency response times and level of service.		Change in communication and/or the level of service is perceptible but reasonable to maintaining effectiveness and quality of service.	NA
Effects to commercial telecommunication systems, communications, or level of service	Magnitude or Intensity	Substantial adverse changes in level service and communications capabilities.	Effect that is potentially significant, but with mitigation is less than significant.	Minor changes in level of service and communications while transitioning to the new system.	No perceptible effect to level of service or communications while transitioning to the new system.
	Geographic Extent	Local/City, County/Region, or State/Territory.		Local/City, County/Region, or State/Territory.	Local/City, County/Region, or State/Territory.
	Duration or Frequency	Persistent, long-term, or permanent effects to communications and level of service.		Minimal effects to level of service or communications lasting no more than a short period (minutes to hours) during the construction and deployment phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to utilities, including electric power transmission facilities and water and sewer facilities	Magnitude or Intensity	Substantial disruptions in the delivery of electric power or to physical infrastructure that results in disruptions, including frequent power outages or drops in voltage in the electrical power supply system (“brownouts”). Disruption in water delivery or sewer capacity, or damage to or interference with physical plant facilities that impact delivery of water or sewer systems.	Effect that is potentially significant, but with mitigation is less than significant.	Minor disruptions to the delivery of electric power, water, and sewer services, or minor modifications to physical infrastructure that result in minor disruptions to delivery of power, water, and sewer services.	There would be no perceptible impacts to delivery of other utilities and no service disruptions.
	Geographic Extent	Local/City, County/Region, or State/Territory.		Local/City, County/Region, or State/Territory.	Local/City, County/Region, or State/Territory.
	Duration or Frequency	Effects to other utilities would be seen throughout the entire construction phase.		Effects to other utilities would be of short duration (minutes to hours) and would occur sporadically during the entire construction phase.	NA

NA = Not Applicable

13.2.1.3. Description of Environmental Concerns

Transportation System Capacity and Safety

The primary concerns for transportation system capacity and safety related to FirstNet activities would primarily occur during the construction phases of deployment. Depending on the exact site locations and placement of new assets in the field, temporary impacts on traffic congestion, railway use, airport or harbor operations, or use of other transportation corridors could occur if site locations were near or adjacent to roadways and other transportation corridors, requiring temporary closures (lane closures on roadways, for example). Coordination would be necessary with the relevant transportation authority (i.e., SCDOT, airport authorities, railway companies, and harbormasters) to ensure proper coordination during deployment. Based on the impact significance criteria presented in Table 13.2.1-1, such impacts would be less than significant due to the temporary nature of the deployment activities, even if impacts would be realized at one or more isolated locations. These impacts would be noticeable during the deployment phase, but would be short-term, with no anticipated impacts continuing into the operational phase, unless any large-scale maintenance would become necessary during operations.

Capacity of Local Health, Public Safety, and Emergency Response Services

The capacity of local health, public safety, and emergency response services would experience less than significant impacts during deployment or operation phases. During deployment and system optimization, existing services would likely remain operational in a redundant manner ensuring continued operations and availability of services to the public. The only potential impact would be extremely rare, if emergency response services were using transportation infrastructure to respond to an emergency at the exact time that deployment activities were taking place. This type of impact would be isolated at the local or neighborhood level, and the likelihood of such an impact would be extremely low. Once operational, the new network would provide beneficial impacts to the capacity of local health, public safety, and emergency response services through enhanced communications infrastructure, thereby increasing capacity for and enhancing the ability of first responders to communicate during emergency response situations. Based on the impact significance criteria presented in Table 13.2.1-1, potential negative impacts would be less than significant. Substantial beneficial impacts are likely to result from implementation.

Modifies Existing Public Safety Response Telecommunication Practices, Physical Infrastructure, or Level of Service in a manner that directly affects Public Safety Communication Capabilities and Response Times

The Proposed Action and Alternatives contemplated by FirstNet would not cause negative impacts to existing public safety response telecommunication practices, physical infrastructure, or level of service in a manner that directly affects public safety communication capabilities and response times. Based on the impact significance criteria presented in Table 13.2.1-1, any potential impacts would be less than significant during deployment. As described above, during deployment and system optimization, existing services would likely remain operational in a redundant manner ensuring continued operations and availability of services to the public. Once

operational, state, and local public safety organizations would need to evaluate telecommunication practices and standard operating procedures (SOPs). FirstNet's mission is to complement such practices and SOPs in a positive manner; therefore, only beneficial or complementary impacts would be anticipated. Public safety communication capabilities and response times would be expected to also experience beneficial impacts through enhanced communications abilities. It is possible that FirstNet would be upgrading physical telecommunications infrastructure, thus the infrastructure would also experience a positive and beneficial impact. Disposal or reuse of old public safety communications infrastructure would also likely need to be considered once the specifics are known. Any negative impacts would be expected to be less than significant given the short-term nature of the deployment activities.

Effects to Commercial Telecommunication Systems, Communications, or Level of Service

Commercial assets would be using a different spectrum for communications; as such, commercial telecommunication systems, communications, or level of service would experience no impacts. FirstNet has exclusive rights to use of the assigned spectrum, and only designated public safety organizations would be authorized to connect to FirstNet's network. Depending on the use patterns of FirstNet's spectrum, such spectrum use may be over-built or under-utilized.[137] Anticipated impacts would be less than significant due to the limited extent and temporary nature of deployment.

Effects to Utilities, including Electric Power Transmission Facilities, and Water and Sewer Facilities

The activities proposed by FirstNet would have less than significant impacts on utilities, including electric power transmission facilities, and water and sewer facilities. Depending on the specific project contemplated, installation of new equipment could require connection with local electric sources, and use of site-specific local generators, on a temporary or permanent basis. Also, depending on the specific project contemplated, the draw or use of power from the transmission facilities may need to be examined; however, it is not anticipated that such use of power would have negative impacts, due to the local nature of the proposed activities and the widespread availability and use of the power grid in the United States.

13.2.1.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment, and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific

[137] Telecommunications equipment for specific spectrum use can be built where other equipment for other spectrum use already exists. If the new equipment and spectrum is not fully utilized, the geographic region may experience "over-build," where an abundance of under-utilized equipment may exist in that geographic location. This situation can be caused by a variety of factors including changes in current and future use patterns, changes in spectrum allocation, changes in laws and regulations, and other factors.

deployment requirements, some activities would result in potential impacts to infrastructure and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to infrastructure under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to infrastructure resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes or disruption of transportation, telecommunications, or utility services.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would have no impacts on infrastructure resources because there would be no ground disturbance and no interference with existing utility, transportation, or communication systems.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the use of portable devices that use satellite technology would not impact infrastructure resources because there would be no change to the built or natural environment from the use of portable equipment. Installation of satellite-enabled equipment would not be expected to have any impacts to infrastructure resources, given that construction activities would occur on existing structures would not be expected to interfere with existing equipment, and transportation capacity and safety, and access to emergency services would not be impacted.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact infrastructure resources, it is anticipated that this activity would have no impact on infrastructure resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to infrastructure as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur as a result of direct interface with existing infrastructure, most notably existing telecommunication infrastructure.

The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to infrastructure include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence (POPs),[138] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to infrastructure resources, depending on the specific assets connected on either end of the buried fiber. If a fiber optic plant is being used to tie into existing telecommunications assets, then localized impacts to telecommunications sites could occur during the deployment phase, however, it is anticipated that this tie-in would cause less than significant impacts as the activity would be temporary and minor.
  - New Build – Aerial Fiber Optic Plant: Installation of a new aerial fiber optic plant could impact new telecommunications infrastructure through the installation of new, or replacement of existing, telecommunications poles.
  - Collocation on Existing Aerial Fiber Optic Plant: Similar to new build activities (above), collocation on existing aerial fiber optic plant could include installation of new or replacement towers requiring ground disturbance.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in or near bodies of water would not impact infrastructure resources because there would be no local infrastructure to impact, other than harbor operations. However, impacts to infrastructure resources could potentially occur as result of the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable, depending on the exact site location and proximity to existing infrastructure.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment such as small boxes or huts, or access roads, could potentially impact to infrastructure. Impacts could include disruption of service in transportation corridors, disruption of service to telecommunications infrastructure, or other temporary impacts.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads might result in temporary or unintended impacts to current utility services during installation or interconnection activities. Generally, however, these deployment activities would be independent and would not be expected to interfere with other existing towers and structures. In addition, installation activities would have beneficial impacts due to expansion of infrastructure at a local level. Such activities could enhance public safety

[138] Points of Presence are connections or access points between two different networks, or different components of one network.

infrastructure, and other telecommunications as the site could potentially be available for subsequent collocation.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to soils. However, if additional power units are needed, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to soil resources could occur, including soil erosion and topsoil mixing, as well as soil compaction and rutting associated with heavy equipment use.
- Deployable Technologies: Deployable technologies such as COWs, COLTs, and SOWs are composed of cellular base stations, sometimes with expandable antenna masts, and generators that connect to utility power cables. Connecting the generators to utility power cables has the potential to disrupt electric power utility systems or cause power outages; however, this is expected to be temporary and minor. Some staging or landing areas (depending on the type of technology) could require minor construction and maintenance within public road ROWs and utility corridors, heavy equipment movement, and minor excavation and paving near public roads, which have the potential to impact transportation capacity and safety as these activities could increase transportation congestion and delays. Implementation of deployable technologies could result in potential impacts to infrastructure resources in terms of infrastructure expansion, if deployment requires paving of previously unpaved surfaces or other new infrastructure build to accommodate the deployable technology. In addition, beneficial impacts could be realized, as deployable technologies are used when other infrastructure is impaired in some way; so deployable technologies could provide continuity of service during emergency events. Where deployable technologies would be implemented on existing paved surfaces and the acceptable load on those paved surfaces is not exceeded, or where aerial deployable technologies may be utilized but launched from existing paved surfaces, it is anticipated that there would be no impacts to infrastructure resources because there would be no disturbance of the natural or built environment.

In general, the abovementioned activities could potentially impact infrastructure resources in different ways, resulting in both potentially negative and potentially positive impacts. Potential negative impacts to infrastructure associated with deployment could include temporary disruption of various types of transportation corridors, temporary impacts on existing or new telecommunications sites, and more permanent impacts on utilities, if new infrastructure required tie-in to the electric grid. These impacts are expected to be less than significant at the programmatic level as the deployment activities will likely be of short duration (generally a few hours to a few months depending on the activity), would be regionally based around the on-going phase of deployment, and minor. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Positive impacts to infrastructure resources may result from the expansion of public safety and commercial telecommunications capacity and an improvement in public safety telecommunications coverage, system resiliency, response times, and system redundancy.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no impacts at the programmatic level to infrastructure associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if further construction related activities are required along public road and utility ROWs, increased traffic congestion, current telecommunication system interruption, and utility interruptions could occur. These potential impacts would be expected to be minor and temporary as explained above.

Numerous beneficial impacts would be associated with operation of the NPSBN. The new system is intended to result in substantial improvements in public safety response times and the ability to communicate effectively with and between public safety entities, and would likely result in substantial improvements in level of service and communications capabilities. Operation of the NPSBN is intended to involve high-speed data capabilities, location information, images, and eventually streaming video, which would likely significantly improve communications and the ability of the public safety community to effectively engage and respond. The NPSBN is also intended to have a higher level of redundancy and resiliency than current commercial networks to support the public safety community effectively, even in events of extreme demand. This improvement in the level of resiliency and redundancy is intended to increase the reliability of systems, communications, and level of service, and also minimize disruptions and misinformation resulting from limited or disrupted service. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.1.5. Alternatives Impact Assessment

The following section assesses potential impacts to infrastructure associated with the Deployable Technologies Alternative and the No Action Alternative. [139]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new

[139] As mentioned above and in Section 2.1.2 Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to infrastructure as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to infrastructure at the programmatic level even if deployment requires expansion of infrastructure, such as paving of previously unpaved surfaces or other new infrastructure built to support deployment. This is primarily due to the small amount of paving or new infrastructure that might have to be constructed to accommodate the deployables. The site-specific location of deployment would need to be considered, and any local infrastructure assets (transportation, telecommunications, or utilities) would need to be considered, planned for, and managed accordingly to try and avoid any negative impacts to such resources. Beneficial impacts could be realized, as deployable technologies are used when other infrastructure is impaired in some way; so deployable technologies could provide continuity of service during emergency events. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no impacts at the programmatic level to infrastructure resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment, as part of routine maintenance or inspection occurs off an established access road or utility ROW, or if additional maintenance-related construction activities occur within public road and utility ROWs, less than significant impacts would likely still occur to transportation systems or utility services due to the limited amount of new infrastructure needed to accommodate the deployables. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated deployment or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to infrastructure as a result of deployment and operation of the Proposed Action. Environmental conditions would therefore be

the same as those described in Section 13.1.1, Infrastructure. The state also would not realize positive, beneficial impacts to infrastructure resources described above.

13.2.2. Soils

13.2.2.1. Introduction

This section describes potential impacts to soil resources in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.2.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on soil resources were evaluated using the significance criteria presented in Table 13.2.2-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to soil resources addressed in this section are presented as a range of possible impacts.

Table 13.2.2-1: Impact Significance Rating Criteria for Soils

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Soil erosion	Magnitude or Intensity	Severe, widespread, and observable erosion in comparison to baseline, high likelihood of encountering erosion-prone soils.	Effect that is potentially significant, but with mitigation is less than significant.	Perceptible erosion in comparison to baseline conditions; low likelihood of encountering erosion-prone soil types.	No perceptible change in baseline conditions.
	Geographic Extent	State or territory.		Region or county.	NA
	Duration or Frequency	Chronic or long-term erosion not likely to be reversed over several years.		Isolated, temporary, or short-term erosion that that is reversed over few months or less.	NA
Topsoil mixing	Magnitude or Intensity	Clear and widespread mixing of the topsoil and subsoil layers.	Effect that is potentially significant, but with mitigation is less than significant.	Minimal mixing of the topsoil and subsoil layers has occurred.	No perceptible evidence that the topsoil and subsoil layers have been mixed.
	Geographic Extent	State or territory.		Region or county.	NA
	Duration or Frequency	NA		NA	NA
Soil compaction and rutting	Magnitude or Intensity	Severe and widespread, observable compaction and rutting in comparison to baseline.	Effect that is potentially significant, but with mitigation is less than significant.	Perceptible compaction and rutting in comparison to baseline conditions.	No perceptible change in baseline conditions.
	Geographic Extent	State or territory.		Region or county.	NA
	Duration or Frequency	Chronic or long-term compaction and rutting not likely to be reversed over several years.		Isolated, temporary, or short term compaction and rutting that is reversed over a few months or less.	No perceptible change in baseline conditions.

NA = Not Applicable

13.2.2.3. Description of Environmental Concerns

Soil Erosion

Soil erosion is an environmental concern for nearly every construction activity that involves ground disturbance. Construction erosion typically only occurs in a small area of land with the actual removal of vegetative cover from construction equipment or by wind and water erosion. Of concern in South Carolina and other states with similar geography and weather patterns is the erosion of construction site soils to natural waterways, where the sediment could impair water and habitat quality, and potentially affect aquatic plants and animals (NRCS, 2000). Parts of South Carolina contain soil types that occur on steep slopes and, therefore, have a medium to high potential for erosion. Those soil suborder types include: Aqualfs, Aquents, Aquepts, Aquods, Aquolls, Aquults, Fluvents, Saprists, Udalfs, Udepts, and Udults (see Section 13.1.2.4, Soil Suborders and Figure 13.1.2-2).

Based on the impact significance criteria presented in Table 13.2.2-1, building of some of FirstNet's network deployment sites could cause potentially significant erosion at locations with highly erodible soil and steep grades. For the majority of projects, impacts to soils would be expected to be less than significant given the short-term and temporary duration of the activities.

To the extent practicable, FirstNet would attempt to minimize ground-disturbing construction in areas with high erosion potential due to steep slopes or soil type. Where construction is required in areas with a high erosion potential, FirstNet could implement BMPs and mitigation measures, where practicable and feasible, be implemented to avoid or minimize impacts, and minimize the periods when exposed soil is open to precipitation and wind (see Chapter 16).

Topsoil Mixing

The loss of topsoil (i.e., organic and mineral topsoil layers) by mixing is a potential impact at all ground disturbing construction sites, including actions requiring clearing, excavation, grading, trenching, backfilling, or site restoration/remediation work.

Based on impact significance criteria presented in Table 13.2.2-1, and due to the relatively small-scale (less than 1 acre) of most FirstNet project sites.

Soil Compaction and Rutting

Soil compaction and rutting at construction sites could involve heavy land clearing equipment such as bulldozers and backhoes, trenchers and directional drill rigs to install buried fiber, and cranes to install towers and aerial infrastructure. Soils with the highest potential for compaction or rutting were identified by using the STATSGO2 database (see Section 13.1.2.4, Soil Suborders). The most compaction susceptible soils in South Carolina are Aqualfs, Aquents, Aquepts, Aquods, Aquolls, Aquults, Saprists, and Udepts, hydric soils and with poor drainage conditions. These soils are found throughout the state (see Figure 13.1.3-2). Based on impact significance criteria presented in Table 13.2.2-1, the risk of soil compaction and rutting resulting from FirstNet deployment activities would be less than significant, due to the extent of susceptible soils in the state.

13.2.2.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could deploy various types of facilities or infrastructure. Depending on the physical nature and location of FirstNet facilities or infrastructure and the specific action, some activities would result in potential impacts to soil resources and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to soil resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit through existing hand-holes, pulling vaults, junction boxes, huts, and POP structures and would not impact soil resources because it would not produce perceptible changes to soil resources.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, with no impacts to soil resources. If physical access is required to light dark fiber, it would be through existing hand holes, pulling vaults, junction boxes, huts, and similar existing structures.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: Deployment of temporary or portable equipment that use satellite technology, including COWs, COLTs, SOWs, satellite phones, and video cameras, would not impact soil resources because those activities would not require ground disturbance.

Activities with the Potential to Have Impacts

Implementation of the Preferred Alternatives could include potential deployment-related impacts to soil resources resulting from ground disturbance activities, including soil erosion, topsoil mixing, and soil compaction and rutting. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to soil resources include the following:

- Wired Projects

- Wired Projects
  - New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires trenching, plowing (including vibratory plowing), or directional boring, as well as construction of hand holes, pulling vaults, junction boxes, huts, and POP structures that require ground disturbance. Impacts from fiber optic plant installation and structure construction, as well as associated grading and restoration of the disturbed ground when construction is completed, could result in soil erosion, topsoil mixing, or soil compaction and rutting.
  - New Build – Aerial Fiber Optic Plant: Installation of new utility poles, and replacement/upgrading of existing poles and structures could potentially impact soil resources resulting from ground disturbance for pole/structure installation (soil erosion and topsoil mixing), and heavy equipment use from bucket trucks operating on existing gravel or dirt roads (soil compaction and rutting). Potential impacts to soils are anticipated to be small-scale and short-term.
  - Collocation on Existing Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in soil compaction and rutting.
  - New Build – Submarine Fiber Optic Plant: Installation of fiber optic plants in limited nearshore and inland bodies of water could potentially impact soil resources at and near the landings or facilities on shores or the banks of waterbodies that accept the submarine cable. Soil erosion and topsoil mixing could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Perceptible soil compaction and rutting could potentially occur due to heavy equipment use during these activities depending on the duration of the construction activity.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of optical transmission equipment or centralized transmission equipment, including associated new utility poles, hand holes, pulling vault, junction box, hut, and POP structure installation, would require ground disturbance that could potentially impact soil resources. Potential impacts to soils resulting from soil erosion, topsoil mixing, soil compaction, and rutting are anticipated to be small-scale and short-term.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads could result in impacts to soil resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in soil erosion or topsoil mixing, and heavy equipment use during these activities could result in soil compaction and rutting.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to soils. However, if additional power units are needed, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to soil resources could occur, including soil erosion and topsoil mixing, as well as soil compaction and rutting associated with heavy equipment use.
- Deployable Technologies: Implementation of deployable technologies could result in potential impacts to soil resources depending on the technology and location for deployment. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, COLTs) occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities may result in soil compaction and rutting. In addition, implementation of deployable technologies themselves could result in soil compaction and rutting if deployed in unpaved areas. Where technologies such as COWs, COLTs, and SOWs are deployed on existing paved surfaces, there would be no impacts to soil resources because there would be no ground disturbance.

In general, the abovementioned activities could potentially involve land/vegetation clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads, and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to soil resources associated with deployment of this infrastructure could include soil erosion, topsoil mixing, or soil compaction and rutting. These impacts are expected to be less than significant at the programmatic level as the activity would likely be short term, localized to the deployment locations, and would return to normal conditions as soon as revegetation occurs, often by the next growing season. It is expected that heavy equipment would utilize existing roadways and utility rights-of-way for deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described earlier, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there would be no impacts at the programmatic level to soil resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections because there would be no ground disturbance. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, soil compaction and rutting impacts could result as explained above. The

impacts are expected to be less than significant at the programmatic level due to the temporary nature and small scale of operations activities with the potential to create impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.2.5. Alternatives Impact Assessment

The following section assesses potential impacts to soils associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to soil resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to soil resources at the programmatic level, regardless of whether the deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, impacts to soils could occur on paved surfaces if the acceptable load of the surface is exceeded. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities may result in soil compaction and rutting. In addition, implementation of deployable technologies themselves could also result in soil compaction and rutting if deployed in unpaved areas. However, these potential impacts are expected to be less than significant at the programmatic level due to the small scale and short term nature of the deployment. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no impacts to soil resources at the programmatic

level associated with routine inspections of deployable assets, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, less than significant soil compaction and rutting impacts could result at the programmatic level as previously explained above. Finally, if deployable technologies are parked and operated with air conditioning for extended periods, the condensation water from the air conditioner could result in minimal soil erosion. However, it is anticipated that the potential soil erosion would result in less than significant impacts at the programmatic level as described above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed. Therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to soil resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.2, Soils.

13.2.3. Geology

13.2.3.1. Introduction

This section describes potential impacts to South Carolina geology resources associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.3.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on geology resources were evaluated using the significance criteria presented in Table 13.2.3-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to geology addressed in this section are presented as a range of possible impacts.

Table 13.2.3-1: Impact Significance Rating Criteria for Geology

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMP and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Seismic Hazard	Magnitude or Intensity	High likelihood that a project activity could be located within a high-risk earthquake hazard zone or active fault.	Effect that is potentially significant, but with mitigation is less than significant.	Low likelihood that a project activity could be located within an earthquake hazard zone or active fault.	No likelihood of a project activity being located in an earthquake hazard zone or active fault.
	Geographic Extent	Hazard zones or active faults are highly prevalent within the state/territory.		Earthquake hazard zones or active faults occur within the state/territory, but may be avoidable.	Earthquake hazard zones or active faults do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Volcanic Activity	Magnitude or Intensity	High likelihood that a project activity could be located near a volcano lava or mud flow area of influence.	Effect that is potentially significant, but with mitigation is less than significant.	Low likelihood that a project activity could be located near a volcanic ash area of influence.	No likelihood of a project activity located within a volcano hazard zone.
	Geographic Extent	Volcano lava flow areas of influence are highly prevalent within the state/territory.		Volcano ash areas of influence occur within the state/territory, but may be avoidable.	Volcano hazard zones do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Landslide	Magnitude or Intensity	High likelihood that a project activity could be located within a landslide area.	Effect that is potentially significant, but with mitigation is less than significant.	Low likelihood that a project activity could be located within a landslide area.	No likelihood of a project activity located within a landslide hazard area.
	Geographic Extent	Landslide areas are highly prevalent within the state/territory.		Landslide areas occur within the state/territory, but may be avoidable.	Landslide hazard areas do not occur within the state/territory.

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMP and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Duration or Frequency	NA		NA	NA
Land Subsidence	Magnitude or Intensity	High likelihood that a project activity could be located within an area with a hazard for subsidence (e.g., karst terrain).	Effect that is potentially significant, but with mitigation is less than significant.	Low likelihood that a project activity could be located within an area with a hazard for subsidence.	Project activity located outside an area with a hazard for subsidence.
	Geographic Extent	Areas with a high hazard for subsidence (e.g., karst terrain) are highly prevalent within the state/territory.		Areas with a high hazard for subsidence occur within the state/territory, but may be avoidable.	Areas with a high hazard for subsidence do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Potential Mineral and Fossil Fuel Resource impacts	Magnitude or Intensity	Severe, widespread, observable impacts to mineral and/or fossil fuel resources.	Effect that is potentially significant, but with mitigation is less than significant.	Limited impacts to mineral and/or fossil resources.	No perceptible change in mineral and/or fossil fuel resources.
	Geographic Extent	Regions of mineral or fossil fuel extraction areas are highly prevalent within the state/territory.		Mineral or fossil fuel extraction areas occur within the state/territory, but may be avoidable.	Mineral or fossil fuel extraction areas do not occur within the state/territory.
	Duration or Frequency	Long-term or permanent degradation or depletion of mineral and fossil fuel resources.		Temporary degradation or depletion of mineral and fossil fuel resources.	NA
Potential Paleontological	Magnitude or Intensity	Severe, widespread, observable impacts to paleontological resources.	Effect that is potentially significant, but with mitigation is less than significant.	Limited impacts to paleontological and/or fossil resources.	No perceptible change in paleontological resources.

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMP and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Resources Impacts	Geographic Extent	Areas with known paleontological resources are highly prevalent within the state/territory.		Areas with known paleontological resources occur within the state/territory, but may be avoidable.	Areas with known paleontological resources do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Surface Geology, Bedrock, Topography, Physiography, and Geomorphology	Magnitude or Intensity	Substantial and measurable degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphological processes.	Effect that is potentially significant, but with mitigation is less than significant.	Minor degradation or alteration of surface geology, bedrock, topography that do not result in measurable changes in physiographic characteristics or geomorphological processes.	No degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphologic processes.
	Geographic Extent	State/territory.		State/territory.	NA
	Duration or Frequency	Permanent or long-term changes to characteristics and processes.		Temporary degradation or alteration of resources that is limited to the construction and deployment phase.	NA

NA = Not Applicable

13.2.3.3. Description of Environmental Concerns

Environmental concerns regarding geology can be viewed as two distinct types, those that would potentially provide impacts to the project, such as seismic hazards, landslides, and volcanic activity, and those that would be impacts from the project, such as land subsidence, and effects on mineral and fossil fuel resources, paleontological resources, surface geology, bedrock, topography, physiography, and geomorphology. These concerns and their impacts on geology are discussed below.

Seismic Hazard

As discussed in Section 13.1.3, the majority of South Carolina is not at risk to significant earthquake events. As shown in Figure 13.1.3-4, areas of greatest seismicity in South Carolina are concentrated in the southeastern portion of the state, particularly near the City of Charleston and are at greatest risk to earthquakes, though earthquakes typically do not reach magnitudes higher than 6.0 on the Richter scale. Based on the impact significance criteria presented in Table 13.2.3-1, seismic impacts from deployment or operation of the Proposed Action would have no impact on seismic activity; however, seismic impacts to the Proposed Action could be potentially significant if FirstNet's deployment locations were within high-risk earthquake hazard zones.. Given the potential for minor to moderate earthquakes in or near South Carolina, some amount of infrastructure could be subject to earthquake hazards. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Volcanic Activity

Volcanoes do not occur in South Carolina and therefore, do not present a hazard to the state.

Landslides

Similar to seismic hazards, another concern would be placement of equipment in areas that are highly susceptible to landslides. Equipment that is exposed to landslides is subject to misalignment, alteration, or, in extreme cases, destruction; all of these activities could result in connectivity loss.

As discussed in Section 13.1.3, South Carolina is particularly at risk to landslide events throughout the northwestern portion of the state (i.e., Piedmont and Blue Ridge Provinces). Equipment that is exposed to landslides is subject to misalignment, alteration, or, in extreme cases, destruction; all of these activities could result in connectivity loss. The highest potential for landslides in South Carolina is found in areas with steeper terrain. To the extent practicable, FirstNet would avoid deployment in areas that are susceptible to landslide events. Based on the impact significance criteria presented in Table 13.2.3-1, potential impacts to landslides from deployment or operation of the Proposed Action would have less than significant impacts as it is likely that the project would attempt to avoid areas that are prone to landslides; however, landslide impacts to the Proposed Action could be potentially significant if FirstNet's deployment locations were within areas in which landslides are highly prevalent.

However, given that several of South Carolina's larger cities, including Anderson, Greenville, Spartanburg, and Rock Hill, are in areas that are moderately to highly susceptible to landslides, some amount of infrastructure could be subject to landslide hazards. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Land Subsidence

Equipment that is exposed to land subsidence, such as sinkholes created by karst topography or mine collapse, is subject to misalignment, alteration, or, in extreme cases, destruction. Significant long-term land subsidence, due to factors such as aquifer compaction, in coastal areas could lead to relative sea level rise[140] and inundation of equipment. All of these activities could result in connectivity loss.

As discussed in Section 13.1.3.8 and shown in Figure 13.1.3-6, portions of South Carolina are vulnerable to land subsidence due to karst topography. Based on the impact significance criteria presented in Table 13.2.3-1, potential impacts to soil subsidence from deployment or operation of the Proposed Action would have less than significant impacts; however, subsidence impacts to the Proposed Action could be potentially significant to the Proposed Action if FirstNet's deployment locations were within areas at high risk to karst topography or mining areas. To the extent practicable, FirstNet would avoid deployment in known areas of karst topography, where mine collapse is possible, or that are subject to sea level rise. However, given that karst topography exists in many counties throughout the state, some amount of infrastructure may subject to such hazards, in which case BMPs and mitigation measures, would help avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Mineral and Fossil Fuel Resource Impacts

Equipment deployment near mineral and fossil fuel resources is not likely to affect these resources. Rather the new construction is only likely to limit access to extraction of these resources. Based on the impact significance criteria presented in Table 13.2.3-1, impacts to mineral and fossil fuel resources is unlikely as the Proposed Action could be potentially significant if the FirstNet’s deployment locations were to cause severe, widespread, observable impacts to mineral and/or fossil fuel resources. As discussed in Section 13.1.3.7, northern portions of South Carolina contain mineral resources. To the extent practicable, FirstNet would avoid construction in areas where these resources exist. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

[140] Relative Sea Level Rise: "[Sea level rise that] includes the combined movement of both water and land. Even if sea level was constant, there could be changes in relative sea level. For example, a rising land surface would produce a relative fall in sea level, whereas a sinking land surface would produce a relative rise in sea level." (U.S. Geological Survey, 2015)

Potential Paleontological Resource Impacts

Equipment installation and construction activities that require ground disturbance could damage existing paleontological resources, which are both fragile and irreplaceable. Based on the impact significance criteria presented in Table 13.2.3-1, impacts to paleontological resources could be potentially significant if FirstNet's buildout/deployment locations uncovered paleontological resources during construction activities. As discussed in Section 13.1.3.7, fossils are abundant throughout parts of South Carolina. It is anticipated that potential impacts to specific areas known to contain paleontological resources would be avoided, minimized, or mitigated, and any potential impacts would be limited and localized. Potential impacts to paleontological resources should be considered on a site-by-site basis, and BMPs and mitigation measures could further help avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Surface Geology, Bedrock, Topography, Physiography, and Geomorphology

Equipment installation and construction activities that degrade or alter surface geology, bedrock, or topography could cause measurable changes in physiographic characteristics of an area's geology, topography, physiography, or geomorphology. Based on the impact significance criteria presented in Table 13.2.3-1, impacts would be less than significant if FirstNet's deployment is unlikely to cause substantial and measurable degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphological processes. Construction activities related to the Proposed Action and Alternatives are likely to be minor and less than significant as the proposed activities are not likely to require removal of significant volumes of terrain and any rock ripping would likely occur in discrete locations and would be unlikely to result in large-scale changes to the geologic, topographic, or physiographic characteristics. When ground disturbance is required, BMPs and mitigation could be implemented to help avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.3.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

Implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities have the potential to be impacted by geologic hazards, some activities could result in potential impacts to geology, and other activities would have no impacts. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to geology under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. In most cases, there would be no impacts to geologic resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on geologic resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact geologic resources, it is anticipated that this activity would have no impact on geologic resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to geologic resources, or resulting from geologic hazards due to implementation of the Preferred Alternative, would encompass a range of impacts that could occur as a result of ground disturbance activities, including loss of mineral and fuel resources and paleontological resources. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to geologic resources, or impacts from geologic hazards, include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POP huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to geologic resources due to associated ground disturbance, such as impacts to fuel and mineral resources or paleontological resources. Where equipment is installed in locations that are susceptible to landslides, minor earthquakes, or land subsidence, it is possible that equipment could be affected by that hazard.
  - New Build – Aerial Fiber Optic Plant: Installation of new utility poles, and associated use of heavy equipment during construction, could result in potential impacts to geologic resources due to associated ground disturbance. Where equipment is installed in

locations that are susceptible to landslides, minor earthquakes, or land subsidence, it is possible that equipment could be affected by that hazard.

  - Collocation on Existing Aerial Fiber Optic Plant: Replacement of utility poles and structural hardening, and associated use of heavy equipment during construction, could result in potential impacts to geologic resources due to associated ground disturbance. Where equipment is installed in locations that are susceptible to landslides, minor earthquakes, or land subsidence, it is possible that equipment could be affected by that hazard.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water is not expected to impact geologic resources. However, where landings and/or facilities for submarine cable are installed at locations that are susceptible to landslides, minor earthquakes, or land subsidence, it is possible that equipment could be affected by that hazard.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require ground disturbance in locations that are susceptible to geologic hazards (e.g., land subsidence, landslides, or minor earthquakes), it is possible that they could be affected by that hazard.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to geologic resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in erosion or disturbance of geologic resources. Where equipment is installed in locations that are susceptible to landslides, minor earthquakes, or land subsidence, it is possible that equipment could be affected by that hazard.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in ground disturbance. However, if additional power units are needed, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to geologic resources could occur due to ground disturbance. Where equipment is installed in locations that are susceptible to landslides, minor earthquakes, or land subsidence, it is possible that equipment could be affected by that hazard.
  - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to geologic resources depending on the technology and location proposed for deployment. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, COLTs) occurs in unpaved areas, or if the implementation results in

paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. Where deployable technologies would be implemented on existing paved surfaces, there would be no impacts to/from geologic resources because there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: In most cases, the installation of permanent equipment on existing structures, adding equipment to satellites launched for other purposes, or the use of portable devices that use satellite technology would not impact geologic resources because those activities would not require ground disturbance. Where equipment is installed in locations that are susceptible to landslides, minor earthquakes, or land subsidence, it is possible that equipment could be affected by that hazard. The use of portable satellite-enabled devices would not impact geologic resources nor would it be affected by geologic hazards because there would be no ground disturbance nor any impact to the built or natural environment.

In general, the abovementioned activities could potentially involve ground disturbance resulting from land/vegetation clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to geological resources associated with deployment could result in incidental removal of bedrock or mineral resources, or adverse impacts to installed equipment resulting from geologic hazards (e.g., minor earthquakes, landslides, and land subsidence). Specific FirstNet projects are likely to be small scale; correspondingly, disturbance to geologic resources for those types of projects with the potential to impact geologic resources is also expected to be small scale as a result, these potential impacts are expected to be less than significant at the programmatic level. For the same reason, impacts to deployment from geologic hazards are likely to be less than significant at the programmatic level as well. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no impacts to geology at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections because there would be no ground disturbance.

The operation of the Preferred Alternative could be affected by to geologic hazards including minor seismic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be less than significant at the programmatic level as it is anticipated that

deployment locations would avoid, as practicable and feasible, locations that are more likely to be affected by potential seismic activity, landslides, or land subsidence. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.3.5. Alternatives Impact Assessment

The following section assesses potential impacts to geology associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to geology as a result of implementation of this alternative could be as described below.

Deployment Impacts

Implementation of deployable technologies on existing paved surfaces would not result in impacts to geologic resources (or from geologic hazards) as there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, COLTs) occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These impacts are expected to be less than significant at the programmatic level due to the minor amount of paving or new infrastructure needed to accommodate the deployables. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no impacts at the programmatic level to geologic resources (or from geologic hazards) associated with routine inspections of the Preferred Alternative because there would be no ground disturbance.

The operation of the Deployable Technologies Alternative could be affected by to geologic hazards including seismic activity, landslides, and land subsidence. However, potential impacts

would be anticipated to be less than significant at the programmatic level as the deployment would be temporary and likely would attempt to avoid locations that was subject to increased seismic activity, landslides, and land subsidence. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure, or satellites and other technologies. As a result, there would be no impacts to geologic resources (or from geologic hazards) as a result of construction and operation of the Proposed Action. Environmental conditions would be the same as those described in Section 13.1.3, Geology.

13.2.4. Water Resources

13.2.4.1. Introduction

This section describes potential impacts to water resources in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.4.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on water resources were evaluated using the significance criteria presented in Table 13.2.4-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to water resources addressed in this section are presented as a range of possible impacts.

Table 13.2.4-1: Impact Significance Rating Criteria for Water Resources

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Water Quality (groundwater and surface water) - sedimentation, pollutants, nutrients, water temperature	Magnitude or Intensity	Groundwater contamination creating a drinking quality violation, or otherwise substantially degrade groundwater quality or aquifer; local construction sediment water quality violation, or otherwise substantially degrade water quality; water degradation poses a threat to the human environment, biodiversity, or ecological integrity. Violation of various regulations including: CWA, SDWA.	Effect that is potentially significant, but with mitigation is less than significant.	Potential impacts to water quality, but potential effects to water quality would be below regulatory limits and would naturally balance back to baseline conditions.	No changes to water quality; no change in sedimentation or water temperature, or the presence of water pollutants or nutrients.
	Geographic Extent/Context	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons.		Impact is temporary, lasting no more than six months.	NA
Floodplain degradation[a]	Magnitude or Intensity	The use of floodplain fill, substantial increases in impervious surfaces, or placement of structures within a 500-year flood area that will impede or redirect flood flows or impact floodplain hydrology. High likelihood of encountering a 500-year floodplain within a state or territory.	Effect that is potentially significant, but with mitigation is less than significant.	Activities occur inside the 500-year floodplain, but do not use fill, do not substantially increase impervious surfaces, or place structures that will impede or redirect flood flows or impact floodplain hydrology, and do not occur during flood events. Low likelihood of encountering a 500-year floodplain within a state or territory.	Activities occur outside of floodplains and therefore do not increase fill or impervious surfaces, nor do they impact flood flows or hydrology within a floodplain.

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons.		Impact is temporary, lasting no more than one season or water year, or occurring only during an emergency.	NA
Drainage pattern alteration	Magnitude or Intensity	Alteration of the course of a stream of a river, including stream geomorphological conditions, or a substantial and measurable increase in the rate or amount of surface water or changes to the hydrologic regime.	Effect that is potentially significant, but with mitigation is less than significant.	Any alterations to the drainage pattern are minor and mimic natural processes or variations.	Activities do not impact drainage patterns.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent.		Impact is temporary, lasting no more than six months.	NA
Flow alteration	Magnitude or Intensity	Consumptive use of surface water flows or diversion of surface water flows such that there is a measurable reduction in discharge.	Effect that is potentially significant, but with mitigation is less than significant.	Minor or no consumptive use with negligible impact on discharge.	Activities do not impact discharge or stage of waterbody (stream height).
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent.		Impact is temporary, not lasting more than six months.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Changes in groundwater or aquifer characteristics	Magnitude or Intensity	Substantial and measurable changes in groundwater or aquifer characteristics, including volume, timing, duration, and frequency of groundwater flow, and other changes to the groundwater hydrologic regime.	Effect that is potentially significant, but with mitigation is less than significant.	Any potential impacts to groundwater or aquifers are temporary, lasting no more than a few days, with no residual impacts.	Activities do not impact groundwater or aquifers.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact is ongoing and permanent.		Impact is temporary, not lasting more than six months.	NA

[a] Since public safety infrastructure is considered a critical facility, project activities should avoid the 500-year floodplain wherever practicable, per the Executive Orders on Floodplain Management (EO 11988 and EO 13690).[141]
NA = Not Applicable

[141] (See http://www.archives.gov/federal-register/codification/executive-order/11988.html and https://www.federalregister.gov/articles/2015/02/04/2015-02379/establishing-a-federal-flood-risk-management-standard-and-a-process-for-further-soliciting-and).

13.2.4.3. Description of Environmental Concerns

Potential Water Quality Impacts

Water quality impaired waterbodies are those waters that have been identified as not supporting their appropriate uses. Projects in watersheds of impaired waters may be subject to heightened permitting requirements. For example, the CWA requires states to assess and report on the quality of waters in their state. Section 303(d) of the CWA requires states to identify impaired waters. For these impaired waters, states must consider the development of a Total Maximum Daily Load or other strategy to reduce the input of the specific pollutant(s) restricting waterbody uses, in order to restore and protect such uses.

South Carolina's rivers and streams are impaired (see Table 13.1.4-2, Figure 13.1.4-2). Pathogens have affected all of South Carolina's waters. (USEPA, 2015c) Generally, the water quality of South Carolina's aquifers is suitable for public-supply, industrial, and irrigation use (SCDNR, 2009).

Deployment activities could contribute pollutants in a number of ways but the primary likely manner is increased sediment in surface waters. Vegetation removal on site exposes soils to rain and wind that could increase erosion. Impacts to water quality may occur from post-construction vegetation management, such as herbicides, that may leach into groundwater or move to surface waters through soil erosion or runoff, spray drift, or inadvertent direct overspray. Fuel, oil, and other lubricants from equipment could contaminate groundwater and surface waters if carried in runoff. Other water quality impacts could include changes in temperature, pH, dissolved oxygen levels, water odor, color, or taste, or addition of suspended solids.

Soil erosion or the introduction of suspended solids into waterways from implementation of the Preferred Alternative could contribute to degradation of water quality. If the Proposed Action and Alternatives would disturb more than 1 acre of soil, a USEPA NPDES Construction General Permit (CGP) would be required. As part of the permit application for the CGP, a stormwater pollution prevention plan would need to be prepared containing BMPs that would be implemented to prevent, or minimize the potential for, sedimentation and erosion. Adherence to the CGP and the BMPs would help prevent sediment and suspended solids from entering the waterways and ensure that effects on water quality during construction would not be adverse.

Deployment activities associated with the Proposed Action have the potential to increase erosion and sedimentation around construction and staging areas. Grading activities associated with construction would potentially result in a temporary increase in the amount of suspended solids running off construction sites. If a storm event were to occur, construction site runoff could result in sheet erosion of exposed soil. If not adequately controlled, water runoff from these areas would have the potential to degrade surface water quality. Implementing BMPs could reduce potential impacts to surface water quality.

Expected deployment activities would not violate applicable state, federal (e.g., CWA, and Safe Drinking Water Act), and local regulations, cause a threat to the human environment,

biodiversity, or ecological integrity through water degradation, or cause a sediment water quality violation from local construction, or otherwise substantially degrade water quality.

Therefore, based on the impact significance criteria presented in Table 13.2.4-1, water quality impacts would likely be less than significant, and could be further reduced if BMPs and mitigation measures were to be incorporated where practicable and feasible.

During implementation of the Proposed Action and Alternatives, there is the potential to encounter shallow groundwater due to clearing and grading activities, shallow excavation, or relocation of utility lines. This is unlikely, as trenching is not expected to exceed a 48-inch depth. However, groundwater contamination may exist in areas directly within or near the project area. If trenching[142] or tower construction were to occur near or below the existing water table (depth to water), then dewatering would be anticipated at the location. Residual contaminated groundwater could be encountered during dewatering activities. Construction activities would need to comply with state dewatering requirements. Any groundwater extracted during dewatering activities, or subject to the terms of a dewatering permit, may be required to be treated prior to discharge or disposed of at a wastewater treatment facility.

Trenching would not likely introduce new contamination in the state's aquifers. The Proposed Action and Alternatives are unlikely to cause new drinking water violations, or otherwise substantially degrade groundwater quality. Based on the impact significance criteria presented in Table 13.2.4-1, there would likely be less than significant impacts on groundwater quality. In areas where groundwater is close to the surface, then site-specific analysis, BMPs, and mitigation measures could be implemented to further reduce potential impacts.

Floodplain Degradation

Floodplains are low-lying lands next to rivers and streams. When left in a natural state, floodplain systems store and dissipate floods without adverse impacts on human beings, buildings, roads and other infrastructure. The 500-year floodplain is the area of minimal flood hazard, where there is a 0.2-percent-annual-chance flood. Some projects may be outside of a floodplain, but still be in an area with known flooding history.

Based on the impact significance criteria presented in Table 13.2.4-1, floodplain degradation impacts would be potentially less than significant since the majority of FirstNet's likely deployment activities, on the watershed or subwatershed level, would use minimal fill, would not substantially increase impervious surfaces, structures would not impede or redirect flood flows or impact floodplain hydrology, and do not occur during flood events with the exception of deployable technologies which may be deployed in response to an emergency. Additionally, any effects would be temporary, lasting no more than one season or water year, [143] or occur only during an emergency.

[142] Telecommunications activities involve laying conduit, with minimal trenching. Trenching activities would likely be at a minimal depth (less than 36 inches) and width (6 to 12 inches).
[143] A water year is defined as "the 12-month period October 1, for any given year through September 30, of the following year. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months" (USGS, 2016b).

Examples of activities that would have less than significant impacts include:

- Construction of any structure in the 500-year floodplain but is built above base flood elevation pursuant to floodplain management regulations;
- Land uses that include pervious surfaces such as gravel parking lots;
- Land uses that do not change the flow of water or drainage patterns; and
- Limited clearing or grading activities.

Implementation of BMPs and mitigation measures could reduce the risk of additional impacts to floodplain degradation (see Chapter 16).

Drainage Pattern Alteration

Flooding and erosion from land disturbance could changes drainage patterns. Stormwater runoff causes erosion while construction activities and land clearing could change drainage patterns. Clearing or grading activities or the creation of walls or berms can alter water flow in an area or cause changes to drainage patterns. Drainage could be directed to stormwater drains, storage, and retention areas designed to slow water and allow sediments to settle out. Improperly handled drainage could cause increased erosion, changes in stormwater runoff, flooding, and damage to water quality. Existing drainage patterns could be modified by channeling (straightening or restructuring natural watercourses); creation of impoundments (detention basins, retention basins, and dams); stormwater increases; or altered flow patterns.

According to the significance criteria in Table 13.2.4-1, any temporary (lasting less than six months) alterations to drainage patterns that are minor and mimic natural processes or variations within the watershed or subwatershed level would be considered less than significant.

Example of projects that could have minor changes to the drainage patterns include:

- Land uses with pervious surfaces that create limited stormwater runoff;
- Where stormwater is contained on site and does not flow to or impact surface waterbodies offsite on other properties;
- Activities designed so that the amount of stormwater generated before construction is the same as afterwards; and
- Activities designed using low impact development techniques for stormwater.

Since the proposed activities would not substantially alter drainage patterns in ways that alter the course of a stream or river; create a substantial and measurable increase in the rate and amount of surface water; or change the hydrologic regime; and any effects would be short-term; impacts to drainage patterns would be less than significant. BMPs and mitigation measures could be implemented to further reduce any potentially significant impacts.

Flow Alteration

Flow alteration refers to the modification of flow characteristics, relative to natural conditions. Human activities may change the amount of water reaching a stream, divert flow through

artificial channels, or alter the shape and location of streams. Surface water and groundwater withdrawals could alter flow by reducing water volumes in streams. Withdrawals may return to the surface/groundwater system at a point further downstream, be removed from the watershed through transpiration by crops, lawns or pastures, or be transferred to another watershed altogether (e.g., water transferred to a different watershed for drinking supply). Altered flow could increase flooding and introduce more erosion and potential for pollution. Alternatively, if water is diverted from its normal flow, the opposite may occur; wetlands and streams may not receive as much water as necessary to maintain the ecology and previous functions.

Activities that do not impact discharge or stage of waterbody (stream height) are not anticipated to have an impact on flow, according to Table 13.2.4-1. Projects that include minor consumptive use of surface water with less than significant impacts on discharge (do not direct large volumes of water into different locations) on a temporary (no more than six months) are likely to have less than significant impacts on flow alteration, on a watershed or subwatershed level. Examples of projects likely to have less than significant impacts include:

- Construction of any structure in a 100-year or 500-year floodplain that is built above base flood elevation pursuant to floodplain management regulations;
- Land uses that are maintaining or increasing pervious surfaces;
- Land uses that do not change the flow of water or drainage patterns offsite or into surface water bodies that have not received that volume of stormwater previously; and
- Minor clearing or grading activities.

Since the proposed activities would not likely alter flow characteristics or change the hydrologic regime, impacts would be less than significant impacts to flow alteration. BMPs, mitigation measures, and avoidance would further reduce any impacts.

Changes in Groundwater or Aquifer Characteristics

As described in Section 13.1.4.7, approximately 17 percent of total water-supply use in South Carolina originates from groundwater resources. Groundwater is an important natural resource used by industrial, commercial, agricultural, and residential uses for manufacturing, irrigation, and drinking water purposes. Generally, the water quality of South Carolina's aquifers is suitable for drinking and daily water needs. Once a groundwater supply is exhausted or contaminated, it is very expensive, and sometimes impossible, to replace. Water supply demand from the deployment activities is unlikely to exceed safe and sustainable withdrawal capacity rate of the local supply or aquifer.

Storage of generator fuel over groundwater or an aquifer would be unlikely to cause significant impacts to water quality due to the expected small volume of these materials. Activities that may cause changes is groundwater or aquifer characteristics include:

- Excavation, mining, or dredging during or after construction;
- Any liquid waste, including but not limited to wastewater, generation; and
- Storage of petroleum or chemical products.

Private and public water supplies often use groundwater as a water source. To maintain a sustainable system, the amount of water withdrawn from these groundwater sources must be balanced with the amount of water returned to the groundwater source (groundwater recharge).

Deployment activities should be less than significant since they would not substantially deplete supplies of potable groundwater, as any construction dewatering would be short-term. The siting of deployment activities should be considered to avoid areas that would extract groundwater from potable groundwater sources in the area. According to Table 13.2.4-1, potentially significant impacts to groundwater or aquifer characteristics would only occur if actions resulted in substantial and measurable changes in groundwater or aquifer characteristics, including volume, timing, duration, and frequency of groundwater flow, and other changes to the groundwater hydrologic regime on a watershed or within multiple watersheds that is ongoing and permanent. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.4.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to water resources and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to potentially significant impacts depending on the deployment scenario or site-specific conditions. The impact on the water resources that could be affected would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used and the water resource's current use (sole source for drinking water, considered exceptional value for recreation, or provides critical habitat for a species).

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Infrastructure, the following are likely to have no impacts to water resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to water resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.

  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on water resources because there would be no ground disturbance.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact water resources because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact water resources, it is anticipated that this activity would have no impact on water resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to water resources because of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including impaired water quality. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to water resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to water resources. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). Implementing BMPs and mitigation measures could reduce impact intensity.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would impact water resources from a short-term increase in suspended solids in the water. Site-specific impact assessment could be required to marine and shoreline environments prior to installation to fully assess potential impacts to lake or river coastal environments.
  - New Build – Aerial Fiber Optic Plant: Potential impacts would be similar to Buried Fiber Optic Plant. Ground disturbance activities could cause impacts to water quality from increased suspended solids; groundwater impacts from trenching activities are not expected. If a new roadway were built, additional impervious surface would not be

expected to impact water resources or the overall amount of runoff and nonpoint pollution.

- Collocation on Existing Aerial Fiber Optic Plant: Replacement of poles or structural hardening could result in ground disturbance could cause impacts to water quality from increased suspended solids.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required grading or other ground disturbance to install small boxes or huts, or access roads, there could potentially be direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be no impacts to water resources.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). Implementing BMPs and mitigation measures could reduce impact intensity. Trenching would not be expected to occur near or below the existing water table (depth to water). Implementing BMPs could reduce impact intensity. If a new roadway were built, additional impervious surface would not be expected to impact water resources or the overall amount of runoff and nonpoint pollution.
  - Deployable Technologies: Implementation of land-based deployable technologies could result in potential impacts to water resources if deployment involves movement of equipment through streams, occurs in riparian or floodplain areas occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites or deployed in unpaved areas. The amount of impact depends on the land area affected, installation technique, and location. Implementing BMPs and mitigation measures could reduce impact intensity. The activities could also result in indirect impacts on water quality if fuels leak into surface or groundwater. Where deployable technologies would be implemented on existing paved surfaces, or where aerial and vehicular deployable technologies may be used on existing

paved surfaces, it is anticipated that there would be no impacts to water resources because there would be no ground disturbance.

- Deployment of drones, balloons, blimps, or piloted aircraft could have indirect impacts on water quality if fuels spill or other chemicals seep into ground or surface waters. In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to water resources associated with deployment of this infrastructure could include water quality impacts, but are expected to be less than significant due to the small scale of individual activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers or poles; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to water resources associated with deployment of this infrastructure would likely be less than significant at the programmatic level due to the limited geographic scale of individual activities and would likely return to baseline conditions once revegetation of disturbed areas is complete. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities, and are expected to have no impacts at the programmatic level as there would be no ground disturbing activity and it is likely routine maintenance activities would be conducted along exiting roads and utility rights-of way. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. Impacts to surface and groundwater quality from routine operations and maintenance, such as herbicide application to control vegetation, are not expected at the programmatic level. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.4.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing,

usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to water resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to water resources if those activities occurred on paved surfaces. Some staging or launching/landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving, however, these activities would be isolated and short term, and would likely return to baseline conditions once revegetation was complete. Additionally, project activities could result in direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites and from fuels leaking into surface or groundwater. However, spills from vehicles or machinery used during deployment tend to be associated with re-fueling operations, and as such, would likely be a few gallons or less in volume and would likely be easily contained or cleaned up, and therefore would have less than significant impacts at the programmatic level. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Deployable Technologies Alternative would consist of routine maintenance and inspection of the deployable technologies. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The water resources impacts would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used, and the water resource's current use (sole source for drinking water, considered exceptional value for recreation, or provides critical habitat for a species).

It is anticipated that there would be no impacts at the programmatic level to water resources associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors and near waterbodies, the resulting ground disturbance could increase sedimentation in waterbodies, potentially impacting water quality. It is assumed that routine maintenance would not include operation of vehicles or equipment in waterbodies. Finally, if ground-based

deployable technologies are parked and operated with air conditioning for extended periods, the condensation water from the air conditioner could result in soil erosion that could potentially impact waterbodies if the deployables are located adjacent to waterbodies, however, due to the limited and temporary nature of the deployable activities, it is anticipated that these potential impacts would be less than significant at the programmatic level. Site maintenance, including mowing or herbicides, may result in less than significant effects to water quality at the programmatic level, due to the small scale of expected FirstNet activities in any particular location. In addition, the presence of new access roads could increase the overall amount of impervious surface in the area, and increase runoff effects on water resources, as explained above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to water resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.4, Water Resources.

13.2.5. Wetlands

13.2.5.1. Introduction

This section describes potential impacts to wetlands in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.5.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on wetlands were evaluated using the significance criteria presented in Table 13.2.5-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to wetlands addressed in this section are presented as a range of possible impacts.

Table 13.2.5-1: Impact Significance Rating Criteria for Wetlands

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Direct wetland loss (fill or conversion to non-wetland)	Magnitude [a] or Intensity	Substantial loss of high-quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.); violations of Section 404 of the CWA.	Effect that is potentially significant, but with mitigation is less than significant.	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity).	No direct loss of wetlands.
	Geographic Extent/Context	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons.		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration.	NA
Other direct effects: vegetation clearing; ground disturbance; direct hydrologic changes (flooding or draining); direct soil changes; water quality degradation (spills or sedimentation)	Magnitude or Intensity	Substantial and measurable changes to hydrological regime of the wetland impacting salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality; introduction and establishment of invasive species to high quality wetlands.	Effect that is potentially significant, but with mitigation is less than significant.	Impacts to lower quality wetlands affecting the hydrological regime including salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality; introduction and establishment of invasive species to high quality wetlands.	No direct impacts to wetlands affecting vegetation, hydrology, soils, or water quality.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Duration or Frequency	Long-term or permanent alteration that is not restored within 2 growing seasons, or ever.		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration.	NA
Indirect Effects: [b] Change in Function(s) [c] Change in Wetland Type	Magnitude or Intensity	Changes to the functions or type of high quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.).	Effect that is potentially significant, but with mitigation is less than significant.	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity).	No changes in wetland function or type.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Long-term or permanent.		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration.	NA

[a] "Magnitude" is defined based on the type of wetland impacted, using USACE wetland categories. Category 1 are the highest quality, highest functioning wetlands.
[b] Indirect effects are those resulting from direct effects, but they occur elsewhere in space and/or time. Includes indirect hydrologic effects (wetting or drying) that in turn alters wetland function or type.
[c] Wetland functions include hydrologic, ecological, geomorphic, and social functions typically assessed for wetlands as part of USACE compensatory mitigation planning. Typical functions assessed may include flood attenuation, bank stabilization, water quality, organic matter input/transport, nutrient processing, wildlife habitat, T/E species habitat, biodiversity, recreational/social value.
NA = Not Applicable

13.2.5.3. Description of Environmental Concerns

Potential Direct Wetland Loss (Fill or Conversion to Non-Wetland)

Construction-related impacts from several of the deployment activities have the potential for direct wetland impacts such as filling, draining, or conversion to a non-wetland. Examples include placement of fill in a wetland to construct a new tower, trenching through a wetland or directly connected waterway to install a cable, and placement of a structure (tower, building) within the wetland.

Wetlands regulate the quality and quantity of surface and groundwater supplies, reduce flood hazards by serving as retention basins for surface runoff, and maintain water supplies after floodwaters subside. If wetlands were filled, the entire area may be at risk for increased flooding. There could be a loss of open space to be enjoyed by the community, and decreased wildlife populations may be observed due to displacement and increased noise, light, and other human disturbance. To the extent practicable or feasible, FirstNet and/or their partner(s) would avoid filling wetlands or altering the hydrologic regime so that wetlands would not be lost or converted to non-wetlands. Loss of high and low-quality wetlands would be less than significant given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. Potential wetlands impacts can be further reduced by implementing BMPs and mitigation measures (see Chapter 16).

There are more than 3 million acres of palustrine wetlands throughout South Carolina (USFWS, 2014a). Palustrine (freshwater) wetlands include the majority of vegetated freshwater wetlands (freshwater marshes and swamps), as shown in Section 13.1.5.

Based on the impact significance criteria presented in Table 13.2.5 1, the deployment activities would most likely have less than significant direct impacts on wetlands. Additionally, the deployment activities would be unlikely to violate applicable federal, state, and local regulations.

In South Carolina, as discussed in Wetlands, Section 13.1.5.4, South Carolina considers certain wetland communities as areas of special value (or high quality) due to their global or regional scarcity, “unusual local importance,” or habitat they support. These include Carolina Bays and wetlands associated with the North Inlet-Winyah Bay and ACE Base NERRs. If any of the proposed deployment activities were to occur in these high quality wetlands, potentially significant impacts could occur. Carolina bays occur throughout the state, and are not always included on state maps; therefore, site-specific analysis would be required, in addition to BMPs and mitigation measures to avoid potentially significant impacts to wetlands. BMPs and mitigation measures would have to be implemented to reduce and avoidance could help mitigate potentially significant impacts to wetlands. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. Chapter 16, BMPs and Mitigation Measures, provides a listing of the

BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Other Direct Effects

Other direct impacts consist of altering the chemical, physical, or biological components of a wetland to the extent that changes to the wetland functions occur. However, other direct impacts would not result in a loss of total wetland acreage. Changes, for example, could include conversion of a forested wetland system to a non-forested state through chemical, mechanical, or hydrologic manipulation; altered hydrologic conditions (increases or decreases) such as stormwater discharges or water withdrawals that alter the functions of the wetlands.

Based on the impact significance criteria presented in Table 13.2.5-1, construction-related deployment activities that result in long-term or permanent, substantial, and measurable changes to hydrological regime of the wetland (i.e., changes in salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality) may cause potentially significant impacts. In addition, introduction and establishment of invasive species to high quality wetlands within a watershed or multiple watersheds are potentially significant. Other direct effects to high- and low-quality wetlands would be less than significant given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities and the application of federal, state, and local wetlands regulations. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Examples of activities that could have other direct effects to wetlands in South Carolina include:

- *Vegetation Clearing:* removing existing vegetation by clearing forest and herbaceous vegetation during construction activities, grading, seeding, and mulching. Clearing and grading may include increased soil erosion and a decrease in the available habitat for wildlife.
- *Ground Disturbance:* Increased amounts of stormwater runoff in wetlands could alter water level response times, depths, and duration of water detention. Reduction of watershed infiltration capacity could cause wetland water depths to rise more rapidly following storm events.
- *Direct Hydrologic Changes (flooding or draining):* Greater frequency and duration of flooding could destroy native plant communities, as could depriving them of their water supply. Hydrologic changes could make a wetland more vulnerable to pollution. Increased water depths or flooding frequency could distribute pollutants more widely through a wetland. Sediment retention in wetlands is directly related to flow characteristics, including degree and pattern of channelization, flow velocities, and storm surges.

- *Direct Soil Changes:* Changes in soil chemistry could lead to degradation of wetlands that have a specific pH range and/or other parameter.
- *Water Quality Degradation (spills or sedimentation):* The loss of wetlands results in a depletion of water quality both in the wetland and downstream. Filtering of pollutants by wetlands is an important function and benefit. High levels of suspended solids (sedimentation) could reduce light penetration, dissolved oxygen, and overall wetland productivity. Toxic materials in runoff could interfere with the biological processes of wetland plants, resulting in impaired growth, mortality, and changes in plant communities.

Indirect Effects:[144] Changes in Function(s)[145] or Change in Wetland Type

Indirect effects to wetlands could include change in wetland function or conversion of a resource to another type (i.e., wetland to an open body of water). The construction of curb and gutter systems diverts surface runoff and could cause flooding or wetlands to dry out, depending on the direction of diversion. Indirect effects to high- and low-quality wetlands would be less than significant given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities and the application of federal, state, and local wetlands regulations. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures, as practicable and feasible (see Chapter 16).

Examples of functions related to wetlands in South Carolina that could potentially be impacted from construction-related deployment activities include:

- *Flood Attenuation:* Wetlands provide flood protection by holding excess runoff after storms, before slowly releasing it to surface waters. While wetlands may not prevent flooding, they could lower flood peaks by providing detention of storm flows. Correspondingly, disturbance of the wetlands (e.g., dredging or filling) could proportionately reduce water storage function.
- *Bank Stabilization:* By reducing the velocity and volume of flow, wetlands provide erosion control, floodwater retention, and reduce stream sedimentation.
- *Water Quality:* Water quality impacts on wetland soils could eventually threaten a wetland's existence. Where sediment inputs exceed rates of sediment export and soil consolidation, a wetland would gradually become filled.

[144] Indirect effects are those resulting from direct effects, but they occur elsewhere in space and/or time. Includes indirect hydrologic effects (wetting or drying) that in turn alters wetland function or type

[145] Wetland functions include hydrologic, ecological, geomorphic, and social functions typically assessed for wetlands as part of USACE compensatory mitigation planning. Typical functions assessed may include flood attenuation, bank stabilization, water quality, organic matter input/transport, nutrient processing, wildlife habitat, T/E species habitat, biodiversity, recreational/social value.

- *Nutrient Processing:* Wetland forests retain ammonia during seasonal flooding. Wetlands absorb metals in the soils and by plant uptake via the roots. They also allow metabolism of oxygen-demanding materials and reduce fecal coliform populations. These pollutants are often then buried by newer plant material, isolating them in the sediments.
- *Wildlife Habitat:* Impacts on wetland hydrology and water quality affect wetland vegetation. While flooding could harm some wetland plant species, it promotes others. Shifts in plant communities because of hydrologic changes could have impacts on the preferred food supply and animal cover.
- *Recreational Value:* Wetlands provide recreation opportunities for people, such as hiking, bird watching, and photography.
- *Groundwater Recharge:* Wetlands retain water, allowing time for surface waters to infiltrate into soils and replenish groundwater.

According to the significance criteria defined in Table 13.2.5-1, impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity), would be considered potentially less than significant. Since the majority of the wetlands in South Carolina are not considered high quality, deployment activities could have less than significant indirect impacts on wetlands in the state. BMPs and mitigation measures could be implemented, as feasible and practicable, to reduce potential impacts to all wetlands. In areas of the state with high quality wetlands, there could be potentially significant impacts at the project level that would be analyzed on a case-by-case basis. If avoidance were not possible, BMPs and mitigation measures would help to mitigate impacts. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.5.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. To determine the magnitude of potential impacts of site-specific activities, wetland delineations would be required to determine the exact location of all wetlands, including high quality wetlands, as well as a functional assessment by an experienced wetland delineator.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wetlands and others would not. In addition, and as explained in this section, the same type of proposed action

infrastructure could result in a range of no impacts to potentially significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to wetlands under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to wetlands since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on wetlands because there would be ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures, adding equipment to satellites being launched for other purposes, and the use of portable devices that use satellite technology is not likely to impact wetlands since there would be no ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN, however it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wetlands, it is anticipated that this activity would have no impact on wetlands.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to wetlands because of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct effects, other direct effects, and indirect effects on wetlands. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to wetlands include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wetlands. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct and indirect impacts to wetlands. The amount of impact depends on the land area affected, installation technique, proximity to

wetlands, and type of wetland that could be affected (e.g., high quality). Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected. Implementing BMPs and mitigation measures could reduce impact intensity.

  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would potentially impact wetlands found along shorelines. Additional project-specific environmental reviews would be required to assess potential impacts to wetland environments, including coastal and marine environments.
  - New Build – Aerial Fiber Optic Plant: Potential impacts would be similar to Buried Fiber Optic Plant. Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected.
  - Collocation on Existing Aerial Fiber Optic Plant: Any ground disturbance could cause direct and indirect impacts to wetlands from increased suspended solids and runoff from activities, depending on the proximity to wetlands and type of wetlands that could be affected.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required grading or other ground disturbance to install small boxes or hunts, or access roads, there could potentially be direct and indirect impacts to wetlands. The amount of impact from a temporary increase in the amount of suspended solids running off construction sites and into wetlands depends on the land area affected, installation technique, and location. If trenching were to occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could potentially cause direct and indirect impacts to wetlands. The activities could cause a temporary increase in the amount of suspended solids running off construction sites and into wetlands, depending on their proximity. The amount of impact depends on the land area affected, installation technique, and proximity to wetlands, and wetland type. If trenching were to occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to wetlands. However, if additional power units, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to wetlands could occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.

- Deployable Technologies: Implementation of deployable technologies could result in potential impacts to wetlands if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. The amount of impact depends on the land area affected, installation technique, and location. Implementing BMPs and mitigation measures could reduce impact intensity. The activities could also result in other direct impacts on wetlands if fuels leak into nearby waterbodies or wetlands. Deployment of drones, balloons, blimps, or piloted aircrafts could have other direct impacts on wetlands if fuels spill or other chemicals seep into nearby waterbodies or wetlands.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Depending on the deployment activity for this infrastructure, potential impacts to wetlands may occur. The amount of impact depends on the land area affected, installation technique, proximity to wetlands, and type of wetland that could be affected (e.g., high quality). Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected. These impacts are expected to be less than significant at the programmatic level due to the small about of land disturbance (generally less than one acre) and the short timeframe of deployment activities. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there could be ongoing potential other direct impacts to wetlands if heavy equipment is used for routine operations and maintenance application of herbicides occurs to control vegetation along all ROWs and near structures, depending on the proximity to wetlands. The intensity of the impact depends on the amount of herbicides used, frequency, and location of nearby sensitive wetlands. These impacts are expected to be less than significant at the programmatic level due to the limited nature of deployment activities. It is also anticipated that routine maintenance activities would be conducted on existing roads and utility ROW. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.5.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wetlands as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to wetlands at the programmatic level. Some staging or launching/landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct and indirect impacts to wetlands from a temporary increase in the amount of suspended solids running off construction sites to nearby surface waters. The amount of impact depends on the land area affected, installation technique, and proximity to wetlands, and wetland type; however, impacts are expected to be less than significant at the programmatic level due to the small-scale and temporary duration of expected FirstNet deployment activities in any one location. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. See Chapter 16, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Deployable Technologies Alternative would consist of routine maintenance and inspection of the deployable technologies. Any major infrastructure replacement as part of ongoing system maintenance could result in impacts similar to the abovementioned deployment impacts. The wetlands impacts would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used, and the wetland's quality and function.

It is anticipated that there would be less than significant at the programmatic level impacts to wetlands associated with routine inspections of the Deployable Technologies Alternative, as it is

likely existing roads and utility rights-of-way would be utilized for maintenance and inspection activities. Site maintenance, including mowing or herbicides, is anticipated to result in less than significant effects to wetlands at the programmatic level due to the limited nature of site maintenance activities, including mowing and application of herbicides. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to wetlands from construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.5, Wetlands.

13.2.6. Biological Resources

13.2.6.1. Introduction

This Chapter describes potential impacts to terrestrial vegetation, wildlife, fisheries and aquatic habitat, and threatened and endangered species in South Carolina associated with deployment and operation of the Proposed Action and its alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.6.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on terrestrial vegetation, wildlife, fisheries, and aquatic habitats were evaluated using the significance criteria presented in Table 13.2.6-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to terrestrial vegetation, wildlife, and fisheries and aquatic habitat addressed in Sections 13.2.6.3, 13.2.6.4, and 13.2.6.5, respectively, are presented as a range of possible impacts.

Refer to Section 13.2.6.6 for impact assessment methodology and significance criterial associated with threatened and endangered species in South Carolina.

Table 13.2.6-1: Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, Fisheries, and Aquatic Habitats

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Direct Injury/Mortality	Magnitude or Intensity	Population-level or sub-population injury /mortality effects observed for at least one species depending on the distribution and the management of said species. Events that may impact endemics, or concentrations during breeding or migratory periods. Violation of various regulations including: Marine Mammal Protection Act (MMPA), Magnuson Stevens Fishery Conservation And Management Act (MSFCMA), MBTA, and Bald and Golden Eagle Protection Act (BGEPA).	Effect that is potentially significant, but with BMPs and mitigation measures is less than significant.	Individual mortality observed but not sufficient to affect population or sub-population survival.	No direct individual injury or mortality would be observed.
	Geographic Extent	Regional effects observed within South Carolina for at least one species. Anthropogenic[a] disturbances that lead to exclusion from nutritional or habitat resources, or direct injury or mortality of endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location when population is widely distributed, and not concentrated in affected area.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Vegetation and Habitat Loss, Alteration, or Fragmentation	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species or vegetation cover type, depending on the distribution and the management of the subject species. Impacts to terrestrial, aquatic, or riparian habitat or other sensitive natural community vital for feeding, spawning/breeding, foraging, migratory rest stops, refugia, or cover from weather or predators. Violation of various regulations including: MMPA, MSFCMA, MBTA, and BGEPA.	Effect that is potentially significant, but with BMPs and mitigation measures is less than significant.	Habitat alteration in locations not designated as vital or critical for any period. Temporary losses to individual plants within cover types, or small habitat alterations take place in important habitat that is widely distributed and there are no cover type losses or cumulative effects from additional projects.	Sufficient habitat would remain functional to maintain viability of all species. No damage or loss of terrestrial, aquatic, or riparian habitat from project would occur.
	Geographic Extent	Regional effects observed within South Carolina for at least one species. Anthropogenic disturbances that lead to the loss or alteration of nutritional or habitat resources for endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Indirect Injury/Mortality	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species depending on the distribution and the management of said species. Exclusion from resources necessary for the survival of one or more species and one or more life stages. Anthropogenic disturbances that lead to mortality, disorientation, the avoidance, or exclusion from nutritional or habitat resources for endemics or a significant portion of the population or sub-population located in a small area during a specific season. Violation of various regulations including: MMPA, MSFCMA, MBTA, and BGEPA.	Effect that is potentially significant, but with BMPs and mitigation measures is less than significant.	Individual injury/mortality observed but not sufficient to affect population or sub-population survival. Partial exclusion from resources in locations not designated as vital or critical for any given species or life stage, or exclusion from resources that takes place in important habitat that is widely distributed. Anthropogenic disturbances are measurable but minimal as determined by individual behavior and propagation, and the potential for habituation or adaptability is high given time.	No stress or avoidance of feeding or important habitat areas. No reduced population resulting from habitat abandonment.
	Geographic Extent	Regional or site specific effects observed within South Carolina for at least one species. Behavioral reactions to anthropogenic disturbances depend on the context, the time of year age, previous experience, and activity. Anthropogenic disturbances that lead to startle responses of large groupings of individuals during haulouts, resulting in injury or mortality.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to Migration or Migratory Patterns	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species depending on the distribution and the management of said species. Temporary or long-term loss of migratory pattern/path or rest stops due to anthropogenic activities. Violation of various regulations including: MMPA, MSFCMA, MBTA, and BGEPA.	Effect that is potentially significant, but with BMPs and mitigation measures is less than significant.	Temporary loss of migratory rest stops due to anthropogenic activities take place in important habitat that is widely distributed and there are no cumulative effects from additional projects.	No alteration of migratory pathways, no stress, or avoidance of migratory paths/patterns due to project.
	Geographic Extent	Regional effects observed within South Carolina for at least one species. Anthropogenic disturbances that lead to exclusion from nutritional or habitat resources during migration, or lead to changes of migratory routes for endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location when population is widely distributed, and not concentrated in affected area.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Reproductive Effects	Magnitude or Intensity	Population or sub-population level effects in reproduction and productivity over several breeding/spawning seasons for at least one species depending on the distribution and the management of said species. Violation of various regulations including: MMPA, MSFCMA, MBTA, and BGEPA.	Effect that is potentially significant, but with BMPs and mitigation measures is less than significant.	Effects to productivity are at the individual rather than population level. Effects are within annual variances and not sufficient to affect population or sub-population survival.	No reduced breeding or spawning success.
	Geographic Extent	Regional effects observed within South Carolina for at least one species. Anthropogenic disturbances that lead to exclusion from prey or habitat resources required for breeding/spawning or stress, abandonment, and loss of productivity for endemics or a significant portion of the population or sub-population located in a small area during the breeding/spawning season.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several breeding/spawning seasons for at least one species.		Temporary, isolated, or short-term effects that are reversed within one breeding season.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Invasive Species Effects	Magnitude or Intensity	Extensive increase in invasive species populations over several seasons.	Effect that is potentially significant, but with BMPs and mitigation measures is less than significant.	Mortality observed in individual native species with no measurable increase in invasive species populations.	No loss of forage and cover due to the invasion of exotic or invasive plants introduced to project sites from machinery or human activity.
	Geographic Extent	Regional impacts observed throughout South Carolina.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term changes not likely to be reversed over several years or seasons.		Periodic, temporary, or short-term changes that are reversed over one or two seasons.	NA

NA: Not Applicable

[a] Anthropogenic: "Made by people or resulting from human activities. Usually used in the context of emissions that are produced as a result of human activities" (USEPA, 2016d).

13.2.6.3. Terrestrial Vegetation

Impacts to terrestrial vegetation occurring in South Carolina are discussed in this section.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. The most common direct injuries are permanent or temporary loss or disturbance of individual plants. Based on the impact significance criteria presented in Table 13.2.6-1, direct injury or mortality impacts could be significant if population-level or sub-population effects were observed for at least one species depending on the distribution and the management of the subject species. Although unlikely, direct mortality/injury to plants could occur in construction zones from land clearing, excavation activities, or vehicle traffic; however, these events are expected to be relatively small in scale and therefore would have less than significant impacts at the programmatic level. The implementation of BMPs and mitigation measures and avoidance measures could help to minimize or altogether avoid potential impacts to plant population survival. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Vegetation and Habitat Loss, Alteration, or Fragmentation

Habitat impacts are primarily physical disturbances that result in alterations in the amount or quality of a habitat. As with all of the effects categories, the magnitude of the potential impact depends on the duration, location, and spatial scale of the system and associated activities. Habitat fragmentation is the loss or breaking down of continuous and connected habitat. About 17 percent of South Carolina has experienced extensive land use change due to cropland creation and about 11 percent of the state has experienced extensive land use change due to urbanization. However, a large portion of the state, about 62 percent, remains as relatively unfragmented forest, particularly the Francis Marion National Forest and Sumter National Forest (USGS, 2012b).

Construction of new infrastructure and long-term facility maintenance could result in the alteration of the type of vegetative communities in these localized areas, and in some instances the permanent loss of vegetation. In general, these impacts are expected to be less than significant at the programmatic level due to the short-term, localized nature of the deployment activities. Further, some limited amount of infrastructure may be built in sensitive or rare regional vegetative communities, in which case BMPs and mitigation measures could be recommended and consultation with appropriate resource agencies, if required, could be undertaken to minimize or avoid potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Indirect Injury/Mortality

Indirect effects are effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR 1508.8[b]). Indirect injury/mortality could include stress related to disturbance. The alteration of soils or hydrology within a localized area could result in stress or mortality of plants. Construction activities that remove large quantities of soil in the immediate vicinity of trees could cause undue stress to trees from root exposure, although this is unlikely to occur due to the small size of expected FirstNet activities. Indirect injury/mortality impacts vary depending on the species, time of year and duration of construction or deployment. Overall, these impacts are expected to be less than significant at the programmatic level due to the short-term and small-scale nature of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Effects to Migration or Migratory Patterns

No effects to the long-term migration or migratory patterns for terrestrial vegetation (e.g., forest migration) are expected as a result of the Proposed Action, given the small-scale of deployment activities.

Reproductive Effects

No reproductive effects to terrestrial vegetation are expected as a result of the Proposed Action given the small-scale of deployment activities.

Invasive Species Effects

When human activity results in a species entering an ecosystem new to it, the species is classified as introduced or, depending on its ability to spread rapidly and outcompete native species, invasive. The introduction of invasive species could have a dramatic effect on natural resources and biodiversity. The State of South Carolina does not maintain a list of regulated noxious weeds. The South Carolina Exotic Pest Plant Council with members from state agencies, private industry, and education; publishes a terrestrial invasive plant list, which does not have any regulatory authority, “to identify and categorize plants that pose threats to natural areas in South Carolina.”

As described in Section 13.1.6.4, when non-native species are introduced into an ecosystem in which they did not evolve, their populations sometimes increase rapidly. Even if natives are not completely eliminated, the ecosystem often becomes much less diverse. The potential to introduce invasive plants within construction zones and during long-term site maintenance can occur from vehicles and equipment being transported from one region to another, or when conducting revegetation of a site after deployment activities are complete. Overall, these impacts are expected to be less than significant at the programmatic level due to the small-scale and localized nature of likely FirstNet activities. BMPs could help to minimize or avoid the potential for introducing invasive plant species during implementation of the Proposed Action. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation

measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to terrestrial vegetation resources and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range impacts, from no impacts to less than significant impacts at the programmatic level, depending on the deployment scenario or site-specific conditions. The terrestrial vegetation that would be affected would depend on the ecoregion, the species' phenology,[146] and the nature as well as the extent of the habitats affected. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no impacts to terrestrial vegetation under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Although terrestrial vegetation could be impacted, it is anticipated that effects to vegetation would be minimal since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on terrestrial vegetation because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures, attaching equipment to satellite launches for other purposes, and the use of portable devices that use satellite technology would not

[146] Phenology is the seasonal changes in plant and animal lifecycles, such as emergence of insects or migration of birds.

impact terrestrial vegetation because those activities would not require ground disturbance.

- Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact biological resources, it is anticipated that this activity would have no impact on terrestrial vegetation.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to terrestrial vegetation as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; indirect injury/mortality; and invasive species effects. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to terrestrial vegetation include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to terrestrial vegetation. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.
  - New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilities to house outside plant equipment could result in potential impacts to terrestrial vegetation. Impacts may vary depending on the number or individual poles installed, but could include direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.
  - Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would not impact terrestrial vegetation. However, impacts to terrestrial vegetation could potentially occur as a result of the construction of landings and/or facilities on shore to accept submarine cables could potentially occur as a result of land clearing, excavation activities, and heavy equipment use. Effects could include direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.

  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct or indirect injury to plants, vegetation loss, and invasive species effects.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads), microwave facilities, or access roads could result in impacts to terrestrial vegetation. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower which would not result in impacts to terrestrial vegetation. However, if new power units, replacement towers, structural hardening, and physical security measures require land clearing or excavation activities, impacts would be similar to new wireless construction.
  - Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, or SOWs could result in direct impacts to terrestrial vegetation if deployment occurs on vegetated areas, or the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects. Deployment of drones, balloons, blimps, or piloted aircrafts could potentially impact terrestrial vegetation if deployment occurs on vegetated areas. Impacts would be similar to deployment of COWs, COLTs, and SOWs.

In general, the abovementioned activities could potentially involve land/vegetation clearing; topsoil removal; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or cables; heavy equipment movement; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to terrestrial vegetation associated with deployment of this infrastructure, depending on their scale, could include direct or indirect injury/mortality to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the vegetation affected. Despite the variability, these potential impacts are expected to be less than significant at the programmatic level due to the small-scale and limited geographic scope of expected deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The terrestrial vegetation that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that there would no impacts to terrestrial vegetation associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections because there would be no ground disturbance. Site maintenance, including mowing or herbicides, may result in less than significant effects at the programmatic level due to the small-scale of expected activities. These potential impacts could result from accidental spills from maintenance equipment or release of herbicides and because these areas would not be allowed to revert to a more natural state. If usage of heavy equipment or land clearing activities occurs off established roads or corridors as part of routine maintenance or inspections, direct or indirect injury/mortality to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species could occur to terrestrial vegetation, however impacts are expected to be less than significant due to the small-scale of expected activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to terrestrial vegetation associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to terrestrial vegetation as a result of implementation of this alternative could be as described below.

Deployment Impacts

As described above, implementation of deployable technologies could result in less than significant impacts from land/vegetation clearing, excavation, and paving activities. These

activities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects. Greater frequency and duration of deployments could change the magnitude of impacts. Nonetheless, impacts are expected to remain less than significant due to the relatively small-scale of FirstNet activities at individual locations. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operational Impacts

As described above, operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. The impacts could vary greatly among species, vegetative community, and geographic region, but are expected to remain less than significant at the programmatic level. As with the Preferred Alternative, it is anticipated that there would be less than significant impacts to terrestrial vegetation at the programmatic level with routine operations and maintenance due to the relatively small scale of likely FirstNet project sites. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to terrestrial vegetation as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.6.3, Terrestrial Vegetation.

13.2.6.4. Wildlife

Impacts to amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates occurring in South Carolina and South Carolina's near offshore environment (i.e., less than two miles from the edge of the coast) are discussed in this section. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. The most common direct injuries are entanglement, vehicle or vessel strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals from disturbance events.

Based on the impact significance criteria presented in Table 13.2.6-1, less than significant impacts would be anticipated at the programmatic level given that the majority of proposed

deployment activities are likely to be small-scale and would be dependent on the location and type of deployment activity. Although anthropogenic disturbances may be measurable (although minimal) for some FirstNet Proposed Actions, impacts to individual behavior of animals would be short term and direct injury or mortality impacts at the population-level or sub-population effects would not likely be observed; therefore, impacts are generally expected to be less than significant, as discussed further below. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Terrestrial Mammals

Vehicle strikes are common sources of direct mortality or injury to both small and large mammals in South Carolina. Mammals are attracted to roads for a variety of reasons including use as a source of minerals, foraging, and migration (FHWA, 2009). Individual injury or mortality as a result of vehicle strikes associated with the Proposed Action could occur.

Entanglement in fences or other barriers could be a source of mortality or injury to terrestrial mammals, though entanglements would likely be isolated, individual events.

For example, if tree-roosting bats, and particularly maternity colonies are present at a site location, removal of trees during land clearing activities could result in direct injury/mortality if bats are utilizing them as roost trees or for rearing young. The scale of this impact would be expected to be small-scale and would be dependent on the location and type of deployment activity, and tree removal. Site avoidance measures could be implemented to avoid disturbance to bats.

Marine Mammals

Entanglements from marine debris as well as ingestion of marine debris could result in injury or death to marine mammals. Marine debris is any manmade object discarded, disposed of, or abandoned that enters the marine environment. Entanglements from marine debris are not anticipated from FirstNet activities.

Many of the whale species known to occur offshore of South Carolina are also protected under the ESA. Potential Environmental impacts pertaining to these whales are discussed in Section 13.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Birds

Mortalities from collisions or electrocutions with manmade cables and wires are environmental concerns for avian species. Generally, collision events occur to night-migrating birds, “poor” fliers (e.g., ducks), night-migrating birds, heavy birds (e.g., swans and cranes), and birds that fly in flocks; while species susceptible to electrocution are birds of prey, ravens, and thermal soarers, typically having large wing spans (FAA, 2012b) (Gehring, Kerlinger, & Manville, 2011).

Avian mortalities or injuries could also result from vehicle strikes, although typically occur as isolated events.

Direct injury and mortality of birds could occur to ground-nesting birds when nests are either disturbed or destroyed during land clearing, excavation and trenching, and other ground disturbing activities. Removal of trees during land clearing activities could also result in direct injury/mortality to forest dwelling birds if they are utilizing them as roost trees for resting or shelter from predators and inclement weather, or as nest trees for rearing young. The scale of this impact would be associated with the amount of tree removal and the abundance of forest-dwelling birds roosting/nesting in the area. These impacts could be particularly pronounced in IBAs within the state as these areas provide them with essential habitat that supports various life stages (Hill, et al., 1997). Direct injury/mortality are not anticipated to be widespread or affect bird populations due to the small-scale of likely FirstNet actions.

Direct mortality and injury to birds of South Carolina are not likely to be widespread or affect populations of species as a whole; individual impacts may be realized depending on the location and type of deployment activity. Direct injury/mortality are not anticipated to be widespread or affect bird populations due to the small scale of likely FirstNet actions. If siting considerations, BMPs, and mitigation measures are implemented (Chapter 16), potential impacts could be minimized. Applicable BMPs and mitigation measures, as defined through consultation with USFWS for MBTA or BGEPA, if required, could help to avoid or minimize any potential impacts. Environmental consequences pertaining to federally listed species will be discussed in Section 13.2.6.6, Threatened and Endangered Species.

Reptiles and Amphibians

The majority of South Carolina's amphibian and reptile species are widely distributed throughout the state; however, some species have more limited ranges. Either direct mortality to amphibians or reptiles could occur in construction zones by excavation activities or by vehicle strikes; however, these effects are expected to be temporary and isolated, affecting only individual animals.

Filling or draining of wetland breeding habitat (see Section 13.2.4, Water Resources) and alterations to ground or surface water flow from development associated with the Proposed Action may also have effects to state amphibian and reptile populations, though BMPs and mitigation measures would help to avoid or minimize the potential impacts.[147]

Five species of marine turtles – all listed as threatened or endangered under the ESA – occur in South Carolina's offshore environment. Environmental consequences pertaining to these reptiles are discussed in Section 13.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Terrestrial Invertebrates

The terrestrial invertebrate populations of South Carolina are so widely distributed that injury/mortality events are not expected to affect populations of species as a whole.

[147] See Chapter 16, Wetlands, for a discussion of BMPs for wetlands.

Vegetation and Habitat Loss, Alteration, or Fragmentation

As described in Section 13.2.6.3, habitat loss could occur through exclusion, directly or indirectly, preventing an animal from accessing an optimal habitat (e.g., breeding, forage, or refuge), either by physically preventing use of a habitat or by causing an animal to avoid a habitat, either temporarily or long-term. It is expected that activities associated with the Proposed Action would cause exclusion effects only in very special circumstances, as in most cases an animal could fly, swim, or walk to a nearby area that would provide refuge.

In general, potential effects of vegetation and habitat loss, alteration, or fragmentation are expected to be less than significant because of the small-scale nature and limited geographic scope of expected deployment activities. These potential impacts are described for South Carolina's wildlife species below. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Terrestrial Mammals

Mammals occupy a wide range of habitats throughout South Carolina and may experience localized effects of habitat loss or fragmentation. Removal or loss of vegetation may impact large mammals (e.g., black bear) by decreasing the availability of forest for cover from predators or foraging. Loss of cover may increase predation on both breeding adults as well as their young. The loss, alteration, or fragmentation of forested habitat would also impact some small mammals (e.g., bats, foxes) that utilize these areas for roosting, foraging, sheltering, and for rearing their young. Loss of habitat or exclusions from these areas could be avoided or minimized by implementing BMPs and mitigation measures (see Chapter 16).

Marine Mammals

The West Indian manatee periodically inhabits South Carolina's tidal waters, easily moving from fresh to estuarine to marine environments. Bottlenose dolphins are the most common near shore marine mammal in South Carolina. In addition, there are several species of whales that can be observed off the coast of South Carolina, including finback whales, humpback whales, and North Atlantic right whales. Manatees often use secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, mating, and calving (USFWS, 2001a). Manatees could be temporarily excluded from a resource due to the presence of humans, noise, or vessel traffic during deployment activities. Effects on manatees from exclusion from resources would be low magnitude and temporary in duration.

Loss of habitat or exclusions from these areas for manatees, and whales could be avoided or minimized by BMPs and mitigation measures (see Chapter 16). Potential environmental impacts pertaining to the endangered whales and West Indian manatee protected under the ESA are discussed in Section 13.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Birds

The direct removal of migratory bird nests is prohibited under the MBTA. The USFWS and the SCDNR can provide regional guidance on the most critical time periods (e.g., breeding season) to avoid vegetation clearing. The removal and loss of vegetation could affect avian species directly by loss of nesting, foraging, stopover, and cover habitats.

Noise disturbance and human activity, as discussed previously, could directly restrict birds from using their preferred resources. Greater human activity of longer duration would increase the likelihood that birds would avoid the area, possibly being excluded from essential resources. These impacts could be particularly pronounced in IBAs within the state as birds may temporarily avoid these areas (Hill, et al., 1997).

The degree to which habitat exclusion affects birds depends on many factors. The impact to passerine[148] species from disturbance or displacement from construction activities is likely to be short-term with minor effects from exclusion. Exclusion from resources concentrated in a small migratory stop area during peak migration could have major impacts to species that migrate in large flocks and concentrate at stop overs (e.g., shorebirds). BMPs and mitigation measures, including nest avoidance during construction-related activities, would help to avoid or minimize the potential impacts to birds from exclusion of resources, as appropriate.

Reptiles and Amphibians

Important habitats for South Carolina amphibians and reptiles typically consist of wetlands and the surrounding upland forest. Impacts are expected to be less than significant given the short-term nature and limited geographic scope of individual activities. If proposed project sites were unable to avoid sensitive areas, BMPs and mitigation measures (see Chapter 16) could be implemented to avoid or minimize the potential impacts.

Filling or draining of wetland breeding habitat (see Section 13.2.4, Water Resources) and alterations to ground or surface water flow from development associated with the Proposed Action may also have effects to South Carolina's amphibian and reptile populations; site-specific analysis of potential wetland impacts would need to be conducted.

Terrestrial Invertebrates

Habitat loss and degradation are the most common causes of invertebrate species' declines; however, habitat for many common terrestrial invertebrates is generally assumed to be abundant and widely distributed across the state, therefore no significant effects to terrestrial invertebrates are expected. Impacts to sensitive invertebrate species are discussed below in Section 13.2.6.6, Threatened and Endangered Species and Species of Concern.

Indirect Injury/Mortality

Indirect injury/mortality impacts vary depending on the species, time of year and duration of deployment. Overall, impacts are expected to remain less than significant due to the short-term

[148] Passerines are an order of "perching" birds that have four toes, three facing forward, and one backward, which allows the bird to easily cling to both horizontal and nearly vertical perches.

nature and limited geographic scope of expected activities, though BMPs and mitigation measures could further help to avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Terrestrial Mammals

Stress from repeated disturbances during critical time periods (e.g., roosting and mating) could reduce the overall fitness and productivity of young and adult terrestrial mammals. Indirect effects could occur to roosting bats from noise, light, or human disturbance causing them to leave their roosting locations or excluding them from their summer roosting/maternity colony roosts. For example, some bat species establish summer roosting or maternity colonies in the same general area that they return to year and after year. The majority of FirstNet deployment activities would be short-term in nature, and, repeated disturbances would not occur.

Marine Mammals

Repeated disturbance (e.g., from vessel traffic) could cause stress to individuals resulting in lower fitness and productivity. Given that the majority of FirstNet deployment activities are not expected to be located offshore or in the oceanic environment, less than significant impacts to no impacts would be anticipated for marine mammals.

Birds

Repeated disturbance, especially during the breeding and nesting season, could cause stress to individuals lowering fitness and productivity. These impacts could be particularly pronounced in IBAs within the state if birds temporarily avoid those areas, since they provide essential habitat for various life stages (Hill, et al., 1997). The majority of FirstNet deployment activities would be short-term in nature, therefore repeated disturbances would not occur. Depending on the project type and location, individual species may be disturbed resulting in less than significant impacts.

Reptiles and Amphibians

Changes in water quality, especially during the breeding seasons, could cause stress resulting in lower productivity. The majority of FirstNet deployment activities would be short-term in nature, and repeated disturbances would not occur.

Terrestrial Invertebrates

Terrestrial invertebrates could experience chronic stress, either by changes in habitat composition or competition for resources, resulting in lower productivity. Due to the large number of invertebrates distributed throughout the state, and given the short-term nature of most of the deployment activities, this impact would likely be less than significant.

Effects to Migration or Migratory Patterns

Migration is the regular movement of animals from one region to another and back again. Migratory patterns vary by species and sometimes within the same species. Overall, potential impacts are anticipated to be less than significant due to the small-scale and localized nature of expected activities, which would be unlikely to result in long-term avoidance. Potential effects to migration patterns of South Carolina's amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates are described below. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Terrestrial Mammals

Some large mammals (e.g., black bears) will perform short seasonal migrations between foraging/breeding habitats and denning habitats. Some small mammals (e.g., bats) also have migratory routes that include spring and fall roosting areas between their summer maternity roosts and hibernacula.[149] Any clearance, drilling, and construction activities needed for network deployment, including noise associated with these activities, has the potential to divert mammals from these migratory routes. Impacts could vary depending on the species, time of year of construction/operation, and duration, but are generally expected to be less than significant given the short-term nature and limited geographic scope for individual activities. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Marine Mammals

Noise associated with the installation of cables in the near/offshore waters of coastal South Carolina could impact marine mammal migration patterns, though impacts are likely to be short-term provided the noise sources are not wide ranging and below Level A and B sound exposure thresholds.[150] It is clear that behavioral responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. Marine mammals have the capacity to divert from sound sources during migration, and therefore impacts are expected to be less than significant since noise generating activities would be of short duration and are not likely to result in long-term avoidance. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Birds

Because many birds have extremely long migrations, protection efforts for critical sites along migratory routes must be coordinated over distances often involving many different countries. For example, as a group, shorebirds migrating through South Carolina undertake some of the longest-distance migrations of all animals. According to the Audubon Society, a total of 49

[149] A location chosen by an animal for hibernation.
[150] Level A: 190 dB re 1µPa (rms) for seals and 180 dB re 1µPa (rms) for whales, dolphins, and porpoises. It is the minimum exposure criterion for injury at the level at which a single exposure is estimated to cause onset of permanent hearing loss. Level B: 160 dB re 1µPa (rms). It is defined as the onset of significant behavioral disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (Southall, et al., 2007).

IBAs have been identified in South Carolina, including (Audubon Society of South Carolina, 2015). These IBAs are located throughout the state, although the largest concentrations are located along South Carolina's Atlantic Coast. Many migratory routes are passed from one generation to the next. Impacts could vary (e.g., mortality of individuals or abandonment of stopover sites by whole flocks) depending on the species, time of year of construction/operation, and duration, and impacts are expected to be than significant. BMPs and mitigation measures could help to further avoid or minimize effects to migratory birds.

Reptiles and Amphibians

Several species of salamanders and frogs are known to seasonally migrate in South Carolina. Post-metamorphic salamanders, such as the frosted flatwoods salamander, migrate out of the ponds where they were born and into the uplands where they live until they move back to ponds to breed as adults (USFWS, 2009). Mortality and barriers to movement could occur as result of the Proposed Action (Berven & Grudzien, 1990) (Calhoun & DeMaynadier, 2007).

Species that use streams as dispersal or migratory corridors may be impacted if these waterways are restricted or altered, but impacts are expected to be less than significant. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Terrestrial Invertebrates

The majority of FirstNet deployment or operation activities are likely to be small-scale in nature; no effects to migratory patterns of South Carolina's terrestrial invertebrates are expected as a result of the Proposed Action.

Reproductive Effects

Reproductive effects are considered those that either directly or indirectly reduce an animal's ability to produce offspring or reduce the rates of growth, maturation, and survival of offspring, which could affect the overall population of individuals. Overall, potential impacts are anticipated to be less than significant due to the short-term and limited nature of expected activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Terrestrial Mammals

Restricted access to important winter hibernacula or summer maternity roosts for bats and dens for large mammals, such as the black bear, has the potential to negatively affect body condition and reproductive success of mammals in South Carolina. For example, pregnant black bears use certain types of habitats that allow for more effective defense of their cubs from predators (FWC, 2015).

Disturbance from deployment and operations could also result in the abandonment of offspring leading to reduced survival, although these activities are expected to be small-scale and impacts are expected to be less than significant given the short-term nature and limited geographic scope

for individual activities. Reproductive effects as a result of displacement and disturbance could be minimized through the use of BMPs and mitigation measures.

Marine Mammals

Marine mammals return to their calving grounds annually for reproductive success. Restricted access, such as the displacement of whales from preferred calving habitats, may reduce fitness and survival of calves potentially affecting overall productivity. Impacts from the FirstNet activities are expected to be less than significant since activities are likely to be small-scale in nature. BMPs and mitigation measures could help to avoid or minimize the potential impacts.

Disturbance to marine mammals from activities associated with the Proposed Action could result in the abandonment, or mortality of offspring, though BMPs and mitigation measures could help to avoid or minimize the potential impacts.

Birds

Impacts due to Proposed Action deployment and operations could include abandonment of the area and nests due to disturbance. Disturbance (visual and noise) may displace birds into less suitable habitat and thus reduce survival and reproduction. These impacts could be particularly pronounced in IBAs within the state if birds temporarily avoid those areas, since they provide essential habitat for various life stages. The majority of FirstNet deployment or operation activities are likely to be small-scale in nature, and applicable BMPs and mitigation measures, as defined through consultation with USFWS for MBTA or BGEPA, if required, could help to avoid or minimize any potential impacts. Environmental consequences pertaining to federally listed species will be discussed in Section 13.2.6.6, Threatened and Endangered Species.

Reptiles and Amphibians

Reproductive effects to reptile nests may occur through direct loss or disturbance of nests. For example, the loggerhead sea turtle leaves its breeding habitat in the coastal waters of the Atlantic and travels to nesting sites on sand beaches along the Atlantic coast.

Reproductive effects to sub-populations of amphibians and reptiles may occur through the direct loss of vernal pools as breeding habitat if deployment activities occur near breeding pools, or alter water quality through sediment infiltration, or obstruction of natural water flow to pools, though BMPs would help to avoid or minimize the potential impacts.

Terrestrial Invertebrates

The majority of FirstNet deployment or operation activities are likely to be short-term in nature; therefore, no reproductive effects to terrestrial invertebrates are expected as a result of the Proposed Action.

Invasive Species Effects

When human activity results in a species entering an ecosystem new to it, the species is classified as introduced or invasive. The introduction of invasive species could have a dramatic effect on natural resources. Exotic wildlife species are regulated and a permit must be obtained

from SCDNR prior to importing a wildlife species that is not normally domesticated in South Carolina.

FirstNet deployment activities could result in short-term or temporary changes to specific project sites, although these sites are expected to return to their natural state in a year or two. Invasive species are not expected to be introduced to project sites as part of the deployment activities from machinery or construction workers. Therefore, potential impacts are expected to be less than significant.

Potential invasive species effects to South Carolina's wildlife are described below.

Terrestrial Mammals

In South Carolina, wild pigs adversely impact several native large and small mammals, including turkey, sheep, and deer. They feed on young mammals, destroy native vegetation resulting in erosion and water resource concerns, and could carry/transmit disease to livestock and humans (SCDNR, 2014l).

FirstNet deployment or operation activities could result in short-term or temporary changes to specific project sites, although these sites are expected to return to their natural state in a year or two. FirstNet deployment activities are not expected to introduce terrestrial mammal species to project sites, as these activities are temporary and would not provide a mechanism for transport of invasive terrestrial mammals to project sites from other locations.

Marine Mammals

Although FirstNet deployment activities could result in short-term or temporary changes to specific project sites, these sites are expected to return to their natural state in a year or two. Proposed FirstNet deployment activities near water would likely occur onshore with limited activities in the water; therefore, the introduction of non-native species would likely not occur.

Birds

FirstNet deployment activities could result in short-term or temporary changes to specific project sites; these sites are expected to return to their natural state in a year or two. Invasive bird species are not expected to be introduced at project sites as part of the deployment activities from machinery or construction workers.

Reptiles and Amphibians

Although FirstNet deployment activities could result in short-term or temporary changes to specific project sites, these sites are expected to return to their natural state in a year or two. Invasive reptile or amphibian species are not expected to be introduced at project sites as part of the deployment activities. Invasive reptile or amphibian species are not expected to be introduced at project sites from machinery or laborers.

Terrestrial Invertebrates

Terrestrial invertebrate populations are susceptible to invasive plant species that may change or alter the community composition of specific plants on which they depend. Effects from invasive

plant species to terrestrial invertebrates would be similar to those described for habitat loss and degradation.

Invasive insects, such as the emerald ash borer (pose a threat to forest and agricultural resources (USFS, 2015e). The potential to introduce invasive invertebrates within construction zones and during long-term site maintenance could occur from vehicles and equipment being transported from one region to another, or when conducting revegetation of a site after deployment activities are complete. BMPs and mitigation measures could help to avoid or minimize the potential for introducing invasive terrestrial invertebrate species during implementation of the Proposed Action. Invasive species effects related to terrestrial invertebrates could be minimized with the implementation of BMPs and mitigation measures (Chapter 16).

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wildlife resources and others would not. In addition, and as described in this section, infrastructure developed under the Preferred Alternative could result in a range of impacts, from no impacts to less than significant impacts, depending on the deployment scenario or site-specific conditions. The wildlife that would be affected would depend on the ecoregion, the species' phenology and the nature and extent of the habitats affected. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no impacts to wildlife resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Noise generated by equipment required to install fiber would be infrequent and of short duration, and unlikely to produce measurable changes in wildlife behavior. It is anticipated that effects to wildlife would be temporary and would not result in any perceptible change.

  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on wildlife resources because there would be no ground disturbance.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures, attaching equipment to satellites launched for other purposes, and the use of portable devices that use satellite technology would not impact wildlife because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wildlife resources, it is anticipated that this activity would have no impact on wildlife resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to wildlife resources as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species effects. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to wildlife resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wildlife resources. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct injury/mortalities of wildlife that are not mobile enough to avoid construction activities (e.g., reptiles, small mammals, and young individuals), that utilize burrows (e.g., ground squirrels), or that are defending nest sites (such as ground-nesting birds). Disturbance, including noise, associated with the above activities involving heavy equipment or land clearing could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects. Implementation of BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential impacts to wildlife resources. Impacts may vary depending on the number or individual poles installed and the extent of ground disturbance, but could include direct injury/mortality of individuals as described above;

habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; and invasive species effects.

- Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, habitat loss or alteration, effects to migratory patterns, indirect injury/mortality, and invasive species effects. Noise disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in migratory effects and indirect injury/mortality.
- New Build – Submarine Fiber Optic Plant: The installation of cables in or near bodies of water and construction of landings and/or facilities on the shores or the banks of waterbodies that accept the submarine cables could potentially impact wildlife (see Section 13.2.4, Water Resources, for a discussion of potential impacts to water resources). Potential effects could include direct injury/mortality, habitat loss, alteration, or fragmentation depending on the site location. If activities occurred during critical periods, effects to migratory patterns as well as reproductive effects and indirect injury/ mortality could occur.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of wildlife as described for other New Build activities. Habitat loss, alteration and fragmentation; effects to migration or migratory patterns, indirect injury/mortality, and invasive species effects could occur as a result of construction and resulting disturbance.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (e.g., generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to wildlife resources. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, habitat loss, alteration or fragmentation, and effects to migratory patterns. Security lighting and fencing could result in direct and indirect injury or mortality, effects to migratory patterns, as well as reproductive effects. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to wildlife. However, if additional power units are needed, replacement towers, or structural hardening are required, impacts would be similar to new wireless construction. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.

- Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, and SOWs could result in direct injury/mortalities to wildlife on roadways. If external generators are used, noise disturbance could potentially impact migratory patterns of wildlife. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
- Deployment of drones, balloons, blimps, and piloted aircraft could potentially impact wildlife by direct or indirect injury/mortality from collision, entanglement, or ingestion and effects to migratory patterns and reproductive effects from disturbance and/or displacement due to noise. The magnitude of these effects depends on the timing and frequency of deployments. However, deployment activities are expected to be temporary and isolated, and likely affecting only a small number of wildlife.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers or poles; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to wildlife resources associated with deployment of this infrastructure are anticipated to be less than significant at the programmatic level given the small scale of likely individual FirstNet projects; however, some deployment activities could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the project type, location, ecoregion, the species' phenology, and the nature and extent of the habitats affected. As stated above, these impacts would likely be limited to individual wildlife species and unlikely to cause population-level impacts and are therefore expected to remain less than significant at the programmatic level. Proposed FirstNet actions at some individual sites may have a higher level of impacts due to location-specific conditions, and therefore those proposed activities would undergo site-specific environmental review. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The wildlife that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that there would be less than significant impacts to wildlife resources at the programmatic level associated with routine inspections of the Preferred Alternative. Site maintenance would be infrequent, including mowing or limited application of herbicides, may result in less than significant effects to wildlife at the programmatic level including direct injury/mortality to less mobile wildlife, or exposure to contaminants from accidental spills from

maintenance equipment or release of pesticides. Potential spills of these materials would be expected to be in small quantities.

During operations, direct injury/mortality of wildlife could occur from collisions and/or entanglements with transmission lines, towers, and aerial platforms.

Wildlife resources could still be affected by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. These features could also continue to disrupt movements of terrestrial wildlife, particularly during migrations between winter and summer ranges or in calving areas.

In addition, the presence of new access roads and transmission line ROWs may increase human use of the surrounding areas, which could increase disturbance to wildlife resulting in effects to migratory pathways, indirect injury/mortalities, reproductive effects, as well as the potential introduction and spread of invasive species as explained above. As stated above, these impacts would likely be limited to individuals and unlikely to cause population-level impacts, and therefore would likely than less than significant at the programmatic level given the short-term nature and limited geographic scope for individual activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to wildlife resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wildlife resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As described above, implementation of deployable technologies could result in less than significant impacts from direct and indirect injury or mortality events, changes in migratory patterns, disturbance, or displacement. Greater frequency and duration of deployments could change the magnitude of impacts depending on species, life history, and region of the District. However, impacts are expected to remain less than significant at the programmatic level because

deployment activities are expected to be temporary and localized, likely affecting only a small number of wildlife. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operational Impacts

As described above, operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be less than significant impacts at the programmatic level because deployable activities are expected to be temporary and localized, likely affecting only a small number of wildlife. Proposed FirstNet actions at specific individual sites may have a higher level of impacts due to location-specific conditions, and therefore those proposed activities would undergo site-specific environmental review. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the nationwide, interoperable, public safety broadband network would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to wildlife resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.6.4, Terrestrial Wildlife.

13.2.6.5. Fisheries and Aquatic Habitats

Impacts to fisheries and aquatic habitats occurring in South Carolina and South Carolina's near offshore environment are discussed in this section. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. The most common direct injuries are entanglement, vessel strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals from disturbance events. (USEPA, 2012e)

Based on the impact significance criteria presented in Table 13.2.6-1, less than significant impacts would be anticipated at the programmatic level given that the majority of proposed deployment activities are likely to be small-scale and would be dependent on the location and type of deployment activity. Although anthropogenic disturbances may be measurable (although minimal) for some FirstNet projects, direct injury or mortality impacts at the population-level or

sub-population-level would not likely be observed. BMPs and mitigation measures could help to avoid or minimize potential impacts to fisheries and aquatic invertebrate population survival.

Vegetation and Habitat Loss, Alteration, or Fragmentation

As with all of the effects categories, the magnitude of the impact depends on the duration, location, and spatial scale of the system and associated activities. Habitat fragmentation is the breaking down of continuous and connected habitat, and impeding access to resources and mates.

Depending on the location, construction of new infrastructure and long-term facility maintenance could result in the shoreline habitat alteration in localized areas; in some instances, the permanent loss of riparian vegetation could occur, which could lead to water quality impacts and in turn aquatic habitat alteration. Habitat loss is not likely to be widespread or affect populations of species as a whole; fish species would be expected to swim to a nearby location, depending on the nature of the deployment activity. Therefore, potential impacts are expected to be less than significant. Additionally, deployment activities with the potential for impacts sensitive aquatic habitats could be addressed through the implementation of BMPs and mitigation measures.

Indirect Injury/Mortality

Erosion or sedimentation from land clearing and excavation activities near or within riparian areas, floodplains, wetlands, streams, and other aquatic habitats could have potential impacts on water quality. Exposure to contaminants from accidental spills from vehicles and equipment could also potentially affect water quality. These potential effects could result in changes to habitat, food sources, or prey resulting in indirect mortality/injury to fish and aquatic invertebrates. Indirect injury/mortality impacts vary depending on the species, time of year, and duration of deployment. Nonetheless, these impacts are expected to be less than significant due to the short-term nature and limited geographic scope of deployment activities. BMPs and mitigation measures to protect water resources (see Section 13.2.4, Water Resources) could help to minimize or avoid potential impacts.

Effects to Migration or Migratory Patterns

Migration is the regular movement of animals from one region to another and back again. Migratory patterns vary by species and sometimes within the same species. FirstNet deployment impacts are anticipated to be localized and at a small-scale, and would vary depending on the species, time of year, and duration of deployment. Impacts would vary depending on the species, time of year, and duration of deployment, but would be localized and small-scale, and therefore are expected to be less than significant. BMPs and mitigation measures, as feasible and appropriate, could help to further avoid or minimize any potential impacts.

Reproductive Effects

Reproductive effects are those that either directly or indirectly reduce an animal's ability to produce offspring or reduce the rates of growth, maturation, and survival of offspring, which

could affect the overall population of individuals. Restrictions to spawning/breeding areas for fish and aquatic invertebrates and the alteration of water quality through sediment infiltration, obstruction of natural water flow, or loss of submerged vegetation resulting from the deployment of various types of infrastructure, are not anticipated, and therefore impacts are expected to be less than significant. BMPs and mitigation measures could help to further avoid or minimize any potential impacts.

Invasive Species Effects

The potential to introduce invasive plants within construction zones can occur from vehicles and equipment being transported from one region to another, or when conducting revegetation of a site after deployment activities are complete. FirstNet deployment activities could result in short-term or temporary changes to specific project sites and these sites are expected to return to their natural state in a year or two. Invasive species are not expected to be introduced to project sites as part of the deployment activities from machinery or construction workers, therefore impacts are expected to be less than significant. BMPs and mitigation measures could help to avoid or minimize the potential for introducing invasive aquatic plant and animal species during implementation of the Proposed Action.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to fisheries and aquatic habitats and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. The fisheries and aquatic habitats that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no impacts to fisheries and aquatic habitats under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance, including noise, associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that effects to fisheries and aquatic habitats would be temporary and would not result in any perceptible change.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on fisheries and aquatic habitats because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact fisheries and aquatic habitats because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact fisheries, it is anticipated that this activity would have no impact on the aquatic environment.

Activities with the Potential to Have Impacts

Potential /deployment-related impacts to fisheries and aquatic habitats as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species effects. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to fisheries and aquatic habitats include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to fisheries and aquatic habitats. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities, particularly if they occur adjacent to water resources that support fish, could result in habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects.
  - New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential impacts to fisheries and aquatic habitats

if activities occur near water resources that support fish. Impacts may vary depending on the number or individual poles installed or if access roads or stream crossings are needed, but could include habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects.

  - Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could, if conducted near water resources that support fish, result in habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water and construction of landings and/or facilities on the shore to accept submarine cables could result in direct injury/mortalities of fisheries and aquatic invertebrates that are not mobile enough to avoid construction activities (e.g., mussels), that utilize burrows (e.g., crayfish), or that are defending nest sites (some fish). Disturbance, including noise, associated with the above activities could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, particularly near water resources that support fish, such disturbance could result in habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to fisheries and aquatic habitats, if such actions were deployed near water resources. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads, particularly if they occur near waterbodies, could result in habitat loss or indirect injury/mortality, and invasive species effects, although highly unlikely. Refer to Section 2.4, Radio Frequency Emissions, for more information on RF emissions.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to fisheries and aquatic habitats. However, if new power units, replacement towers, structural hardening, or physical security measures required ground disturbance, impacts would be similar to new wireless construction. For a discussion of RF emissions refer to Section 2.4, Radio Frequency Emissions.

- Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, or SOWs could result in habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects if new access roads or other ground disturbing activities are necessary that generate erosion, sedimentation, or water quality impacts. For a discussion of RF emissions refer to Section 2.4, Radio Frequency Emissions.
- Deployment of drones, balloons, blimps, or piloted aircraft could potentially impact fisheries and aquatic habitat if deployment occurs within or adjacent to water resources. The magnitude of these effects depends on the timing and frequency of deployments, and could result in result in habitat loss, alteration, and fragmentation; indirect injury/mortality, and invasive species effects.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to fisheries and aquatic habitats associated with deployment of this infrastructure could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. These impacts are anticipated to be less than significant at the programmatic level due to the small scale and localized nature of deployment activities that have the potential to impact aquatic habitats. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The fisheries and aquatic habitats that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated, at the programmatic level, that there would be less than significant impacts to fisheries and aquatic habitats associated with routine inspections of the Preferred Alternative. Site maintenance activities that may result in accidental spills from maintenance equipment or pesticide runoff near fish habitat are expected to have less than significant effects to fisheries and aquatic habitats. Potential spills of these materials would be expected to be in small quantities.

Fisheries and aquatic habitat could still be affected by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. These features could also continue to disrupt movements of fish passage. In addition, the presence of new access roads and transmission line ROWs near water resources that support fish may increase human use of the surrounding areas, which could increase disturbance to

fisheries and aquatic habitats resulting in effects to migratory pathways, indirect injury/mortalities, reproductive effects, as well as the potential introduction and spread of invasive species as explained above. Fisheries and aquatic habitat may also be impacted if increased access leads to an increase in the legal or illegal take of biota. However, impacts are expected to be less than significant at the programmatic level due to the small scale of expected activities with the potential to affect fisheries and aquatic habitat. As a result of the small scale, only a limited number of individuals are anticipated to be impacted, furthermore, habitat impacts would also be minimal in scale. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to fisheries and aquatic habitats associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to fisheries and aquatic habitats as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts from habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects. Greater frequency and duration of deployments could change the magnitude of impacts depending on species, life history, and region of the state. However, impacts are expected to remain less than significant at the programmatic level due to the limited nature of expected deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operational Impacts

Operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, the impacts could vary greatly among species and geographic region. Nonetheless, it is anticipated that there would be

less than significant impacts to fisheries and aquatic habitats associated with routine operations and maintenance due to the limited nature of expected deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the nationwide, interoperable, public safety broadband network would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to fisheries and aquatic habitats as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.6.5, Fisheries and Aquatic Habitats.

13.2.6.6. Threatened and Endangered Species and Species of Conservation Concern

This section describes potential impacts to threatened and endangered species in South Carolina and South Carolina's offshore environment associated with deployment and operation of the Proposed Action and Alternatives. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on threatened and endangered species and their habitat were evaluated using the significance criteria presented in Table 13.2.6-2. The categories of impacts for threatened and endangered species and their habitats are defined as may affect, likely to adversely affect; may affect, not likely to adversely affect; and no effect. Characteristics of each effect type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes across the state, the potential impacts to threatened and endangered species addressed below are presented as a range of possible impacts.

Table 13.2.6-2: Impact Significance Rating Criteria for Threatened and Endangered Species

Type of Effect	Effect Characteristics	Impact Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
Injury/Mortality of a Listed Species	Magnitude or Intensity	As per the ESA, this impact threshold applies at the individual level so applies to any mortality of a listed species and any impact that has more than a negligible potential to result in unpermitted take of an individual of a listed species. Excludes permitted take.	Does not apply in the case of mortality (any mortality unless related to authorized take falls under likely to adversely affect category). Applies to a negligible injury that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect. Includes permitted take.	No measurable effects on listed species.
	Geographic Extent	Any geographic extent of mortality or any extent of injury that could result in take of a listed species.	Any geographic extent that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect. Typically applies to one or very few locations.	
	Duration or Frequency	Any duration or frequency that could result in take of a listed species.	Any duration or frequency that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect. Typically applies to infrequent, temporary, and short-term effects.	
Reproductive Effects	Magnitude or Intensity	Any reduction in breeding success of a listed species.	Changes in breeding behavior (e.g., minor change in breeding timing or location) that are not expected to result in reduced reproductive success.	No measurable effects on listed species.
	Geographic Extent	Reduced breeding success of a listed species at any geographic extent.	Changes in breeding behavior at any geographic extent that are not expected to result in reduced reproductive success of listed species. Typically applies to one or very few locations.	
	Duration or Frequency	Any duration or frequency that could result in reduced breeding success of a listed species.	Infrequent, temporary, or short-term changes in breeding behavior that do not reduce breeding success of a listed species within a breeding season.	
Behavioral Changes	Magnitude or Intensity	Disruption of normal behavior patterns (e.g., breeding, feeding, or sheltering) that could result in take of a listed species.	Minor behavioral changes that would not result in take of a listed species.	No measurable effects on listed species.

Type of Effect	Effect Characteristics	Impact Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
	Geographic Extent	Any geographic extent that could result in take of a listed species.	Changes in behavior at any geographic scale that are not expected to result in take of a listed species. Typically applies to one or very few locations.	
	Duration or Frequency	Any duration or frequency that could result in take of a listed species.	Infrequent, temporary, or short-term changes that are not expected to result in take of a listed species.	
Loss or Degradation of Designated Critical Habitat	Magnitude or Intensity	Effects to any of the essential features of designated critical habitat that would diminish the value of the habitat for the survival and recovery of the listed species for which the habitat was designated.	Effects to designated critical habitat that would not diminish the functions or values of the habitat for the species for which the habitat was designated.	No measurable effects on designated critical habitat.
	Geographic Extent	Effects to designated critical habitat at any geographic extent that would diminish the value of the habitat for listed species. Note that the likely to adversely affect threshold for geographic extent depends on the nature of the effect. Some effects could occur at a large scale but still not appreciably diminish the habitat function or value for a listed species. Other effects could occur at a very small geographic scale but have a large adverse effect on habitat value for a listed species.	Effects realized at any geographic extent that would not diminish the functions and values of the habitat for which the habitat was designated. Typically applies to one or few locations within a designated critical habitat.	
	Duration or Frequency	Any duration or frequency that could result in reduction in critical habitat function or value for a listed species.	Any duration or frequency that would not diminish the functions and values of the habitat for which the habitat was designated. Typically applies to Infrequent, temporary, or short-term changes.	

Description of Environmental Concerns

Injury/Mortality of a Listed Species

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. The most common direct injuries are entanglement, vehicle strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals from disturbance events.

Based on the impact significance criteria presented in Table 13.2.6-2 any direct injury or mortality of a listed species at the individual-level, as well as any impact that has the potential to result in unpermitted take of an individual species at any geographic extent, duration, or frequency, may affect and likely adversely affect a listed species. Direct injury/mortality environmental concerns pertaining to federally listed terrestrial mammals, birds, reptiles and amphibians, fish, invertebrates, and plants with known occurrence in South Carolina are described below. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Terrestrial Mammals

There is one endangered and one threatened terrestrial mammal species federally listed and known to occur in South Carolina, the red wolf and the northern long-eared bat.

Direct mortality or injury to the northern long-eared bat could occur if tree clearing activities occurred at roosting sites while bats were present. While projects would not likely directly affect winter hibernacula (e.g., caves), human disturbance in and around hibernacula when bats are present could lead to adverse effects to these species as well. Impacts would likely be isolated, individual events and therefore may affect, but are not likely to adversely affect, a listed species.

BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Marine Mammals

There is one federally listed endangered marine mammal species that is known to occur in South Carolina, the West Indian Manatee averages 9 feet in length and weigh about 1,000 pounds (USFWS, 2015g). Manatees found in U.S. waters are recognized as a separate subspecies known as the Florida manatee (USFWS, 2001a). Entanglements from marine debris as well as ingestion of marine debris are unlikely due to the limited nature of expected FirstNet activities in a marine environment. Impacts would likely be isolated, individual events. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures,

as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Birds

Three endangered and three threatened bird species are federally listed and known to occur in South Carolina; they include the Bachman's warbler, Kirtland's warbler, red-cockaded woodpecker, piping plover, red knot, and wood stork. Depending on the project type and location, direct mortality or injury to these birds could occur from collisions or electrocutions with manmade cables and wires, vehicle strikes, or by disturbance or destruction of nests during ground disturbing activities. However, these potential impacts may affect, but are not likely to adversely affect, listed species, as FirstNet would attempt to avoid deployment activities in areas where they are known to rest. If proposed project sites were unable to avoid sensitive areas, BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Fish

One endangered fish species is federally listed and known to occur in South Carolina; it includes the shortnose sturgeon. The majority of FirstNet deployment projects would not occur in an aquatic environment. Direct mortality or injury to this species are unlikely but could occur from entanglements resulting from the Proposed Action, but are unlikely as the majority of FirstNet deployment projects would not occur in the aquatic environment. Therefore, potential impacts may affect, but are not likely to adversely affect, listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Reptiles and Amphibians

All of the federally (three endangered and two threatened) listed marine reptiles are also known to occur in the coastal area and offshore environment of South Carolina; they include green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle. The majority of FirstNet deployment projects would not occur in an aquatic environment. Direct mortality or injury could occur from accidental trampling at nest sites if eggs are present during the Proposed Action. Potential effects would likely be isolated, individual events.

One threatened amphibian species is federally listed and known to occur in South Carolina, the frosted flatwoods salamander. Direct mortality to these species could occur in construction zones either by excavation activities or by vehicle strikes. Potential effects would likely be isolated, individual events, and FirstNet would attempt, as practicable and feasible, to avoid areas where the species may occur. Therefore, potential impacts may affect, but would not likely adversely affect, listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

One endangered invertebrate species that is federally listed and known to occur in South Carolina, the Carolina heelsplitter. The majority of FirstNet deployment projects would not occur in an aquatic environment. Direct mortality or injury to this species are unlikely but could occur from entanglements resulting from the Proposed Action. FirstNet would attempt, as practicable and feasibl, to avoid areas where these species may occur,. Potential impacts may affect, but are not likely to adversely affect, the listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Plants

Fifteen endangered and six threatened plant species are federally listed and known to occur in South Carolina as summarized in Table 13.1.6-9. Direct mortality to federally listed plants could occur if land clearing or excavation activities associated with the Proposed Action occur in an area inhabited by one of these species. FirstNet would attempt, as practicable and feasible, to avoid areas where these species may occur, therefore, potential impacts may affect, but are not likely to adversely affect, listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Reproductive Effects

Reproductive effects are considered those that either directly or indirectly reduce the breeding success of a listed species by altering its breeding timing or location, or reducing the rates of growth, maturation, and survival of offspring, which can affect the breeding success. Potential effects to federally listed terrestrial mammals, marine mammals, birds, terrestrial reptiles and marine reptiles, amphibians, fish, invertebrates, and plants with known occurrence in South Carolina are described below.

Terrestrial Mammals

Noise, light, and other human disturbances associated with the Proposed Action could adversely affect federally listed terrestrial mammals such as the northern long-eared bat, within or near Proposed Action activities. Impacts would be directly related to the frequency, intensity, and duration of these activities; however, they are anticipated to be small-scale and localized. FirstNet would attempt, as practicable and feasible, to avoid these areas. Therefore, potential impacts may affect, but are not likely to adversely affect, listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Marine Mammals

The West Indian manatee often uses secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, mating, and calving (USFWS, 2001a). Noise, light, and other human disturbances associated with the Proposed Action could adversely affect manatees within or near Proposed Action activities. Impacts would be directly related to the frequency, intensity, and duration of these activities; however, they are anticipated to be small-scale and localized. FirstNet would attempt, as practicable and feasible, to avoid these areas. Therefore, potential impacts may affect, but are not likely to adversely affect, listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Birds

Noise, light, or human disturbance within nesting areas could cause federally listed birds to relocate to less desirable locations, or cause stress to individuals reducing survival and reproduction. FirstNet would attempt, as practicable and feasible, to avoid these areas. Therefore, potential impacts may affect, but are not likely to adversely affect, listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Fish

Deployment activities resulting in increased disturbance (e.g., humans, noise), especially during spawning activity, and changes in water quality can cause stress resulting in lower productivity (see Section 13.2.4, Water Resources, for a discussion of potential impacts to water resources). Effects to reproduction of the federally listed fish species in South Carolina are unlikely as the majority of FirstNet deployment projects would not occur in an aquatic environment and, as practicable and feasible, FirstNet would attempt to avoid these areas. Therefore, potential impacts may affect, but are not likely to adversely affect, listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Reptiles and Amphibians

All of the federally listed sea turtles found in the offshore areas of South Carolina use South Carolina's beaches and barrier islands as nesting habitat. Changes in water quality, especially during the breeding seasons, can cause stress resulting in lower productivity. Further, land clearing activities, noise, and human disturbance during the critical periods (e.g., mating, nesting) could lower fitness and productivity. FirstNet would attempt, as practicable and feasible, to avoid these areas. Therefore, potential impacts may affect, but are not likely to adversely affect, listed species. BMPs and mitigation measures, as defined through consultation

with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

Changes in water quality from ground disturbing activities could cause stress resulting in lower productivity for the federally listed mussel in South Carolina. In addition, introduction of invasive aquatic species could potentially affect mussels as a result of fish populations that they rely on for their reproductive cycle being altered (USFWS, 2012). Potential impacts to federally listed invertebrate species may affect, but are not likely to adversely affect, those species, as FirstNet would attempt, as practicable and feasible, to avoid these areas. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Plants

Potential impacts could occur from ground-disturbing activities to listed plant species as a result of the Proposed Action. However, FirstNet would attempt, as practicable and feasible, to avoid these areas. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Behavioral Changes

Effects to normal behavior patterns that could lead to disruptions in breeding, feeding, or sheltering, resulting in take of a listed species would be considered potentially significant. Potential effects to federally listed terrestrial mammals, marine mammals, birds, reptiles and amphibians, fish, invertebrates, and plants with known occurrence in South Carolina are described below.

Mammals

No behavioral effects to federally listed mammals are expected as a result of the Proposed Action. Bats have the capacity to divert from sound sources during foraging. Terrestrial mammals have the capacity to divert from sound sources during feeding and migration. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur; therefore, potential impacts may affect, but would likely not adversely affect, these species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Marine Mammals

Noise associated with the installation of cables in the near/offshore waters of coastal South Carolina could affect marine mammal migration patterns, though impacts are likely to be short-

term provided the noise sources are not wide ranging and below Level A and B sound exposure thresholds. It is clear that behavioral responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. Marine mammals have the capacity to divert from sound sources during migration. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Birds

Because many birds have extremely long migrations, protection efforts for critical sites along migratory routes must be coordinated over distances often involving many different countries. For example, the red knot has been found to fly up to 9,300 miles from their breeding and wintering sites and often return to the same sites year and after year in South Carolina. Disturbance in stopover, foraging, or breeding areas (visual or noise) or habitat loss/fragmentation can cause stress to individuals causing them to abandon areas for less desirable habitat and potentially reduce over fitness and productivity. Activities related to the Proposed Action, such as aerial deployment or construction activities, could result in effects to the federally listed birds. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur; therefore, potential impacts may affect, but would likely not adversely affect, these species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Reptiles and Amphibians

Habitat loss or alteration, particularly from fragmentation or invasive species, could affect nesting and foraging sites of the federally listed reptile species, resulting in reduced survival and productivity; however, the localized nature of disturbances during deployment activities are not anticipated to stress federally listed reptiles or amphibians. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur; therefore, potential impacts may affect, but would likely not adversely affect, these species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Fish

Changes in water quality as a result of ground disturbing activities could impact food sources for the federally fish species in South Carolina. Further, increased human disturbance, noise, and vessel traffic could cause stress to these species causing them to abandon spawning locations or altering migration patterns. Behavioral changes to these listed species are unlikely as the majority of FirstNet deployment projects would not occur in aquatic environment. Therefore, potential impacts may affect, but are not likely to adversely affect, these species. BMPs and

mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

Changes in water quality, habitat loss or alternation, and introduction of aquatic invasive species could impact food sources for federally listed mussels resulting in lower productivity. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Plants

No behavioral effects to federally listed plants are expected as a result of the Proposed Action.

Loss or Degradation of Designated Critical Habitat

Effects to designated critical habitat and any of its essential features that could diminish the value of the habitat for the listed species or its survival and recovery would be considered an adverse effect and could be potentially significant. Depending on the species or habitat, the adverse effect threshold would vary for geographic extent. In some cases, large-scale impacts could occur that would not diminish the functions and values of the habitat, while in other cases small-scale changes could lead to potentially significant adverse effects, such as impacts to designated critical habitat for a listed species that is only known to occur in one specific location geographically. Potential effects to the federally listed bird, reptile, and invertebrate species with designated critical habitat in South Carolina are described below.

Terrestrial Mammals

No designated critical habitat occurs for terrestrial mammals in South Carolina. Therefore, no effect to threatened and endangered species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Marine Mammals

No designated critical habitat occurs for marine mammals in South Carolina. Therefore, no effect to threatened and endangered species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Birds

One of the federally listed bird species in South Carolina has federally designated critical habitat. Critical habitat for the piping plover has been designated along South Carolina's barrier islands. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur; therefore, potential impacts may affect, but would

likely not adversely affect, designated critical habitat. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No critical habitat has been designated for the other federally listed bird species in South Carolina; therefore, no effect to these species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Fish

No designated critical habitat occurs for fish in South Carolina. Therefore, no effect to threatened and endangered species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Reptiles and Amphibians

One of the federally listed reptiles in South Carolina has federally designated critical habitat. Critical habitat for the loggerhead sea turtle was designated along South Carolina's barrier islands.

Land clearing, excavation activities, and other ground disturbing activities in this region of South Carolina could lead to habitat loss or degradation, which could lead to adverse effects to the loggerhead sea turtle and reticulated flatwoods salamander depending on the duration, location, and spatial scale of the associated activities. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur; therefore, potential impacts may affect, but would likely not adversely affect, designated critical habitat. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No critical habitat has been designated for the other federally listed reptile or amphibian species in South Carolina; therefore, no effect to these species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Invertebrates

Critical habitat has been designated for the federally listed invertebrate species in South Carolina. Critical habitat for the Carolina heelsplitter was designated in the northeastern part of South Carolina along Gills Creek, Flat Creek, Lynches River, Mountain Creek, Beaverdam Creek, and Cuffytown Creek. Land clearing, excavation activities, and other ground disturbing activities in these regions of South Carolina could lead to habitat loss or degradation, which could lead to adverse effects to these invertebrates depending on the duration, location, and spatial scale of the associated activities. Proposed FirstNet deployment activities near water would likely occur onshore with limited activities in the water and therefore would not likely disturb critical habitat. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur; therefore, potential impacts may affect, but would likely not

adversely affect, designated critical habitat. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Plants

No designated critical habitat occurs for plants in South Carolina. Therefore, no effect to threatened and endangered species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential effects to threatened and endangered species and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. The threatened and endangered species that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Effect

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no effect on threatened and endangered species or their habitat under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Noise generated by equipment required to install fiber would be infrequent and of short duration, and unlikely to produce measurable changes in wildlife behavior. It is anticipated that effects to wildlife would be temporary and would not result in any perceptible change.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on threatened and endangered species or their habitat because there would be no ground disturbance and very limited human activity.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would have no effect on threatened and endangered if those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to affect protected species, it is anticipated that this activity would have no effect on protected species.

Activities with the Potential to Affect Listed Species

Potential deployment-related effects to threatened and endangered species and their habitats as a result of implementation of the Preferred Alternative would encompass a range of effects that could occur, including direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential effects to threatened and endangered species include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to threatened and endangered species. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct injury/mortalities of threatened and endangered species that are not mobile enough to avoid construction activities (e.g., mollusks, small mammals, and young). Disturbance, including noise, associated with the above activities could result in direct injury/mortality, reproductive effects, and behavioral changes.
  - New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential impacts to threatened and endangered species and their habitat. Impacts may vary depending on the number or individual poles installed, but could include direct injury/mortality, reproductive effects, or behavioral changes.
  - Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, reproductive effects, or behavioral changes. Noise disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in reproductive effects or behavior changes.

  - New Build – Submarine Fiber Optic Plant: The installation of cables in or near bodies of water and construction of landings and/or facilities on the shores or the banks of waterbodies that accept the submarine cables could potentially impact threatened and endangered species and their habitat, particularly aquatic species (see Section 13.2.4, Water Resources, for a discussion of potential impacts to water resources). Effects could include direct injury/mortality, and if activities occurred during critical periods, reproductive effects and behavioral changes could occur.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts, there would be no impacts to threatened and endangered species or their habitats. If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of threatened and endangered species as described for other New Build activities. Reproductive effects and behavioral changes could also occur as a result of construction and resulting disturbance.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to threatened and endangered species and their habitat. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, reproductive effects, or behavioral changes. Security lighting and fencing could result in direct injury/mortality, disruption of normal behavior patterns, as well as reproductive effects. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower; FirstNet activities would be infrequent, temporary, or short-term in nature and are unlikely to result in direct injury/mortality or behavioral changes to threatened and endangered species. However, if replacement towers or structural hardening are required, impacts could be similar to new wireless construction. Hazards related security/safety lighting and fencing may produce direct injury/mortality, reproductive effects, and behavioral changes. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Deployable Technologies: Implementation of land-based deployable technologies including COWs, COLTs, or SOWs could result in direct injury/mortalities to threatened and endangered species on roadways. If external generators are used, noise disturbance could potentially result in reproductive effects or behavioral changes to threatened and endangered species. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.

Deployment of drones, balloons, piloted aircraft, or blimps could potentially impact threatened and endangered species by direct injury/mortality, reproductive effects, or behavioral changes. The magnitude of these effects depends on the timing and frequency of deployments.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to threatened and endangered species associated with deployment of this infrastructure could include direct injury/mortality, reproductive effects, and behavioral changes, and loss/degradation of designated critical habitat depending on the species' phenology and the nature and extent of the habitats affected. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur; therefore, potential impacts may affect, but are not likely adversely affect protected species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The threatened and endangered species that would be affected would depend on the species' phenology and the nature and extent of the habitats affected.

It is anticipated that operational impacts may affect, but are not likely to adversely affect threatened and endangered species due to routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Site maintenance, including mowing or application of herbicides, may affect, but are not likely to adversely affect threatened and endangered species, as they would be conducted infrequently, and BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

During operations, direct injury/mortality of threatened and endangered species could occur from collisions and/or entanglements with transmission lines, towers, and aerial platforms. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur. Therefore, listed species may be affected, but are not likely to be adversely affected. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Threatened and endangered species may be affected, but are not likely to be adversely affected, by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. These features could also continue to disrupt movements of some species, particularly during migrations between winter and summer ranges. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential effects to threatened and endangered species associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential effects to threatened and endangered species as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies may affect, but is not likely to adversely affect, threatened and endangered species as a result of direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. Greater frequency and duration of deployments could change the magnitude of impacts depending on species, life history, and region of the state. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Operational Impacts

As explained above, operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that activities may affect, but are not likely to adversely affect, threatened and endangered species and their habitats as a result of routine operations,

management, and monitoring. FirstNet would attempt, as practicable and feasible, to avoid areas where these species are known to occur. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the nationwide, interoperable, public safety broadband network would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no effect to threatened and endangered species as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.6.6, Threatened and Endangered Species and Species of Concern.

13.2.7. Land Use, Recreation, and Airspace

13.2.7.1. Introduction

This section describes potential impacts to land use, recreation, and airspace resources in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.7.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on land use, recreation, and airspace resources were evaluated using the significance criteria presented in Table 13.2.7-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to land use, recreation, and airspace resources addressed in this section are presented as a range of possible impacts.

Table 13.2.7-1: Impact Significance Rating Criteria for Land Use, Recreation, and Airspace

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less Than Significant with Mitigation Incorporated**	**Less Than Significant**	**No Impact**
Direct land use change	Magnitude or Intensity	Change in designated/permitted land use that conflicts with existing permitted uses, and/or would require a change in zoning. Conversion of prime or unique agricultural lands.	Effect that is potentially significant, but with mitigation is less than significant.	Minimal changes in existing land use, or change that is permitted by-right, through variance, or through special exception.	No changes to existing development, land use, land use plans, or policies. No conversion of prime or unique agricultural lands.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Land use altered indefinitely.		Short-Term: Land use altered for as long as the entire construction phase or a portion of the operations phase.	NA
Indirect land use change	Magnitude or Intensity	New land use directly conflicts with surrounding land use pattern, and/or causes substantial restriction of land use options for surrounding land uses.	Effect that is potentially significant, but with mitigation is less than significant.	New land use differs from, but is not inconsistent with, surrounding land use pattern; minimal restriction of land use options for surrounding land uses.	No conflicts with adjacent existing or planned land uses.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Land use altered indefinitely.		Short-Term: Land use altered for as long as the entire construction phase or a portion of the operations phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less Than Significant with Mitigation Incorporated**	**Less Than Significant**	**No Impact**
Loss of access to public or private recreation land or activities	Magnitude or Intensity	Total loss of access to recreation land or activities.	Effect that is potentially significant, but with mitigation is less than significant.	Restricted access to recreation land or activities.	No disruption or loss of access to recreational lands or activities.
	Geographic Extent	Most or all recreational land/sites in a state or territory; recreational lands/sites that are of national significance.		Effects realized at one or multiple isolated locations; recreational lands that are not nationally significant, but that are significant within the state/territory.	NA
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA
Loss of enjoyment of public or private recreation land (due to visual, noise, or other impacts that make recreational activity less desirable)	Magnitude or Intensity	Total loss of enjoyment of recreational activities; substantial reduction in the factors that contribute to the value of the recreational resource, resulting in avoidance of activity at one or more sites.	Effect that is potentially significant, but with mitigation is less than significant.	Small reductions in visitation or duration of recreational activity.	No loss of enjoyment of recreational activities or areas; no change to factors that contribute to the value of the resource.
	Geographic Extent	Most or all recreational land/sites in a state or territory; recreational lands/sites that are of national significance.		Effects realized at one or multiple isolated locations; recreational lands that are not nationally significant, but that are significant within the state/territory.	NA
	Duration or Frequency	Persists during or beyond the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less Than Significant with Mitigation Incorporated**	**Less Than Significant**	**No Impact**
Use of airspace	Magnitude or Intensity	Measurable, substantial change in flight patterns and/or use of airspace.	Effect that is potentially significant, but with mitigation is less than significant.	Alteration to airspace usage is minimal.	No alterations in airspace usage or flight patterns.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Airspace altered indefinitely.		Short-Term: Airspace altered for as long as the entire construction phase or a portion of the operations phase.	NA

NA = Not Applicable

13.2.7.3. Description of Environmental Concerns

Direct Land Use Change

Changes in land use could be influenced by the deployment, operation, and maintenance of facilities or other infrastructure, and the acquisition of rights-of-way or easements, as required. The deployment, operation, and maintenance of facilities or other infrastructure, and the acquisition of ROWs or easement could influence changes in land use. The deployment, operation, and maintenance of structures, towers, roads, and other permanent features could conflict with exiting development or land use. The installation of poles, towers, structures, or other aboveground facilities or assets could have short- or long-term effects to existing development or land use based on the characteristics of the structures or facilities, such as the location, type, or height. In addition, the acquisition of ROWs or easements and the construction of roads to access facilities and locations could influence changes in land use. The effects from these actions would depend on the geographic location; compatibility with existing land uses; and characteristics of the right-of-way, easement, or access road. These characteristics, such as the length, width, and location could change the existing land use to another category or result in the short- or long-term loss of the existing land use.

Based on the impact significance criteria presented in Table 13.2.7-1, less than significant impacts would be anticipated given the size and nature of the majority of the proposed deployment activities. Direct land use changes would be minimized and isolated at specific locations and all required permits would be obtained; only short-term impacts during the construction phase would be expected.

Indirect Land Use Change

Changes in surrounding land use patterns and options for surrounding land uses could be influenced by the deployment, operation, and maintenance of facilities and the acquisition of rights-of-way or easement. The deployment, operation, and maintenance of structures, towers, roads, and other permanent features could conflict with surrounding land use patterns and options for surrounding land uses. The installation of poles, towers, structures, or other aboveground facilities or assets could have short- or long-term effects to surrounding land use patterns or options for surrounding land uses based on the characteristics of the structures or facilities, such as the location, type, or height. In addition, the acquisition of ROWs or easements and the construction of roads to access facilities and locations could influence changes in surrounding land uses. The effects from these actions would depend on the geographic location; compatibility with surrounding land uses; and characteristics of the ROW, easement, or access road. These characteristics, such as the length, width, and location could conflict with surrounding land use patterns or restrict options for surrounding land uses.

Based on the impact significance criteria presented in Table 13.2.7-1, less than significant impacts would be anticipated, as any new land use would be small-scale and short-term during the construction phase.

Loss of Access to Public or Private Recreation Land or Activities

The deployment, operation, and maintenance of facilities and the acquisition of ROW or easement could influence access to public or private recreation land or activities. Localized, short-term accessibility to recreation land or activities could be impacted by the deployment and maintenance of structures, towers, roads, and other permanent features. In the long-term, the deployment and installation of poles, towers, structures, or other aboveground facilities could alter the types and locations of recreation activities.

Based on the impact significance criteria presented in Table 13.2.7-1, less than significant impacts would be anticipated as restricted access or a loss of access to recreation areas would not occur; only short-term impacts or small-scale limitations during the construction phase would be expected.

Loss of Enjoyment of Public or Private Recreation Land

The deployment of new towers, and the resulting built tower, could influence the enjoyment of public or private recreation land. Crews accessing the site during the deployment and maintenance of structures, towers, roads, and other permanent features could temporarily impact enjoyment of recreation land. The deployment of poles, towers, structures, or other aboveground facilities could affect the enjoyment of recreational land based on the characteristics of the structures or facilities, including permanent impacts to scenery, short-term noise impacts, and the presence of deployment or maintenance crews.

Based on the impact significance criteria presented in Table 13.2.7-1, less than significant impacts would be anticipated as only small reductions, if any, in recreational visits or durations would occur due to the relatively small-scale nature of likely FirstNet activities. Only short-term impacts during the construction phase would be expected.

Use of Airspace

Primary concerns to airspace include the following: if aspects of the Proposed Action would result in violation of FAA regulations; undermine the safety of civilian, military, or commercial aviation; or infringe on flight activity and flight corridors. Potential impacts could include air routes or flight paths, available flight altitudes, disruption of normal flight patterns, and restrictions to flight activities. Construction of new towers or alternations to existing towers could obstruct navigable airspace in South Carolina.

Based on impact significance criteria presented in Table 13.2.7-1, airspace impacts are not likely to change or alter flight patterns or airspace usage. As drones, balloons, and piloted aircraft would likely only be deployed in an emergency and for a short period, FirstNet would be unlikely to have a significant impact on airspace resources.

13.2.7.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure, and the specific deployment requirements, some activities would result in potential impacts to land use, recreation, and airspace resources and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to land use, recreation, and airspace resources under the conditions described below:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring alongside the road in utility corridors or within public road rights-of-way.
    - Land Use: See Activities with the Potential to Have Impacts below.
    - Recreation: See Activities with the Potential to Have Impacts below.
    - Airspace: No impacts to airspace would be anticipated since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace (See Section 13.1.7.5 Obstructions to Airspace Considerations).
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas.
    - Land Use: It is anticipated that there would be no impacts to land use since the activities that would be conducted would not directly or indirectly result in changes to existing and surrounding land uses.
    - Recreation: See Activities with the Potential to Have Impacts below.
    - Airspace: It is anticipated that there would be no impacts to airspace since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace (See Section 13.1.7.5 Obstructions to Airspace Considerations).

- New Build – Aerial Fiber Optic Plant: Installing new poles and hanging cables on previously disturbed or new (undisturbed) ROWs or easements and the potential construction of access roads.
  - Land Use: See Activities with the Potential to Have Impacts below.
  - Recreation: See Activities with the Potential to Have Impacts below.
  - Airspace: Installation of new poles would not have an effect on airspace because utility poles are an average of 40 feet in height and do not intrude into useable airspace.
- Collocation on Existing Aerial Fiber Optic Plant: Installation of new fiber on existing poles would be limited to previously disturbed areas.
  - Land Use: It is anticipated that there would be no impacts to land use since the activities that would be conducted would not directly or indirectly result in changes to existing and surrounding land uses.
  - Recreation: No impacts to recreation would be anticipated since the activities that would be conducted would not cause disruption or loss of access to recreational lands or activities or the enjoyment of those lands or activities.
  - Airspace: No impacts are anticipated to airspace from collocations.
- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber and installation of new equipment in existing huts.
  - Land Use: It is anticipated that there would be no impacts to land use since the activities would not directly or indirectly result in changes to existing and surrounding land uses.
  - Recreation: Use of existing dark fiber would not impact recreation because it would not impede access to recreational resources.
  - Airspace: Lighting of dark fiber would have no impacts on airspace.
- New Build – Submarine Fiber Optic Plant: Installing cables in limited nearshore or inland bodies of water and the constructing landings and/or facilities on shore to accept submarine cable.
  - Land Use: See Activities with the Potential to Have Impacts below.
  - Recreation: See Activities with the Potential to Have Impacts below.
  - Airspace: The installation of cables in limited nearshore or inland bodies of water and construction of landings/facilities would not impact flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 13.1.7.5 Obstructions to Airspace Considerations).

- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment would occur in existing boxes or huts. The section below addresses potential impacts to land use, recreation resources, and airspace if deployment of new boxes, huts, or access roads is required.
  - Land Use: See Activities with the Potential to Have Impacts below.
  - Recreation: See Activities with the Potential to Have Impacts below.
  - Airspace: No impacts to airspace would be anticipated since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 13.1.7.5 Obstructions to Airspace Considerations).

- Wireless Projects
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, structure or building.
    - Land Use: There would be no impacts to existing and surrounding land uses. The potential addition of power units, structural hardening, and physical security measures would not impact existing or surrounding land uses.
    - Recreation: See Activities with the Potential to Have Impacts below.
    - Airspace: See Activities with the Potential to Have Impacts below.

- Deployable Technologies
  - Deployable Technologies: These technologies would be used where permanent, fixed infrastructure cannot be deployed due to a variety of factors such as the need to supplement coverage or to avoid or mitigate permanent impacts to sensitive resources or receptors.
    - Land Use: It is anticipated that there would be no impacts to existing or surrounding land uses because these technologies would be temporarily located in areas compatible with other land uses.
    - Recreation: No impacts to recreation are anticipated, as deployable technologies would not affect the use or enjoyment of recreational lands.
    - Airspace: Use of land-based deployable technologies (COW, COLT, and SOW) is not expected to result in impacts to airspace, provided antenna masts do not exceed 200 feet Above Ground Level (AGL) or do not trigger any of the other FAA obstruction to airspace criteria.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: Installation of permanent equipment on existing structures and the use of portable devices that use satellite technology.

        - Land Use: It is anticipated that there would be no impacts to existing or surrounding land uses because these technologies would be temporarily located in areas compatible with other land uses.
        - Recreation: It is anticipated that there would be no impacts to recreational uses because these technologies would be temporarily deployed but would not restrict access to, or enjoyment of, recreational lands.
        - Airspace: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact airspace because those activities would not result in changes to flight patterns and airspace usage or result in obstructions to airspace.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would have no impacts on land use, recreation, or airspace, it is anticipated that this activity would have no impact on land use, recreation, or airspace.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to land use, recreation resources, or airspace as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including changes to existing and surrounding land uses. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to land use resources include the following:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring alongside the road in utility corridors or within public road rights-of-way.
        - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations.
        - Recreation: It is anticipated that plowing, trenching, or directional boring may cause temporary, localized restrictions to recreational land or activities, which may persist during the deployment phase. It is reasonable to anticipate that small reductions in visitation to localized areas may occur during the deployment phase.
        - Airspace: No impacts are anticipated – see previous section.
    - New Build – Aerial Fiber Optic Plant: Installing new poles and hanging cables on previously disturbed or new (undisturbed) ROWs or easements and the potential construction of access roads.
        - Land Use: These activities could result in term potential impacts to land uses. Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New structures, poles, or access roads on previously

undisturbed ROWs or easements could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new structures with existing and surrounding land uses.

- Recreation: Deployment activities may cause temporary, localized restricted access to recreation land or activities, which may persist for the duration of the deployment phase. Small reductions to visitation during the deployment phase may be anticipated.
- Airspace: No impacts are anticipated – see previous section.

- New Build – Submarine Fiber Optic Plant: Installing cables in limited nearshore or inland bodies of water and the constructing landings and/or facilities on shore to accept submarine cable.
  - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New landings and/or facilities on shore could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.
  - Recreation: Deployment may temporarily restrict recreation on or within limited nearshore or inland bodies of water and the surrounding area during the deployment phase. Reductions in visitation may result during deployment.
  - Airspace: No impacts are anticipated – see previous section.
- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of equipment including construction of new boxes, huts, or access roads.
  - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New boxes, huts, or access roads could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.
  - Recreation: Deployment of installation equipment and the construction of boxes, huts, or access roads may restrict access to recreation land or activities. Reductions in visitation during deployment may occur.
  - Airspace: No impacts are anticipated – see previous section.

- Wireless Projects
  - New Wireless Communication Towers: Installing new wireless towers, associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads.
    - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New wireless towers, associated structures, or access

roads could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.

- Recreation: Deployment of new towers and associated structures could result in temporary, localized restricted access for recreation land or activities for the duration of the deployment phase. Reductions in visitation or duration of recreational activity may result from restricted access.
- Airspace: Installation of new wireless towers could result in impacts to airspace if towers exceed 200 feet AGL or meets other criteria. An OE/AAA could be required for the FAA to determine if the proposed construction does affect navigable airways or flight patterns of an airport if the aerial fiber optic plant is located in proximity to one of South Carolina's airports.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower.
  - Land Use: No impacts are anticipated – see previous section.
  - Recreation: Installation of antennas or microwaves to existing towers may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation.
  - Airspace: Collocation of mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, addition of power units, structural hardening, and physical security measures could result in impacts if located near airports or air navigation facilities.

- Deployable Technologies
  - Deployable Technologies: These technologies would be used where permanent, fixed infrastructure cannot be deployed due to a variety of factors such as the need to supplement coverage or to avoid or mitigate permanent impacts to sensitive resources or receptors.
    - Land Use: No impacts are anticipated – see previous section.
    - Recreation: No impacts are anticipated – see previous section.
    - Airspace: Implementation of deployable aerial communications architecture could result in temporary or intermittent impacts to airspace. Deployment of tethered systems (such as balloons or blimps) could pose an obstruction hazard if deployed above 200 feet and near South Carolina airports. Potential impacts to airspace (such as SUAs and MTRs) may be possible depending on the planned use of drones, piloted aircrafts, untethered balloons, and blimps (e.g., frequency of deployment, altitudes, proximity to airports and airspaces classes/types, length of deployment, etc.).

Coordination with the FAA would be required to determine the actual impact and the required certifications. It is expected that FirstNet would attempt to avoid changes to airspace and the flight profiles (boundaries, flight altitudes, operating hours, etc.).

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of permanent equipment on existing structures and the use of portable devices that use satellite technology.
    - Land Use: No impacts are anticipated – see previous section
    - Recreation: It is anticipated the installation of equipment on existing structures may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation.
    - Airspace: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology may impact airspace if equipment creates an obstruction.

In general, the abovementioned activities could potentially involve construction activities. Potential impacts to land uses associated with deployment could include temporary restrictions to existing and surrounding land uses in isolated locations. Potential impacts to recreation land and activities could include temporary, localized restricted access and reductions in visitation or duration of recreational activities. Potential impacts to airspace could include obstructions. These potential impacts are expected to be less than significant at the programmatic level due to the temporary and small-scale nature of deployment activities. Additionally FirstNet (or its network partners), would prepare an OE/AAA for any proposed tower that might affect navigable airways or flight patterns of an airport. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no impacts at the programmatic level to land use, recreation resources, or airspace associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for temporary, short-term inspections because there would be no ground disturbance, no airspace activity, and no access restriction to recreational lands. If routine maintenance or inspection activities would conflict with existing or surrounding land uses, impact recreation resources, or conflict with airspace, impacts could result as explained above.

Operation of the Deployable Technologies options of the Preferred Alternative could result in the temporary presence of deployable vehicles and equipment (including airborne equipment),

potentially for up to two years in some cases. Operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. It is anticipated that there would be no impacts at the programmatic level to land use, recreation resources, or airspace associated with routine inspections, assuming that the same access roads used for deployment are also used for inspections.

The degree of change in the visual environment (see Section 13.2.8, Visual Resources)—and therefore the potential indirect impact on a landowner's ability to use or sell of their land as desired—would be highly dependent on the specific deployment location and length of deployment. Once deployment locations are known, the location would be subject to an environmental review to help ensure environmental concerns are identified. The use of deployable aerial communications architecture could temporarily add new air traffic or aerial navigation hazards. The magnitude of these effects would depend on the specific location of airborne resources along with the duration of their use. FirstNet would coordinate with the FAA to review required certifications, as necessary. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.7.5. Alternatives Impact Assessment

The following section assesses potential impacts to land use, recreation resources, and airspace associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to land use, recreation, and airspace resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to land use. While a single deployable technology may have imperceptible impact, multiple technologies operating in close proximity for longer periods could impact existing and surrounding land uses. There could be impacts to recreation activities during the deployment of technologies if such deployment were to occur within or near designated recreation areas. Enjoyment of activities dependent upon the visibility of wildlife or scenic vistas may be affected, however, impacts would be less than significant at the programmatic level due to the temporary nature of likely deployment activities. If deployment triggers any

obstruction criterion or result in changes to flight patterns and airspace restrictions, FirstNet (or its partners) would consult with the FAA to determine how to proceed. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no impacts to land use, recreation resources, or airspace associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. Operation of deployable technologies would result in land use, land ownership, airspace, and recreation (access and enjoyment) similar in type to those described for the Preferred Alternative. The frequency and extent of those potential impacts would be greater than for the Proposed Action because under this Alternative, deployable technologies would be the only options available. As a result, this alternative would require a larger number of terrestrial and airborne deployable vehicles and a larger number of deployment locations in—all of which would potentially affect a larger number of properties and/or areas of airspace. Overall, these potential impacts would be less than significant at the programmatic level due to the temporary nature of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure, or satellites and other technologies. As a result, there would be no impacts to land use, recreation resources, or airspace. Environmental conditions would therefore be the same as those described in Section 13.1.7, Land Use, Recreation, and Airspace.

13.2.8. Visual Resources

13.2.8.1. Introduction

This section describes potential impacts to visual resources in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.8.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on visual resources were evaluated using the significance criteria presented in Table 13.2.8-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and

duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to visual resources addressed in this section are presented as a range of possible impacts.

Table 13.2.8-1: Impact Significance Rating Criteria for Visual Resources

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Adverse change in aesthetic character of scenic resources or viewsheds	Magnitude or Intensity	Fundamental and irreversibly negative change in aesthetic character.	Effect that is potentially significant, but with mitigation is less than significant.	Intermittently noticeable change in aesthetic character that is marginally negative.	No visible effects
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations.	No visible effects
	Duration or Frequency	Permanent or persistent changes to aesthetic character lasting throughout or beyond the construction or deployment phase.		Persisting through the construction and deployment phase, but aesthetics of the area would be returned to original state following the construction and deployment phase.	Transient or no visible effects.
Nighttime lighting	Magnitude or Intensity	Lighting dramatically alters night-sky conditions.	Effect that is potentially significant, but with mitigation is less than significant.	Lighting alters night-sky conditions to a degree that is only intermittently noticeable.	Lighting does not noticeably alter night-sky conditions.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations.	No visible effects.
	Duration or Frequency	Permanent or persistent changes to night-sky conditions lasting throughout or beyond the construction or deployment phase.		Persisting through the construction and deployment phase, but lighting would be removed and night-sky conditions would be returned to original state following the construction and deployment phase.	Transient or no visible effects.

13.2.8.3. Description of Environmental Concerns

Adverse Change in Aesthetic Character of Scenic Resources or Viewsheds

A primary concern during and following construction of structures, towers, roads or other permanent features is the long-term disruption of scenery and viewsheds. In South Carolina, residents and visitors travel to many national monuments, historic sites, and national parks, as well as numerous sites within sensitive resource corridors, including the South Carolina National Heritage Corridor and the Gullah/Geechee Cultural Heritage Corridor. If lands considered visually significant or scenic were subject to vegetation loss or removal, short- or long-term effects to viewsheds or scenic resources could occur. Bare ground or interruption of a landscape due to vegetation removal could be considered an adverse change in the aesthetic character of scenic resources or viewsheds. New towers or structures constructed within scenic areas could disrupt the perceived aesthetic character or scenery of an area. If new towers were constructed to a height that required lighting, nighttime vistas could be affected in areas where the night skies do not have light disruptions or are within unpopulated areas.

South Carolina's Code of Laws Title 48, 49 and 50, establishes the responsibilities of SCDNR to serve as the principal advocate for and steward of South Carolina's natural resources, including the state scenic rivers program. If new towers or facilities were constructed to a height that required lighting, nighttime vistas could be affected in areas where the night skies do not have light disruptions or are within unpopulated areas. If nighttime lighting were necessary for the operation or function of a facility that caused regional impacts or permanent changes to night sky conditions, those effects would be considered potentially significant.

Based on the impact significance criteria presented in Table 13.2.8-1, lighting that illuminates the night sky, diminishes night sky viewing over long distances, and persists over the long-term would be considered potentially significant. Although likely FirstNet actions are expected to be small-scale, certain discrete locations may experience potentially significant impacts to night skies. See Chapter 16, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Nighttime Lighting

If new towers or facilities were constructed to a height that required lighting, nighttime vistas could be affected in areas where the night skies do not have light disruptions or are within unpopulated areas. If nighttime lighting were necessary for the operation or function of a facility that caused regional impacts or permanent changes to night sky conditions, those effects could be considered potentially significant.

Based on the impact significance criteria presented in Table 13.2.8 1, lighting that illuminates the night sky, diminishes night sky viewing over long distances, and persists over the long-term could be considered potentially significant. Although likely FirstNet actions are expected to be small-scale, certain discrete locations may experience potentially significant impacts to night skies, although potentially minimized to less than significant with implementation of BMPs and

mitigation measures, as defined in Chapter 16, BMPs and Mitigation Measures. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented.

13.2.8.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to visual resources and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to visual resources under the conditions described below:

- Wired Projects
  - Collocation on Existing Aerial Fiber Optic Plant: While the addition of new aerial fiber optic plant to an existing aerial fiber optic transmission system would likely be visible, the change associated with this option is so small as to be essentially imperceptible. This option would involve no new nighttime lighting and pole replacement would be limited.
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to visual resources since the activities would be conducted at small entry and exit points and are not likely to produce perceptible changes, and would not require nighttime lighting.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on visual resources because there would be no ground disturbance, would not require nighttime lighting, and would not produce any perceptible changes.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use

satellite technology would not impact visual resources since those activities would not require ground disturbance or vegetation removal.

- Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact visual resources, it is anticipated that this activity would have no impact on visual resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to visual resources as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur as a result of ground disturbance, vegetation removal, or installation of permanent structures if development occurs in scenic areas. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to visual resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to visual resources. The degree of impact would depend on the timing and location of the project; installation of a hut or POP would be permanent, whereas ground disturbing activities would be short-term. In most cases, development located next to existing roadways would not affect visual resources unless vegetation were removed or excavation occurred in scenic areas.
  - New Build – Aerial Fiber Optic Plant: Construction and installation of new or replacement poles and hanging cables could result in impacts to the aesthetic character of scenic resources or viewsheds depending on the location of the installation. In most cases, development in public rights-of-ways would not affect visual resources unless vegetation were removed or construction occurred in scenic areas. If new lighting were necessary, impacts to night skies could occur. Construction of new roadways could result in linear disruptions to the landscape, surface disturbance, and vegetation removal; all of which could impact the aesthetic character of scenic resources or viewsheds, depending on the location of the installation.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in or near bodies of water would not impact visual resources. However, impacts to the aesthetic character of scenic resources or viewsheds could potentially occur as result of the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required grading, vegetation removal, or other ground disturbance to install small boxes or huts, or access roads, potential impacts to visual resources could occur but effects would be temporary and localized.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to visual resources. Land/vegetation clearing, excavation activities, landscape grading, and other surface disturbing activities during the installation of new wireless towers and associated structures or access roads could result in the degradation of the aesthetic character of scenic resources or viewsheds. Impacts may be experienced by viewers if new towers were located in or near a national park unit or other sensitive area. If new towers were constructed to a height that required aviation lighting, nighttime vistas could be impacted in areas where the night skies do not have light disruptions or are within unpopulated areas. If nighttime lighting were necessary for the operation or function of a facility, impacts to night sky conditions could occur.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower and would not likely result in additional impacts to visual resources. However, if additional power units are needed, structural hardening or physical security measures required ground disturbance or removal of vegetation, impacts to the aesthetic character of scenic resources or viewsheds could occur.
  - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to visual resources if long-term deployment occurs in scenic areas, or if the implementation requires minor construction of staging or landing areas, results in vegetation removal, areas of surface disturbance, or additional nighttime lightning.

In general, the abovementioned activities could potentially involve land/vegetation clearing, and potential scenic intrusion of towers, poles, roads, infrastructure, and other structures. Potential impacts to visual resources associated with deployment could include interruptions of landscapes, degradation of the aesthetic character of scenic resources or viewsheds, and overall changes in valued scenic resources, particularly for permanent fixtures such as towers or facilities. These impacts are expected to be less than significant at the programmatic level due to the temporary and small-scale nature of deployment activities. As discussed above, potential impacts to night skies from lighting are expected to be less than significant at the programmatic level with BMPs and mitigation measures incorporated. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there would be no impacts at the programmatic level to visual resources associated with routine

inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Nighttime lighting in isolated rural areas or if sited near a national park would be less than significant at the programmatic level with BMPs and mitigation measures incorporated during operations. Additionally, FirstNet would work closely with the NPS to address any concerns they might have if a tower needed to be placed in an area that might affect the nighttime sky at a NPS unit. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.8.5. Alternatives Impact Assessment

The following section assesses potential impacts to visual resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to infrastructure as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in potential impacts to visual resources if long-term deployment occurs in scenic areas. If staging or landing areas (depending on the type of technology) require surface disturbance or vegetation clearing, or if these areas were within scenic landscapes, impacts could occur to the aesthetic character of scenic resources or viewsheds. These impacts are expected to be less than significant at the programmatic level at the programmatic level as generally they would be limited to the deployment location and could often be screened or otherwise blocked from view. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no impacts to visual resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for

deployment are also used for inspections. The potential visual impacts—including aesthetic conditions and nighttime lighting—of the operation of deployable technologies would be less than significant given the limited geographic scope for individual activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to visual resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.8, Visual Resources.

13.2.9. Socioeconomics

13.2.9.1. Introduction

This section describes potential impacts to socioeconomics in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.9.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on socioeconomics were evaluated using the significance criteria presented in Table 13.2.9-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to socioeconomics addressed in this section are presented as a range of possible impacts.

Table 13.2.9-1: Impact Significance Rating Criteria for Socioeconomics

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with Mitigation Incorporated**	**Less than Significant**	**No Impact**
Impacts to real estate (could be positive or negative)	Magnitude or Intensity	Changes in property values and/or rental fees, constituting a significant market shift.	Effect that is potentially significant, but with mitigation is less than significant.	Indiscernible impact to property values and/or rental fees.	No impacts to real estate in the form of changes to property values or rental fees.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA
Changes to spending, income, industries, and public revenues	Magnitude or Intensity	Economic change that constitutes a market shift.	Effect that is potentially significant, but with mitigation is less than significant.	Indiscernible economic change.	No change to spending, income, industries, and public revenues.
	Geographic Extent	Regional impacts observed throughout the state/ territory.		Effects realized at one or multiple isolated cities/towns.	NA
	Duration or Frequency	Persists during or beyond the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA
Impacts to employment	Magnitude or Intensity	High level of job creation at the state or territory level.	Effect that is potentially significant, but with mitigation is less than significant.	Low level of job creation at the state/territory level.	No job creation due to project activities at the state/territory level.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated cities/towns.	NA
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with Mitigation Incorporated**	**Less than Significant**	**No Impact**
Changes in population number or composition	Magnitude or Intensity	Substantial increases in population, or changes in population composition (age, race, gender).	Effect that is potentially significant, but with mitigation is less than significant.	Minor increases in population or population composition.	No changes in population or population composition.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA

NA = Not Applicable

13.2.9.3. Description of Environmental Concerns

This section discusses at a high level the types of socioeconomic impacts that could result from deployment of the NPSBN. Socioeconomic impacts could be negative or positive. Subsections below address socioeconomic impacts in four general areas, following the breakdown of the significance rating criteria in the table above:

- Impacts to Real Estate;
- Economic Benefits or Adverse Impacts Related to Changes in Spending, Income, Industries, and Public Revenues;
- Impacts to Employment; and
- Changes in Population Number or Composition.

In addition to the specific impacts noted below, the Proposed Action would likely have broad, beneficial impacts to all four areas in times of disaster, by improving the response of public safety personnel. Reduced damages and faster recovery would result. This would support property values; maintain corporate income, personal income, and government revenues; preserve jobs; and reduce disruptions to populations.

Impacts to Real Estate

Deployment of the NPSBN has the potential to improve property values in areas that have reduced property values below typical market values due to below average public safety communication services. Improved services would reduce response times and improve responses (provide a better fit of the response to the need). These effects would reduce the potential for economic losses and thus support investments in property and greater market value for property. Any increases in property values are most likely in areas that have low property values and below average public safety communication services. Increases are less likely in areas that already have higher property value. As discussed in Existing Environment, property values vary across South Carolina. Median values of owner-occupied housing units in the 2009–2013 period ranged from over $191,000 in the greater Charleston/North Charleston area, to just over $123,000 in the Anderson and Spartanburg areas. These figures are general indicators only. Property values are probably both higher and lower in specific localities. Any property value effects of deployment of the NPSBN would occur at a localized level.

Some telecommunications infrastructure, such as wireless communications towers, may adversely affect property values, depending on infrastructure location and other characteristics. Researchers believe these negative impacts relate to perceptions of the aesthetics of towers, or fears over electromagnetic radiation. Economists and appraisers have studied this issue and use a statistical analysis methodology known as hedonic pricing, or hedonic modelling, to assess how different attributes of properties such as distance from a tower affect property value (Bond, Sims, & Dent, 2013). Essentially, analysts compare the value of multiple properties while statistically controlling for differences in property attributes, in order to isolate the effect of a specific attribute such as proximity of a communications tower.

A recent literature review examined such studies in the United States, Germany, and New Zealand (Bond, Sims, & Dent, 2013). These studies all focused on residential properties. One study identified a positive effect on price in one neighborhood due to the presence of a wireless communications tower. Most studies identified negative effects on price. Generally, these negative effects were small: an approximately two percent decrease in property price. In one case, the average reduction in price was 15 percent. In all cases, the effects declined rapidly with distance, with some cases showing no effect beyond 100 meters (328 feet) and one case showing effects up to about 300 meters (984 feet).

Based on review of the particulars of each study, the literature review authors hypothesize that many additional factors regarding communications towers, besides distance, may affect property value. These include the type, height, size, and appearance of communication towers; grouping of towers; the level of activity in the property market at the time properties are listed or sold; and the level of negative local media focus on potential health effects of communication towers at the time properties are listed or sold.

Economic Benefits or Adverse Impacts Related to Changes in Spending, Income, Industries, and Public Revenues

Developing the NPSBN may increase economic activity as governments and partners make expenditures to deploy, operate, and maintain telecommunications and broadband infrastructure. Funds for such expenditures would come primarily from federal, state, and local government sources or through private entities under a written agreement with such governmental entities. FirstNet has three primary sources of funding to carry out its mission: (1) up to $7 billion in cash funded by proceeds of incentive auctions authorized by the Act; (2) network user or subscriber fees; and (3) fees from covered leasing agreements that allow FirstNet to permit a secondary users to access network capacity on a secondary basis for non-public safety services only. The use of NPSBN capacity on a secondary basis for non-public safety services, including commercial services, by parties entering into a covered leasing agreement with FirstNet may also increase economic activity and generation of income for such party.

Direct spending of federal, state, and private sector funds to deploy and operate the NPSBN would likely represent new income to businesses that provide goods and services for the network, resulting in a positive impact. This direct impact would lead to indirect impacts (as directly impacted businesses purchase supporting goods and services) and induced impacts (as the employees of all affected businesses spend the wages they have earned). Because most FirstNet infrastructure investments would be dispersed across the nation, the business income and wages generated in any particular state or community would generally be small relative to the overall state or community economy, but measurable. Based on the significance criteria above, the business income and wage impacts would be considered positive and less than significant. It is also highly unlikely that these impacts would lead to significant market shifts or other significant changes to local/regional economic structure.

Spending and income generation related to developing the NPSBN would also result in changes to public revenues. Property taxes may change as property values increase or decrease due to the installation of new infrastructure. General and selective sales taxes may change (most likely increase), reflecting expenditures during system development and maintenance. Public utility

tax revenues may change. These taxes are a subcategory of selective sales taxes that includes taxes on providers of land and mobile telephone, telegraph, cable, and internet services (U.S. Census Bureau, 2006). These service providers may obtain new taxable revenues from operation of components of the public safety broadband network. In such cases, public utility tax revenues may increase, but they could also remain the same or decrease if providers are granted tax breaks in return for operating portions of the network. Individual and corporate income taxes may change as FirstNet infrastructure development and operation creates new taxable income for involved companies and workers.

FirstNet's partner(s) may be given the right to use excess NPSBN capacity commercially. This would result in additional economic activity and generation of income. In turn, this could have revenue implications for federal and state governments, through taxes on sales and on corporate income generated by commercial use of the network.

FirstNet may have an additional, non-revenue benefit to the public sector. The network is likely to create operational cost savings and increased productivity for public safety personnel.

Impacts to Employment

Private companies and government organizations that receive income from deploying and operating the NPSBN would use portions of that income to hire the employees they need to provide their support to the network. This generation of new employment could be a minor, direct, beneficial impact of expenditures on FirstNet. Additional, indirect employment increases would occur as additional businesses hire workers to provide supporting goods and services. For instance, FirstNet partner(s) and their subcontractors and vendors would need engineers and information technology professionals, project managers, construction workers, manufacturing workers, maintenance workers, and other technical and administrative staff. Further employment gains would occur as businesses throughout the economy benefit from consumer spending by wage-earners in direct and indirectly affected businesses.

For the most part, employment gains in any particular state or community would generally be measurable, but small relative to the overall state or community economy. This is because FirstNet infrastructure investments would be dispersed across the nation. Based on the significance criteria above, the employment impacts would be considered positive and less than significant. However, even small employment gains are beneficial, and would be especially welcomed in areas that have high unemployment. As discussed in Affected Environment, unemployment rates (as shown by the unemployment rate map and selected economic indicators table) vary considerably across South Carolina. The average unemployment rate in 2014 was 6.2 percent, slightly higher than the national rate of 6.4 percent. Counties with unemployment rates below the national average (that is, better employment performance) were distributed around the Columbia, Charleston/North Charleston, Hilton Head, Greenville, and Anderson areas. The highest unemployment rates were generally in the counties located in the central portions of the state.

Large companies that win major contracts for deploying and operating the NPSBN may have concentrations of employees in some specific locations; for instance, engineers and other system

designers may be located in one or a few specific offices. While such employment concentrations could be important to specific communities, these and other employment impacts would still not be significant based on the criteria in Table 13.2.9-1 because they would not constitute a "high level of job creation at the state or territory level."

Changes in Population Number or Composition

In general, changes in population numbers occur when employment increases or decreases to a degree that affects the decisions of workers on where they can find employment; that is, when workers and their families move to or leave an area because of employment opportunities or the lack thereof. As noted above, deployment and operation of the NPSBN is likely to generate new employment opportunities (directly and indirectly), but employment changes would not be large enough in any state to be considered significant. Therefore, it is highly unlikely that the NPSBN would lead to significant changes in population numbers according to the significance criteria table above. Further, it is unlikely that the NPSBN would lead to any measurable changes in population numbers in any geographic areas, with the possible exception of cities where companies that win major NPSBN contracts establish centers for NPSBN deployment and operation activities. Smaller numbers of employees in any area would not produce measurable population changes because population is always in flux due to births, deaths, and in-migration and out-migration for other reasons.

Population composition refers to age, gender, race, ethnicity, and other characteristics of the individuals making up a population. Given the low potential for changes to population numbers, it is highly unlikely that the NPSBN would lead to any changes in population composition.

13.2.9.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could deploy various types of facilities or infrastructure. Almost all deployment activities would have socioeconomic impacts, because they represent economic activity that would result, for instance, in expenditures and generation of income. These effects are measurable by economists, even if very small, but their significance is determined by application of the criteria in Table 13.2.9-1. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch

vehicle would be very unlikely to impact socioeconomics, it is anticipated that this activity would have no impact on socioeconomic resources

Activities with the Potential to Have Impacts

Potential impacts to socioeconomics for the Preferred Alternative would encompass a range of impacts that could result from deployment activities. The discussion below summarizes how the four types of socioeconomic impacts discussed above and listed again here apply to each type of deployment activity. For detail on the nature of these impacts, see the Description of Environmental Concerns section above.

- Impacts to Real Estate;
- Changes to Spending, Income, Industries, and Public Revenues;
- Impacts to Employment; and
- Changes in Population Number or Composition.

Positive impacts on property values would generally not result from one or a few particular activities, but instead would result from the totality of the new NPSBN infrastructure and operational systems that enable improved public safety services to currently underserved areas. Similarly, any change to population numbers in a few locations as discussed above would result from large contract awards and contractor decisions about employee locations, not from specific deployment activities. Therefore, these types of impacts are not included in the activity-focused discussions below.

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
  - Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant on existing utility poles and other structures would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, and would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water, and associated onshore activities at existing or new facilities would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment through existing or new boxes or huts would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
  - New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires construction activities and would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be

small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

  - New Build – Aerial Fiber Optic Plant: Pole/structure installation would have the following types of socioeconomic impacts:

    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

- Wireless Projects

  - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads would have the following types of socioeconomic impacts:

    - Impacts to Real Estate – As discussed above, communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). Such impacts, if they occur, would be limited to a small area around each project and would generally be a small percentage reduction in property value; thus, the impacts would be less than significant.

    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility would have the following types of socioeconomic impacts. While communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013), the impacts of existing wireless towers are presumably already factored into property values and would not be affected by the addition of new equipment.

    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help

support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

  - Deployable Technologies: COWs, COLTs, and SOWs and aerial deployable technologies require storage, staging, and (for aerial deployables) launch/landing areas. Development of such areas, or enlargement of existing areas to accommodate FirstNet equipment, would have the following types of socioeconomic impacts:

    - Impacts to Real Estate – It is possible that development or enlargement of storage, staging, and launch/landing areas could have adverse impacts on nearby property values. This is because such facilities may have adverse aesthetic aspects (e.g., large areas of pavement and large numbers of parked vehicles), equipment maintenance activities at such facilities may generate noise, and operational activities may generate traffic. Such factors could affect nearby property values. These impacts, if they occur, would occur within a limited distance of each site, and would be limited to a relatively small number of sites within the region and state. Therefore, these impacts would be less than significant.

    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

- Satellites and Other Technologies

  - Satellite-Enabled Devices and Equipment: It is anticipated that the deployment of such devices and equipment would be similar to collocation of wireless equipment on existing wireless towers, structures, or buildings, and would have the following types of socioeconomic impacts:

    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

In general, the abovementioned activities would have less than significant beneficial

socioeconomic impacts at the programmatic level. The discussion above characterized the impacts of each type of activity. The socioeconomic impacts of all activities considered together would also be less than significant at the programmatic level. Even when considered together, the impacts would be very small relative to the total economic activity and property value of any region or the state. In addition, with the possible exception of property values, all deployment impacts would be limited to the construction phase. To the extent that certain activities could have adverse impacts to property values, those impacts are also expected to be less than significant at the programmatic level, as described above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of primarily of routine maintenance and inspection of fixed infrastructure. As with deployment activities, all operational activities would have socioeconomic impacts, because all represent economic activity. Public or private sector employees would conduct all operational activities, and therefore support employment and involve payment of wages. Even if these economic effects are a very small for each operational activity and not significant across the entire state, they are measurable socioeconomic impacts.

Potential socioeconomic impacts would primarily be beneficial, and generally of these types:

- Changes to Spending, Income, Industries, and Public Revenues – Operational activities would require expenditures, which then generate business income and employee wages, and may result in new public sector revenues such as taxes on sales and income. All such effects would be small in scale relative to the regional and state economy; their impacts would be less than significant.
- Impacts to Employment – Public and private sector organizations responsible for operating the NPSBN would sustain existing employees and/or hire new employees to carry out operational activities. They would generate a less than significant number of jobs regionally and statewide.

The potential negative impacts on property values mentioned above for deployment of new wireless communication towers and deployable technology storage, staging, and launch/landing areas may also apply in the operations phase. The ongoing presence of such facilities has aesthetic and other effects that may reduce nearby property values, relative to values in the absence of such facilities. These impacts, if they occur, would be less than significant at the programmatic level as they would occur within a limited distance of each site, and would be limited to a relatively small number of sites within the region and state. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.9.5. Alternatives Impact Assessment

The following section assesses potential impacts to socioeconomics associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to socioeconomics resulting from implementation of this alternative could be as described below.

Deployment Impacts

As explained above, all deployment activities represent economic activity and thus have socioeconomic impacts. These impacts would primarily be beneficial, such as generation of business income and employee wages, and creation or sustainment of jobs. The impacts would be small for each activity and therefore less than significant at the programmatic level.

Deployable technologies such as COWs, COLTs, and SOWs, along with aerial deployable technologies, would require storage, staging, and launch/landing areas. Development or enlargement of these facilities could have adverse impacts on nearby property values. The potential for such impacts is higher under this alternative than the Preferred Alternative because it is likely that these facilities would be implemented in greater numbers and over a larger geographic extent. These potential impacts are anticipated to be less than significant at the programmatic level as described above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

All operational activities represent economic activity and thus have socioeconomic impacts. These impacts would primarily be beneficial because they are small individually, overall impacts would be less than significant at the programmatic level.

The ongoing presence of facilities for housing and maintaining deployable technologies may have adverse aesthetic aspects (e.g., large areas of pavement and large numbers of parked vehicles) or other aspects (e.g., noise and traffic) that could negatively affect the value of surrounding properties. The potential for such impacts is higher under this alternative than the Preferred Alternative because it is likely that these facilities would be more numerous, present over a larger geographic extent, and used with greater frequency and duration. These impacts, if they occur, would be less than significant as they would be limited to a relatively small number

of sites within the region and state. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed. Therefore, there would be no associated deployment or installation activities to deploy wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to socioeconomics from deployment and operation of the No Action Alternative. Socioeconomic conditions would therefore be the same as those described in Section 13.1.9, Socioeconomics.

13.2.10. Environmental Justice

13.2.10.1. Introduction

This section describes potential impacts to environmental justice in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.10.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on environmental justice were evaluated using the significance criteria presented in Table 13.2.10-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to environmental justice addressed in this section are presented as a range of possible impacts.

Table 13.2.10-1: Impact Significance Rating Criteria for Environmental Justice

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects associated with other resource areas (e. g., human health and safety, cultural resources, socioeconomics) that have a disproportionately high and adverse impact on low-income populations and minority populations	Magnitude or Intensity	Direct and disproportionately high and adverse effects on environmental justice communities (as defined by EO 12898) that cannot be fully mitigated.	Effect that is potentially significant, but with mitigation is less than significant.	Direct effects on environmental justice communities (as defined by EO 12898) that are not disproportionately high and adverse, and therefore do not require mitigation.	No direct effects on environmental justice communities, as defined by EO 12898.
	Geographic Extent	Effects realized within counties at the Census Block Group level.		Effects realized within counties at the Census Block Group level.	Effects realized within counties at the Census Block Group level.
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA

NA = Not Applicable

13.2.10.3. Description of Environmental Concerns

Effects Associated with Other Resource Areas that have a Disproportionately High and Adverse Impact on Low-Income Populations and Minority Populations

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Executive Office of the President, 1994), and guidance from CEQ, require federal agencies to evaluate potential human health and environmental effects on environmental justice populations. Specifically, "Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or American Indian tribes when those impacts are interrelated to impacts on the natural or physical environment" (CEQ, 1997). Thus, effects associated with other resource areas are of interest from an environmental justice perspective. This includes Human Health and Safety, Cultural Resources, Socioeconomics, Noise, Aesthetics and Visual Resources, and other resources.

Potential concerns noted in the impact analyses for these resources include dust, noise, traffic, and other adverse impacts of construction activities. New wireless communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). See Socioeconomics Environmental Consequences for additional discussion. The presence and operation of large storage, staging, and launch/landing areas for deployable technologies could raise environmental justice concerns as described below. American Indian tribes are considered environmental justice populations (CEQ, 1997); thus, impacts on tribal cultural resources (for instance, due to construction) could be a concern from an environmental justice perspective.

Impacts are considered environmental justice impacts only if they are *both* "adverse" and "disproportionately high" in their incidence on environmental justice populations relative to the general population (CEQ, 1997). The focus in environmental justice impact assessments is always, by definition, on adverse effects. However, telecommunications projects, such as those proposed by FirstNet, may have beneficial effects. These effects may include better provision of police, fire, and EMS; improvements in property values; and the generation of jobs and income. These impacts are considered in the Socioeconomics Environmental Consequences (Section 13.2.9).

Construction impacts are localized, and property value impacts of wireless telecommunications projects rarely extend beyond 300 meters (984 feet) of a communications tower (Bond, Sims, & Dent, 2013). In addition, impacts related to deployment are of short duration. The potential for significant environmental justice impacts from the FirstNet deployment activities would be limited. Most, but not all, of the FirstNet operational activities have very limited potential for impacts as these activities are limited in scale and short in their duration.

Before FirstNet deploys projects, additional site-specific analyses to identify specific environmental justice populations and assess specific impacts on those populations may be necessary. Such analyses could tier-off the methodology and results of this PEIS. The areas shown in the environmental justice screening map of Affected Environment (Section 13.1.10.4) as having moderate potential or high potential for environmental justice populations would particularly warrant further screening. As discussed in Section 13.1.10.3, South Carolina's

population has a considerably higher percentage of persons who identify as Black/African American than the region or the nation. The state's percentages of other minority groups and All Minorities are lower than the region and nation. The poverty rate for South Carolina is somewhat higher than that for the South region and considerably higher than the nation's poverty rate. South Carolina has a high proportion of areas with High Potential for environmental justice populations. High Potential areas are particularly prevalent in the southern two-thirds of the state. High and Moderate Potential areas occur both within and outside of the 10 largest population concentrations. Further analysis using the data developed for the screening analysis in Section 13.1.10.4, Environmental Justice Screening Results, may be useful. In addition, USEPA's EJSCREEN tool and USEPA's lists of environmental justice grant and cooperative agreement recipients may help identify local environmental justice populations (USEPA, 2015f; USEPA, 2016b).

A site-specific analysis would also evaluate whether an actual environmental justice impact on those populations would be likely to occur. Analysts could use the evaluation presented below under "Activities with the Potential to Have Impacts" as a starting point. Analysts should bear in mind that any such activities that are problematic based on the adverse impact criterion of environmental justice may also have beneficial impacts on those same environmental justice communities.

13.2.10.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could deploy various types of facilities or infrastructure. Depending on the physical nature and location of FirstNet facilities or infrastructure and the specific action, some activities would result in potential impacts to environmental justice communities and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to environmental justice under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit would be through existing hand holes, pulling vaults, junction boxes, huts, and POP structures. Activities at these small entry points would be limited and

temporary and thus are not likely to produce perceptible changes affecting any surrounding communities. Therefore, they would not affect environmental justice communities.

  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, and therefore would have no impacts on environmental justice. If physical access is required to light dark fiber, it would likely be through existing hand holes, pulling vaults, junction boxes, huts, and similar existing structures, with no resulting impacts on environmental justice communities.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the deployment of such devices and equipment would not involve new ground disturbance impacts to environmental justice communities would not occur. Impacts associated with satellite-enabled devices requiring construction activities are addressed below.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact environmental justice, it is anticipated that this activity would have no impact on environmental justice.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to environmental justice for the Preferred Alternative would encompass a range of impacts that could occur as a result of disturbance to communities from construction activities, such as noise, dust, and traffic. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to environmental justice communities include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires construction activities such as trenching, plowing (including vibratory plowing), or directional boring, as well as construction of hand holes, pulling vaults, junction boxes, huts, and POP structures. These activities could temporarily generate noise and dust, or disrupt traffic. If such impacts occur disproportionately to environmental justice communities, they would be considered environmental justice impacts.
  - New Build – Aerial Fiber Optic Plant: Pole/structure installation could temporarily generate noise and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would not impact environmental justice because there would be no ground disturbance or other impacts associated with this activity that would adversely

impact communities. Associated onshore activities occurring at existing facilities such as staging of equipment and materials, or connection of cables, would be small in scale and temporary; thus, they would not impact environmental justice communities. Construction of new landings and/or facilities onshore to accept submarine cable could temporarily generate noise and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts, there would be no adverse impacts on surrounding communities, and thus no potential for environmental justice impacts. Installation of optical transmission equipment or centralized transmission equipment requiring construction of new utility poles, hand holes, pulling vaults, junction boxes, huts, and POP structures could temporarily generate noise and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads requires construction activities that could temporarily generate noise and dust, or disrupt traffic. New communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). (See Socioeconomics Environmental Consequences for additional discussion.) If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility. This activity would be small in scale, temporary, and highly unlikely to produce adverse human health or environmental impacts on the surrounding community. Thus, it would not impact environmental justice communities. If collocation requires construction for additional power units, structural hardening, and physical security measures, the construction activity could temporarily generate noise and dust and disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
  - Deployable Technologies: COWs, COLTs, and SOWs and aerial deployable technologies require storage, staging, and (for aerial deployables) launch and landing areas. To the extent such areas require new construction, noise, and dust could be temporarily generated, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

In general, the impacts from the abovementioned activities would be short-term and could potentially involve objectionable dust, noise, traffic, or other localized impacts due to construction activities. In some cases, these effects and aesthetic effects could potentially impact property values, particularly from new towers. These impacts are expected to be less than significant at the programmatic level, but are problematic from an environmental justice perspective if they occur disproportionately in environmental justice communities. These impacts are expected to be less than significant, but are problematic from an environmental justice perspective if they occur disproportionately in environmental justice communities. Since environmental justice impacts occur at the site-specific level, analyses of individual proposed projects would help determine potential impacts to specific environmental justice communities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of primarily of routine maintenance and inspection of fixed infrastructure. It is anticipated that such activities would not result in environmental justice impacts, as the intensity of these activities would be low (low potential for objectionable effects such as noise and dust) and their duration would be very short. Routine maintenance and inspection would not adversely affect property values, for the same reasons. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment activities that involve construction.

Impacts are expected to be less than significant given the short-term nature and limited geographic scope for individual activities. Impacts are expected to be less than significant at the programmatic level. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.10.5. Alternatives Impact Assessment

The following section assesses potential impacts to environmental justice associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to environmental

justice communities resulting from implementation of this alternative could be as described below.

Deployment Impacts

As explained above, deployable technologies such as COWs, COLTs, and SOWs, along with aerial deployable technologies, could require storage, staging, and launch/landing areas. To the extent such areas require new construction, noise, and dust could be generated temporarily, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts. Impacts are expected to be less than significant at the programmatic level because they would be temporary in nature. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

The ongoing presence of facilities for housing and maintaining deployable technologies may have adverse aesthetic aspects (e.g., large areas of pavement and large numbers of parked vehicles) that could negatively affect the value of surrounding properties. In addition, equipment maintenance activities at such facilities may temporarily generate noise, and operational activities may generate traffic. These effects may be adverse in themselves, and may impact property values. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts. Impacts are expected to be less than significant as operations are expected to be temporary in nature. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed. Therefore, there would be no associated construction or installation activities to deploy wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to environmental justice as a result of deployment and operation of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 13.1.10, Environmental Justice.

13.2.11. Cultural Resources

13.2.11.1. Introduction

This section describes potential impacts to cultural resources in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.11.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on cultural resources were evaluated using the significance criteria presented in Table 13.2.11-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to cultural resources addressed in this section are presented as a range of possible impacts.

Table 13.2.11-1: Impact Significance Rating Criteria for Cultural Resources

Type of Effect	Effect Characteristics	Impact Level			
		Adverse effect	**Mitigated adverse effect[1]**	**Effect, but not adverse**	**No effect**
Physical damage to and/or destruction of historic properties[2]	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	Adverse effect that has been procedurally mitigated through Section 106 process.	Effects to a non-contributing portion of a single or many historic properties.	No direct effects to historic properties.
	Geographic Extent	Direct effects APE.		Direct effects APE.	Direct effects APE.
	Duration or Frequency	Permanent direct effects to a contributing portion of a single or many historic properties.		Permanent direct effects to a non-contributing portion of a single or many historic properties.	No direct effects to historic properties.
Indirect effects to historic properties (i.e., visual, noise, vibration, atmospheric)	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	Adverse effect that has been procedurally mitigated through Section 106 process.	Effects to a contributing or non-contributing portion of a single or many historic properties.	No indirect effects to historic properties.
	Geographic Extent	Indirect effects APE.		Indirect effects APE.	Indirect effects APE.
	Duration or Frequency	Long-term or permanent indirect effects to a single or many historic properties.		Infrequent, temporary, or short- or long-term or permanent indirect effects to a single or many historic properties.	No indirect effects to historic properties.
Loss of character defining attributes of historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	Adverse effect that has been procedurally mitigated through Section 106 process.	Effects to a non-contributing portion of a single or many historic properties.	No direct or indirect effects to historic properties.
	Geographic Extent	Direct and/or indirect effects APE.		Direct and/or indirect effects APE.	Direct and/or indirect effects APE.

Type of Effect	Effect Characteristics	Impact Level			
		Adverse effect	**Mitigated adverse effect[1]**	**Effect, but not adverse**	**No effect**
	Duration or Frequency	Long-term or permanent loss of character defining attributes of a single or many historic properties.		Infrequent, temporary, or short-term changes to character defining attributes of a single or many historic properties.	No direct or indirect effects to historic properties.
Loss of access to historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	Adverse effect that has been procedurally mitigated through Section 106 process.	Effects to a non-contributing portion of a single or many historic properties.	No segregation or loss of access to historic properties.
	Geographic Extent	Any area surrounding historic properties that would cause segregation or loss of access to a single or many historic properties.		Any area surrounding historic properties that could cause segregation or loss of access to a single or many historic properties.	No segregation or loss of access to historic properties.
	Duration or Frequency	Long-term or permanent segregation or loss of access to a single or many historic properties.		Infrequent, temporary, or short-term changes in access to a single or many historic properties.	No segregation or loss of access to historic properties.

[1] Whereas mitigation measures for other resources discussed in this PEIS may be developed to achieve an impact that is "Less than Significant with Mitigation Incorporated," historic properties are considered to be "non-renewable resources," given their very nature. As such, any and all unavoidable adverse effects to historic properties, per Section 106 of the NHPA (as codified in 36 CFR Part 800.6), would require FirstNet to consult with the SHPO/THPO and other consulting parties, including American Indian Tribes and Native Hawaiian Organizations, to develop appropriate mitigation.

[2] Per NHPA, a "historic property" is defined as any district, archaeological site, building, structure, or object that is either listed or eligible for listing in the NRHP. Cultural resources present within a project's APE are not historic properties if they do not meet the eligibility requirements for listing in the NRHP. Sites of religious and/or cultural significance refer to areas of concern to American Indian Tribes and other consulting parties that, in consultation with the respective party(ies), may or may not be eligible for listing in the NRHP. These sites may also be considered TCPs. Therefore, by definition, these significance criteria only apply to cultural resources that are historic properties, significant sites of religious and/or cultural significance, or TCPs. For the purposes of brevity, the term historic property is used here to refer to either historic properties, significant sites of religious and/or cultural significance, or TCPs.

13.2.11.3. Description of Environmental Concerns

Physical Damage to and/or Destruction of Historic Properties

One of the primary environmental concerns during deployment activities is damage to or destruction of historic and cultural resources. Deployment involving ground disturbance has the potential to damage or destroy archaeological sites, and the attachment of communications equipment to historic building and structures has the potential to cause damage to features that are historically significant.

Based on the impact significance criteria presented in Table 13.2.11-1, direct deployment impacts could be potentially significant if FirstNet's deployment locations were in areas with moderate to high probabilities for archaeological deposits, within historic districts, or at historic properties. To the extent practicable, FirstNet would attempt to minimize activities in areas with archaeological deposits or within historic districts. However, given that archaeological sites and historic properties are present throughout South Carolina, some deployment activities may be in these areas, in which case BMPs (see Chapter 16) would help avoid or minimize the potential impacts.

Indirect Effects to Historic Properties (i.e., visual, noise, vibration, atmospheric)

The potential for indirect effects to historic properties would be present during deployment of the proposed facilities/infrastructure and during trenching, grading, and/or foundation excavation activities. Indirect effects include the introduction of visual, noise, atmospheric, and/or vibration effects that diminish a property's historic integrity. The greatest likelihood of potentially significant impacts from indirect effects would be from the deployment of equipment in areas that would cause adverse visual effects to historic properties. To the extent practicable, FirstNet would attempt to minimize activities in areas within or adjacent to historic districts or properties.

Loss of Character Defining Attributes of Historic Properties

Deployment of FirstNet equipment has the potential to cause the loss of character defining attributes of historic properties; such attributes are the features of historic properties that define their NRHP eligibility. Examples of such impacts would be the loss of integrity of archaeological sites through ground disturbing activities, and direct impacts to historic buildings from equipment deployment that adversely alter historic architectural features. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Loss of Access to Historic Properties

The deployment of equipment requiring a secure area has the potential to cause the loss of access to historic properties. The highest potential for this type of significant impact would be from the deployment of equipment in secure areas that impact the access to sites of cultural importance to American Indians. It is anticipated that FirstNet would identify potential impacts to such areas

through the NHPA consultation process, and would minimize deployment activities that would cause such loss of access.

13.2.11.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to cultural resources, while others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant at the programmatic level impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to cultural resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to cultural resources since the activities that would be conducted at these small entry and exit points are not likely to produce impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on cultural resources. If required, and if done in existing huts with no ground disturbance, installation of new associated equipment would also have no impacts to cultural resources because there would be no ground disturbance and no perceptible visual changes.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact cultural resources because those activities would not require ground disturbance or create new visual effects.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are

already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact cultural resources, it is anticipated that this activity would have no impact on cultural resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to cultural resources as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur as a result of ground disturbance activities including destruction of cultural or historic artifacts. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to cultural resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POP, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to cultural resources. Soil disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in the disturbance of archaeological sites, and the associated structures could have visual effects on historic buildings and structures within South Carolina.
  - New Build – Aerial Fiber Optic Plant: Ground disturbance during the installation of new utility poles and the use of heavy equipment during the installation of new utility poles and hanging of cables could result in the disturbance of archaeological sites, and the associated structures could have visual effects on historic buildings and structures within the state.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could impact cultural resources, as coastal areas of South Carolina where sea level was lower during glacial periods (generally the Middle Archaic Period and earlier) have the potential to contain archaeological sites. Impacts to cultural resources could also potentially occur as a result of the construction of landings and/or facilities on shore to accept submarine cable, which could result in the disturbance of archaeological sites (archaeological deposits are frequently associated with bodies of water and South Carolina has numerous maritime archaeological sites associated with 17th-19th century settlement and expansion), and the associated structures could have visual effects on historic properties.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be no impacts to cultural resources. If installation of transmission equipment required grading or other ground disturbance to install small boxes or huts, or access roads, there could potentially be impacts to cultural resources.

Ground disturbance could impact archaeological sites, and the associated structures could have visual effects on historic properties.

  - Collocation on Existing Aerial Fiber Optic Plant: Soil excavation and excavated material placement during the replacement of poles and structural hardening could result in direct and indirect effects to cultural resources, although any effects to access would be short-term. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in direct and indirect effects to cultural resources.

- Wireless Projects
  - New Wireless Communication Towers: Deployment of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to historic properties. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the deployment of new wireless towers and associated structures or access roads, could result in the disturbance of archaeological sites. The deployment of new wireless communication towers and their associated structures could result in visual impacts to historic properties or the loss of access to historic properties.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower could result in impacts to historic properties. Ground disturbance activities could result in the disturbance of archaeological sites, and the deployment of collocated equipment could result in visual impacts or physical damage to historic properties, especially in urban areas such as Columbia that have larger numbers of historic public buildings.
  - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to cultural resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, impacts to historic properties could occur if the deployment is long-term, or if the deployment involves aerial technologies with the potential for visual or other indirect impacts.

In general, the abovementioned activities could potentially involve ground disturbance, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to cultural resources associated with deployment could include physical damage to or destruction of historic properties, indirect impacts including visual effects, the loss of access to historic properties, or the loss of character-defining features of historic properties. These activities could affect, but not adversely affect, cultural resources at the programmatic level, as the potential adverse effects would be temporary and limited to the area near individual Proposed Action deployment site. Additionally, some equipment proposed to be installed on or near properties that are listed or eligible for listing on the NRHP could potentially be removed. Additionally as appropriate, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides

a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major communications infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no effects to cultural resources at the programmatic level associated with routine inspections of the Preferred Alternative. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors, or if the acceptable load of the surface is exceeded, ground disturbance impacts on archaeological sites could result as explained above. These potential impacts would be associated with ground disturbance or modifications of properties; however, due to the small scale of expected activities, these actions could affect but would not likely adversely affect cultural resources. In the event that maintenance and inspection activities occur off existing roads, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.11.5. Alternatives Impact Assessment

The following section assesses potential impacts to cultural resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to cultural resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in impacts to cultural resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in impacts to archaeological sites. These activities could affect, but not adversely affect,

cultural resources at the programmatic level due to the limited amount of expected ground disturbing activities and the short-term nature of deployment activities. However, in the event that land/vegetation clearing is required, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the deployment impacts, it is anticipated that there would be effects, but no adverse effects to historic properties associated with implementation/running of the deployable technology. No adverse effects would be expected at the programmatic level to either site access or viewsheds due to the temporary nature of expected activities. As with the Preferred Alternative, it is anticipated that there would be no effects to cultural resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors, impacts to archaeological sites could occur, however, in the event that this is required, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to cultural resources as a result of deployment and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.11, Cultural Resources.

13.2.12. Air Quality

13.2.12.1. Introduction

This section describes potential impacts to South Carolina's air quality from deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.12.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on South Carolina's air quality were evaluated using the significance criteria presented in Table 13.2.12-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic

extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to South Carolina's air quality addressed in this section are presented as a range of possible impacts.

Table 13.2.12-1: Impact Significance Rating Criteria for Air Quality

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with Mitigation Incorporated**	**Less than Significant**	**No Impact**
Increased air emissions	Magnitude or Intensity	Pollutant concentrations would exceed one or more NAAQS in nonattainment and maintenance areas. Emissions in attainment areas would cause an area to be out of attainment for any NAAQS. Projects do not conform to the SIP covering nonattainment and maintenance areas.	Effect that is potentially significant, but with mitigation is less than significant.	Negligible emissions would occur for any criteria pollutants within an attainment area but would not cause a NAAQS exceedance.	Action would not cause pollutant concentrations to exceed the NAAQS in nonattainment and maintenance areas. Emissions in attainment areas would not cause air quality to go out of attainment for any NAAQS. Projects are *de minimis* or conform to the SIP covering nonattainment and maintenance areas.
	Geographic Extent/Context	NA		NA	NA
	Duration or Frequency	Permanent or long-term.		Short term.	Temporary.

NA = Not Applicable

13.2.12.3. Description of Environmental Concerns

Increased Air Emissions

The Proposed Action has the potential to generate air pollutant emissions. These emissions could be above and beyond what is typically generated in a given area and may alter ambient air quality. Deployment activities may involve the use of vehicles, heavy equipment, and other equipment that could emit exhaust and create fugitive dust in localized areas. During operations, routine maintenance and other use of generators at tower facilities may emit exhaust for specific durations (maintenance) or unpredictable timeframes (if power is lost to a site, for example). Impacts are likely to be less than significant due to the mobile nature of the sources and the temporary and short-term duration of deployment activities. Although unlikely, the emissions of criteria pollutants could impair the air quality of the region and potentially affect human health. Potential impacts to air quality from emissions may occur in areas where the current air quality exceeds, or has a history of exceeding, one or more NAAQS. York, South Carolina, is in maintenance and York (Charlotte-Rock Hill, NC-SC (SC portion)) is in nonattainment for ozone and Areas exist in South Carolina that are in maintenance or nonattainment for ozone (see Section 13.1.12, Air Quality and Figure 13.1.12-1).

Based on the significance criteria presented in Table 13.2.12-1, air emission impacts would likely be less than significant given the size and nature of the majority of the proposed deployment activities. The majority of FirstNet's deployment activities would not be located in sensitive areas nor would a large number of emission sources be deployed/operated long-term in the same area from fixed or mobile sources or construction activities. Less than significant emissions could occur for any of the criteria pollutants within attainment areas in South Carolina; however, NAAQS exceedances are not anticipated. Given that nonattainment areas are present, in South Carolina, FirstNet would try to minimize potential emissions where possible and would recommend the implementation of BMPs, where feasible and practicable, to avoid or minimize potential impacts.

13.2.12.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction, deployment, and operation activities.

Deployment and Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementing the Preferred Alternative could result in deploying various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to air quality and others would not. The potential impacts could range from no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action, the following are likely to have no impacts to air quality under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Activities associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit. Gaining access to the conduit and installing the cable may result in minor disturbance at entry and exit points; however, this activity would be temporary and infrequent, and is not expected to produce any perceptible changes in air emissions.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction and have no short-term emissions to air quality because it would create minimal new sources of emissions.
- Satellites and Other Technologies
  - Satellite Enabled Devices and Equipment: The duration of construction activities associated with installing permanent equipment on existing structures would most likely be short-term. It is anticipated that insignificant concentrations of criteria pollutants would be emitted during installment of this equipment from the use of machinery. Deployment and operation of satellite-enabled devices and portable equipment are expected to have minimal to no impact on ambient air quality concentrations.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact air quality resources, it is anticipated that this activity would have no impact on those resources.

Activities with Potential Impacts to Air Quality

Construction, deployment, and operation activities related to the Preferred Alternative could impact air quality by generating various quantities of criteria and air pollutant emissions. It is expected that such impacts would be less than significant due to the shorter duration and localized nature of the activities. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber as well as land/vegetation clearing, excavation activities, and

landscape grading could result in fugitive dust and products of combustion from the use of vehicles and heavy equipment.

  - New Build – Aerial Fiber Optic Plant: The use of heavy equipment during the installation of new poles and hanging cables, as well as constructing access roads, POP huts, or other associated facilities to house plant equipment could result in products of combustion from the use of vehicles and machinery, as well as fugitive dust emissions from site preparation.
  - Collocation on Existing Aerial Fiber Optic Plant: Excavation equipment used during pole replacement, and other heavy equipment used for structural hardening or reinforcement, could result in products of combustion from the use of vehicles and heavy equipment, as well as fugitive dust from site preparation.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in or near bodies of water could generate products of combustion from vessels used to lay the cable. In addition, the construction of landings and/or facilities on shore or the banks of waterbodies that accept the submarine cable could result in products of combustion and fugitive dust from heavy equipment used for grading, foundation excavation, or other ground disturbing activities.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Emissions associated with the installation of optical transmission or centralized transmission equipment would be limited to the short-term, temporary use of vehicle and construction equipment. Long-term impacts are unlikely, as the power requirements for optical networks are relatively low.

- Wireless Projects
  - New Wireless Communication Towers: Activities associated with installing new wireless towers and associated structures (e.g., generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in products of combustion. Operating vehicles and other heavy equipment, running generators while conducing excavation activities and landscape grading to install new wireless towers and associated structures or access roads could result in products of combustion and fugitive dust.
  - Collocation on Existing Wireless Tower, Structure, or Building: Vehicles and equipment used to mount or install equipment, such as antennas or microwave dishes, on an existing tower could impact air quality. However, if additional power units are needed, structural hardening, and physical security measures required grading or excavation, then exhaust and fugitive dust from heavy equipment used for these activities could also result in increased air emissions.
  - Deployable Technologies: The type of deployable technology used would dictate the types of air pollutants generated. For example, mobile equipment deployed via heavy trucks could generate products of combustion from the internal combustion engines associated with the vehicles and onboard generators. These units may also generate

fugitive dust depending on the type of road traveled during deployment (i.e., paved versus unpaved roads). Aerial platforms (e.g., UASs or other aircraft) would generate pollutants during all phases of flight.

In general, the pollutants of concern from the abovementioned activities would be products of combustion from burning fossil fuels in internal combustion engines and fugitive dust from site preparation activities and vehicles traveling on unpaved road surfaces. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the construction impacts. These impacts are anticipated to be less than significant at the programmatic level due to the limited nature of the deployment. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major communications infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be less than significant impacts to air quality at the programmatic level associated with routine inspections of the Preferred Alternative due to the limited nature of the activity. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors additional air quality impacts may occur, however, they would be less than significant at the programmatic level as they would still be limited in nature. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.12.5. Alternatives Impact Assessment

The following section assesses potential impacts to air quality associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific equipment associated with the Deployable Technologies Alternative could include heavy trucks with onboard generators, aerial vehicles (e.g., UASs or other aircraft), and ground support vehicles and other equipment for aerial deployment. The stand-alone Deployable Technologies Alternative differs from the Preferred Alterative in the number of mobile and aerial vehicles likely to deploy, the distances traveled from storage locations, and the duration of deployment. The potential impacts to air quality are as follows:

Deployment and Operation Impacts to Air Quality

Implementing deployable technologies could result in products of combustion from mobile equipment deployed via heavy trucks using internal combustion engines associated with the vehicles and onboard generators. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may have a greater cumulative impact, although this is expected to be less than significant at the programmatic level based on the defined significance criteria, since activities would be temporary and short-term. These vehicles may also produce fugitive dust if traveling on unpaved roads. Some staging or landing areas (depending on the type of technology) may require excavation, site preparation, and paving. Heavy equipment used for these activities could emit products of combustion as a result of burning fossil fuels in internal combustion engines. The deployment and operation of aerial technology is anticipated to generate pollutants during all phases of flight, except for balloons. The products of combustion from ground support vehicles, as well as the duration of ground support operations and travel between storage and deployment locations, would dictate the concentrations and associated impacts. Additionally, routine maintenance and inspections of the deployable technologies are anticipated to be less than significant at the programmatic level, given that these activities are of low-intensity and short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, FirstNet would not deploy the NPSBN and there would be no impact to ambient air quality. By not deploying NPSBN, FirstNet would avoid generating emissions from construction, installation, or operation of wired, wireless, or deployable infrastructure or technologies; satellites; and other technologies.

13.2.13. Noise

13.2.13.1. Introduction

This section describes potential noise impacts from construction, deployment, and operation of the Proposed Action and Alternatives in South Carolina. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.13.2. Impact Assessment Methodology and Significance Criteria

The noise impacts of the Proposed Action were evaluated using the significance criteria presented in Table 13.2.13-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the

potential noise impacts to South Carolina addressed in this section are presented as a range of possible impacts.

Table 13.2.13-1: Impact Significance Rating Criteria for Noise

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures incorporated**	**Less than Significant**	**No Impact**
Increased noise levels	Magnitude or Intensity	Noise levels would exceed typical noise levels from construction equipment and generators. Noise levels at noise sensitive receptors (such as residences, hotels/motels/inns, hospitals, and recreational areas) would exceed 55 dBA or specific state noise limits. Noise levels plus baseline noise levels would exceeds 10 dBA increase from baseline noise levels (i.e., louder). Project noise levels near noise receptors at National Parks would exceed 65 dBA.	Effect that is potentially significant, but with mitigation is less than significant.	Noise levels resulting from project activities would exceed natural sounds, but would not exceed typical noise levels from construction equipment or generators.	Natural sounds would prevail. Noise generated by the action (whether it be construction or operation) would be infrequent or absent, mostly immeasurable.
	Geographic Extent/Context	County or local.		County or local.	County or local.
	Duration or Frequency	Permanent or long-term.		Short term.	Temporary.

NA = Not Applicable

13.2.13.3. Description of Environmental Concerns

Increased Noise Levels

The Proposed Action has the potential to generate noise during construction and operation of various equipment used for deployment. These noise levels could be above what is typically generated in a given area and may alter the ambient acoustical environment. If significant, the noise could cause impacts on residential areas, or other facilities that are sensitive to noise, such as churches, hospitals, or schools. The construction activities for deploying some of the various equipment evaluated under the Proposed Action could cause short-term impacts to nearby populations. However, it is likely that there would be less long-term effects from operational use of the proposed equipment (see Section 13.1.13, Noise).

Based on the significance criteria presented in Table 13.2.13-1, noise impacts would likely be less than significant given the size and nature of the majority of the proposed deployment activities. The majority of FirstNet's deployment activities would not be located in sensitive areas nor would a large number of noise sources be deployed/operated long-term in the same area. Noise levels from deployment activities are not expected to exceed typical noise levels for short-term/temporary construction equipment or generators.

To the extent practicable, FirstNet would attempt to mitigate or minimize noise effects during construction or operation. BMPs and mitigation measures could help to limit impacts on nearby noise-sensitive receptors. However, given that much of the concentration and setup of equipment would often occur in populated areas, FirstNet operations would not be able to completely avoid noise impacts due to construction and operations at various receptors.

13.2.13.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction, deployment, and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementing the Preferred Alternative could result in deploying various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential noise impacts and while others would not. In addition, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no noise impacts under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Noise generated by equipment required to install fiber would be infrequent and of short duration, and is not expected to create perceptible impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction and have no noise impacts.
- Satellites and Other Technologies
  - Satellite Enabled Devices and Equipment: The duration of construction activities associated with installing permanent equipment on existing structures would most likely be short-term. It is anticipated that insignificant levels of noise would be emitted during installment of this equipment. Noise caused by these construction and installation activities would be similar to other construction activities in the area, such as the installation of cell phone towers or other communication equipment. Deployment and operation of satellite-enabled devices and equipment are expected to have minimal to no impact on the noise environment.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact noise resources, it is anticipated that this activity would have no impact on those resources.

Activities with the Potential for Noise Impacts

Construction, deployment, and operation activities related to the Preferred Alternative could create noise impacts from either the construction or operation of the infrastructure. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber as well as land/vegetation clearing, excavation activities, and landscape grading could result in high noise levels from the use of heavy equipment and machinery.
  - New Build – Aerial Fiber Optic Plant: The use of heavy equipment during the installation of new poles and hanging cables, as well as constructing access roads, POP huts, or other associated facilities to house plant equipment would be short-term and could result in increased noise levels from the use of vehicles and machinery.

  - Collocation on Existing Aerial Fiber Optic Plant: Excavation equipment used during potential pole replacement, and other heavy equipment used for structural hardening or reinforcement, could result in temporary increased in noise levels from the use of heavy equipment and machinery.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Installation of new associated huts or equipment, if required, could result in short-term and temporarily higher noise levels if the activity required the use of heavy equipment for grading or other purposes.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could generate noise if vessels are used to lay the cable. In addition, the construction of landings and/or facilities on shore to accept submarine cable could result in short-term and temporarily increased noise levels to local residents and other noise sensitive receptors from heavy equipment used for grading, foundation excavation, or other ground disturbing activities.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Noise associated with the installation of optical transmission or centralized transmission equipment would be limited to the short-term, temporary use of vehicle and construction equipment. Long-term impacts are unlikely, as the noise emissions from optical networks are relatively low. Heavy equipment used to grade and construct access roads could generate increased levels of noise over baseline levels temporarily.
- Wireless Projects
  - New Wireless Communication Towers: Activities associated with installing new wireless towers and associated structures (e.g., generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in localized construction noise. Operating vehicles, other heavy equipment, and generators would be used on a short-term basis and could increase noise levels.
  - Collocation on Existing Wireless Tower, Structure, or Building: Vehicles and equipment used to mount or install equipment, or to grade or excavate additional land on sites for installation of equipment, such as antennas or microwave dishes on an existing tower, could impact the local noise environment temporarily.
  - Deployable Technologies: The type of deployable technology used would dictate the types of noise generated. For example, mobile equipment deployed via heavy trucks could generate noise from the internal combustion engines associated with the vehicles and onboard generators. Aerial platforms (e.g., UASs or other aircraft, except balloons) generate noise during all phases of flight, including takeoff, landing, and flight operations over necessary areas that could impact the local noise environment.

In general, noise from the abovementioned activities would be products of site preparation, installation, and construction activities, as well as additional construction vehicles traveling on nearby roads and localized generator use. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the construction impacts at the

programmatic level. These impacts are expected to be less than significant due to the temporary duration of deployment activities. Additionally, pre-existing noise levels achieved after some months (typically less than a year but could be a few hours for linear activities such as pole construction). Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

Operation activities associated with the Preferred Alternative would be less than significant at the programmatic level and for routine maintenance and inspection of the facilities because of the temporary nature of the activities, which would not create new permanent sources of noise. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that potential noise impacts would be similar to or less than those described for the deployment activities. If usage of vehicles or heavy equipment as part of routine maintenance or inspections or onsite generator use occurs, potential noise impacts could result as explained above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.13.5. Alternatives Impact Assessment

The following section assesses potential noise impacts associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific equipment associated with the Deployable Technologies Alternative would be heavy trucks with onboard generators, aerial vehicles (e.g., UASs or other aircraft), and ground support vehicles and equipment for aerial deployment. The stand-alone Deployable Technologies Alternative differs from the Preferred Alterative in the number of mobile and aerial vehicles likely to deploy, the distances traveled from storage locations and the duration of deployment. The potential noise impacts are as follows:

Deployment Noise Impacts

Implementing deployable technologies could result in noise from mobile equipment deployed via heavy trucks, including not only onboard generators, but also the vehicles themselves. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may increase localized noise levels. Several vehicles traveling together could also create short-term noise impacts on residences or other noise-

sensitive receptors as they pass by. The deployment of aerial technology is anticipated to generate noise during all phases of flight. Aerial technologies would have the highest level of noise impact if they are required to fly above residential areas, areas with a high concentration of noise-sensitive receptors (i.e., schools or churches), or over national parks or other areas where there is an expectation of quiet and serenity on their way to their final destinations. Residences near deployment areas for aerial technologies (i.e., airports or smaller airfields) could also be affected during takeoff and landing operations. Additionally, routine maintenance and inspections of the deployable technologies are anticipated to be less than significant, given that these activities are of low-intensity and short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

Operation activities associated with the Deployable Technologies Alternative would be similar to several of the deployment activities related to routine maintenance and inspection of the facilities. Operation of generators could also generate noise in the area. However, could be deployed to areas with few existing facilities, so noise impacts could be minimal in those areas. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that potential noise impacts would be the same as those described for the deployment activities. If usage of vehicles or heavy equipment as part of routine maintenance or inspections occurs, potential noise impacts could result as explained above.

Operational impacts from aerial technologies would include repeated flyovers by UAS vehicles while they are needed in the area. This could generate less than significant at the programmatic level, short-term impacts on any residential areas or other noise-sensitive receptors under the flight path of these vehicles. However, once these operations cease, noise levels would quickly return to baseline levels. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, FirstNet would not deploy the NPSBN and there would be no impact to ambient noise. By not deploying the NPSBN, FirstNet would avoid generating noise from construction, installation, or operation of wired, wireless, deployable infrastructure or satellites and other technologies.

13.2.14. Climate Change

13.2.14.1. Introduction

This section describes potential impacts to climate and climate change-vulnerable resources in South Carolina associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and

mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.14.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on climate and potential climate change impacts on the Proposed Action's installations and infrastructure were evaluated using the significance criteria presented in Table 13.2.14-1. As described in Section 13.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to climate and climate change-vulnerable resources addressed in this section are presented as a range of possible impacts.

CEQ requires the consideration of climate change from two perspectives. The first is the potential for impacts on climate change through GHG emissions resulting from the Proposed Action or alternatives. The second is related to the implications and possible effects of climate change on the environmental consequences of the Proposed Action or alternatives. This extends to the impacts of climate change on facilities and infrastructure that would be part of the Proposed Action or alternatives (CEQ, 2014).

CEQ has established the significance criteria for GHG emissions at 25,000 MT CO_2e on an annual basis, with the requirement that if projected emissions exceed this threshold, a GHG emissions quantitative analysis is warranted (CEQ, 2014). Although 25,000 MT is a very small fraction (one 266,920th) of the total U.S. emissions of 6,673 MMT CO_2e in 2013 (USEPA, 2015n), the sum of additional emissions as a consequence of the deployment of FirstNet, combined with multiple new sources of CO_2 and other GHGs from other projects and human activities, could be significant.

CEQ guidance for the consideration of effects of climate change on the environmental consequences of the proposed action is more general. In addition to the consideration of climate change's effects on environmental consequences, it also includes the impact that climate change may have on the projects themselves (CEQ, 2014). Projects located in areas that are vulnerable to the effects of climate change (e.g., sea level rise) may be at risk. Analysis of these risks through the NEPA process could provide useful information to the project planning to ensure these projects are resilient to the impacts of climate change.

Table 13.2.14-1: Impact Significance Rating Criteria for Climate Change

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less Than Significant with Mitigation Measures Incorporated**	**Less Than Significant**	**No Impact**
Contribution to climate change through GHG emissions	Magnitude or Intensity	Exceedance of 25,000 metric tons of CO_2e/year, and global level effects observed.	Effect that is potentially significant, but with mitigation is less than significant.	Only slight change observed.	No increase in greenhouse gas emissions or related changes to the climate as a result of project activities.
	Geographic Extent	Global impacts observed.		Global impacts observed.	NA
	Duration or Frequency	Long-term changes. Changes cannot be reversed in a short term.		Changes occur on a longer time scale. Changes cannot be reversed in the short term.	NA
Effect of climate change on FirstNet installations and infrastructure	Magnitude or Intensity	Climate change effects (such as sea level rise or temperature change) negatively impact FirstNet infrastructure.	Effect that is potentially significant, but with mitigation is less than significant.	Only slight change observed.	No measurable impact of climate change on FirstNet installations or infrastructure.
	Geographic Extent	Local and regional impacts observed.		Local and regional impacts observed.	NA
	Duration or Frequency	Long-term changes. Changes cannot be reversed in a short term.		Changes occur on a longer time scale. Changes cannot be reversed in the short term.	NA

NA = Not Applicable

Projected Future Climate

There have been increasing numbers of days above 95 °F and nights above 75°F, and decreasing numbers of extremely cold days since 1970 in the Southeast. Temperatures across this section of the United States are expected to increase during this century. Major consequences of warming include significant increases in the number of hot days, defined as 95 °F or above, and decreases in freezing events. (USGCRP, 2014a)

Air Temperature

Figure 13.2.14-1 and Figure 13.2.14-2 illustrate the anticipated temperature changes for low and high GHG emission scenarios for South Carolina from a 1969 to 1971 baseline.

Cfa – Figure 13.2.14-1 shows that by mid-century (2040 to 2059), temperatures in South Carolina under a low emissions scenario would increase by approximately 4 °F in the northwestern portion of the state and 3 °F in the remainder of the state. By the end of the century (2080 to 2099) under a low emissions scenario temperatures in the entire state of South Carolina would increase by approximately 5 °F in the majority of the state and 4 °F on the coast. (USGCRP, 2009)

Figure 13.2.14-2 shows that under a high emissions scenario for the period (2040 to 2059), temperatures would increase by approximately 5 °F. Under a high emissions scenario for the period (2080 to 2099) in the Cfa region of South Carolina, temperatures would increase by approximately 8 °F in the majority of the state and 7 °F on the coast. (USGCRP, 2009)

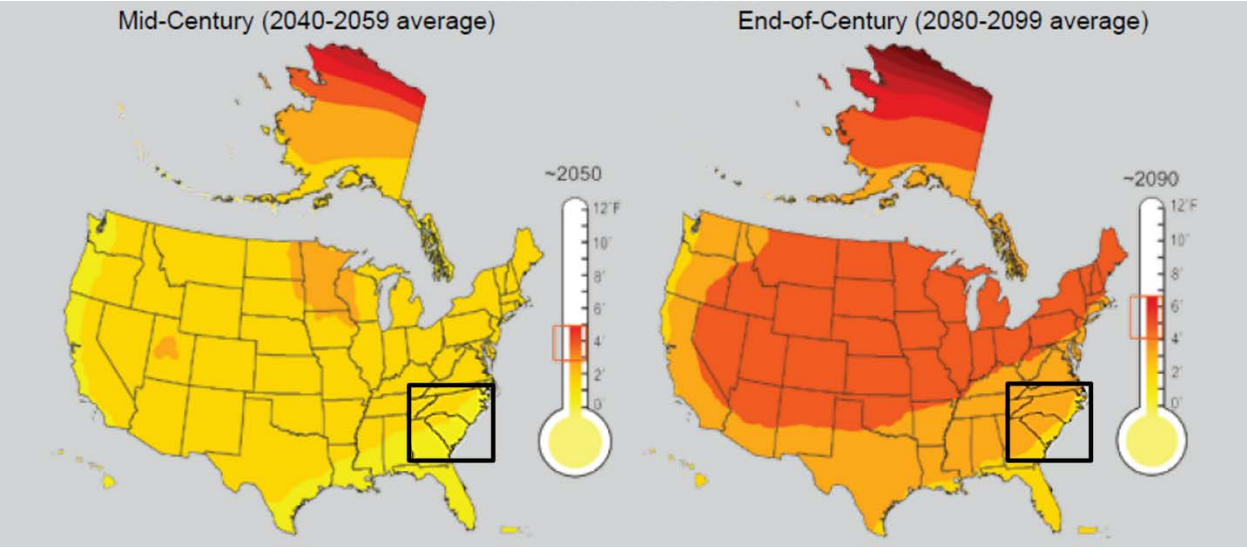


Figure 13.2.14-1: South Carolina Low Emission Scenario Projected Temperature Change

Source: (USGCRP, 2009)

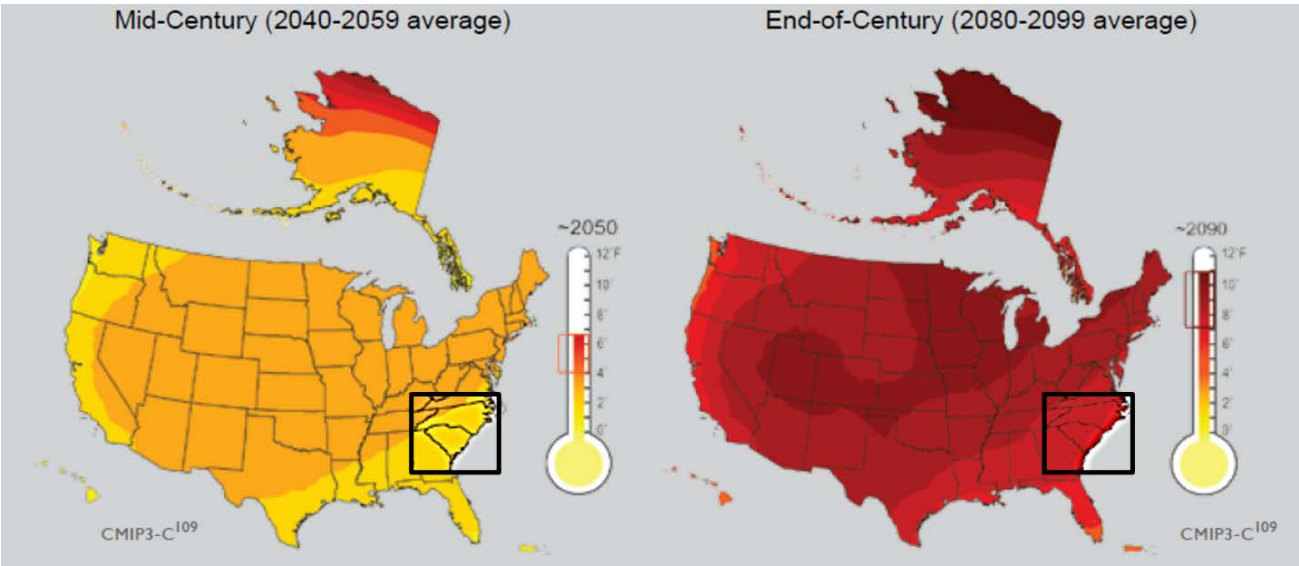


Figure 13.2.14-2: South Carolina High Emission Scenario Projected Temperature Change

Source: (USGCRP, 2009)

Precipitation

Predicting future precipitation patterns in the Southeast are much less certain than projections for temperature. The Southeast is located in the transition zone between projected wetter conditions to the north and drier conditions to the southwest. Therefore, many of the model projections show only small changes relative to natural variations. However, many models do project drier conditions in the far southwest portion of the region and wetter conditions in the far northeast portion of the region. (USGCRP, 2014a)

Figure 13.2.14-3 and Figure 13.2.14-4 show predicted seasonal precipitation change for an approximate 30-year period of 2071 to 2099 compared to a 1970 to 1999 approximate 30-year baseline. Figure 13.2.14-3 shows seasonal changes in a low emissions scenario, which assumes rapid reductions in emissions where rapid reductions means more than 70 percent cuts from current levels by 2050. (USGCRP, 2014b)

Figure 13.2.14-4 shows a high emissions scenario, which assumes continued increases in emissions, with associated large increases in warming and major precipitation changes. (Note: white areas in the figures indicate that the changes are not projected to be larger than could be expected from natural variability). (USGCRP, 2014b)

Cfa – Under the low emissions scenario, in the 30-year period for 2071 to 2099, precipitation would increase by 10 percent on a portion of the coast in winter while the precipitation in the remainder of the state will remain constant. In spring and summer, precipitation is expected to increase by 10 percent in a majority of the state while precipitation in a small portion along the coast is expected to remain constant. There are no expected changes to fall precipitation on the

western side of the state and there is a 10 percent increase on the eastern side of the state. (USGCRP, 2014b)

Figure 13.2.14-4 shows that if emissions continue to increase, winter precipitation could increase as much as 20 percent over the period 2071 to 2099 in the northern portion of the state with a 10 percent increase in precipitation in the remainder of the state. In spring and summer, precipitation in this scenario is expected to 10 percent in half of the state and remain constant in the remainder of the state. Fall precipitation is expected to increase 10 percent. (USGCRP, 2014b)

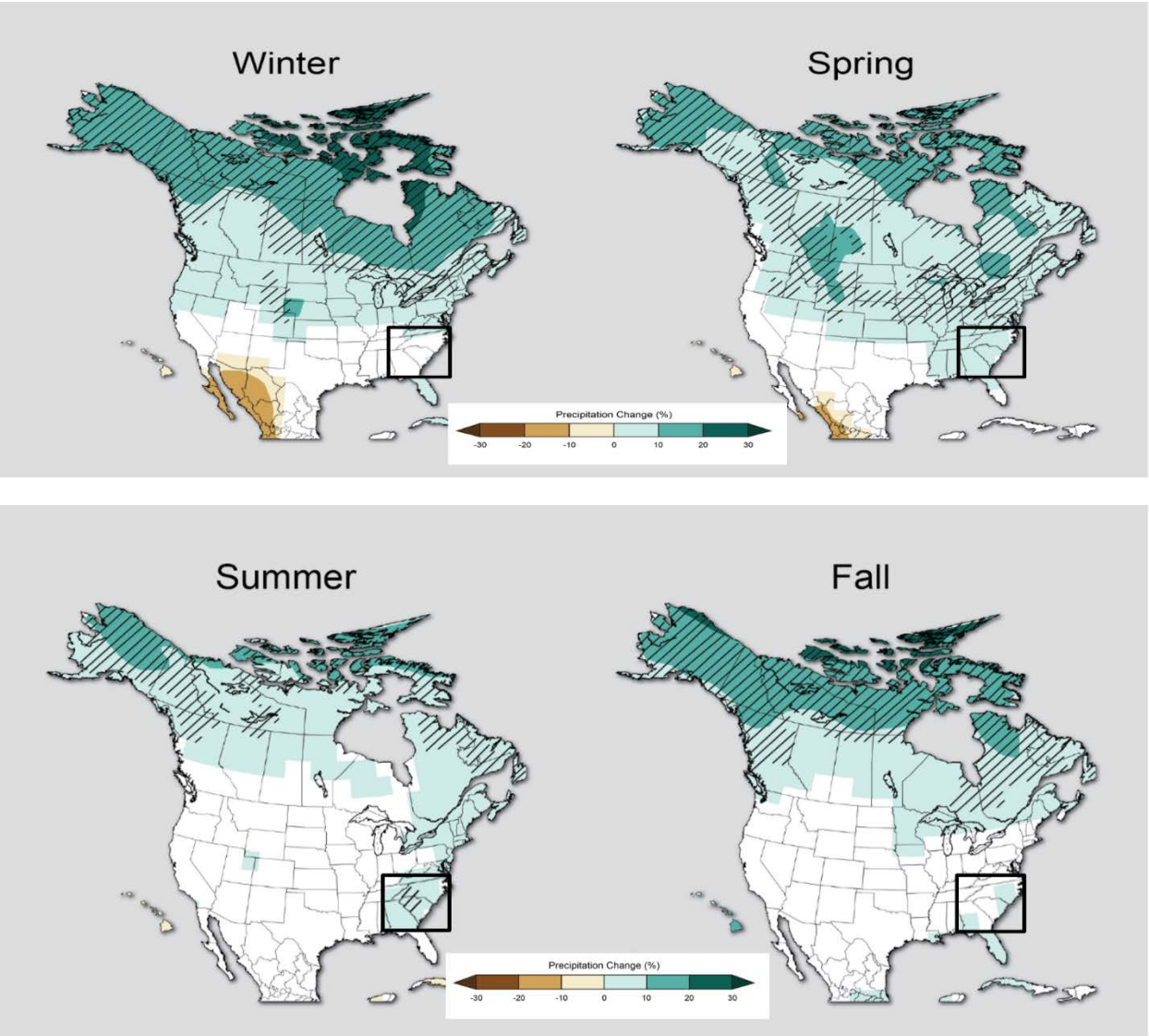


Figure 13.2.14-3: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a Low Emissions Scenario

Source: (USGCRP, 2014b)

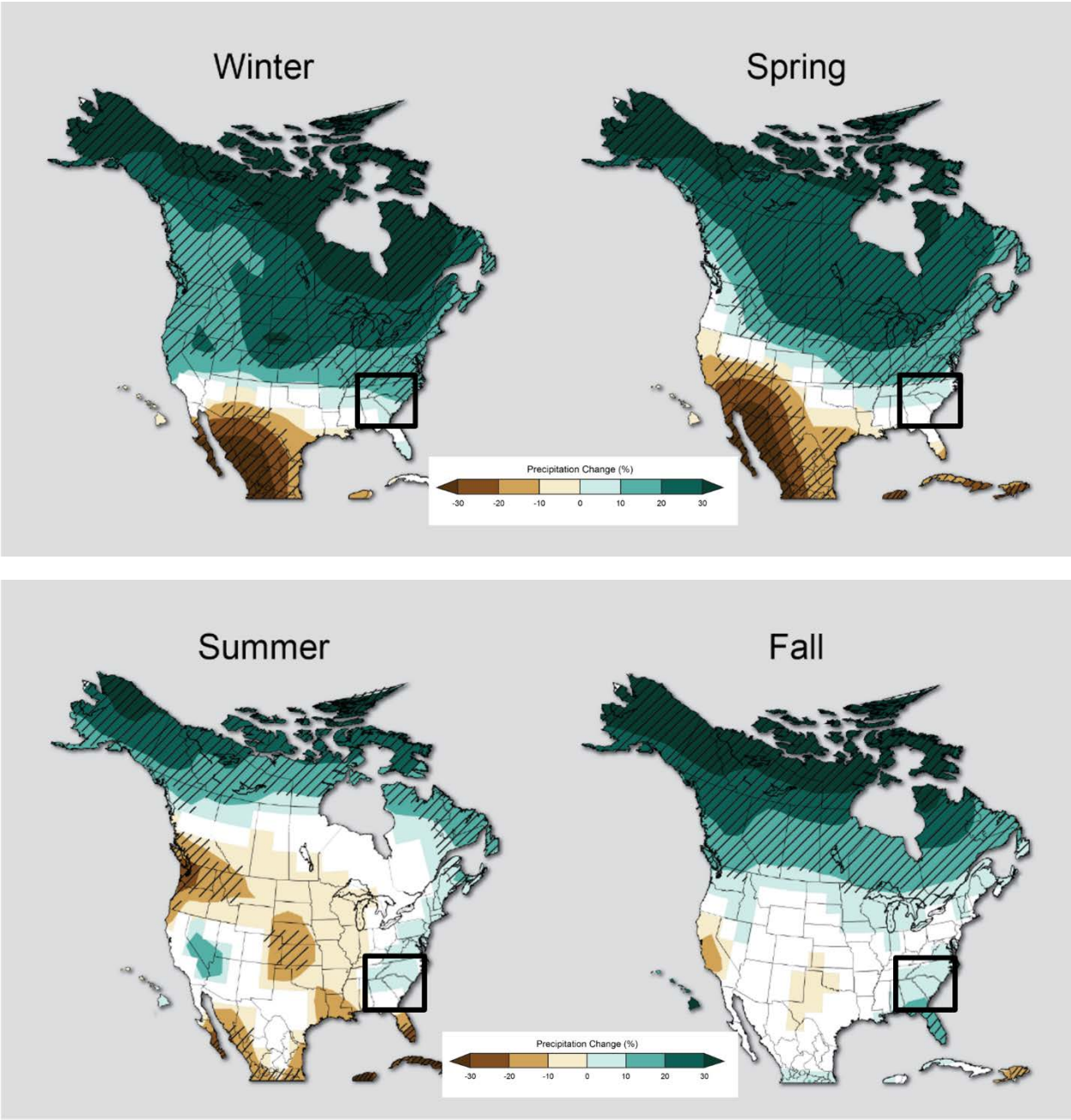


Figure 13.2.14-4: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a High Emissions Scenario

Source: (USGCRP, 2014b)

Sea Level

Several factors would continue to affect sea level rise in the future. Glacier melt adds water to the ocean, and increasing ocean temperatures result in thermal expansion. Worldwide, "glaciers have generally shrunk since the 1960s, and the rate at which glaciers are melting has accelerated over the last decade. The loss of ice from glaciers has contributed to the observed rise in sea

level" (USEPA, 2012d). When water warms, it also expands, which contributes to sea level rise in the world's oceans. "Several studies have shown that the amount of heat stored in the ocean has increased substantially since the 1950s." (USEPA, 2012d). Sea level and currents could be influenced by the amount of heat stored in the ocean (USEPA, 2012d).

The amount of sea level rise would vary in the future along different stretches of the U.S. coastline and under different absolute global sea level rise scenarios. Variation in sea level rise along different stretches of coast is mostly due to varying rates of land subsidence (also known as relative sea level rise). In the National Climate Assessment (NCA) potential sea level rise scenarios were reported. These scenarios were developed based on varying degrees of ocean warming and ice sheet loss as estimated by organizations like IPCC (NOAA 2012). Figure 13.2.14-5 and Figure 13.2.14-6 show feet of sea level above 1992 levels at different tide gauge stations. Figure 13.2.14-5 shows an 8 inch global sea level rise above 1992 levels by 2050 and Figure 13.2.14-6 shows a 1.24 foot global sea level rise above 1992 levels by 2050 (USGCRP, 2014c).

Cfa – Figure 13.2.14-5 presents an 8-inch global average sea level rise above 1992 levels, resulting in a 0.7 to 1.3 foot sea level rise in 2050 along the coast of South Carolina. Figure 13.2.14-6 indicates that a 1.24-foot sea level rise above 1992 level would result in a 1.3 to 2.0 foot sea level rise in 2050 along the coast of South Carolina. (USGCRP, 2014c)

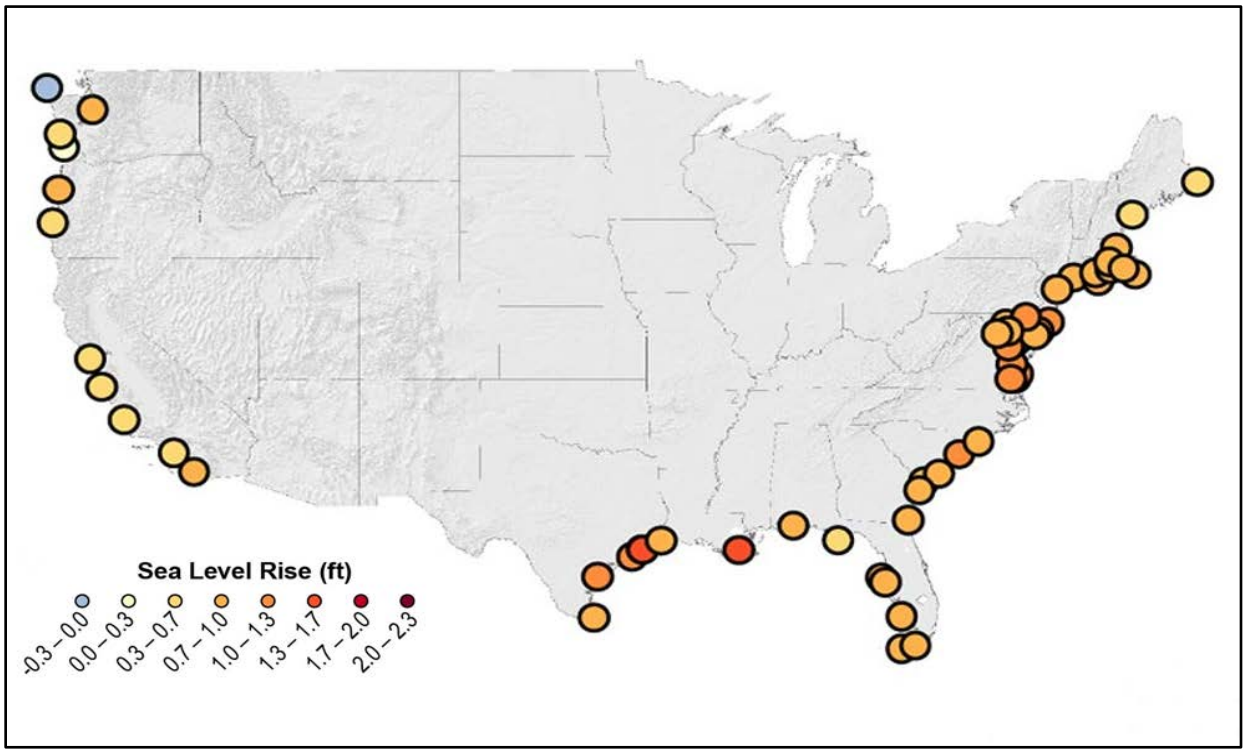


Figure 13.2.14-5: 8-inch Sea Level Rise Above 1992 Levels by 2050

Source: (USGCRP, 2014c)

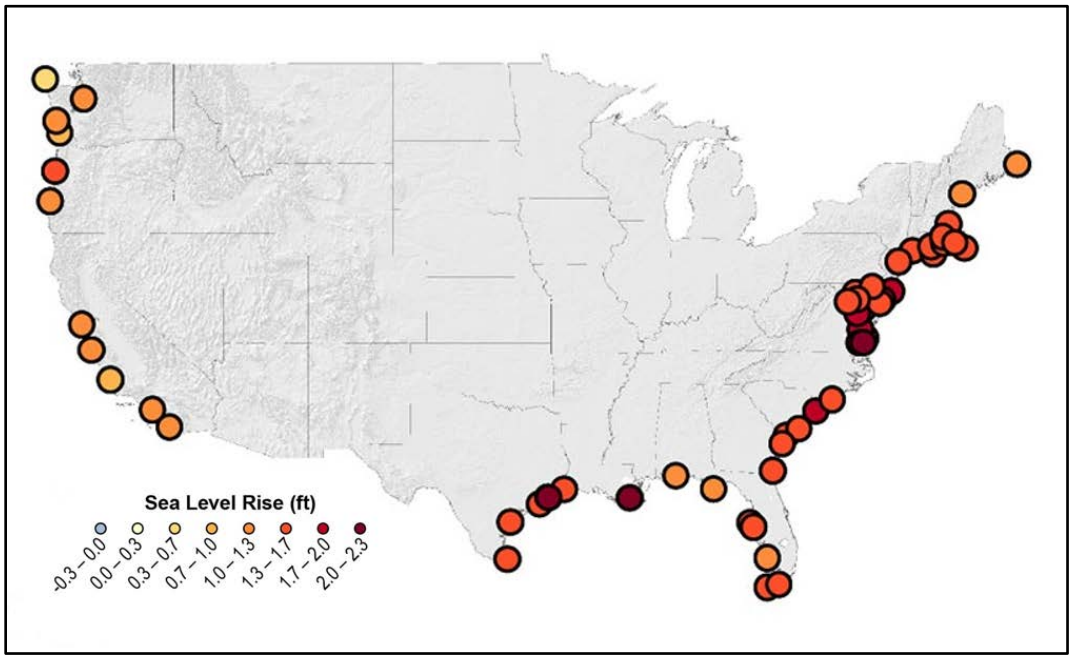


Figure 13.2.14-6: 1.24-foot Sea Level Rise Above 1992 Levels by 2050

Source: (USGCRP, 2014c)

Severe Weather Events

It is difficult to forecast the impact of climate change on severe weather events such as thunderstorms and hurricanes. Trends in thunderstorms and hurricanes are subject to greater uncertainties than trends in temperature and associated variables directly related to temperature such as sea level rise. Climate scientists are studying the influences of climate change on severe storms such as hurricanes. Recent research has yielded insights into the connections between warming and factors that cause severe storms. For example, atmospheric instability and increases in wind speed with altitude link warming with tornadoes and thunderstorms. Additionally, research has found a link between warming and conditions favorable for severe thunderstorms. However, more research is required to make definitive links between severe weather events and climate change. (USGCRP, 2014d)

United States coastal waters are expected to experience more intense hurricanes with related increases in wind, rain, and storm surges (but not necessarily an increase in the number of storms that make landfall) (USGCRP, 2014d). Changes in hurricane intensity are difficult to project because there are contradictory effects at work. Warmer oceans increase storm strength with higher winds and increased precipitation. However, changes in wind speed and direction with height are also projected to increase in some regions; this tends to inhibit storm formation and growth. Current research suggests stronger, more rain-producing tropical storms and hurricanes are generally more likely, though such storms may form less frequently; ultimately, more research would provide greater certainty. (USGCRP, 2009)

13.2.14.3. Description of Environmental Concerns

Greenhouse Gas Emissions

Increases in GHG emissions have altered the global climate, leading to generalized temperature increases, weather disruption, increased droughts and heatwaves, and may have potentially catastrophic long-term consequences for the environment. Although GHGs are not yet regulated by the federal government, many states have set various objectives related to reducing GHG emissions, particularly CO_2 emissions from fossil fuels.

Based on the impact significance criteria presented in Table 13.2.14-1, climate change impacts as a result of GHG emissions could be significant and require a quantitative analysis if FirstNet's deployment of technology was responsible for increased emissions of 25,000 MT/year or more. The GHG emissions resulting from FirstNet activities fall into two categories: short-term and long-term. Short-term emissions could be associated with deployment activities (vehicles and other motorized construction equipment) and would have no long-term or permanent impact on GHG emissions or climate change. Long-term (both temporary and permanent) emission increases could result from operations, including the use of grid-provided electricity by FirstNet equipment such as transmitters and optical fiber, and from the temporary use of portable or onsite electric generators (a less efficient, more carbon-intensive source of electricity), during emergency situations when the electric grid was down, for example after a hurricane.

A single large cell tower would typically require 20-60kW of power to operate (Balshe, 2011). The CO_2 emissions associated with the operation of the tower would depend on whether it was supplied by a stand-alone power source, such as a generator, or from the grid, and whether it was operating at full power on a continuous basis. A standard 60kW 3-phase diesel generator consumes approximately 5.0 gallons of diesel per hour (Diesel Service & Supply, 2016). Diesel fuel combustion emits 22.38 lbs. of CO_2 per gallon (EIA, 2015f). A 60kW transmitter running on a generator would therefore be responsible for 1,221 kg of CO_2/day. Running continuously, the tower would cause the emission of 446 MT of CO_2 per year.

However, grid-provided electricity would result in less CO_2 emissions than onsite provided energy. Using the average carbon intensity of grid-provided electricity of 1,136.53 lbs./MWh (USEPA, 2015o), the same transmitter would be responsible for approximately 271 MT of CO_2 per year running continuously. Actual emissions would depend on the fuel mix and efficiency of the systems from which electricity was generated. Some may even run on low/no-emissions renewable energy. Therefore, this scenario is a "worst-case" for GHG emissions. If the system deployment resulted in the operation of more than 50 60 kW towers operating at maximum power in remote locations on diesel generators on a continuous basis, the 25,000 MT/year threshold may be exceeded and a quantitative analysis required. By comparison optical fiber is considerably more energy efficient and consumes considerably less power than transmitters (Vereecken, et al., 2011), and would not impact GHG emissions in such a way as to require a quantitative analysis.

Effects of Climate Change on Project-Related Resource Effects

Climate change may increase project-related impacts by magnifying or otherwise altering impacts in other resources areas. Forested areas of the Southeast, including South Carolina, may be at a higher risk of wildland fires, particularly during the periods of extended drought that are forecasted under warming scenarios (Mitchell, 2014). Summer heat stress may negatively impact human and animal health, crop and other agricultural production, natural ecosystems and their dependent species, and water quality. (USGCRP, 2014e).

Impact of Climate Change on FirstNet Installations and Infrastructure

South Carolina is at risk for stronger hurricanes as a result of climate change. Sea level rise would increase the height, areal extent, and persistence of coastal flooding during these events (USGCRP, 2014f). Stronger storms may also increase the potential for damage from high winds and wind-borne debris. In inland areas of South Carolina out of the immediate path of storm surge are nevertheless at risk of flooding. Climate change is projected to increase the frequency and severity of torrential downpours which in turn may increase the potential for flash floods with negative impacts to communities and infrastructure (USGCRP, 2014g). Extended periods of extreme heat may impede the operation of and increase electricity demand on the grid in the Southeastern states from air conditioning (DOE, 2015) and overwhelm the capacity of onsite equipment needed to keep microwave and other transmitters cool.

13.2.14.4. Potential Impacts of the Preferred Alternative

Greenhouse Gas Emissions

The following section assesses potential GHG emission impacts associated with implementation of the Preferred Alternative in South Carolina, including deployment and operation activities.

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment and operation of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to GHG emissions, climate impacts in other resource areas, and FirstNet infrastructure and operations, and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to climate change under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: There would be no short-term emissions associated with construction, as construction would not take place. The

equipment required to blow or pull fiber through existing conduit would be used temporarily and infrequently, resulting in no perceptible generation of GHG emissions.

  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction and have no short or long-term emissions. This would create no perceptible change in GHG emissions.

- Satellites and Other Technologies
  - Distribution of Satellite Enabled Devices and Equipment: The installation of satellite-enabled equipment on existing structures, or the use of portable satellite-enabled devices would not create any perceptible changes in GHG emissions because they would not create any new emissions sources.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. Therefore it is anticipated that there would be no GHG emissions or any climate change effects on the project because these activities.

Activities with the Potential to Have Impacts

The deployment and use of energy-consuming equipment as a result of the implementation of the Preferred Alternative would result in GHG emissions whose significance would vary depending on their power requirements, duration and intensity of use, and number. The types of infrastructure deployment scenarios that could be part of the Preferred Alternative and result in potential impacts to GHG emissions and climate change include the following:

- Wired Projects
  - New Build - Buried Fiber Optic Plant: This activity would include plowing (including vibratory plowing), trenching, and directional boring, and could involve construction of POPs, huts, or other facilities to house outside plant equipment or hand holes to access fiber. These activities could generate GHG emissions.
  - New Build Aerial Fiber Optic Plant: These projects would require construction equipment for installing or replacing new poles and hanging cables as well as excavation and grading for new or modified right-of-ways or easements. It could also include construction of POPs, huts, or other facilities to house outside plant equipment. These activities could generate GHG emissions.
  - Collocation on Existing Aerial Fiber Optic Plant: These projects would require equipment for replacement of existing wiring and poles. GHG emissions associated with these projects would arise from use of machinery and vehicles to complete these activities.
  - New Build – Submarine Fiber Optic Plant: The deployment of small work boats with engines similar to recreational vehicle engines may be required to transport and lay small wired cable. The emissions from these small marine sources would contribute to GHGs.

  - Installation of Optical Transmission or Centralized Transmission Equipment: The construction of small boxes or huts or other structures would require construction equipment, which could generate GHG emissions.

- Wireless Project
  - New Wireless Tower Construction: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in short-term, temporary GHG emissions from vehicles and construction equipment. Long-term, permanent or temporary increases in GHG emissions would result from the electricity requirements of the towers (both grid-provided and back-up), and would depend on their size, number, and the frequency and duration of their use.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on existing towers. There would be no short-term GHG emissions associated with construction, as it would not occur. Minor, short-term, temporary GHG emissions may result from any associated equipment used for installation, such as cranes or other equipment. Long-term, permanent or temporary increases in GHG emissions would result from the electricity requirements of the towers (both grid-provided and back-up), and would depend on their size, number, and the frequency and duration of their use.
- Deployable Technologies
  - COWs, COLTs, SOWs: The long-term operations of these mobile systems have the potential to have GHG emission impacts in excess of 25,000 MT if operated in large numbers over the long-term. However this would be highly dependent on their size, number, and the frequency and duration of their use.
  - Emissions associated with the deployment and maintenance of a complete network solution of this type may be significant if large numbers of piloted or unmanned aircraft were used for a sustained period of time (i.e., months to years). Emissions would depend on the type of platforms used, their energy consumption, and the duration of the network's operation.

Potential climate change impacts associated with deployment activities as a result of implementation of the Preferred Alternative include increased GHG emissions. GHG emissions would arise from the combustion of fuel used by equipment during construction and changes in land use. Emissions occurring as a result of soil disturbance and loss of vegetation are expected to be less than significant at the programmatic level due to the limited and localized nature of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Climate Change Impacts on FirstNet Infrastructure or Operations

Climate change effects on the Preferred Alternative could be potentially significant to less than significant at the programmatic level with BMPs and mitigation measures incorporated because climate change may potentially impact FirstNet installations or infrastructure during periods of extreme heat, severe storms, and other weather events. FirstNet installations should be evaluated in the design and planning phase through tiering to this analysis, in the context of their local geography and anticipated climate hazards to ensure they are properly hardened or there is sufficient redundancy to continue operations in a climate-affected environment. Mitigation measures could minimize or reduce the severity or magnitude of a potential impact resulting to the project, including adaptation, which refers to anticipating adverse effects of climate change and taking appropriate action to prevent and minimize the damage climate change effects could cause.

13.2.14.5. Alternatives Impact Assessment

The following section assesses potential impacts to climate associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration.

Deployment Impacts

As explained above, implementation of deployable technologies could involve use of fossil-fuel-powered vehicles, powered generators, and/or aerial platforms. There could be some emissions and soil and vegetation loss as a result of excavation and grading for staging and/or landing areas depending on the type of technology. GHG emissions are expected to be less than significant at the programmatic level based on the defined significance criteria, since activities would be temporary and short-term. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operations Impacts

Implementing land-based deployable technologies (COW, COLT, SOW) could result in emissions from mobile equipment on heavy trucks using internal combustion engines associated with the vehicles and onboard generators. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may have

a cumulative impact, although this impact is expected to be less than significant due to the temporary nature of the operation of deployable infrastructure. Some staging or landing areas (depending on the type of technology) may require excavation, site preparation, and paving. Heavy equipment used for these activities could produce emissions as a result of burning fossil fuels in internal combustion engines. The operation of aerial technology is anticipated to generate pollutants during all phases of flight, except for balloons. These activities are expected to be less than significant at the programmatic level due the limited duration of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Climate Change Impacts on FirstNet Deployable Infrastructure or Operations

Climate change effects have the most noticeable impacts over a long period. Climate change effects such as temperature, precipitation changes, and extreme weather during operations would be expected but could have little to no impact on the deployed technology at the programmatic level due to the temporary nature of deployment. However, if these technologies are deployed continuously (at the required location) for an extended period, climate change effects on deployables could be similar to the Proposed Action, as explained above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure, or satellites and other technologies. As a result, there would be no impacts to GHG emissions or climate as a result of deployment and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.14, Climate Change.

13.2.15. Human Health and Safety

13.2.15.1. Introduction

This section describes potential impacts to human health and safety in South Carolina associated with deployment of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.15.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on human health and safety were evaluated using the significance criteria presented in Table 13.2.15-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to human health and safety addressed in this section are presented as a range of possible impacts.

Table 13.2.15-1: Impact Significance Rating Criteria for Human Health and Safety

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with Mitigation Incorporated**	**Less than Significant**	**No Impact**
Exposure to Worksite Occupational Hazards as a Result of Activities at Existing or New FirstNet Sites	Magnitude or Intensity	Exposure to concentrations of chemicals above occupational regulatory limits and time weighted averages. A net increase in the amount of hazardous or toxic materials or wastes generated, handled, stored, used, or disposed of, resulting in unacceptable risk, exceedance of available waste disposal capacity and probable regulatory violations. Exposure to recognized workplace safety hazards (physical and chemical). Violations of various regulations including: OSHA, RCRA, CERCLA, TSCA, EPCRA.	Effect is potentially significant, but with mitigation is less than significant.	No exposure to chemicals above health-protective screening levels. Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks. No exposure to unsafe working conditions or other workplace safety hazards.	No exposure to chemicals, unsafe working conditions, or other workplace safety hazards.
	Geographic Extent	Regional impacts observed (“regional” assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory).		Impacts only at a local/neighborhood level.	NA
	Duration or Frequency	Occasional frequency during the life of the project.		Rare event.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with Mitigation Incorporated**	**Less than Significant**	**No Impact**
Exposure to Hazardous Materials, Hazardous Waste, and Mine Lands as a Result of FirstNet Site Selection and Site-Specific Land Disturbance Activities	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the public. A net increase in the amount of hazardous or toxic materials or wastes generated, handled, stored, used, or disposed of, resulting in unacceptable risk, exceedance of available waste disposal capacity and probable regulatory violations. Site contamination conditions could preclude development of sites for the proposed use. Violations of various regulations including OSHA, RCRA, CERCLA, TSCA, EPCRA. Unstable ground and seismic shifting.	Effect is potentially significant, but with mitigation is less than significant.	No exposure to chemicals above health-protective screening levels. Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks. No exposure to unstable ground conditions or other workplace safety hazards.	No exposure to chemicals, unstable ground conditions, or other workplace safety hazards.
	Geographic Extent	Regional impacts observed (“regional” assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory).		Impacts only at a local/neighborhood level.	NA
	Duration or Frequency	Occasional frequency during the life of the project.		Rare event.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with Mitigation Incorporated**	**Less than Significant**	**No Impact**
Exposure to Hazardous Materials, Hazardous Waste, and Occupational Hazards as a Result of Natural And Manmade Disasters	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the public. Site contamination conditions could preclude development of sites for the proposed use. Physical and biologic hazards. Loss of medical, travel, and utility infrastructure.	Effect is potentially significant, but with mitigation is less than significant.	No exposure to chemicals above health-protective screening levels. Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks. No exposure to unsafe conditions. No loss of medical, travel, or utility infrastructure.	No exposure to chemicals, unsafe conditions, or other safety and exposure hazards.
	Geographic Extent	Regional impacts observed (“regional” assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory).		Impacts only at a local/neighborhood level.	NA
	Duration or Frequency	Occasional frequency during the life of the project.		Rare event.	NA

NA = Not Applicable

13.2.15.3. Description of Environmental Concerns

Worksite Physical Hazards, Hazardous Materials, and Hazardous Waste

The human health and safety concern having the greatest likelihood to occur during FirstNet deployment activities is occupational injury to telecommunication workers. The nature of telecommunication work requires workers to execute job responsibilities that could sometimes be hazardous. Telecommunication work activities present physical and chemical hazards to workers. The physical hazards have the potential to cause acute injury, long-term disabilities, or in the most extreme incidents, death. Other occupational activities such as handling hazardous materials and hazardous waste often do not result in acute injuries, but may compound over multiple exposures, resulting in increased morbidity. Based on the impact significance criteria presented in Table 13.2.15-1, occupational injury impacts could be potentially significant if the FirstNet deployment locations require performing occupational activities that have the highest relative potential for physical injury and/or chemical exposure. Examples of activities that may present increased risk and higher potential for injury include working from heights (i.e., from towers and roof tops), ground-disturbing activities like trenching and excavating, confined space entry, operating heavy equipment, and the direct handling of hazardous materials and hazardous waste. Predominately, these hazards are limited to occupational workers, but may impact the public if there are trespassers or if any physical of chemical hazard extends beyond the restricted access of FirstNet work sites.

To protect occupational workers, OSHA mandates that employers be required to protect their employees from occupational hazards that could result in injury. Depending on the source of the hazard and the site-specific work conditions, OSHA generally recommends the following hierarchy for protecting onsite workers (OSHA, 2015c).

- Engineering controls;
- Work practice controls;
- Administrative controls; and
- Personal protective equipment (PPE).

Engineering controls are often physical barriers that prevent access to a worksite, areas of a worksite, or from idle and operating equipment. Physical barriers take many forms like perimeter fences, trench boxes,[151] chain locks, bollards, storage containers (for storing equipment and chemicals), or signage and caution tape. Other forms of engineering controls could include machinery designed to manipulate the quality of the work environment, such as ventilation blowers. Whenever practical, engineering controls may result in the complete removal of the hazard from the work site, an example of which would be the transport and offsite disposal of hazardous waste or asbestos containing materials.

[151] Trench boxes are framed metal structures inserted into open trenches to support trench faces, to protect workers from cave-ins and similar incidents (OSHA, 2016d).

Work practice controls could be implemented as abiding by specific OSHA industry standards, such as the Confined Space Entry standard (29 CFR 1910.146) or thru the development of employer specific workplace rules and operational practices (OSHA, 2015c). To the extent practicable, FirstNet contractors would likely implement and abide by work practice controls through employee safety training and by developing site-specific health and safety plans (HASP). The HASPs would identify all potential hazardous materials and hazardous wastes, potential physical hazards, and applicable mitigation steps. Other components of a HASP identifying appropriate PPE for each task and the location of nearby medical facilities. Safety Data Sheets describing the physical and chemical properties of hazardous materials used during FirstNet deployment and maintenance activities, as well as the physical and health hazards, routes of exposure, and precautions for safe handling and use would be kept and maintained at all FirstNet project sites. In addition to HASPs and safety data sheets, SOPs would be developed and implemented by FirstNet partner(s) for critical and/or repetitive tasks that require attention to detail, specialized knowledge, or clear step-wise directions to prevent worker injury and to ensure proper execution.

Administrative controls are employer-initiated methods to reduce the potential for injury and physical fatigue (OSHA, 2015c). Administrative controls may take the form of limiting the number of hours an employee is allowed to work per day, requiring daily safety meetings before starting work, utilizing the buddy system for dangerous tasks and any other similar activity or process that is designed to identify and mitigate unnecessary exposure to hazards. When engineering controls, work practice controls, and administrative controls are not feasible or do not provide sufficient protection, employers must also provide appropriate PPE to their employees and ensure its proper use. PPE is the common term used to refer to the equipment worn by employees to minimize exposure to chemical and physical hazards. Examples of PPE include gloves, protective footwear, eye protection, protective hearing devices (earplugs, muffs), hard hats, fall protection, respirators, and full body suits. PPE is the last line of defense to prevent occupational injuries and exposure. (OSHA, 2015c)

South Carolina's Occupational Safety and Health Plan (SCOSH) is an OSHA-approved "State Plan," which has jurisdiction over all private and public sector employees, except federal employees (OSHA, 2015a). Therefore, SCOSH has regulatory authority and enforcement for occupational safety relating to FirstNet site work to the leadership and interpretation of OSHA.

Hazardous Materials, Hazardous Waste, and Mine Lands

The presence of environmental contamination and mine lands at FirstNet deployment sites has the potential to negatively impact health and safety of workers and the general public. Though as of May 2015, there were no high priority AMLs (sites posing health and safety hazards) in South Carolina (DOI, 2015). Past or present contaminated media, such as soil and groundwater, may be present and become disturbed as a result of site activities. Mines may cause unstable surface and subsurface conditions because of underground shaft collapses or seismic shifting. Based on the impact significance criteria presented in Table 13.2.15-1, human health impacts could be significant if FirstNet deployment sites are near contaminated properties or abandoned or active mine lands. Prior to the start of any FirstNet deployment project, potential site

locations should be screened for known environmental contamination and/or mining activities using federal resources such as the USEPA CIMC database and U.S. Department of Interior's Abandoned Mine Lands inventory, or through an equivalent commercial resource.

By screening sites for environmental contamination, mining activities, and reported environmental liabilities, the presence of historic contamination and unsafe ground conditions could be evaluated and may influence the site selection process. In general, the lower the density of environmental contamination or mining activities, the more favorable the site will be for FirstNet deployment projects. If sites containing known environmental contamination (or mine lands) are selected for proposed FirstNet deployment activities it may be necessary to implement additional controls (e.g., engineering, work practice, administrative, and/or PPE) to ensure workers, and the general public, are not unnecessarily exposed to the associated hazards. Additionally, for any proposed FirstNet deployment site, it is possible undocumented environmental contamination is present.

During proposed FirstNet deployment activities, if any soil or groundwater is stained or emitting an unnatural odor, it may be an indication of environmental contamination. When such instances are encountered, it may be necessary to stop work until the anomaly is further assessed through record reviews or environmental sampling. Proposed FirstNet deployment would attempt to avoid known contaminated sites. However, in the event that FirstNet is unable to avoid a contaminated site, then site analysis and remediation would be required under RCRA, CERCLA, and applicable state laws in order to protect workers and the public from direct exposure or fugitive contamination.

Exposure assessments identify relevant site characteristics, temporal exposure parameters, and toxicity data to determine the likelihood of adverse health effects. More formally known as a human health risk assessment (HHRA), these studies provide mathematical justification for implementing controls at the site to protect human health. If the HHRA determines the potential for adverse health effects is too great, SCOSH may require FirstNet to perform environmental clean-up actions at the site to lower the existing levels of contamination. HHRAs help determine which level of PPE (i.e., Level D, Level C, Level B, or Level A) is necessary for a work activity. HHRAs take into account all exposure pathways: absorption, ingestion, inhalation, and injection. Therefore, specific protective measures (e.g., controls and PPE) that disrupt the exposure pathways could be identified, prioritized, and implemented.

Natural and Manmade Disasters

The impacts of natural and manmade disasters are likely to present unique health and safety hazards, as well as exacerbate pre-existing hazards, such as degrading occupational work conditions and disturbing existing environmental contamination. The unique hazards presented by natural and manmade disasters may include, fire, weather incidents (e.g., floods, tornadoes, hurricanes, etc.), earthquakes, vandalism, large- or small-scale chemical releases, utility disruption, community evacuations, or any other event that abruptly and drastically denudes the availability or quality of transportation infrastructure, utility infrastructure, medical infrastructure, and sanitation infrastructure. Additionally, such natural and manmade disasters

could directly impact public safety communication infrastructure assets through damage or destruction.

Based on the impact significance criteria presented in Table 13.2.15-1, human health impacts could be significant if FirstNet deployment sites are located in areas that are directly impacted by natural and manmade disasters that could lead to exposure to hazardous wastes, hazardous materials, and occupational hazards. FirstNet's emphasis on public safety-grade communications infrastructure may result in a less than significant beneficial impact, as new infrastructure could be deployed with additional structural hardening, and existing infrastructure may be hardened as appropriate and feasible, in an effort to reduce the possibility of infrastructure damage or destruction to some degree.

Potential mitigation measures for natural disasters is to be aware of current weather forecasts, seismic activities, and other newsworthy events that may indicate upcoming disaster conditions. Awareness provides time and opportunity to plan evacuation routes, to relocate critical equipment and parts, and to schedule appropriate work activities preceding and after the natural disaster. These mitigation steps reduce the presence of workers and dangerous work activities to reduce the potential for injury or death. Manmade disasters could be more difficult to anticipate due to the unexpected or accidental nature of the disaster. Though some manmade disasters are due to malicious intentions, many manmade disasters result from human error or equipment failure. The incidence of manmade disasters affecting FirstNet deployment sites would be difficult to predict and diminish because the source of such disasters is most likely to originate from sources independent of FirstNet activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.15.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and maintenance activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to human health and safety and others would not. In addition, and as explained in this section, the same type of proposed action infrastructure could result in a range of no impacts to less than significant with mitigation, depending on the deployment scenario or site-specific activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to human health and safety under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: the pulling or blowing of fiber optic cable would be performed through existing conduit. Use of mechanical equipment would be limited to pulley systems and blowers. Some locations with no existing power supply may require the use of electrical generators. Hazardous materials needed for this work would include fiber optical cable lubricants, mechanical oil/grease, and fuel for electrical generators although these materials are expected to be used infrequently and in small quantities. These activities are not likely to result in serious injury or chemical exposure, or surface disturbances since work would be limited to existing entry and exit points, would be temporary, and intermittent. It is anticipated that there would be no impacts to human health and safety.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts on human health and safety because there would be no ground disturbance or heavy equipment used.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact human health and safety resources, it is anticipated that this activity would have no impact on those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to human health and safety as a result of implementation of the Preferred Alternative would encompass a range of impacts that occur as a result of ground disturbance activities, construction activities, equipment upgrade activities, management of hazardous materials and/or hazardous waste, and site selection. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to human health and safety include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber would require the use of heavy equipment and hazardous materials. The additional noise and activity at the site would require workers to demonstrate a high level of situational awareness. Failure to follow OSHA and industry controls could result in injuries. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or

releases that could impact the general public in the immediate vicinity. Additionally, some of this work would likely be performed along road ROWs, increasing the potential for vehicle traffic to collide with site workers or equipment. If a proposed deployment activity involves the operation of heavy equipment, managing hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.

- New Build – Aerial Fiber Optic Plant: Installation of new poles and fiber optic lines could require excavation activities, working from heights, use of hazardous materials, and site locations in ROWs. Hazards associated with the site work include injury from heavy equipment, fall hazards, chemical hazards, and the potential for vehicle traffic to collide with site workers or equipment. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- Collocation on Existing Aerial Fiber Optic Plant: Installation of overhead fiber optic lines would require work from height. In some instances, new poles would be installed requiring excavation activities with heavy equipment. Hazards associated with the site work include injury from heavy equipment, fall hazards, chemical hazards, and the potential for vehicle traffic to collide with site workers or equipment. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- New Build – Submarine Fiber Optic Plant: The installation of fiber optic cables in limited nearshore and inland bodies of water requires workers to operate over aquatic and/or marine environments, which presents opportunities for drowning. When working over water exposure to sun, high or low temperatures, wind, and moisture could impact worker safety. Construction of landings and/or facilities on shore to accept submarine cable would require site preparation, construction, and management of hazardous materials and hazardous waste. Excavation of soils or sediments at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment would require site preparation, construction activities, and management of hazardous materials and hazardous waste. Excavation of soils at

proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads would require site preparation, construction activities, and management of hazardous materials and hazardous waste. Communication towers would be erected, requiring workers to perform their duties from heights sufficient to result in serious injury or death in the event of falling. Working from heights may also result in additional overhead hazards and falling objects. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider. For a discussion of radio frequency emissions and potential impacts, refer to Section 2.4, Radio Frequency Emissions.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. This would require workers to perform their duties from heights sufficient to result in serious injury or death in the event of falling not result in impacts to soils. Working from heights may also result in additional overhead hazards and falling objects. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider. For a discussion of radio frequency emissions and potential impacts, refer to Section 2.4, Radio Frequency Emissions.
- Deployable Technologies
  - The use of deployable technologies could result in soil disturbance if land-based deployables are deployed on unpaved areas or if the implementation results in paving of previously unpaved surfaces. The use of heavy machinery presents the possibility for spills and soil and water contamination, and noise emissions could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Set-up of a cellular base station contained in a trailer with a large expandable antenna mast is not expected to result in impacts to human health and safety. However, due to the larger size of the deployable technology, site

preparation or trailer stabilization may be required to ensure the self-contained unit is situated safely at the site. Additionally, the presence of a dedicated electrical generator would produce fumes and noise. The possibility of site work and the operation of a dedicated electrical generator have the potential for impacts to human health and safety. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions. Use of aerial vehicles would not involve telecommunication site work. Prior to deployment and when not in use, the aerial vehicles would likely require preventive maintenance. Workers responsible for these activities may handle hazardous materials, not limited to fuel, solvents, and adhesives.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The use of portable devices that utilize satellite technology would not impact human health and safety because there is no construction activities or use of hazardous materials. The installation of permanent equipment on existing structures may require workers to operate from heights or in sensitive environments. As a result, the potential for falling, overhead hazards, and falling objects is greater and there is a potential to impact human health and safety.

In general, the abovementioned FirstNet activities could potentially involve site preparation work, construction activities, work in potentially harmful environments (road ROWs, work over water, and environmental contamination), management of hazardous materials and hazardous waste, and weather exposure. Potential impacts to human health and safety associated with deployment of the Proposed Project could include injury from site preparation and operating heavy equipment, construction activities, falling/overhead hazards/falling objects, exposure and release of hazardous chemicals, and hazardous waste. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise exposure, and risk of infectious disease transmission would be less than significant at the programmatic level due to the small scale of likely FirstNet activities that would be temporary and of short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there would be less than significant impacts to human health and safety associated with routine inspections of the Preferred Alternative. Use of PPE or other mitigation measures could be necessary to adequately protect workers. If usage of heavy equipment is part of routine maintenance, the potential for impacts to human health and safety would also increase. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and

injuries, noise exposure, and risk of infectious disease transmission would be less than significant at the programmatic level due to the small-scale of likely FirstNet activities that would be temporary and of short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

13.2.15.5. Alternatives Impact Assessment

The following section assesses potential impacts to human health and safety associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable land-based infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to human health and safety as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to human health and safety. The largest of the land-based deployable technologies may require site preparation work or stabilization work to ensure the self-contained trailers are stable. Heavy equipment may be necessary to complete the site preparation work. However, in general, the deployable technologies are small mobile units that could be transported as needed. While in operation, the units are parked and operate off electrical generators or existing electrical power sources. Connecting deployable technology to a power supply may present increased electrocution risk during the process of connecting power. If the power source were an electrical generator, then there would also likely be a need to manage fuel onsite. These activities could result in less than significant impacts to human health and safety at the programmatic level. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise exposure, and risk of infectious disease transmission would be less than significant at the programmatic level due to the small scale of likely FirstNet activities that would be temporary and of short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no impacts to human health and safety at the programmatic level associated with routine inspections. Use of PPE or other mitigation measures may be necessary to adequately protect workers. If usage of heavy equipment is part of routine maintenance, the potential for impacts to human health and safety would also increase. These impacts would be less than significant at the programmatic level because of the small-scale of likely FirstNet activities; activities associated would routine maintenance, inspection, and deployment of deployable technologies would be temporary and often of limited duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to human health and safety as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 13.1.15, Human Health and Safety.

SC APPENDIX A – COMMUNITIES OF CONCERN

Table A-1.1 SCDNR S1 Ranked Terrestrial Communities of Concern in South Carolina

Vegetative Community Type	USEPA Ecoregion(s)	Description
Beech Magnolia hammock	Southern Coastal Plain	Shady forests which usually have calcareous soils and are dominated by a number of hardwood species Pignut hickory (*Carya glabra*), Red hickory (*Carya ovalis*), Laurel oak (*Quercus laurifolia*), American holly (*Ilex opaca*), Sweetgum (*Liquidambar styraciflua),* Spruce pine (*Pinus glabra*), Beech (*Fagus grandifolia*), and Southern magnolia (*Magnolia grandiflora*).
Hillside herb bog	Southern Coastal Plain	Seasonally or permanently saturated wetlands on sandhills slopes dominated by many herbaceous species, including grasses, insectivorous plants and orchids including Moss (*Sphagnum* spp.), Sundew (*Drosera* spp.), Rose pogonia (*Pogonia ophioglossoides*), Ladies' tresses (*Spiranthes* spp.), Sweet pitcherplant (*Sarracenia rubra),* Beak rush (*Rhynchospora* spp.), Umbrella sedge (*Fimbristylis* spp.), Toothache grass (*Ctenium aromaticum),* and Whip nut-rush (*Scleria triglomerata).*
Interdune pond	Southern Coastal Plain	Freshwater ponds or swales that form between beach dunes and ridges. Although a freshwater community, the salinity of these wetlands can vary with tidal connection.
Marl forest	Southern Coastal Plain	Forested area over buried or exposed marl
Piedmont seepage forest	Piedmont	Continually saturated forest on flat areas with closed canopy. Seepage of ground water tends to keep these wetlands saturated year round. Characteristics species include Poison sumac (*Toxicodendron vernix*), Swamp haw (*Viburnum cassinoides*), Stiff dogwood (*Cornus foemina*), Red maple (*Acer rubrum*), and Swamp tupelo (*Nyssa biflora*)
Seepage pocosin	Southeastern Plain	Seasonally or permanently saturated slopes on sandhills with hard clay lens below peaty/sandy soil. Water percolating downhill is forced to the surface where hardpan rises relative to the soil surface.
Southern mixed hardwood forest	Southern Coastal Plain	Forested lowlands with fairly deep well-drained loamy sands. Includes a well-developed canopy of many hardwoods exists including *Quercus hemisphaerica*, *Q. virginiana*, *Carya* spp., *Ilex opaca* and *Liquidambar styraciflua*. Community also includes Spruce and loblolly pines are also characteristic. Very diverse group of subcanopy and understory species.
Upland depression swamp forest	Piedmont	Consists of poorly drained upland flats over basic soil with a high diversity of herbaceous flora.

Sources: (Griffith, et al., 2002) (USEPA, 2013b) (Nelson, 1986)

Table A-1.2: Essential Fish Habitat for Mid-Atlantic Species of South Carolina

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Atlantic butterfish	Pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and on the continental shelf and slope, primarily from Georges Bank to Cape Hatteras, North Carolina.	Pelagic habitats in inshore estuaries and embayments in Boston harbor, from the south shore of Cape Cod to the Hudson River, and in Delaware and Chesapeake bays, and on the continental shelf from the Great South Channel (western Georges Bank) to Cape Hatteras, North Carolina.	Pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, in inshore waters of the Gulf of Maine and the South Atlantic Bight, and on the inner and outer continental shelf from southern New England to South Carolina.	Pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, inshore waters of the Gulf of Maine and the South Atlantic Bight, on Georges Bank, on the inner continental shelf south of Delaware Bay, and on the outer continental shelf from southern New England to South Carolina.
Atlantic Sharpnose Shark (highly migratory)	No EFH egg life stage.	Gulf of Mexico coastal areas from Texas through the Florida Keys. In the Atlantic from the mid-coast of Florida to Cape Hatteras.	Gulf of Mexico coastal areas from Texas through the Florida Keys. In the Atlantic from the mid-coast of Florida to Cape Hatteras, and a localized area off of Delaware.	Gulf of Mexico from Texas through the Florida Keys out to a depth of 200 meters. In the Atlantic from the mid-coast of Florida to Maryland.
Bigeye Thresher Shark (highly migratory)	No EFH egg life stage.	Offshore along the central Gulf of Mexico and off Key West, Florida. Offshore along the Atlantic east coast from southern to the mid-Florida coast, and from Georgia to southern New England.	Offshore along the central Gulf of Mexico and off Key West, Florida. Offshore along the Atlantic east coast from southern to the mid-Florida coast, and from Georgia to southern New England.	Offshore along the central Gulf of Mexico and off Key West, Florida. Offshore along the Atlantic east coast from southern to the mid-Florida coast, and from Georgia to southern New England.

[152] YOY (Young of the year): "All of the fish of a species that were born in the past year, from transformation to juvenile until January 1." (USEPA, 2015d)

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Bigeye Tuna (highly migratory)	No EFH defined	No EFH defined	Offshore in the Gulf of Mexico south of Louisiana and Mississippi, off the southern west coast of Florida and south of the Florida Keys; as well as in the Atlantic off the Florida east coast through South Carolina, and from North Carolina, south of Cape Hatteras, to Cape Cod.	Offshore in the central Gulf of Mexico and the mid-east coast of Florida. Atlantic east coast from Cape Hatteras to Cape Cod.
Bignose Shark (highly migratory)	No EFH egg life stage.	No EFH defined	Localized offshore areas from Louisiana through the west coast Florida to the Florida Keys in the Gulf of Mexico, and the east coast of Florida and South Carolina in the Atlantic. Continuous offshore EFH from North Carolina to New Jersey.	Localized offshore areas from Louisiana through the west coast Florida to the Florida Keys in the Gulf of Mexico, and the east coast of Florida and South Carolina in the Atlantic. Continuous offshore EFH from North Carolina to New Jersey.
Blacknose Shark (highly migratory)	No EFH egg life stage.	In the Gulf of Mexico coastal areas from the Florida Panhandle and west coast of Florida. In Atlantic coastal areas from Georgia to southern North Carolina.	Localized areas off Texas and western Louisiana, and coastal areas from Mississippi through the Florida Keys in the Gulf of Mexico. Atlantic east coast from the mid-coast of Florida to Cape Hatteras.	Localized areas off Texas and central Louisiana, and coastal areas from eastern Louisiana through the Florida Keys in the Gulf of Mexico Atlantic east coast from the mid-coast of Florida to Cape Hatteras.
Blacktip Shark (highly migratory)	No EFH egg life stage.	Coastal areas in the Gulf of Mexico from Texas through the Florida Keys. In Atlantic coastal areas from northern Florida through Georgia, and the mid-coast of South Carolina.	Coastal areas in the Gulf of Mexico from Texas through the Florida Keys. In Atlantic coastal areas localized off of the southeast Florida coast and from West Palm Beach, Florida to Cape Hatteras.	Coastal areas in the Gulf of Mexico from Texas through the Florida Keys. In Atlantic coastal areas southeast Florida to Cape Hatteras.
Blue Marlin (highly migratory)	No EFH in South Carolina.	No EFH in South Carolina.	In the central Gulf of Mexico from southern Texas to the Florida Panhandle through the Florida Keys to southern Cape Cod.	In the central Gulf of Mexico, from southern Texas to the Florida Panhandle, through the Florida Keys to southern Cape Cod.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Blue Shark (highly migratory)	No EFH egg life stage.	No EFH in South Carolina.	Localized areas in the Atlantic off the mid-east coast of Florida, South Carolina, and the Gulf of Maine, and from Cape Hatteras to New England.	Localized areas in the Atlantic off Florida and Georgia, and from South Carolina to the Gulf of Maine.
Bluefish	Offshore, the pelagic waters over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream), at mid-shelf depths.	Offshore, the pelagic waters greater than 45 feet over the Continental Shelf, and the "slope sea" and Gulf Stream between latitudes 29º 00 N and 40º 00 N.	Offshore, the pelagic waters over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream), and the "slope sea" and Gulf Stream between latitudes 29 00 N and 40 00 N. Inshore, EFH includes all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida.	Offshore, the pelagic waters over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream). Inshore, EFH includes all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida.
Bonnethead Shark (highly migratory)	No EFH egg life stage.	Coastal areas in the Gulf of Mexico along Texas, and from eastern Mississippi through the Florida Keys. Atlantic east coast from the midcoast of Florida to South Carolina.	Coastal areas in the Gulf of Mexico along Texas, and from eastern Mississippi through the Florida Keys. Atlantic east coast from the midcoast of Florida to South Carolina.	Coastal areas in the Gulf of Mexico along Texas, and from eastern Mississippi through the Florida Keys. Atlantic east coast from the mid-coast of Florida to Cape Lookout.
Bull Shark (highly Migratory)	No EFH egg life stage.	No EFH designated in South Carolina.	Gulf of Mexico coastal areas along the Texas coast, eastern Louisiana to the Florida Panhandle, and the west coast of Florida through the Florida Keys. Atlantic coastal areas localized from the mid-east coast of Florida to South Carolina.	Gulf of Mexico along the southern and mid-coast of Texas to western Louisiana, eastern Louisiana to the Florida Keys. East coast of Florida to South Carolina in the Atlantic.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Common Thresher Shark (highly migratory)	No EFH egg life stage.	Localized areas in the central Gulf of Mexico and Florida Keys. In the Atlantic, localized areas off the mid-east coast of Florida, Georgia, South Carolina, and the Gulf of Maine, and from North Carolina through Cape Cod.	Localized areas in the central Gulf of Mexico and Florida Keys. In the Atlantic, localized areas off the mid-east coast of Florida, Georgia, South Carolina, and the Gulf of Maine, and from North Carolina through Cape Cod.	Localized areas in the central Gulf of Mexico and Florida Keys. In the Atlantic, localized areas off the mid-east coast of Florida, Georgia, South Carolina, and the Gulf of Maine, and from North Carolina through Cape Cod.
Dusky Shark (highly migratory)	No EFH egg life stage.	Areas along the Atlantic east coast of Florida to the mid-coast of Georgia, South Carolina to southern Cape Cod.	Localized areas in the central Gulf of Mexico, southern Texas, the Florida Panhandle, mid-west coast of Florida, and Florida Keys. Atlantic east coast of Florida and South Carolina to southern Cape Cod.	Localized areas in the central Gulf of Mexico, southern Texas, the Florida Panhandle, mid-west coast of Florida, and Florida Keys. Atlantic east coast of Florida and South Carolina to southern Cape Cod.
Finetooth Shark (highly migratory)	No EFH egg life stage.	Along the Gulf of Mexico coast of Texas, eastern Louisiana, Mississippi, Alabama, and the Florida Panhandle. Atlantic east coast along Georgia and South Carolina.	Localized coastal areas along southern Texas and Key West, Florida, and from eastern Louisiana through the Florida Panhandle in the Gulf of Mexico. Atlantic east coast from the mid-coast of Florida to Cape Hatteras.	Localized coastal areas along southern Texas and Key West, Florida, and from eastern Louisiana through the Florida Panhandle in the Gulf of Mexico. Atlantic east coast from the mid-coast of Florida to Cape Hatteras.
Great Hammerhead Shark (highly migratory)	No EFH egg life stage.	Coastal areas throughout the west coast of Florida and scattered in the Gulf of Mexico from Alabama to Texas. Atlantic east coast from the Florida Keys to New Jersey.	Coastal areas throughout the west coast of Florida and scattered in the Gulf of Mexico from Alabama to Texas. Atlantic east coast from the Florida Keys to New Jersey.	Coastal areas throughout the west coast of Florida and scattered in the Gulf of Mexico from Alabama to Texas. Atlantic east coast from the Florida Keys to New Jersey.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Longbill Spearfish (highly migratory).	No EFH designated.	No EFH designated.	In the central Gulf of Mexico through eastern Louisiana to the Florida Panhandle. In the Atlantic from Florida Keys to the mid-east coast of Florida and localized areas from northern Florida to Cape Cod, with concentrations from North Carolina to Delaware.	Same as juvenile EFH.
Longfin Inshore Squid	Inshore and offshore bottom habitats from Georges Bank southward to Cape Hatteras, include a variety of hard bottom types, submerged aquatic vegetation (e.g., *Fucus* sp.), sand, and mud.	See Juvenile EFH for pre-recruitment EFH.	Pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in the southwestern Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, and Raritan Bay.	Pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in inshore waters of the Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, Raritan Bay, and Delaware Bay.
Longfin Mako Shark (highly migratory)	No EFH egg life stage.	Offshore central Gulf of Mexico through the Florida Keys. In the Atlantic from southern Florida through South Carolina, off North Carolina, and Cape Hatteras to Cape Cod.	Offshore central Gulf of Mexico through the Florida Keys. In the Atlantic from southern Florida through South Carolina, off North Carolina, and Cape Hatteras to Cape Cod.	Offshore central Gulf of Mexico through the Florida Keys. In the Atlantic from southern Florida through South Carolina, off North Carolina, and Cape Hatteras to Cape Cod.
Night Shark (highly migratory)	No EFH egg life stage.	Offshore in the Gulf of Mexico off Texas, Louisiana, and the Florida Panhandle to the Florida Keys. Southern and mid-east coast of Florida and South Carolina to Delaware in the Atlantic.	Offshore in the Gulf of Mexico off Texas, Louisiana, and the Florida Panhandle to the Florida Keys. Southern and mid-east coast of Florida and South Carolina to Delaware in the Atlantic.	Offshore in the Gulf of Mexico off Texas, Louisiana, and the Florida Panhandle to the Florida Keys. Southern and mid-east coast of Florida and South Carolina to Delaware in the Atlantic.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Northern Shortfin Squid	Pelagic habitats along the outer continental shelf and slope within the latitudinal range of 40°N to 35°50 N.	See Juvenile EFH for pre-recruitment EFH.	Pelagic habitats along the outer continental shelf and slope as far south as South Carolina, on Georges Bank, and on the inner continental shelf off New Jersey and southern Maine and New Hampshire.	Pelagic habitats on the continental shelf and slope from Georges Bank to South Carolina, and in inshore and offshore waters of the Gulf of Maine.
Oceanic Whitetip Shark (highly migratory)	No EFH egg life stage.	Offshore at localized areas in the central Gulf of Mexico and Florida Keys. Offshore in the Atlantic in depths greater than 200 meters from Florida to southern New England.	Offshore at localized areas in the central Gulf of Mexico and Florida Keys. Offshore in the Atlantic in depths greater than 200 meters from Florida to southern New England.	Offshore at localized areas in the central Gulf of Mexico and Florida Keys. Offshore in the Atlantic in depths greater than 200 meters from Florida to southern New England.
Roundscale Spearfish (highly migratory, similar to white marlin)	No EFH designated.	No EFH designated.	Offshore in the central Gulf of Mexico from southern Texas to the Florida Panhandle. Florida Keys to mid-east coast of Florida, and Georgia to Cape Cod.	Offshore in the central Gulf of Mexico from southern Texas to the Florida Panhandle. Florida Keys to the mid-east coast of Florida, and South Carolina to Cape Cod.
Sailfish (highly migratory)	No EFH defined for South Carolina.	No EFH defined for South Carolina.	In the central Gulf of Mexico, and off southern Texas, Louisiana, and the Florida Panhandle. Atlantic east coast from the Florida Keys to mid-coast of South Carolina, the Outer Banks of North Carolina, and Maryland.	In the central Gulf of Mexico, and off southern Texas, Louisiana, and the Florida Panhandle. Atlantic east coast from the Florida Keys to mid-coast of South Carolina, the Outer Banks of North Carolina, and Maryland.
Sand Tiger Shark (highly migratory)	No EFH egg life stage.	Along the Atlantic east coast from northern Florida to Cape Cod.	Localized areas along the mid-east coast of Florida and South Carolina and from North Carolina to mid-New Jersey coast in the Atlantic.	Localized areas along the mid and northern east coast of Florida, South Carolina, and southern North Carolina, and from Cape Lookout to southern New Jersey in the Atlantic.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Sandbar Shark (highly migratory)	No EFH egg life stage.	Localized coastal area on the Florida Panhandle. Atlantic coastal areas localized along Georgia and South Carolina, and from Cape Lookout to Long Island, New York.	Localized areas along the Atlantic coast of Florida, South Carolina, and southern North Carolina, and from Cape Lookout to southern New England.	Localized area off of Alabama, and coastal areas from the Florida Panhandle to the Florida Keys in the Gulf of Mexico. Atlantic coastal areas throughout Florida to southern New England.
Scalloped Hammerhead Shark (highly migratory)	No EFH egg life stage.	Coastal areas in the Gulf of Mexico from Texas to the southern west coast of Florida. Atlantic east coast from the mid-east coast of Florida to southern North Carolina.	Coastal areas in the Gulf of Mexico from the southern to mid-coast of Texas, eastern Louisiana to the southern west coast of Florida, and the Florida Keys. Offshore from the mid-coast of Texas to eastern Louisiana. Atlantic east coast of Florida through New Jersey.	Coastal areas in the Gulf of Mexico along the southern Texas coast, and eastern Louisiana through the Florida Keys. Offshore from southern Texas to eastern Louisiana.
Shortfin Mako Shark (highly migratory)	No EFH egg life stage.	Localized areas in the central Gulf of Mexico and the Florida Keys. In the Atlantic, localized areas off of Florida, South Carolina, and Maine, and from Cape Lookout though southern New England.	Localized areas in the central Gulf of Mexico and the Florida Keys. In the Atlantic, localized areas off of Florida, South Carolina, and Maine, and from Cape Lookout though southern New England.	Localized areas in the central Gulf of Mexico and the Florida Keys. In the Atlantic, localized areas off of Florida, South Carolina, and Maine, and from Cape Lookout though southern New England.
Silky Shark (highly migratory)	No EFH egg life stage.	In the Gulf of Mexico from the southern coast of Texas across the central Gulf of Mexico and from eastern Louisiana to the Florida Keys. Atlantic east coast from Florida to New Jersey, with localized areas in southern New England.	In the Gulf of Mexico from the southern coast of Texas across the central Gulf of Mexico and from eastern Louisiana to the Florida Keys. Atlantic east coast from Florida to New Jersey, with localized areas in southern New England.	In the Gulf of Mexico from the southern coast of Texas across the central Gulf of Mexico and from eastern Louisiana to the Florida Keys. Atlantic east coast from Florida to New Jersey, with localized areas in southern New England.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Skipjack Tuna (highly migratory)	In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits (no EFH in South Carolina).	In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits (no EFH in South Carolina).	Localized areas in the central Gulf of Mexico from Louisiana through the Florida Panhandle. Localized areas in the Atlantic off of Georgia, South Carolina, and North Carolina to Maryland, and from Delaware to Cape Cod and the southern east coast of Florida through the Florida Keys.	In the central Gulf of Mexico, off of Texas through Florida. Localized areas in the Atlantic off of South Carolina and the northern east coast of Florida, and from Cape Hatteras to Cape Cod and the southern east coast of Florida through the Florida Keys.
Smooth dogfish (highly migratory)	No EFH egg life stage.	Offshore areas within the Gulf of Mexico from Texas through Florida. In the Atlantic, nearshore, and offshore areas from South Carolina north to Cape Cod and Georges Bank.	Offshore areas within the Gulf of Mexico from Texas through Florida. In the Atlantic, nearshore, and offshore areas from South Carolina north to Cape Cod and Georges Bank.	Offshore areas within the Gulf of Mexico from Texas through Florida. In the Atlantic, nearshore, and offshore areas from South Carolina north to Cape Cod and Georges Bank.
Spinner shark (highly migratory)	No EFH egg life stage.	Localized coastal areas in the Gulf of Mexico along Texas, eastern Louisiana, the Florida Panhandle, Florida west coast, and the Florida Keys; and in the Atlantic along the east coast of Florida to southern North Carolina.	Gulf of Mexico coastal areas from Texas to the Florida Panhandle, and the mid-west coast of Florida to the Florida Keys. Atlantic east coast of Florida through North Carolina.	Localized areas in the Gulf of Mexico off of southern Texas, Louisiana through the Florida Panhandle, and from the mid-coast of Florida through the Florida Keys. In the Atlantic along the east coast of Florida, and localized areas from South Carolina to Virginia.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
Summer flounder	EFH is the waters over the Continental Shelf (from the coast out to the limits of the EEZ), from Cape Hatteras, North Carolina to Cape Canaveral, Florida, to depths of 360 ft.	EFH is the nearshore waters of the Continental Shelf (from the coast out to the limits of the EEZ), from Cape Hatteras, North Carolina to Cape Canaveral Florida, in nearshore waters (out to 50 miles from shore). Inshore, EFH is all the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database, in the "mixing" (defined in ELMR as 0.5 to 25.0 ppt) and "seawater" (defined in ELMR as greater than 25 ppt) salinity zones.	EFH is the waters over the Continental Shelf (from the coast out to the limits of the EEZ) to depths of 500 ft., from Cape Hatteras, North Carolina to Cape Canaveral, Florida. Inshore, EFH is all of the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database for the "mixing" and "seawater" salinity zones.	EFH is the waters over the Continental Shelf (from the coast out to the limits of the EEZ) to depths of 500 ft., from Cape Hatteras, North Carolina to Cape Canaveral, Florida. Inshore, EFH is the estuaries where summer flounder were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the outer Continental Shelf at depths of 500 ft. in colder months.
Swordfish (highly migratory)	Offshore from off Cape Hatteras, North Carolina extending south around peninsular Florida through the Gulf of Mexico to the U.S./Mexico border from the 200 m isobath to the EEZ boundary; associated with the Loop Current boundaries in the Gulf and the western edge of the Gulf Stream in the Atlantic.	Same as EFH for species eggs.	Offshore in the central Gulf of Mexico from southern Texas through the Florida Keys and Atlantic east coast from south Florida to Cape Cod.	Offshore in the central Gulf of Mexico from southern Texas to the Florida Panhandle and western Florida Keys. Atlantic east coast from southern Florida to the mid-east coast of Florida, and Georgia to Cape Cod.
Tiger Shark (highly migratory)	No EFH egg life stage.	Off Texas, western Louisiana, and the Florida Panhandle in the Gulf of Mexico. In the Atlantic from the mid-east coast of Florida to Virginia.	In the central Gulf of Mexico and off Texas and Louisiana, and from Mississippi through the Florida Keys. Atlantic east coast from Florida to New England.	In the Gulf of Mexico, from Texas to the west coast of Florida, and the Florida Keys. Atlantic east coast from Florida to southern New England.

Mid-Atlantic Species				
Common Name	**Eggs**	**Larvae/YOY**[152]	**Juveniles**	**Adults**
White Marlin (highly migratory)	No EFH designated.	No EFH designated.	In the central Gulf of Mexico from southern Texas to the Florida Panhandle. Florida Keys to mid-east coast of Florida, and Georgia to Cape Cod.	In the central Gulf of Mexico from southern Texas to the Florida Panhandle. Florida Keys to the mid-east coast of Florida, and South Carolina to Cape Cod.
White Shark (highly migratory)	No EFH egg life stage.	Along the mid- and southern west coast of Florida in the Gulf of Mexico, and along the mid- and northern east coast of Florida, South Carolina, and North Carolina in the Atlantic. Maryland to Cape Cod.	Along the mid- and southern west coast of Florida in the Gulf of Mexico, and along the mid- and northern east coast of Florida, South Carolina, and North Carolina in the Atlantic. Maryland to Cape Cod.	Along the mid- and southern west coast of Florida in the Gulf of Mexico, and along the mid- and northern east coast of Florida, South Carolina, and North Carolina in the Atlantic. Maryland to Cape Cod.
Yellowfin Tuna (highly migratory)	In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits (no EFH in South Carolina).	In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits (no EFH in South Carolina).	In the central Gulf of Mexico from Florida Panhandle to southern Texas. Mid-east coast of Florida and Georgia to Cape Cod.	In the central Gulf of Mexico from the Florida Panhandle to southern Texas. Mid-east coast of Florida and Georgia to Cape Cod.

Source: (NOAA, 2015e)

Table A-1.3: Essential Fish Habitat for South Atlantic Species of South Carolina

South Atlantic Species	
Species	**Description of EFH**
Coastal Migratory Pelagics	EFH for coastal migratory pelagic species includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including *Sargassum*. In addition, all coastal inlets, all state-designated nursery habitats of particular importance to coastal migratory pelagics. For cobia, EFH also includes high salinity bays, estuaries, and seagrass habitat. In addition, the Gulf Stream is an EFH because it provides a mechanism to disperse coastal migratory pelagic larvae. For king and Spanish mackerel and cobia EFH occurs in the South Atlantic and Mid-Atlantic Bights.
Corals	EFH for *Antipatharia* (black corals) includes rough, hard, exposed, stable substrate, offshore in high (30-35%) salinity waters in depths exceeding 18 meters (54 feet), not restricted by light penetration on the outer shelf throughout the management area. EFH habitat for octocorals excepting the order Pennatulacea (sea pens and sea pansies) includes rough, hard, exposed, stable substrate in subtidal to outer shelf depths within a wide range of salinity and light penetration throughout the management area. EFH for Pennatulacea (sea pens and sea pansies) includes muddy, silty bottoms in subtidal to outer shelf depths within a wide range of salinity and light penetration.
Golden Crab	EFH for golden crab includes the U.S. Continental Shelf from Chesapeake Bay south through the Florida Straits (and into the Gulf of Mexico). In addition, the Gulf Stream is an EFH because it provides a mechanism to disperse golden crab larvae.
Snapper-Grouper Species	EFH for snapper-grouper species includes coral reefs, live/hard bottom, submerged aquatic vegetation, artificial reefs and medium to high profile outcroppings on and around the shelf break zone from shore to at least 600 feet (but to at least 2000 feet for wreckfish) where the annual water temperature range is sufficiently warm to maintain adult populations of members of this largely tropical complex. EFH includes the spawning area in the water column above the adult habitat and the additional pelagic environment, including *Sargassum*, required for larval survival and growth up to and including settlement. In addition the Gulf Stream is an EFH because it provides a mechanism to disperse snapper grouper larvae. For specific life stages of estuarine dependent and nearshore snapper-grouper species, EFH includes areas inshore of the 100-foot contour, such as attached macroalgae; submerged rooted vascular plants (seagrasses); estuarine emergent vegetated wetlands (saltmarshes, brackish marsh); tidal creeks; estuarine scrub/shrub (mangrove fringe); oyster reefs and shell banks; unconsolidated bottom (soft sediments); artificial reefs; and coral reefs and live/hard bottom.
Spiny Lobster	EFH for spiny lobster includes nearshore shelf/oceanic waters; shallow subtidal bottom; seagrass habitat; unconsolidated bottom (soft sediments); coral and live/hard bottom habitat; sponges; algal communities (*Laurencia*); and mangrove habitat (prop roots). In addition, the Gulf Stream is an EFH because it provides a mechanism to disperse spiny lobster larvae.
Peneaid Shrimp	EFH includes inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity, and all interconnecting water bodies. Inshore nursery areas include tidal freshwater (palustrine), estuarine, and marine emergent wetlands (e.g., intertidal marshes); tidal palustrine forested areas; mangroves; tidal freshwater, estuarine, and marine submerged aquatic vegetation (e.g., seagrass); and subtidal and intertidal non-vegetated flats. This applies from North Carolina through the Florida Keys.
Rock Shrimp	EFH consists of offshore terrigenous and biogenic sand bottom habitats from 18 to 182 meters in depth with highest concentrations occurring between 34 and 55 meters. This applies for all areas from North Carolina through the Florida Keys. In addition the Gulf Stream is an EFH because it provides a mechanism to disperse rock shrimp larvae.

South Atlantic Species	
Species	**Description of EFH**
Royal Red Shrimp	EFH includes the upper regions of the continental slope from 180 meters (590 feet) to about 730 meters (2,395 feet), with concentrations found at depths of between 250 meters (820 feet) and 475 meters (1,558 feet) over blue/black mud, sand, muddy sand, or white calcareous mud. In addition, the Gulf Stream is an EFH because it provides a mechanism to disperse royal red shrimp larvae.
Dolphin/Wahoo	EFH for dolphin and wahoo includes the Gulf Stream, Charleston Gyre, Florida Current, and pelagic *Sargassum*.

Source: (NOAA, 2015e)

ACRONYMS

Acronym	Definition
AARC	Average Annual Rate of Change
ACDP	Air Contaminant Discharge Permits
ACHP	Advisory Council On Historic Preservation's
ACS	American Community Survey
AFB	Air Force Base
AGL	Above Ground Level
AIM	Aeronautical Information Manual
AIRFA	American Indian Religious Freedom Act
AML	Abandoned Mine Lands
APE	Area of Potential Effect
AQCR	Air Quality Control Region
ARPA	Archaeological Resources Protection Act
ASL	Above Sea Level
ASPM	Aviation System Performance Metrics
ATC	Air Traffic Control
ATO	Air Traffic Organization
BCD	Building Codes Division
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BOR	Bureau of Reclamation
CAA	Clean Air Act
CCD	Common Core of Data
CCMP	Comprehensive Conservation and Management Plan
CCR	Consumer Confidence Reports
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFOI	Census of Fatal Occupational Injuries
CGP	Construction General Permit
CH_4	Methane
CHS	Charleston International Airport
CIMC	Cleanups in My Community
CMPA	Cooperative Management and Protection Area
CIO	Chief Information Officer
COLT	Cell On Light Truck
COW	Cell On Wheels
CRREL	Cold Regions Research and Engineering Laboratory
CRS	Community Rating System
CWA	Clean Water Act
CWS	Community Water Systems
DEQ	Department of Environmental Quality
DHEC	Department of Health and Environmental Control
DMV	Department of Motor Vehicles
DNR	Department of Natural Resources
DHHS	Department of Health and Human Services
DOD	Department of Defense
DOE	Department of Energy
DWS	Drinking Water Services
EDACS	Enhanced Digital Access System
EFH	Essential Fish Habitat
EIA	Energy Information Agency

Acronym	Definition
EMS	Emergency Medical Services
EPCRA	Emergency Planning and Community Right to Know Act
EPHT	Environmental Public Health Tracking
ESU	Evolutionary Significant Units
FCC	Federal Communication Commission
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FHWA	Federal Highway Administration
FLM	Federal Land Manager
FLPMA	Federal Land Policy and Management Act of 1976
FSDO	Flight Standards District Offices
FSS	Flight Service Station
FWS	Fish and Wildlife Service
GA/SC	Augusta-Richmond County
GAP	Gap Analysis Program
GHG	Greenhouse Gas
GNIS	Geographic Names Information System
GSP	Greenville-Spartanburg International Airport
HAP	Hazardous Air Pollutant
HAPC	Habitat Areas of Particular Concern
HASP	Health and Safety Plans
HHRA	Human Health Risk Assessment
IBA	Important Bird Areas
IFR	Instrument Flight Rules
IPCC	Intergovernmental Panel On Climate Change
ISCP	Indirect Source Construction Permit
IWIN	Integrated Wireless Network
LBS	Locations-Based Services
LCCS	Land Cover Classification System
LID	Low Impact Development
LLR	Labor, Licensing and Regulation
LMR	Land Mobile Radio
LRAPA	Lane Regional Air Protection Authority
LRR	Land Resource Regions
LTE	Long Term Evolution
MBTA	Migratory Bird Treaty Act
MCAS	Marine Corps Air Station
MHI	Median Household Income
MLRA	Major Land Resource Areas
MMPA	Marine Mammal Protection Act
MMT	Million Metric Tons
MSFCA	Magnuson-Stevens Fisheries Conservation Act
MSFCMA	Magnuson Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MYA	Million Years Ago
MYR	Myrtle Beach International Airport
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAICS	North American Industry Classification System
NAS	National Airspace System
NASAO	National Association of State Aviation Officials
NCA	National Climate Assessment

Acronym	Definition
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NESCA	Nongame and Endangered Species Conservation Act
NFIP	National Flood Insurance Program
NHA	National Heritage Areas
NHL	National Historic Landmarks
NHPA	National Historic Preservation Act
NHS	National Historic Sites
NIH	National Institutes of Health
NIST	National Institute of Standards and Technology
NM	Nautical Miles
NNL	National Natural Landmarks
NOC/AOP	Notice of Construction and Approval of Plans
NOTAM	Notices To Airmen
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NPSBN	Nationwide Public Safety Broadband Network
NRC	National Response Center
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSA	National Security Areas
NSR	Norfolk Southern Railway
NTFI	National Task Force On Interoperability
NTNC	Non-Transient Non-Community
NWI	National Wetlands Inventory
NWR	National Wildlife Refuges
OE/AAA	Obstruction Evaluation and Airport Airspace Analysis
ONA	Outstanding Natural Area
PAB/PUB	Ponds and Aquatic Beds
PADUS	Protected Areas Database of the United States
PATCON	Called the Palmetto Tactical Communications Network
PGA	Peak Ground Acceleration
POP	Points of Presence
PPE	Personal Protective Equipment
PSAP	Public Safety Answering Point
PSC	Public Service Commission
PSCR	Public Safety Communications Research
PSD	Prevention of Significant Deterioration
PTE	Potential To Emit
RACOM	Radio Communications
RCRA	Resource Conservation and Recovery Act
RF	Radio Frequency
SAA	Sense and Avoid
SAIPE	Small Area Income and Poverty Estimates
SASP	State Aviation System Plan
SC	South Carolina
SC/NC	Myrtle Beach/Socastee
SCDHEC	South Carolina Department of Health and Environmental Control
SCDLLR	South Carolina Department of Labor, Licensing & Regulation
SCDNR	Department of Natural Resources

Acronym	Definition
SCDNR	South Carolina Department of Natural Resources
SCDOT	South Carolina Department of Transportation
SCEPPC	South Carolina Exotic Pest Plant Council
SCOSH	South Carolina's Occupational Safety and Health Plan
SDS	Safety Data Sheets
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SO_3	Sulfur Trioxide
SOC	Standard Occupational Classification
SOP	Standard Operating Procedures
SOW	System On Wheels
SO_X	Oxides of Sulfur
SPDES	State Pollutant Discharge Elimination System
SPL	Sound Pressure Level
SUA	Special Use Airspace
THPO	Tribal Historic Preservation Office
TRI	Toxics Release Inventory
UA	Unmanned Aircraft
UAS	Unmanned Aircraft Systems
UHF	Ultra High Frequency
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCP	Voluntary Cleanup Program
VFR	Visual Flight Rules
VHF	Very High Frequency
WMA	Wildlife Management Areas
WONDER	Wide-Ranging Online Data For Epidemiologic Research

REFERENCES

The citations in this Draft PEIS reflect the most recent information on the referenced site at the time the document was written. If the site was updated after that point, the more recent information will be incorporated into the final document, as feasible.

40 CFR 230.3(t). (1993, August 25). *Clean Water Act-Guidelines for Specification of Disposal Sites for Dredged or Fill Material*. Retrieved April 6, 2015, from http://www.ecfr.gov/cgi-bin/text-idx?SID=7977290449ab243f2865159951305a77&node=40:25.0.1.3.24&rgn=div5

Advisory Council on Historic Preservation. (2004). *36 CFR Part 800 - Protection of Historic Properties.* Retrieved July 21, 2015, from Advisory Council on Historic Preservation: http://www.achp.gov/regs-rev04.pdf

Agency for Toxic Substances and Disease Registry. (2007, December 17). *PUBLIC HEALTH ASSESSMENT*. Retrieved November 16, 2015, from SAVANNAH RIVER SITE : http://www.atsdr.cdc.gov/hac/pha/SavannahRiverSite121707/SavannahRiverSiteFinalPHA121707.pdf

American Trails. (2015, August 14). *National Trails Training Partnership*. Retrieved September 15, 2015, from http://www.americantrails.org/resources/feds/NatTrSysOverview.html

Amtrak. (2015a, October). *South Train Routes*. Retrieved October 31, 2015, from Amtrak: http://www.amtrak.com/south-train-routes

Amtrak. (2015b, April 6). *Amtrak System Timetable.* Retrieved from Amtrak: https://www.amtrak.com/ccurl/194/703/System-Timetable-Spring-Fall-2015.pdf

Anderson, D. G., & Faught, M. K. (1998). *The Distribution of Fluted Paleoindian Projectile Points: Update 1998.* Retrieved November 2015, from http://www.jstor.org/stable/40897755

Anderson, D. G., Hally, D. J., & Rudolph, J. L. (1986). The Mississippian Occupation of the Savannah River Valley. *Southeastern Archaeology, 5*(1), 32-51. Retrieved November 2015, from http://www.jstor.org/stable/40713472

Audubon Society of South Carolina. (2015). *Important Bird Areas*. Retrieved from Audubon South Carolina: http://sc.audubon.org/conservation/important-bird-areas-0

Balshe, W. (2011). *Power System Considerations for Cell Tower Applications.* Cummins Power Generation. Retrieved from https://www.cumminspower.com/www/literature/technicalpapers/PT-9019-Cell-Tower-Applications-en.pdf

Berven, K., & Grudzien, T. (1990). Dispersal in the wood frog (Rana sylvatica): implications for genetic population structure. *Evolution, Volume 44*(Issue 8), 2047-2056. Retrieved from http://www.jstor.org/stable/2409614?seq=1#page_scan_tab_contents

BLM. (1984). *Manual 8400 - Visual Resource Management.* Washington: Department of the Interior, Bureau of Land Management.

BLM. (2005). *Land Use Planning Handbook.* Retrieved March 2016, from http://www.blm.gov/wo/st/en/prog/planning/nepa/webguide/document_pages/land_use_planning.html

BLM. (2014, August). *DRECP Noise and Vibration*. Retrieved 07 22, 2015, from http://www.blm.gov/style/medialib/blm/ca/pdf/pa/energy/drecp/draft_drecp.Par.37401.File.dat/III.21%20Noise%20and%20Vibration.pdf

BLS. (2013a). *Incidence rate and number of nonfatal occupational injuries by industry and ownership, 2013 (U.S.).* Retrieved September 22, 2015, from http://www.bls.gov/iif/oshwc/osh/os/ostb3966.pdf

BLS. (2013b). *Fatal occupational injuries to private sector wage and salary workers, government workers, and self-employed workers by industry, all United States, 2013.* Retrieved September 22, 2015, from http://www.bls.gov/iif/oshwc/cfoi/cftb0279.pdf

BLS. (2014). *Table A-5. Fatal occupational injuries by occupation and event or exposure, all United States, 2014.* Retrieved September 29, 2015, from 2014 Census of Fatal Occupational Injuries (preliminary data): http://www.bls.gov/iif/oshwc/cfoi/cftb0290.pdf

BLS. (2015a). *Local Area Unemployment Statistics, Employment status of the civilian noninstitutional population, 1976 to 2014 annual averages*. Retrieved April 2015, from http://www.bls.gov/lau/rdscnp16.htm

BLS. (2015b, March 25). *May 2014 State Occupational Employment and Wage Estimates, South Carolina.* Retrieved November 13, 2015, from Occupational Employment Statistics: http://www.bls.gov/oes/current/oes_SC.htm#49-0000

BLS. (2015c, October 22). *State Occupational Injuries, Illnesses, and Fatalities*. Retrieved November 13, 2015, from http://www.bls.gov/iif/oshstate.htm#SC

BLS. (2015d, March 25). *Occupational Employment and Wages, May 2014: 49-9052 Telecommunications Line Installers and Repairers*. Retrieved October 8, 2015, from Occupational Employment Statistics: http://www.bls.gov/oes/current/oes499052.htm

BLS. (2015e, April 22). *State Occupational Injuries, Illnesses, and Fatalities*. Retrieved November 13, 2015, from Injuries, Illnesses, and Fatalities: http://www.bls.gov/iif/state_archive.htm#SC

BLS. (2015f, September 21). *Census of Fatal Occupational Injuries (2011 forward)*. Retrieved September 18, 2015, from Census of Fatal Occupational Injuries (2011 forward): http://data.bls.gov/pdq/SurveyOutputServlet;jsessionid=D50AB7BE7C7731D5A8549E2E0212D1CD.tc_instance4

BLS. (2015g, November 19). *Schedule of upcoming releases and access to archived news releases*. Retrieved February 16, 2016, from Injuries, Illnesses, and Fatalities: http://www.bls.gov/iif/osh_nwrl.htm

BLS. (2015h, May). *U.S. Bureau of Labor Statistics*. Retrieved from May 2015 State Occupational Employment and Wage Estimates South Carolina: http://www.bls.gov/oes/current/oes_sc.htm

BLS. (2016, March 30). *Telecommunications: NAICS 517*. Retrieved from Industries at a Glance: http://www.bls.gov/iag/tgs/iag517.htm

Bond, S., Sims, S., & Dent, P. (Eds.). (2013). *Towers, Turbines, and Transmission Lines: Impacts on Property Value.* Chichester, West Sussex, United Kingdom: Wiley-Blackwell.

Cabak, M. A., Sassaman, E, K., & Gillam, C. J. (1998). Distributional Archaeology in the Southeast: an Early Archaic Example from the Aiken Plateau, South Carolina. *Southeastern Archaeology, 17*(1), 22-38. Retrieved November 2015, from http://www.jstor.org/stable/41890387

Calhoun, A., & DeMaynadier, P. (2007). Science and conservation of vernal pools in northeastern North America: ecology and conservation of seasonal wetlands in northeastern North America. *CRC Press LLC.* Retrieved from

http://www.nae.usace.army.mil/Portals/74/docs/regulatory/VernalPools/Ch12_ScienceConservationofVernalPools.pdf

CCS. (2008). *Final Draft South Carolina Greenhouse Gas Emissions Inventory and Reference Case Projections 1990-2020*. Retrieved 11 20, 2015, from www.climatestrategies.us/library/library/download/953

CEC. (2011, April). *North American Terrestrial Ecoregions - Level III.* Retrieved from USEPA Ecoregions of North America: ftp://ftp.epa.gov/wed/ecoregions/pubs/NA_TerrestrialEcoregionsLevel3_Final-2june11_CEC.pdf

Centers for Disease Control and Prevention. (2015, September 17). CDC WONDER: Underlying Cause of Death, 1999-2013 Results. Retrieved November 13, 2015, from http://wonder.cdc.gov/controller/datarequest/D76

CEQ. (1997, December). *Environmental Justice: Guidance Under the National Environmental Policy Act.* Retrieved April 2015, from https://ceq.doe.gov/nepa_information/justice.html

CEQ. (2014). *Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions*. Retrieved June 2014, from https://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghg-guidance

Chafin, L. (2009, January). *Edna' Trillium*. Retrieved from http://www.georgiawildlife.com/sites/default/files/uploads/wildlife/nongame/pdf/accounts/plants/trillium_persistens.pdf

Charpentier, V., Inizan, M. L., & Feblot-Augustins, J. (2002). Fluting in the Old World: The Neolithic Projectile Points of Arabia. *Lithic Technology, 27*(1), 39-46. Retrieved August 2015, from http://www.jstor.org/stable/23273456

CHS. (2014, December). *Operations Summary*. Retrieved October 31, 2015, from https://www.chs-airport.com/CCAA-Reports/Operations-Reports/Copy-of-Ops-Summary-Dec-2014-%283%29.aspx?feed=acd062ce-4d8c-4a16-bc89-ad2a30baa61d

CHS. (2015, October). *About Us*. Retrieved October 31, 2015, from https://www.chs-airport.com/AviationAuthority/About-Us.aspx

CIO Council. (2015). *Data Center Consolidation and Optimization*. Retrieved from https://cio.gov/drivingvalue/data-center-consolidation/

City of Lincoln. (2015). *What are Saline Wetlands?* Retrieved July 2015, from http://lincoln.ne.gov/city/parks/parksfacilities/wetlands/wetlandsinfo.htm

Claassen, C. (1986, January). Shellfishing Seasons in the Prehistoric Southeastern United States. *American Antiquity, 51*(1), 21-37. Retrieved November 2015, from http://www.jstor.org/stable/280391

Climate Central. (2014a, July). *South Carolina and the Surging Sea.* Retrieved from Climate Central: http://sealevel.climatecentral.org/uploads/ssrf/SC-Report.pdf

Climate Central. (2014b, January). *The Front Lines of Climate Change: Charleston's Struggle*. Retrieved from http://www.climatecentral.org/news/the-front-lines-of-climate-change-charlestons-struggle-16934

Columbia University. (2015). *Metamorphic Rocks*. Retrieved November 2015, from http://www.columbia.edu/~vjd1/meta_rx.htm

Cooke, C. (1936). *Geology of the Coastal Plain of South Carolina.* Washington, DC: Department of the Interior. Retrieved November 2015, from http://pubs.usgs.gov/bul/0867/report.pdf

Cowardin, L. M., Carter, V., Golet, F. C., & LaRoe, E. T. (1979). *Classification of wetlands and deepwater habitats of the United States, FWS/OBS-79/31*. Retrieved April 5, 2015, from http://www.fws.gov/wetlands/Documents/classwet/index.html

Crouch, G. (2015, February 2). *Palmetto P25 User Instructions Transition Letter*. Retrieved from http://www.admin.sc.gov/files/Palmetto%20800%20P-25%20Letter%2002-02-15v1.pdf

CSC. (2007, March). Retrieved from Telecommunications Facilities: An Illustrated Primer on the Siting of Facilities within Connecticut and Throughout the Nation: http://www.ct.gov/csc/lib/csc/csc_tower_3_07.pdf

CT DEEP. (2015). *The Public Trust*. Retrieved from http://www.ct.gov/Deep/cwp/view.asp?A=2705&Q=323792

Dahl, T. E. (1999). *South Carolina's Wetlands Status and Trends, 1982 – 1989*. Retrieved November 2015, from https://www.fws.gov/wetlands/Documents/South-Carolinas-Wetlands-Status-and-Trends-1982-1989.pdf

DCNR. (2014). *Department of Conservation and Natural Resources - Bureau of Forestry*. Retrieved August 5, 2016, from Common Trees of Pennsylvania: http://www.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_20029752.pdf

Detroit Publishing Company. (1900). *U.S. Customs House, Charleston, SC*. Retrieved from https://www.loc.gov/item/det1994004477/PP/

Detroit Publishing Company. (1901). *Fort Sumter, Charleston, SC*. Retrieved from http://www.loc.gov/item/2008679543/

Di Gregorio, A., & Jansen, L. J. (1998). *Land Cover Classification System (LCCS): Classification Concepts and User Manual*. Rome: Food and Agriculture Organization of the United Nations.

Diesel Service & Supply. (2016, June). *Approximate Diesel Fuel Consumption Chart*. Retrieved from http://www.dieselserviceandsupply.com/Diesel_Fuel_Consumption.aspx

DNR. (2015). *Major Rivers and Lakes of South Carolina*. Retrieved from Department of Natural Resources, South Carolina: https://www.dnr.sc.gov/water/river/pdf/SCwaterbodies.pdf

DOC. (2013, February 21). *Department of Commerce Environmental Justice Strategy*. Retrieved July 2015, from http://open.commerce.gov/sites/default/files/DOC_Environmental_Justice_Strategy.pdf

DOE. (2006). *Area Completion Projects*. Retrieved November 16, 2015, from http://www.srs.gov/general/programs/soil/extpage.html

DOE. (2015). *Climate Change and the U.S. Energy Sector: Regional Vulnerabilities and Resilience Solutions*. Retrieved December 15, 2015, from http://energy.gov/epsa/downloads/climate-change-and-us-energy-sector-regional-vulnerabilities-and-resilience-solutions

DOI. (2008). *Navajo Reservoir RMP/FEA Appendix E Noise*. Retrieved 07 22, 2015, from https://www.usbr.gov/uc/envdocs/ea/navajo/appdx-E.pdf

DOI. (2015, May 26). *Abandoned Mine Land Inventory System (e-AMLIS) State and Tribal Summary*. Retrieved November 24, 2015, from Office of Surface Mining Reclamation and Enforcement: http://amlis.osmre.gov/Summaries.aspx

Edinger, G. J., Evans, D. J., Gebauer, S., Howard, T. G., Hunt, D. M., & Olivero, A. M. (2014, March). *Ecological Communities of New York State*. Retrieved March 19, 2015, from A revised and expanded edition of Carol Reschke's Ecological Communities of New York State.: http://www.dec.ny.gov/animals/97703.html

EIA. (2011, July). *Greenhouse Gas Emissions Overview*. Retrieved July 28, 2015, from Emissions of Greenhouse Gases in the United States: http://www.eia.gov/environment/emissions/ghg_report/ghg_overview.cfm

EIA. (2015a, October). *Electricity*. Retrieved November 2015, from U.S. Energy Information Administration: http://www.eia.gov/electricity/data/state/

EIA. (2015b, November). *South Carolina Profile Overview*. Retrieved November 2015, from U.S. Energy Information Administration: http://www.eia.gov/state/?sid=SC

EIA. (2015c, October 26). *State CO2 Emissions - 1980 to 2013*. Retrieved April 26, 2016, from http://www.eia.gov/environment/emissions/state/

EIA. (2015d, May 21). *South Carolina - State Profile and Energy Estimates*. Retrieved November 9, 2015, from http://199.36.140.204/state/?sid=SC

EIA. (2015e, October 26). *State-Level Energy-Related Carbon Dioxide Emissions 2000-2013*. Retrieved April 26, 2016, from http://www.eia.gov/environment/emissions/state/analysis/

EIA. (2015f, July 7). *How much carbon dioxide is produced by burning gasoline and diesel fuel?* Retrieved September 21, 2015, from http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11

EIA. (2015g, May 21). *South Carolina State Energy Profile*. Retrieved November 24, 2015, from U.S. Energy Information Administration: http://www.eia.gov/state/print.cfm?sid=SC

EIA. (2016). *Glossary - Electricity*. Retrieved from U.S. Energy Information Administration: https://www.eia.gov/tools/glossary/?id=electricity

Executive Office of the President. (1994, February). *Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. Retrieved April 2015, from 59 Federal Register 7629: https://federalregister.gov/a/94-3685

FAA. (2007, August 26). *Hearing and Noise in Aviation*. Retrieved 07 22, 2015, from https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/hearing_brochure.pdf

FAA. (2008). *Chapter 14 Airspace.* Retrieved June 2015, from Pilot's Handbook of Aeronautical Knowledge: http://www.faa.gov/regulations_policies/handbooks_manuals/aviation/pilot_handbook/media/phak%20-%20chapter%2014.pdf

FAA. (2012a, April 05). *Advisory Circular AC 36-3H*. Retrieved 07 22, 2015, from http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC36-3H%20Chg%201.pdf

FAA. (2012b). *Evaluation for new obstruction lighting techniques to reduce avian fatalities.* Retrieved from http://www.tc.faa.gov/its/worldpac/techrpt/tctn12-9.pdf

FAA. (2013 First Edition). *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap.* Washington D.C.: U.S. Department of Transportation Federal Aviation Administration.

FAA. (2014, January). *Federal Aviation Administration, Air Traffic Organization*. Retrieved June 2015, from http://www.faa.gov/about/office_org/headquarters_offices/ato/

FAA. (2015a, June 25). *Airport Data and Contact Information*. Retrieved October 31, 2015, from http://www.faa.gov/airports/airport_safety/airportdata_5010/

FAA. (2015b). *Aviation System Performance Metrics (ASPM) Database*. Retrieved 07 22, 2015, from https://aspm.faa.gov/

FAA. (2015c, September 22). *CY14 Passenger Boardings at Commercial Service Airports*. Retrieved October 31, 2015, from http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/cy14-commercial-service-enplanements.pdf

FAA. (2015d, March). *Flight Standards District Offices (FSDO)*. Retrieved June 2015, from http://www.faa.gov/about/office_org/field_offices/fsdo/

FAA. (2015e). *Aeronautical Information Manual*. Retrieved August 2015, from http://www.faa.gov/air_traffic/publications/media/aim.pdf

FAA. (2015f). *Obstruction Evaluation / Airport Airspace Analysis (OE/AAA)*. Retrieved July 2015, from Federal Aviation Administration: https://oeaaa.faa.gov/oeaaa/external/portal.jsp

FAA. (2015g, August 6). *FAA Air Traffic Organization Policy, JO 7400.9SZ, Airspace Designations and Reporting Points*. (F. A. U.S. Department of Transportation, Producer) Retrieved October 2015, from FAA, Regulations & Policies, Orders & Notices: http://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.list/parentTopicID/10

FAA. (2015h). *Air Traffic Organization Policy Order JO 7400.8X, Subject: Special Use Airspace.* Federal Aviation Administration, Airspace Policy and Regulations Group. Retrieved July 2015, from http://www.faa.gov/documentlibrary/media/order/7400_8x_2015.pdf

FAA. (2015i). *FAA TFR List*. Retrieved November 2015, from http://tfr.faa.gov/tfr2/list.html

FAA. (2015j, August). *FAA Pilot Safety Brochure - Hearing and Noise in Aviation.* Retrieved 08 05, 2015, from https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/hearing_brochure.pdf

FCC. (2000, August). *Deployment of Advanced Telecommunications Capability: Second Report.* Retrieved Nov 16, 2015, from https://transition.fcc.gov/Bureaus/Common_Carrier/Orders/2000/fcc00290.pdf

FCC. (2012, March 13). *Final Programmatic Environmental Assessment for the Antenna Structure Registration Program.* Retrieved from https://apps.fcc.gov/edocs_public/attachmatch/DOC-312921A1.pdf

FCC. (2013). *Universal Service Monitoring Report.* Retrieved from https://apps.fcc.gov/edocs_public/attachmatch/DOC-330829A1.pdf

FCC. (2014a). *Internet Access Services: Status as of December 31, 2013.* Industry Analysis and Technology Division Wireline Competition Bureau. Federal Communications Commission. Retrieved from https://apps.fcc.gov/edocs_public/attachmatch/DOC-329973A1.pdf

FCC. (2014b). *Local Telephone Competition: Status as of December 31, 2013.* Industry Analysis and Technology Division Wireline Competition Bureau. Retrieved from https://apps.fcc.gov/edocs_public/attachmatch/DOC-329975A1.pdf

FCC. (2015, June 17). *Antenna Structure Registration*. Retrieved June 17, 2015, from Federal Communications Commission: http://wireless2.fcc.gov/UlsApp/AsrSearch/asrRegistrationSearch.jsp

FCC. (2016a, March). *National Broadband Plan Chapter 16 Public Safety*. Retrieved March 29, 2016, from Broadband.gov: http://www.broadband.gov/plan/16-public-safety/

FCC. (2016b, February 1). *Tower and Antenna Siting*. Retrieved February 10, 2016, from https://www.fcc.gov/general/tower-and-antenna-siting

FCC. (2016c, June). *Detail - Microwave*. Retrieved from Application Search Help: http://wireless2.fcc.gov/helpfiles/applicationSearch/ad_microwave.html

Federal Mining Dialogue. (2015, January 6). *Abandoned Mine Lands Portal - Staying Safe*. Retrieved September 29, 2015, from http://www.abandonedmines.gov/ss.html

FEMA. (2000). *44 CFR Section 59.1 of the National Flood Insurance Program (NFIP) Regulations: Definitions of NFIP Terms*. Retrieved May 2015, from http://www.fema.gov/media-library/assets/documents/12437?id=3064

FEMA. (2010, March). *Guidelines for Estimation of Percolation losses for NFIP Studies.* Retrieved August 6, 2015, from FEMA: http://www.fema.gov/media-library-data/20130726-1731-25045-9495/dl_perc.pdf

FEMA. (2013). *Unit 3: NFIP Flood Studies and Maps*. Retrieved May 2015, from http://www.fema.gov/media-library-data/20130726-1539-20490-0241/nfip_sg_unit_3.pdf

FEMA. (2014a, May). *Chapter 8: Floodplain Natural Resources and Functions*. Retrieved May 2015, from https://training.fema.gov/hiedu/docs/fmc/chapter%208%20-%20floodplain%20natural%20resources%20and%20functions.pdf

FEMA. (2014b, May). *Chapter 2: Types of Floods and Floodplains*. Retrieved May 2015, from http://training.fema.gov/hiedu/docs/fmc/chapter%202%20-%20types%20of%20floods%20and%20floodplains.pdf

FEMA. (2014c, May). *The National Flood Insurance Program Community Status Book*. Retrieved November 23, 2015, from http://www.fema.gov/cis/SC.pdf

FEMA. (2014d, May). *Community Rating System*. Retrieved November 23, 2015, from http://www.fema.gov/media-library-data/1398878892102-5cbcaa727a635327277d834491210fec/CRS_Communites_May_1_2014.pdf

FEMA. (2015, April). *Floodplain Management Fact Sheet*. Retrieved May 2015, from https://www.fema.gov/floodplain-management-fact-sheet

Fenneman, N. (1916). *Physiographic Subdivision of the United States.* Retrieved April 2015, from http://www.pnas.org/content/3/1/17.full.pdf?ck=nck

FGDC. (2013, August). *Classification of Wetlands and Deepwater Habitats of the United States.* Retrieved April 17, 2015, from FGDC Subcommittee on Wetlands Data: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/wetlands/nvcs-2013

FHWA. (2009, October). *Advances in Wildlife Crossing Technologies*. Retrieved July 12, 2016, from Public Roads: http://www.fhwa.dot.gov/publications/publicroads/09septoct/03.cfm

FHWA. (2011, July 14). *Highway Traffic and Construction Noise.* Retrieved 07 27, 2015, from fhwa.dot.gov: http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/probresp.cfm#appendix

FHWA. (2013, September 3). *National Scenic Byways Program - Intrinsic Qualities: Identification and Distinctions*. Retrieved May 2016, from http://www.fhwa.dot.gov/hep/scenic_byways/byway_quality/analysis/iq_identification.cfm

FHWA. (2014, October 1). *National Scenic Byways Program*. Retrieved April 8, 2015, from http://www.fhwa.dot.gov/hep/scenic_byways/

FHWA. (2015a, October). *Route Log and Finder List*. Retrieved October 31, 2015, from Federal Highway Administration: http://www.fhwa.dot.gov/planning/national_highway_system/interstate_highway_system/routefinder/index.cfm

FHWA. (2015b, October). *South Carolina*. Retrieved October 31, 2015, from http://www.fhwa.dot.gov/byways/states/SC

FHWA. (2015c). *America's Byways: South Carolina*. Retrieved November 25, 2015, from http://www.fhwa.dot.gov/byways/states/SC

FHWA. (2015d, 05 28). *Highway Traffic Noise*. Retrieved 07 22, 2015, from http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/faq_nois.cfm

Fiber Optic Association. (2010). *Guide to Fiber Optics & Premises Cabling*. Retrieved September 21, 2015, from Safety in Fiber Optic Installations: http://www.thefoa.org/tech/safety.htm

FTA. (2006). *Transit Noise and Vibration Impact Assessment.* FTA.

FWC. (2015). *Land Mammals - Black Bear*. Retrieved from Florida Fish and Wildlife Conservation: http://myfwc.com/wildlifehabitats/profiles/mammals/land/black-bear/

GAO. (2013). *Data Center Consolidation: Strengthened Oversight Needed to Achieve Billions of Dollars in Savings*. Retrieved from http://www.gao.gov/products/GAO-13-627T

Gehring, J., Kerlinger, P., & Manville, A. M. (2011). The role of tower height and guy wires on avian collisions with communication towers. *The Journal of Wildlife Management, 75*, 848-855. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/jwmg.99/abstract

Geological Survey of Georgia. (1911). *Geology of the Coastal Plain of Georgia.* Retrieved November 2015, from https://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/B-26.pdf

GPO. (2010a, April 5). *Title 40 Code of Federal Regulations Part 93.153*. Retrieved July 21, 2015, from http://www.ecfr.gov/cgi-bin/text-idx?SID=2028b268447f0bf79b396678569dac85&mc=true&node=se40.20.93_1153&rgn=div8

GPO. (2010b, April 5). *Title 40 Code of Federal Regulations Part 93.153*. Retrieved July 20, 2015, from http://www.ecfr.gov/cgi-bin/text-idx?SID=2028b268447f0bf79b396678569dac85&mc=true&node=se40.20.93_1153&rgn=div8

GPO. (2011). *Title 7, Agriculture, Chapter 104 - Plant Protection*. Retrieved from https://www.gpo.gov/fdsys/pkg/USCODE-2011-title7/pdf/USCODE-2011-title7-chap104.pdf

GPO. (2015, June). *Electronic Code of Federal Regulations.* Retrieved June 2015, from U.S. Government Publishing Office: http://www.ecfr.gov/cgi-bin/text-idx?SID=6095c0db6bb5edb10c850334725dae34&mc=true&tpl=/ecfrbrowse/Title36/36tab_02.tpl

Griffith, G., Omernick, J., Comstock, J., Schafale, M., McNab, W., Lenat, D., . . . Shelburne, V. (2002). *Ecoregions of North Carolina and South Carolina (color poster with map, descriptive text, summary tables, and photographs)*. Retrieved from http://archive.epa.gov/wed/ecoregions/web/html/ncsc_eco.html

Haynes, C. V., Donahue, D., Jull, A., & Zabel, T. (1984). Application of Accelerator Dating to Fluted Point Paleoindian Sites. *Archaeology of Eastern North America, 12*, 184-191. Retrieved September 2015, from http://www.jstor.org/stable/40914238

Haynes, V. T., Johnson, E., & Stafford, T. W. (1999). AMS Radiocarbon Dating of the Type Plainview and Firstview (Paleoindian) Assemblages: The Agony and the Ecstasy. *American Antiquity, 64*(3), 444-454. Retrieved September 2015, from http://www.jstor.org/stable/2694144

Highsmith, C. M. (2006). *Drayton Hall, Plantation, Charleston, SC*. Retrieved from Library of Congress: https://www.loc.gov/item/2010630440/

Hill, D., Hockin, D., Price, D., Tucker, G., Morris, R., & Treweek, J. (1997). Bird disturbance: improving the quality and utility of disturbance research. *Journal of Applied Ecology, 34*(2), 275-288. Retrieved from http://www.jstor.org/stable/2404876?seq=1#page_scan_tab_contents

Hilty, J. (2015). *Definitions and Line Drawings of Botanical Terminology*. Retrieved from Illinois Wildflowers: http://www.illinoiswildflowers.info/files/line_drawings.htm

Historic American Buildings Survey. (1933). *South Carolina Capitol, Columbia, SC*. Retrieved from http://www.loc.gov/item/sc0098/

Historic American Buildings Survey. (1977). *Charles H. Drayton House*. Retrieved from Library of Congress: http://www.loc.gov/item/sc0514/

Idaho State University. (2000). *Environmental Geology*. Retrieved March 20, 2016, from http://geology.isu.edu/wapi/EnvGeo/EG4_mass_wasting/EG_module_4.htm

Institute of Maritime History. (2015, August). *Rainsford Island Archaeological Survey*. Retrieved August 2015, from http://www.maritimehistory.org/content/rainsford-island-archaeological-survey

International Finance Corporation. (2007, April 30). *Environmental, Health, and Safety Guidelines for Telecommunications*. Retrieved from http://www.ifc.org/wps/wcm/connect/0985310048855454b254f26a6515bb18/Final+-+Telecommunications.pdf?MOD=AJPERES&id=1323152343828

IPCC. (2007). *Climate Change 2007: Synthesis Report.* Retrieved October 2013, from Intergovernmental Panel on Climate Change: www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

IPCC. (2013). *Climate Change 2013: The Physical Science Basis.* Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc.ch/report/ar5/wg1/

Kane, Sharon; Keeton, Richard. (1994). *Beneath These Waters: Archeological and Historical Studies of 11,500 Years Along the Savannah River.* Retrieved from https://ia800806.us.archive.org/32/items/beneaththesewate00ka02/beneaththesewate00ka02.pdf

Kottek. (2006). *World Map of the Köppen-Geiger Climate Classification.* Offenbach, Germany and Vienna, Austria: Gebrüder Borntraeger.

Merriam Webster Dictionary. (2015a). *Airspace*. Retrieved June 2015, from Merriam Webster Dictionary: http://www.merriam-webster.com/dictionary/airspace

Merriam Webster Dictionary. (2015b). *Sea Level*. Retrieved July 2015, from Merriam Webster Dictionary: http://www.merriam-webster.com/dictionary/sea%20level

Merriam Webster Dictionary. (2016). *Ecotone.* Retrieved from http://www.merriam-webster.com/dictionary/ecotone

Mitchell, R. (2014). Future climate and fire interactions in the South Eastern region of the United States. *Forest Ecology and Management*, 316-326.

Mizzell, H. (2015). *South Carolina's Climate the Cocorah's State Climates Series.* Retrieved from Low Country, Update and a Lot of Weather in Between - South Carolina's Climate: http://www.cocorahs.org/Media/docs/ClimateSum_SC.pdf

Moody, D. W., Carr, J., Chase, E. B., & Paulson, R. W. (1986). *National Water Summary 1986 -- Hydrologic Events and Ground-Water Quality.* Retrieved April 5, 2015, from http://pubs.usgs.gov/wsp/2325/report.pdf

Myrtle Beach Chamber of Commerce. (2015). *Statistical Abstract for the Myrtle Beach Area of South Carolina, 24th ed.* Retrieved November 2015, from http://www.myrtlebeachareachamber.com/research/docs/24theditionstatisticalabstract.pdf

NASA. (2013, July). Final Environmental Impact Statement: Sounding Rockets Program at Poker Flat Research Range. Wallops Island, VA. Retrieved July 1, 2016, from http://netspublic.grc.nasa.gov/main/NASA%20SRP%20at%20PFRR%20FEIS%20Volume%20I.pdf

National Association of State Aviation Officials. (2015). *Resources NASAO National Association of State Aviation Officials*. Retrieved July 2015, from NASAO National Association of State Aviation Officials: http://www.nasao.org/Resources.aspx

National Conference of State Legislators. (2015, August). *Federal and State Recognized Tribes*. Retrieved August 2015, from http://www.ncsl.org/research/state-tribal-institute/list-of-federal-and-state-recognized-tribes.aspx#ny

National Institutes of Health. (2015a, June). *What is TOXMAP?* Retrieved from http://toxmap.nlm.nih.gov/toxmap/faq/2009/08/what-is-toxmap.html

National Institutes of Health. (2015b, March). *TOXMAP Environmental Health Maps*. Retrieved November 13, 2015, from http://toxmap-classic.nlm.nih.gov/toxmap/main/mapIt.do?regionID=AA54B10476_1

National League of Cities. (2007). *National League of Cities*. (Census of Governments) Retrieved May 21, 2015, from Subcounty, General-Purpose Governments by Population-Size Group and State: http://www.nlc.org/build-skills-and-networks/resources/cities-101/city-structures/number-of-municipal-governments-and-population-distribution

National Recreation Trails. (2015). *National Recreation Trails Database*. Retrieved November 25, 2015, from http://www.americantrails.org/NRTDatabase/trailList.php?usrTrailName=&usrTrailState=SC&usrTrailCounty=&usrTrailUse=

National Transportation Safety Board. (2005a, November 29). *Railroad Accident Report.* Retrieved November 16, 2015, from NTSB/RAR-05/04: http://www.ntsb.gov/investigations/AccidentReports/Reports/RAR0504.pdf

National Transportation Safety Board. (2005b, November 30). *Office of Railroad, Pipeline & Hazardous Materials Investigations.* Retrieved November 13, 2015, from Graniteville, SC: http://www.ntsb.gov/news/events/Documents/graniteville_sc-iic.ppt

National Wild and Scenic Rivers System. (2015a). *Chattooga River, Georgia, N. Carolina, S. Carolina*. Retrieved November 23, 2015, from http://www.rivers.gov/rivers/chattooga.php

National Wild and Scenic Rivers System. (2015b). *South Carolina*. Retrieved November 25, 2015, from http://www.rivers.gov/south-carolina.php

National Wildlife Federation. (2015). *Ecoregions*. Retrieved from http://www.nwf.org/Wildlife/Wildlife-Conservation/Ecoregions.aspx

NCED. (2015). *State of South Carolina and All Easements*. Retrieved November 2015, from National Conservation Easement Database: http://conservationeasement.us/reports/easements?report_state=South Carolina&report_type=All

NCSU. (2016). *Bunched Arrowhead* . Retrieved from https://www.cals.ncsu.edu/plantbiology/ncsc/rare/images/Sagittaria_fasciculata_NHP.pdf

Nelson, J. (1986). *The natural communities of South Carolina.* Retrieved from http://www.dnr.sc.gov/wildlife/publications/pdf/natcomm.pdf

New Hampshire Department of Environmental Services. (2014). *Geologic Mapping Program.* Retrieved August 2015, from http://des.nh.gov/organization/commissioner/gsu/gmp/categories/overview.htm

NIST. (2015, March). *Nationwide Public Safety Broadband Network Deployment: Network Parameter Sensitivity Analysis.* U.S. Department of Commerce. National Institute of Standards and Technology (NIST), Wireless Networks Division, Communications Technology Laboratory. Retrieved from http://nvlpubs.nist.gov/nistpubs/ir/2015/NIST.IR.8039.pdf

NOAA. (2010). *Essential fish habitat conservation mandate (Gulf of Mexico region).* Retrieved from http://sero.nmfs.noaa.gov/sustainable_fisheries/gulf_fisheries/generic/documents/pdfs/2013/gom_efh_guide_2010.pdf

NOAA. (2012). *Global Sea Level Rise Scenarios for the United States National Climate Assessment.* Climate Program Office. Silver Spring: National Oceanic and Atmospheric Administration. Retrieved March 10, 2016, from http://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf

NOAA. (2014a). *Hawksbill sea turtle (Eretmochelys imbricata).* Retrieved from http://www.nmfs.noaa.gov/pr/species/turtles/hawksbill.html

NOAA. (2014b). *Loggerhead turtle (Caretta caretta).* Retrieved from http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.htm

NOAA. (2014c). *Shortnose sturgeon (Acipenser brevirostrum).* Retrieved from http://www.fisheries.noaa.gov/pr/species/fish/shortnose-sturgeon.html

NOAA. (2014d, October 14). *What is that? Jellyfish and other gelatinous animals*. Retrieved from Okeanos Explorere: http://oceanexplorer.noaa.gov/okeanos/explorations/ex1404/logs/oct1/oct1.html

NOAA. (2015a). *Flood Related Hazards*. Retrieved July 2015, from http://www.floodsafety.noaa.gov/hazards.shtml

NOAA. (2015b). *North Inlet-Winyah Bay National Estuarine Research Reserve*. Retrieved November 2015, from http://nerrs.noaa.gov/reserves/north-inlet-winyah-bay.html

NOAA. (2015c). *ACE Basin National Estuarine Research Reserve*. Retrieved November 2015, from http://nerrs.noaa.gov/reserves/ace-basin.html

NOAA. (2015d). *Guide to essential fish habitat descriptions*. Retrieved from http://www.greateratlantic.fisheries.noaa.gov/hcd/list.htm

NOAA. (2015e). *Essential fish habitat mapper*. Retrieved from http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html

NOAA. (2015f). *North Inlet - Winyah Bay National Estuarine Research Reserve. Aerial view of meandering tidal creeks and extensive pristine marshes in North Inlet Estuary*. Retrieved November 2015, from http://www.photolib.noaa.gov/htmls/nerr0315.htm

NOAA. (2015g). *Kemp's ridley turtle (Lepidochelys kempii)*. Retrieved from http://www.nmfs.noaa.gov/pr/species/turtles/kempsridley.html

NOAA. (2015h). *National Oceanic and Atmospheric Administration*. Retrieved from Data Tools: 1981 - 2010 Normals: http://www.ncdc.noaa.gov/cdo-web/datatools/normals

NOAA. (2015i). *Kemp's ridley turtle (Lepidochelys kempii)*. Retrieved from http://www.nmfs.noaa.gov/pr/species/turtles/kempsridley.htm

NOAA. (2015j). *Leatherback turtle (Dermochelys coriacea)*. Retrieved from http://www.nmfs.noaa.gov/prot_res/species/turtles/leatherback.html

NOAA. (2016a). *Final Rule to List Eleven Distinct Population Segments of the Green Sea Turtle as Endangered and Threatened*. Retrieved from Federal Register: https://www.federalregister.gov/articles/2016/04/06/2016-07587/endangered-and-threatened-wildlife-and-plants-final-rule-to-list-eleven-distinct-population-segments

NOAA. (2016b). *Fact Sheet Green Turtle* . Retrieved from NOAA: http://www.nmfs.noaa.gov/pr/species/turtles/green.html

North Inlet-Winyah Bay. (2015). *About North Inlet-Winyah Bay*. Retrieved November 23, 2015, from http://www.northinlet.sc.edu/about/niwb.html

NPS. (1979). *Historic Resources of the Columbia Multiple Resource Area.* Retrieved January 27, 2016, from http://www.nationalregister.sc.gov/MPS/MPS008.pdf

NPS. (1988). *Historic Resources of St. Helena Island, c. 1740 - c. 1935 - MPS.* Washington: National Park Service.

NPS. (1995, July 12). *The Secretary of the Interior's Standards for the Treatment of Historic Properties and the Guidelines for the Treatment of Cultural Landscapes.* Retrieved September 4, 2015, from National Park Service: http://www.nps.gov/tps/standards/four-treatments/landscape-guidelines/index.htm

NPS. (2000). *Geologic Glossary.* Retrieved August 2015, from https://www.nature.nps.gov/geology/usgsnps/misc/glossaryDtoI.html#G

NPS. (2003, January 16). *History E-Library*. Retrieved October 20, 2015, from http://www.nps.gov/parkhistory/hisnps/NPSHistory/nomenclature.html

NPS. (2004). *Rocky Mountain National Park.* Retrieved September 1, 2015, from http://www.nps.gov/romo/learn/management/upload/romo_geo_overview.pdf

NPS. (2011, May 19). *Connecting with Native Americans*. Retrieved April 12, 2015, from http://www.nps.gov/history/tribes/Heritage_Areas.htm

NPS. (2012a, July 17). *The National Trails System Act*. Retrieved April 12, 2015, from http://www.nps.gov/nts/legislation.html

NPS. (2012b, June 28). *Flat Creek Natural Area and 40 Acre Rock*. Retrieved November 25, 2015, from http://www.nature.nps.gov/nnl/site.cfm?Site=FLCR-SC

NPS. (2012c, June 28). *National Natural Landmarks Program South Carolina*. Retrieved November 25, 2015, from http://www.nature.nps.gov/nnl/state.cfm?State=SC

NPS. (2012d). *South Carolina*. Retrieved November 2015, from National Natural Landmarks Program: http://www.nature.nps.gov/nnl/state.cfm?State=SC

NPS. (2013, December 10). *Geologic Hazards*. Retrieved September 1, 2015, from Geologic, Energy, and Mineral Resources: http://www.nature.nps.gov/geology/hazards/

NPS. (2014a, October 22). *National Natural Landmarks Program*. Retrieved April 21, 2015, from http://nature.nps.gov/nnl/index.cfm

NPS. (2014b, June). *National Park Service Press Release*. Retrieved June 2015, from http://www.nps.gov/news/release.htm?id=1601

NPS. (2014c, September). *National Register of Historic Places Program: Research*. Retrieved June 2015, from National Register of Historical Places: http://www.nps.gov/nr/research/

NPS. (2014d, September). *South Carolina*. Retrieved November 2015, from http://www.nps.gov/state/sc/index.htm

NPS. (2014e, June 16). *National Park Service Science of Sound*. Retrieved 07 22, 2015, from http://www.nature.nps.gov/sound/science.cfm

NPS. (2015a). *Geology of the Coastal Plain.* Retrieved April 2015, from http://www.nps.gov/cue/geology/geo_coastalplain.htm

NPS. (2015b). *Congaree National Park*. Retrieved November 2015, from http://www.nps.gov/cong/index.htm

NPS. (2015c). *Kings Mountain National Military Park*. Retrieved November 2015, from http://www.nps.gov/kimo/index.htm

NPS. (2015d). *National Heritage Areas*. Retrieved November 24, 2015, from http://www.nps.gov/maps/full.html?mapId=01a03739-ab0c-40eb-bc3d-6791d3bb67fa

NPS. (2015e, October 5). *Gullah/Geechee Cultural Heritage Corridor*. Retrieved October 5, 2015, from http://www.nps.gov/guge/learn/historyculture/index.htm

NPS. (2015f, April 27). *National Historic Landmarks Program*. Retrieved April 28, 2015, from http://www.nps.gov/nhl/INDEX.htm

NPS. (2015g). *Listing of National Historic Landmarks by State: South Carolina.* Retrieved November 25, 2015, from Recent & Selected NHL Designations: South Carolina: http://www.nps.gov/nhl/find/statelists/sc/SC.pdf

NPS. (2015h, November 24). *South Carolina*. Retrieved November 25, 2015, from http://www.nps.gov/state/sc/index.htm

NPS. (2015i, November 19). *Congaree National Park*. Retrieved November 25, 2015, from http://www.nps.gov/cong/index.htm

NPS. (2015j). *Wilderness*. Retrieved September 2015, from http://wilderness.nps.gov/faqnew.cfm

NPS. (2015k). *National Register of Historic Places Program: Fundamentals*. Retrieved September 23, 2015, from http://www.nps.gov/nr/national_register_fundamentals.htm

NPS. (2015l). *National Park Services*. Retrieved 2015, from http://www.nps.gov/nr/

NPS. (2015m). *National Heritage Areas: A Map of All the National Heritage Areas*. Retrieved May 2015, from National Park Service: http://www.nps.gov/maps/full.html?mapId=01a03739-ab0c-40eb-bc3d-6791d3bb67fa

NPS. (2015n). *National Park Service, Find A Park - South Carolina*. Retrieved November 2015, from http://www.nps.gov/state/sc/index.htm

NPS. (2015o, February 18). *National Historic Landmarks Program.* Retrieved May 2016, from https://www.nps.gov/nhl/

NPS. (2016, June). *National Historic Landmarks Program*. Retrieved from https://www.nps.gov/nhl/learn/intro.htm

NRCS. (1996a). *Soil Quality Resource Concerns: Soil Erosion*. Retrieved September 2015, from http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051278.pdf

NRCS. (1996b). *Soil Quality Resource Concerns: Compaction*. Retrieved September 2015, from http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051594.pdf

NRCS. (1999). *Soil Taxonomy A Basic System of Soil Classification for Making and Interpreting Soil Surveys.* Retrieved from http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051232.pdf

NRCS. (2000, March). *Soil Quality - Urban Technical Note No. 1.* Retrieved from Erosion and Sedimentation on Construction Sites: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053285.pdf

NRCS. (2003). *Soil Compaction: Detection, Prevention, and Alleviation*. Retrieved September 2015, from http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053258.pdf

NRCS. (2006). *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.* Retrieved May 2015, from Major Land Resource Area: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051845.pdf

NRCS. (2009). *Protecting pollinators*. Retrieved from http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mt/newsroom/photos/?cid=nrcs144p2_057907

NRCS. (2015a). *STATSGO2 Database.* Retrieved June 2015, from http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

NRCS. (2015b). *What is Soil?* Retrieved June 2015, from Soil Education: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054280

NRCS. (2015c). *Hydric Soils -- Introduction.* Retrieved June 2015, from http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/?cid=nrcs142p2_053961

NRCS. (2015d). *Twelve Orders of Soil Taxonomy*. Retrieved August 2015, from Soils: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053588

NRCS. (2015e). *Using Soil Taxonomy to Identify Hydric Soils.* Retrieved July 2015, from http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_010785.pdf

NRCS. (2015f). *Erosion*. Retrieved September 2015, from http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/erosion/

NTFI. (2005). *Why Can't We Talk? Working Together to Bridge the Communications Gap to Save Lives: A Guide for Public Officials.* U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. National Task Force on Interoperability (NTFI). Retrieved from https://www.ncjrs.gov/pdffiles1/nij/204348.pdf

NTIA. (2005, October). *Interference Protection Criteria Phase 1 - Compilation from Existing Sources.* Retrieved January 6, 2016, from NTIA Report 05-432: https://www.ntia.doc.gov/files/ntia/publications/ipc_phase_1_report.pdf

NTIA. (2014). *Download Data.* Retrieved from National Broadband Map: http://www.broadbandmap.gov/data-download

NWS. (2011a, October 21). *National Weather Service: JetStream - Online School for Weather*. Retrieved from National Oceanic and Atmospheric Administration: http://www.srh.noaa.gov/jetstream//global/climate.htm#map

NWS. (2011b, October 21). *National Weather Service: JetStream - Online School for Weather*. Retrieved from National Oceanic and Atmospheric Administration: http://www.srh.noaa.gov/jetstream//global/climate_max.htm

NWS. (2015, June 10). *Office of Climate, Water, and Weather Services*. Retrieved November 16, 2015, from 2014 Summary of Hazardous Weather Fatalities, Injuries, and Damage by State: http://www.nws.noaa.gov/om/hazstats/state14.pdf

Olcott, P. G. (1995a). *Carbonate-Rock Aquifers, HA 730-M*. Retrieved May 5, 2015, from http://pubs.usgs.gov/ha/ha730/ch_m/M-text4.html

Olcott, P. G. (1995b). *Sandstone Aquifers, HA-730-M*. Retrieved May 5, 2015, from http://pubs.usgs.gov/ha/ha730/ch_m/M-text5.html

Oregon Department of Geology. (2015). *Earthquake Hazards in the Pacific Northwest*. Retrieved March 2015, from http://www.oregongeology.org/sub/earthquakes/EQs.htm

OSHA. (2002). *Occupational Safety & Health Administration We Can Help*. Retrieved from Hearing Conservation: https://www.osha.gov/Publications/OSHA3074/osha3074.html

OSHA. (2003). *Fact Sheets on Natural Disaster Recovery: Flood Cleanup.* Retrieved December 2013, from https://www.osha.gov/OshDoc/data_Hurricane_Facts/Bulletin2.pdf

OSHA. (2013). *OSHA Technical Manual - Noise.* Retrieved from https://www.osha.gov/dts/osta/otm/new_noise/index.pdf

OSHA. (2015a). *South Carolina State Plan*. Retrieved November 13, 2015, from https://www.osha.gov/dcsp/osp/stateprogs/south_carolina.html

OSHA. (2015b). *Communication Towers*. Retrieved from https://www.osha.gov/doc/topics/communicationtower/index.html

OSHA. (2015c). *Occupational Safety & Health Administration We Can Help*. (S. L. OSHA Directorate of Technical Support and Emergency Management, & U. Salt Lake City, Editors) Retrieved September 22, 2015, from Safety & Health Management System Tools: https://www.osha.gov/SLTC/etools/safetyhealth/comp3.html#Safe Work Practices

OSHA. (2016a, March 28). *Regulations (Standards - 29 CFR).* Retrieved from Occupational Safety & Health Administration: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9867

OSHA. (2016b). *Restoring Communications Systems*. Retrieved February 16, 2016, from Infrastructure Repair and Restoration: https://www.osha.gov/SLTC/etools/hurricane/communications.html

OSHA. (2016c). *OSHA Technical Manual: Noise.* Retrieved May 2016, from Section III: Chapter 5: https://www.osha.gov/dts/osta/otm/new_noise/

OSHA. (2016d, May 29). *Section V: Chapter 2, Excavations: Hazard Recognition in Trenching and Shoring.* Retrieved from https://www.osha.gov/dts/osta/otm/otm_v/otm_v_2.html

Page, S. D. (2012, October 15). Timely Processing of Prevention of Significant Deterioration (PSD) Permits when EPA or a PSD-Delegated Air Agency Issues the Permit. Retrieved April 21, 2015, from https://www.epa.gov/nsr/timely-processing-prevention-significant-deterioration-psd-permits-when-epa-or-psd-delegated-air

Pauketat, T. R. (2012). *The Oxford Handbook of North American Archaeology.* New York, New York: Oxford University Press, Inc.

Poston, J. H. (1997). *The Buildings of Charleston.* Columbia: University of South Carolina Press.

ProximityOne. (2015). *State Population Projections, Outlook 2030*. Retrieved March 2015, from https://proximityone.wordpress.com/2013/12/19/state-population-projections-2030/

PSC. (2015, November). *Frequently Asked Questions for Residential Electric Consumers*. Retrieved November 2015, from Public Service Commission: http://www.psc.sc.gov/Documents/Consumer%20Information/Frequently%20Asked%20Questions%20for%20Residential%20Electric%20Consumers.pdf

PSCR. (2015). *Location-Based Services R&D Roadmap.* Retrieved from http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1883.pdf

Purdue University. (2015). *Hydrologic Soil Groups.* Retrieved June 2015, from https://engineering.purdue.edu/mapserve/LTHIA7/documentation/hsg.html

Purdue University Consumer Horticulture. (2006). *What is Loam?* Retrieved May 19, 2016, from https://hort.purdue.edu/ext/loam.html

Radbruch-Hall, D., Colton, R., Davies, W., Lucchitta, I., Skipp, B., & Varnes, D. (1982). *Landslide Overview Map of the Conterminous United States.* Retrieved November 2015, from http://pubs.usgs.gov/pp/p1183/pp1183.html

RadioReference.com. (2015a, November 12). *Abbeville County South Carolina*. Retrieved November 12, 2015, from http://www.radioreference.com/apps/db/?ctid=2313#cid-19398

RadioReference.com. (2015b, November 12). *York County South Carolina*. Retrieved November 12, 2015, from http://www.radioreference.com/apps/db/?ctid=2358

Rapport, M. (2007). *Aquatic Invasive Species: SC's Most Wanted*. Retrieved from SCDNR Aquatic Nuisance Species Program: www.dnr.sc.gov/invasiveweeds/invaders2.html

Rogers, D. J., Olshansky, R., & Rogers, B. R. (2004). *Damage to Foundations From Expansive Soils*. Retrieved March 23, 2015, from http://web.mst.edu/~rogersda/expansive_soils/DAMAGE%20TO%20FOUNDATIONS%20FROM%20EXPANSIVE%20SOILS.pdf

Sacramento County Airport System. (2015). *Sacramento County Airport System Noise Page*. Retrieved 6 10, 2015, from http://www.sacramento.aero/scas/environment/noise/noise_101/

Sassaman, K. E. (1994). Production for Exchange in the Mid-Holocene Southeast: a Savannah River Valley Example. *Lithic Technology, 19*(1), 42-51. Retrieved November 2015, from http://www.jstor.org/stable/23272912

Sassaman, K. E., Hanson, T, G., & Charles, T. (1988). Raw Material Procurement and the Reduction of Hunter-Gatherer Range in the Savannah River Valley. *Southeastern Archaeology, 7*(2), 79-94. Retrieved November 2015, from http://www.jstor.org/stable/40712876

SC Department of Commerce. (2008). *South Carolina State Rail Plan 2008 Update.* Retrieved 11 17, 2015, from http://sccommerce.com/sites/default/files/document_directory/Rail_Plan_-_South_Carolina_State_Rail_Plan_2008_Part_3_Existing_System_Wilbur_Smith_Associates_2009.pdf

SC Legislature. (2016). *South Carolina Legislature*. Retrieved August 5, 2016, from Bill Search: http://www.scstatehouse.gov/billsearch.php

SCDHEC. (2012, May 24). *State of South Carolina Integrated Report for 2012.* Retrieved November 23, 2015, from http://www.scdhec.gov/HomeAndEnvironment/Docs/tmdl_12-303d.pdf

SCDHEC. (2013). *Solid Waste Management Annual Report Fiscal Year 2013*. Retrieved November 2015, from Department of Health and Environmental Control: http://www.scdhec.gov/library/CR-010906.pdf

SCDHEC. (2014a). *State of South Carolina Integrated Report for 2014.* Retrieved November 19, 2015, from http://www.scdhec.gov/HomeAndEnvironment/Docs/tmdl_14-305b.pdf

SCDHEC. (2014b, December). *South Carolina Nonpoint Source Management Program 2014 Annual Report.* Retrieved November 23, 2015, from https://www.scdhec.gov/HomeAndEnvironment/Docs/319npsannual.pdf

SCDHEC. (2014c). *Environmental Public Health Tracking - FAQ*. Retrieved November 13, 2015, from https://www.scdhec.gov/Health/SCPublicHealthStatisicsMaps/EnvironmentalPublicHealthTracking/OverviewEPHT/

SCDHEC. (2014d). *Superfund*. Retrieved November 12, 2015, from https://www.scdhec.gov/HomeAndEnvironment/Pollution/CleanUpPrograms/StateRemediation/

SCDHEC. (2014e). *Brownfields/Voluntary Cleanup Program & Loan Fund*. Retrieved November 13, 2015, from https://www.scdhec.gov/HomeAndEnvironment/Pollution/CleanUpPrograms/BrownfieldsCleanupLoanFund/

SCDHEC. (2014f). *Seaco Site - Overview.* Retrieved November 13, 2015, from https://www.scdhec.gov/HomeAndEnvironment/Pollution/CleanUpPrograms/OngoingProjectsUpdates/SeacoSite/Overview/

SCDHEC. (2014g). *Seaco Site - Brownfields Contract.* Retrieved November 13, 2015, from https://www.scdhec.gov/HomeAndEnvironment/Pollution/CleanUpPrograms/OngoingProjectsUpdates/SeacoSite/BrownfieldsContracts/

SCDHEC. (2014h). *SC Environmental Public Health Tracking*. Retrieved November 24, 2015, from http://www.scdhec.gov/Health/SCPublicHealthStatisicsMaps/EnvironmentalPublicHealthTracking/

SCDHEC. (2014i, July). *South Carolina Public Water System Compliance Report*. Retrieved November 2015, from Department of Health and Environmental Control: https://www.scdhec.gov/HomeAndEnvironment/docs/ACR2013.pdf

SCDHEC. (2015a, November). *Regulations*. Retrieved November 2015, from Department of Health and Environmental Control: https://www.scdhec.gov/HomeAndEnvironment/YourHomeEnvironmentalandSafetyConcerns/DrinkingWaterConcerns/Regulations/

SCDHEC. (2015b, November). *Testing Your Drinking Water*. Retrieved November 2015, from Department of Health and Environmental Control: https://www.scdhec.gov/HomeAndEnvironment/YourHomeEnvironmentalandSafetyConcerns/DrinkingWaterConcerns/TestingYourWater/#CCR

SCDHEC. (2015c, November). *Overview: 'Discharged from a Pipe' NPDES*. Retrieved November 2015, from Department of Health and Environmental Control: http://www.scdhec.gov/Environment/WaterQuality/NPDES/Overview/

SCDHEC. (2015d, November). *NPDES General Permit Program*. Retrieved November 2015, from Department of Health and Environmental Control: http://www.scdhec.gov/Environment/WaterQuality/NPDES/GeneralPermit/

SCDHEC. (2015e, June 26). *Air Pollution Control Regulations and Standards.* Retrieved November 25, 2015, from South Carolina DHEC: http://www.scdhec.gov/Agency/docs/air-regs/R61-62_5Std2-74.pdf

SCDHEC. (2015f, November). *Landfill Classifications and General Requirements*. Retrieved November 2015, from Department of Health and Environmental Control: http://www.scdhec.gov/HomeAndEnvironment/Land/Landfills/LandfillClassifications/

SCDHEC. (2015g, October). *Bureau of Air Quality Exemption List.* Retrieved November 25, 2015, from South Carolina DHEC: http://www.scdhec.gov/Environment/docs/NewExemptions.pdf

SCDHEC. (2015h, November). *Annual Air Network Monitoring Plan for 2015.* Retrieved November 25, 2015, from South Carolina DHEC: https://www.scdhec.gov/HomeandEnvironment/docs/air_AmbientAirMonitoringPlan.PDF

SCDHEC. (2015i, November). *Ambient Air Monitoring Network.* Retrieved November 25, 2015, from South Carolina DHEC: https://www.scdhec.gov/HomeAndEnvironment/Air/AmbientAir/

SCDHEC. (2015j). *South Carolina's Coast*. Retrieved June 1, 2016, from Coastal Environment: http://www.scdhec.gov/HomeAndEnvironment/Water/YourCoastalEnvironment/

SCDHEC. (2015k). *Santee River*. Retrieved November 19, 2015, from https://www.scdhec.gov/HomeAndEnvironment/Water/Watersheds/WatershedMap/SanteeWatershed/SanteeRiverBasin/

SCDHEC. (2015l, June 26). *South Carolina DHEC Regulation 61-62 Air Pollution Control Regulations and Standards.* Retrieved November 25, 2015, from South Carolina DHEC: http://www.scdhec.gov/Agency/docs/air-regs/r_61-62.pdf

SCDHEC. (2015n). *Santee River/Lake Marion.* Retrieved November 23, 2015, from https://www.scdhec.gov/HomeandEnvironment/docs/03050111-01.pdf

SCDHEC. (2015o). *2015 South Carolina Fish Consumption Advisories.* Retrieved November 23, 2015, from http://www.scdhec.gov/library/ml-004042.pdf

SCDHEC. (2015p, November). *Facilities*. Retrieved November 2015, from Department of Health and Environmental Control: http://www.scdhec.gov/Environment/docs/SW%20FAC%20LIST%20by%20Facility%20Type.pdf

SCDHEC. (2015q). *Great Pee Dee River*. Retrieved November 19, 2015, from https://www.scdhec.gov/HomeAndEnvironment/Water/Watersheds/WatershedMap/PeeDeeWatershed/GreatPeeDeeRiver/

SCDNR. (2005a). *South Carolina Comprehensive Wildlife Conservation Strategy*. Retrieved from http://www.dnr.sc.gov/cwcs/plan/Chapter2.pdf

SCDNR. (2005b). *Migratory shorebird guide.* Retrieved from http://www.dnr.sc.gov/cwcs/pdf/Migratoryshorebirdguild.pdf

SCDNR. (2005c). *Wood stork species summary.* Retrieved from http://www.dnr.sc.gov/cwcs/pdf/Woodstork.pdf

SCDNR. (2005d). *Pond breeding amphibian guide.* Retrieved from http://www.dnr.sc.gov/cwcs/pdf/PondBreedingAmp.pdf

SCDNR. (2005e). *Species summary for the Carolina heelsplitter.* Retrieved from http://www.dnr.sc.gov/cwcs/pdf/CarolinaHeelsplitter.pdf

SCDNR. (2008). *South Carolina Aquatic Invasive Species.* Retrieved from http://www.dnr.sc.gov/invasiveweeds/aisfiles/SCAISplan.pdf

SCDNR. (2009). *South Carolina State Water Assessment.* Retrieved November 19, 2015, from http://www.dnr.sc.gov/water/hydro/HydroPubs/assessment.htm

SCDNR. (2012). *Geologic Hazards of the South Carolina Coastal Plain.* Retrieved from South Carolina Department of Natural Resources: http://www.dnr.sc.gov/geology/Pubs/GGMS/GGMS_Web_Pamphlet.pdf

SCDNR. (2013). *Climate Change Impacts to Natural Resources in South Carolina.*

SCDNR. (2014a). *South Carolina Lakes and Waterways*. Retrieved November 19, 2015, from http://www.dnr.sc.gov/lakes/

SCDNR. (2014b). *Lake Marion*. Retrieved November 20, 2015, from http://www.dnr.sc.gov/lakes/marion/description.html

SCDNR. (2014c). *Lake Moultrie*. Retrieved November 20, 2015, from http://www.dnr.sc.gov/lakes/moultrie/description.html

SCDNR. (2014d). *Lake Murray*. Retrieved November 20, 2015, from http://www.dnr.sc.gov/lakes/murray/description.html

SCDNR. (2014e). *Lake Hartwell*. Retrieved November 20, 2015, from http://www.dnr.sc.gov/lakes/hartwell/description.html

SCDNR. (2014f). *ACE Basin NERR*. Retrieved November 23, 2015, from http://www.dnr.sc.gov/marine/NERR/

SCDNR. (2014g). *Scenic Rivers Act*. Retrieved November 23, 2015, from http://dnr.sc.gov/water/river/act.html

SCDNR. (2014h). *Rare, threatened, and endangered species and communities known to occur in South Carolina.* Retrieved from http://dc.statelibrary.sc.gov/bitstream/handle/10827/16178/DNR_Rare_Threatened_Endangered_Species_DNR_Heritage_2014-06-11.pdf?sequence=1&isAllowed=y

SCDNR. (2014i). *State rank conservation status rank definitions*. Retrieved from http://www.dnr.sc.gov/species/staterank.html

SCDNR. (2014j). *South Carolina State Wildlife Action Plan.* Retrieved from http://www.dnr.sc.gov/swap/main/2015StateWildlifeActionPlan-chaptersonly.pdf

SCDNR. (2014k). *DNR Managed Lands*. Retrieved November 29, 2015, from http://www.dnr.sc.gov/mlands/hpprogram.html

SCDNR. (2014l). *Feral hog damage and disease*. Retrieved from http://www.dnr.sc.gov/wildlife/hog/damage.html

SCDNR. (2015a). *Piedmont Ecoregion Aquatic Habitats.* Retrieved November 2015, from http://webcache.googleusercontent.com/search?q=cache:dxFBYKfZRF8J:https://www.dnr.sc.gov/cwcs/pdf/habitat/PiedmontAquatic.pdf+&cd=4&hl=en&ct=clnk&gl=us

SCDNR. (2015b). *Carolina Bays*. Retrieved November 2015, from http://www.dnr.sc.gov/wildlife/wetlands/carolinabays.html

SCDNR. (2015c, June 26). *Life's Better Outdoors - Golden Eagle*. Retrieved from dnr.sc.gov: http://www.dnr.sc.gov/news/yr2015/june25/june25_eagle.html

SCDNR. (2015d). *Sea turtle information in South Carolina.* Retrieved from http://www.dnr.sc.gov/cwcs/pdf/ResidentJuvenileSeaTurtleGuild.pdf

SCDNR. (2015e). *Sea turtles in South Carolina*. Retrieved from http://www.dnr.sc.gov/marine/pub/seascience/seaturtle.html

SCDNR. (2015f). *Scenic Rivers - Overview*. Retrieved November 29, 2015, from http://myscmap.sc.gov/water/river/overview.html

SCDNR. (2015g). *Hunting*. Retrieved from http://www.dnr.sc.gov/hunting.html

SCDNR. (2015h). *Alligators in South Carolina*. Retrieved from http://www.dnr.sc.gov/wildlife/herps/alligator.html

SCDNR. (2015i). *Wildlife Species*. Retrieved from http://www.dnr.sc.gov/wildlife/species.html

SCDNR. (2016a). *Wild Pigs.* Retrieved from South Carolina Species Information: www.dnr.sc.gov/wildlife/publications/nuisance/wildpigs.pdf

SCDNR. (2016b). *South Carolina Comprehensive Wildlife Conservation Strategy.* Retrieved from South Carolina Department of Natural Resources: http://www.nrc.gov/docs/ML1001/ML100110509.pdf

SCDNR. (2016c). *Common Snakes in South Carolina*. Retrieved from http://www.dnr.sc.gov/wildlife/herps/snakes.html

SCDOT. (2014, August). *SC Statewide Rail Plan*. Retrieved October 31, 2015, from http://www.scdot.org/multimodal/pdf/sc_mtp_rail_plan.pdf

SCDOT. (2015a). *Annual Report*. Retrieved October 31, 2015, from http://www.scstatehouse.gov/reports/DOT/2015SCDOTAnnualReport.pdf

SCDOT. (2015b, October). *State and National Scenic Byways*. Retrieved October 31, 2015, from http://www.scdot.org/getting/scenic_byways/index.aspx

SCEMD. (2013, October). *State Hazard Mitigation Plan.* Retrieved November 23, 2015, from http://www.scemd.org/files/Mitigation/State_Hazard_Mitigation_Plan/1_SHMP_FINAL_2013.pdf

SCEPPC. (2014a). *Terrestrial exotic invasive plant species list.* Retrieved from http://www.se-eppc.org/southcarolina/SCEPPC_LIST2014finalOct.pdf

SCEPPC. (2014b). *South Carolina Exotic Pest Plant Council Terrestrial Exotic Invasive Plant Species List 2014.* Retrieved from South Carolina Exotic Pest Plant Council Terrestrial Exotic Invasive Plant Species List 2014: http://www.se-eppc.org/southcarolina/SCEPPC_LIST2014finalOct.pdf

SCPorts. (2015a, November). *About the Port*. Retrieved November 2015, from Port of Charleston: http://www.scspa.com/about/

SCPorts. (2015b, November). *Port of Georgetown*. Retrieved November 2015, from South Carolina Ports: http://www.port-of-charleston.com/cargo-facilities-georgetown.asp

SCPorts. (2015c, November). *Charleston Terminals*. Retrieved November 2015, from South Carolina Ports: http://www.port-of-charleston.com/cargo-facilities-charleston-terminals-terminals.asp

SCPorts. (2015d, November). *Rail Connections*. Retrieved November 2015, from South Carolina Ports: http://www.scspa.com/cargo/logistics/rail-connections/

SCPorts. (2015e, November). *Highway Connections*. Retrieved November 2015, from South Carolina Ports: http://www.scspa.com/cargo/logistics/highway-connections/

SCPorts. (2015f, November). *Port of Georgetown*. Retrieved November 2015, from South Carolina Ports: http://www.port-of-charleston.com/cargo-facilities-georgetown.asp

SCWRC. (1972). *The Port Royal Sound Ecosystem - A Review.* Retrieved November 23, 2015, from The Port Royal Sound Environmental Study: http://oldweb.bcgov.net/councilcentral/Reports.Studies/Stormwater%20and%20Drainage/1972%20Chapter%203G.pdf.

Sharitz, R., & Gibbons, J. (1982). *The ecology of southeastern shrub bogs (pocosins)) and Carolina bays: a community profile.* Retrieved from http://www.nwrc.usgs.gov/wdb/pub/others/82_04.pdf

Slade, D. (2014, July). *Flooding rising with sea levels in Charleston*. Retrieved from The Post and Courier: http://www.postandcourier.com/article/20140728/PC16/140729369

Smithsonian Institution. (2016). *Glossary -- Courtesy of the Department of Paleobiology, National Museum of Natural History, Washington, DC*. Retrieved May 2016, from http://paleobiology.si.edu/geotime/main/glossary.html#T

South Carolina Aeronautics. (2011a). *South Carolina Aeronautics*. Retrieved November 2015, from http://www.scaeronautics.com/default.asp

South Carolina Aeronautics. (2011b). *South Carolina Aeronautics, State Airport Safety Data Program*. Retrieved November 2015, from http://www.scaeronautics.com/SafetyData.asp

South Carolina Association of Counties. (2016). *SC Counties*. Retrieved from http://www.sccounties.org/sc-counties

South Carolina Department of Administration. (2015, November 12). *Palmetto Radio System* . Retrieved November 12, 2015, from http://www.admin.sc.gov/technology/technology-operations/palmetto-800

South Carolina Department of Archives and History. (2016). *Why are we Looking at That?: Mid-Century and Modern Architecture in South Carolina.* Retrieved January 27, 2016, from http://shpo.sc.gov/research/Documents/WhyThat.pdf

South Carolina Department of Parks, Recreation, and Tourism. (2015a). *City of Myrtle Beach*. Retrieved November 2015, from http://discoversouthcarolina.com/products/10035

South Carolina Department of Parks, Recreation, and Tourism. (2015b). *Lowcountry & Resort Islands Tourism Commission*. Retrieved November 2015, from http://discoversouthcarolina.com/products/5191

South Carolina Emergency Management Division. (2012). *South Carolina Earthquake Guide.* Retrieved November 2015, from http://scearthquakes.cofc.edu/pdf/EQGuide2012.pdf

South Carolina Emergency Management Division. (2015). *Earthquakes.* Retrieved November 2015, from http://www.scemd.org/planandprepare/disasters/earthquakes

South Carolina Environmental Justice Advisory Committee. (2009). *South Carolina Environmental Justice Advisory Committee Final Report.* Retrieved November 2015, from http://www.scstatehouse.gov/archives/dhec/EJAdvisoryFinalReportCombined.pdf

South Carolina Forestry Commission. (2015). *State Forest Recreation*. Retrieved November 29, 2015, from http://www.state.sc.us/forest/recreat.htm

South Carolina Forestry Commission. (2016). *Protecting South Carolina's Forests from Harm*. Retrieved from South Carolina Forest Resource Assessment and Strategy: www.state.sc.us/forest/fra-pro.htm

South Carolina Geological Survey. (1999). *Cenozoic Stratigraphic Column of the Coastal Plain of South Carolina.* Retrieved November 2015, from http://www.dnr.sc.gov/geology/Pubs/GGC/GGC1_Cenozoic_Stratigraphic_Column.pdf

South Carolina Geological Survey. (2005). *Generalized Geologic Map of South Carolina.* Retrieved November 2015, from http://www.dnr.sc.gov/geology/Pubs/GGMS/GGMS1.pdf

South Carolina Geological Survey. (2012). *Geologic Hazards of the South Carolina Coastal Plain.* Retrieved November 2015, from http://www.dnr.sc.gov/geology/Pubs/GGMS/GGMS5.pdf

South Carolina Geological Survey. (2015). *Geology of South Carolina*. Retrieved November 2015, from http://scdnr.maps.arcgis.com/apps/Viewer/index.html?appid=735411a2f5714f28a424422296f77bb1

South Carolina Legislature. (2015). *Code of Laws, Title 55. Aeronautics, Chapter 9. South Carolina Airports Act* . Retrieved November 2015, from http://www.scstatehouse.gov/query.php?search=DOC&searchtext=hazard&category=CODEOFLAWS&conid=8036325&result_pos=&keyval=1109&numrows=10

South Carolina Scenic Byways. (2015). *State & National Scenic Byways*. Retrieved November 29, 2015, from http://www.dot.state.sc.us/getting/Scenic_Byways/index.aspx

South Carolina State Climatology Office. (2015). *South Carolina Climate*. Retrieved from http://www.dnr.sc.gov/climate/sco/ClimateData/cli_sc_climate.php#tropical

South Carolina State Library. (2015). *South Carolina Information: SC History and Culture*. Retrieved September 21, 2015, from http://statelibrary.sc.libguides.com/sc-information/sc-history-culture

South Carolina State Library. (2016, January 27). *A Brief History of South Carolina*. Retrieved January 27, 2016, from http://statelibrary.sc.libguides.com/sc-information/sc-history-culture

South Carolina State Parks. (2015a). *Historic Sites*. Retrieved November 30, 2015, from http://www.southcarolinaparks.com/historic-sites/default.aspx

South Carolina State Parks. (2015b). *Our Mission*. Retrieved November 29, 2015, from http://www.southcarolinaparks.com/our-mission/default.aspx

South Carolina State Trails Program. (2008, August 25). *About the Trails Program*. Retrieved November 30, 2015, from http://www.sctrails.net/trails/TRAILSPROGRAM/About%20Trails%20Program/AboutTrails.html

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr., C. R., . . . Tyack, P. L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals*.

Stalter, R., Leyva, M., & Kincaid, D. T. (1999, September). The Flora of Indian Shell Rings from Coastal South Carolina to Northern Florida. *SIDA, Contributions to Botany, 18*(3), 861-875. Retrieved November 2015, from http://www.jstor.org/stable/41968907

State Symbol USA. (2016). *State Nicknames*. Retrieved from http://www.statesymbolsusa.org/categories/nickname

The Paleontology Portal. (2015). *South Carolina, US*. Retrieved November 2015, from Time & Space: http://paleoportal.org/index.php?globalnav=time_space&sectionnav=state&name=South%20Carolina

Thompson, W. (2015). *Surficial Geology Handbook for Southern Maine*. Retrieved July 2015, from http://www.maine.gov/dacf/mgs/explore/surficial/sghandbook/surficial_geology_handbook_for_southern_maine.pdf

U.S. Army. (2015). *History of Fort Jackson*. Retrieved January 27, 2016, from http://jackson.armylive.dodlive.mil/post/museum/history-post-wwii/

U.S. Bureau of Justice Statistics. (2011, July 26). *Census of State and Local Law Enforcement Agencies*. Retrieved from http://www.bjs.gov/index.cfm?ty=pbdetail&iid=2216

U.S. Census Bureau. (2006). *Government Finance and Employment Classification Manual*. Retrieved July 2015, from http://www2.census.gov/govs/pubs/classification/2006_classification_manual.pdf

U.S. Census Bureau. (2012). *2010 Census Urban and Rural Classification and Urban Area Criteria*. Retrieved June 2015, from http://www2.census.gov/geo/docs/reference/ua/ua_st_list_all.xls

U.S. Census Bureau. (2013, February). *Metropolitan Statistical Areas of South Carolina*. Retrieved October 31, 2015, from U.S. Census Bureau: http://www2.census.gov/geo/maps/metroarea/stcbsa_pg/Feb2013/cbsa2013_SC.pdf

U.S. Census Bureau. (2014, November 15). *Definitions of American Indian and Alaska Native Geographic Areas*. Retrieved November 15, 2015, from https://www.census.gov/geo/partnerships/aian_tsap.html

U.S. Census Bureau. (2015a). *State Area Measurements and Internal Point Coordinates*. Retrieved September 14, 2015, from http://www.census.gov/quickfacts/table/PST045215/45

U.S. Census Bureau. (2015b). *Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014.* Washington, D.C.: US. Census Bureau, Population Division. Retrieved from https://www.census.gov/popest/data/cities/totals/2015/files/SUB-EST2015_45.csv

U.S. Census Bureau. (2015c, May 28). *U.S. Census Bureau*. Retrieved May 21, 2015, from State and County Quickfacts: http://www.census.gov/quickfacts/table/PST045215/45,00

U.S. Census Bureau. (2015d). *Population Estimates Program, 2010-2014 Data*. Retrieved March 2015, from http://www.census.gov/popest/data/national/totals/2014/NST-EST2014-alldata.html

U.S. Census Bureau. (2015e). *2010 Census Summary File 1, Table GCT-PH1, Population, Housing Units, Area, and Density*. (Obtained via Census Bureau online American FactFinder tool) Retrieved June 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_GCTPH1.US01PR&prodType=table

U.S. Census Bureau. (2015f). *American Community Survey, 2009-2013 5-Year Summary File, Table B02001, Race*. (Obtained via Census Bureau online DataFerrett tool) Retrieved April 2015, from http://dataferrett.census.gov/

U.S. Census Bureau. (2015g). *2010 Census Urban and Rural Classification and Urban Area Criteria*. Retrieved June 2015, from http://www.census.gov/geo/reference/ua/urban-rural-2010.html

U.S. Census Bureau. (2015h). *Census 2000 Summary File 1 (SF 1), Table P001, Total Population*. (Obtained via Census Bureau online American FactFinder tool) Retrieved July 2015, from http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

U.S. Census Bureau. (2015i). *American Community Survey, 2009-2013 5-Year Estimates, Table DP05, Demographic and Housing Estimates*. (Obtained via Census Bureau online American FactFinder tool) Retrieved August 2015, from http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

U.S. Census Bureau. (2015j). *Small Area Income and Poverty Estimates (SAIPE), 2013*. Retrieved March 2015, from http://www.census.gov/did/www/saipe/data/statecounty/data/2013.html

U.S. Census Bureau. (2015k). *American Community Survey, 2013 1-Year Estimates, Table DP02, Selected social characteristics*. (Obtained via Census Bureau online American FactFinder tool) Retrieved April 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_DP02&prodType=table

U.S. Census Bureau. (2015l). *American Community Survey, 2013 1-Year Estimates, Table S1902, Mean Income in the Past 12 Months (in 2013 Inflation-Adjusted Dollars).* (Obtained via Census Bureau online American FactFinder tool) Retrieved April 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_S1902&prodType=table

U.S. Census Bureau. (2015m). *2009-2013 American Community Survey 5-Year Estimates, Table DP03: Selected economic characteristics*. (Obtained via Census Bureau online American

FactFinder tool) Retrieved April, July 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_5YR_DP03&prodType=table

U.S. Census Bureau. (2015n). *American Community Survey, 2013 1-year Estimates, Table DP03, Selected economic characteristics*. (Obtained via Census Bureau online American FactFinder tool) Retrieved June 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_DP03&prodType=table

U.S. Census Bureau. (2015o). *American Community Survey and Puerto Rico Community Survey 2013 Subject Definitions*. Retrieved April 2015, from http://www2.census.gov/programs-surveys/acs/tech_docs/subject_definitions/2013_ACSSubjectDefinitions.pdf

U.S. Census Bureau. (2015p). *American Community Survey, 2013 1-Year Estimates, Table DP04, Selected housing characteristics*. (Obtained via Census Bureau online American FactFinder tool) Retrieved April 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_1YR_DP04&prodType=table

U.S. Census Bureau. (2015q). *American Community Survey, 2009-2013 5-year Estimates, Table DP04, Selected housing characteristics*. (Obtained via Census Bureau online American FactFinder tool) Retrieved April, July 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_5YR_DP04&prodType=table

U.S. Census Bureau. (2015r). *2012 Census of Governments: Finance – Surveys of State and Local Government Finances, Table LGF001*. (Obtained via Census Bureau online American FactFinder tool) Retrieved June 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=COG_2012_LGF001&prodType=table

U.S. Census Bureau. (2015s). *American Community Survey, 2012 1-Year Estimates, Table B01003: Total Population*. (Obtained via Census Bureau online American FactFinder tool) Retrieved June 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_1YR_B01003&prodType=table

U.S. Census Bureau. (2015t). *American Community Survey, 2013 1-Year Estimates, Table DP05, Demographic and Housing Estimates*. (Obtained via Census Bureau online American FactFinder tool) Retrieved August 31, 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_DP05&prodType=table

U.S. Census Bureau. (2015u). *American Community Survey, 2013 1-Year Estimates, Table S1701: Poverty Status in the Past 12 Months*. (Obtained via Census Bureau online American FactFinder tool) Retrieved August 31, 2015, from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_S1701&prodType=table

U.S. Census Bureau. (2015v). *American Community Survey, 2009-2013 5-Year Summary File, Table B03002, Hispanic or Latino Origin by Race*. (Obtained via Census Bureau online DataFerrett tool) Retrieved April 2015, from http://dataferrett.census.gov

U.S. Census Bureau. (2015w). *American Community Survey, 2009-2013 5-Year Summary File, Table B17021, Poverty Status of Individuals in the Past 12 Months by Living*

Arrangement. (Obtained via Census Bureau online DataFerrett tool) Retrieved April 2015, from http://dataferrett.census.gov

U.S. Census Bureau. (2015x). *American Community Survey, 2009-2013 5-Year Summary File, Table C17002, Ratio of Income to Poverty Level in the Past 12 Months*. (Obtained via Census Bureau online DataFerrett tool) Retrieved May 2015, from http://dataferrett.census.gov

U.S. Census Bureau. (2015y). *Resident Population of the 50 States, the District of Columbia, and Puerto Rico: Census 2000*, •Resident Population of the 50 States, the District of Columbia, and Puerto Rico: Census 2000. Retrieved March 2015, from https://www.census.gov/population/www/cen2000/maps/respop.html

U.S. Census Bureau. (2015z, March 11). *Foreign Trade*. Retrieved March 2015, from United States Census Bureau: http://www.census.gov/foreign-trade/Press-Release/2013pr/12/ft920/index.html

U.S. Census Bureau. (2016). *American Community Survey (ACS)*. Retrieved March 2016, from http://www.census.gov/programs-surveys/acs/

U.S. Coast Guard. (2015a, December 31). *National Response Center (2015 Reports).* Retrieved March 24, 2016, from http://www.nrc.uscg.mil/FOIAFiles/CY15.xlsx

U.S. Coast Guard. (2015b). *National Response Center*. Retrieved November 16, 2015, from http://www.nrc.uscg.mil/FOIAFiles/Current.xlsx

U.S. Department of Agriculture. (2012, November 18). *Table 8. Land: 2012 and 2007*. Retrieved November 18, 2015, from http://www.agcensus.usda.gov/Publications/2012?Full Report/Volume 1, Chapter 1 State Level/SouthCarolina/

U.S. Fire Administration. (2015, June 11). *National Fire Department Census*. Retrieved from http://apps.usfa.fema.gov/census-download/main/download

U.S. Harbors. (2015). *U.S. Harbors - South Carolina*. Retrieved Dec 7, 2015, from http://sc.usharbors.com/

U.S. War Department. (1946). *World War II Honor List of Dead and Missing Army and Army Air Forces Personnel from South Carolina.* Retrieved January 27, 2016, from https://www.archives.gov/research/military/ww2/army-casualties/south-carolina.html

University of Minnesota. (2001). *Soils and Landscapes of Minnesota*. Retrieved July 2015, from http://www.extension.umn.edu/agriculture/tillage/soils-and-landscapes-of-minnesota/

University of South Carolina. (2013). *College of Arts and Sciences*. Retrieved November 2015, from South Carolina Institute of Archaeology and Anthropology: http://artsandsciences.sc.edu/south-carolina-institute-archaeology-and-anthropology

University of Virginia Weldon Cooper Center. (2015). *University of Virginia Weldon Cooper Center for Public Service, National Population Projections, 2020-2040.* Projections for the 50 States and D.C., one-click download of all files, file USProjections_2020to2040_all_data_udpated_noshapefile.zip. Retrieved March 2015, from http://www.coopercenter.org/demographics/national-population-projections

USACE. (1997, July 1). *Planning and Guidance Letter #97-09: Scenic and Aesthetic Considerations.* Retrieved October 15, 2015, from http://planning.usace.army.mil/toolbox/library/MemosandLetters/pgl97-09.pdf

USACE. (2015, August). *Corps Lakes Gateway: South Carolina*. Retrieved November 25, 2015, from http://corpslakes.usace.army.mil/visitors/states.cfm?state=SC

USDA. (2015). *Plant Pests and Diseases*. Retrieved from https://www.aphis.usda.gov/wps/portal/aphis/ourfocus/planthealth?1dmy&urile=wcm%3

apath%3a%2FAPHIS_Content_Library%2FSA_Our_Focus%2FSA_Plant_Health%2FSA_Domestic_Pests_And_Diseases

USDA. (2016a, May 19). *South Carolina*. Retrieved from National Invasive Species Information Center: www.invasivespeciesinfo.gov/unitedstates/sc.html

USDA. (2016b, July 28). *Species Profiles - European Starling*. Retrieved August 5, 2016, from Invasive Species Information Center: https://www.invasivespeciesinfo.gov/animals/eurostarling.shtml

USDOT. (2014). *Bureau of Transportation Statistics*. Retrieved from USDOT: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_atlas_database/2014/polyline

USDOT. (2015a). *National Transportation Atlas Database*. Retrieved July 2015, from Bureau of Transportation Statistics National Transportation Atlas Database: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_atlas_database/index.html

USDOT. (2015b). *National Transportation Atlas Database*. Retrieved 2015 August, from http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_atlas_database/index.html

USDOT. (2015c). *Federal Railroad Administration Horn Noise FAQ*. Retrieved 07 22, 2015, from https://www.fra.dot.gov/Page/P0599

USEPA. (1973, 07 27). *EPA.gov.* Retrieved 08 05, 2015, from National Service Center for Environmental Publications - Impact Characterization of Noise: http://nepis.epa.gov/Exe/ZyNET.exe/9101DPQN.TXT?ZyActionD=ZyDocument&Client=EPA&Index=Prior+to+1976&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&F

USEPA. (1974). *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Washington, D.C.: EPA.

USEPA. (1979, March 19). *Notification to Federal Land Manager Under Section 165(d) of the Clean Air Act.* Retrieved April 21, 2015, from http://www.epa.gov/sites/production/files/2015-07/documents/fdlndmgr.pdf

USEPA. (1992, October 19). *Clarification of Prevention of Significant Deterioration (PSD) Guidance for Modeling Class I Area Impacts, U.S. Environmental Protection Agency.* (J. S. Seitz, Ed.) Retrieved April 21, 2015, from http://www.epa.gov/sites/production/files/2015-07/documents/class1.pdf

USEPA. (1995). *America's wetlands: Our vital link between land and water*. Retrieved April 21, 2015, from U.S. Environmental Protection Agency, EPA843-K-95-001: http://water.epa.gov/type/wetlands/fish.cfm

USEPA. (2004, April 15). *Inventory of U.S. Greenhouse Gas Emissions and Sinks: Glossary*. Retrieved July 16, 2015, from http://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&vocabName=Greenhouse%20Emissions%20Glossary&uid=1869718#formTop

USEPA. (2010, March 24). *Revisions to the General Conformity Regulations*. Retrieved April 20, 2015, from https://www.epa.gov/general-conformity/final-revisions-general-conformity-regulations

USEPA. (2011, December 12). *CERCLA Overview*. Retrieved from EPA Superfund: http://www.epa.gov/superfund/policy/cercla.htm

USEPA. (2012a). *Water: Estuaries and Coastal Watersheds*. Retrieved April 5, 2015, from Basic Information about Estuaries: http://water.epa.gov/type/oceb/nep/about.cfm

USEPA. (2012b, May). *List of 156 Mandatory Class I Federal Areas*. Retrieved April 20, 2015, from Visibility: http://www3.epa.gov/airquality/visibility/class1.html

USEPA. (2012c, July 16). *Noise Pollution*. Retrieved August 4, 2015, from http://www.epa.gov/air/noise.html

USEPA. (2012d). *Climate Change Indicators in the United States 2012.* Retrieved October 2013, from http://www.epa.gov/climatechange/pdfs/climateindicators-full-2012.pdf

USEPA. (2012e). *Marine debris impacts*. Retrieved from http://www.epa.gov/learn-issues/water-resources#our-waters

USEPA. (2013a, August 13). *General Conformity*. Retrieved April 20, 2015, from https://www.epa.gov/general-conformity

USEPA. (2013b). *Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States*. Retrieved from http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm

USEPA. (2013c, February 21). *EPA Terminology Services (TS)*. (U.S. Environmental Protection Agency) Retrieved July 28, 2015, from http://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do

USEPA. (2014a, October 28). *Who Has to Obtain a Title V Permit*. Retrieved April 20, 2015, from https://www.epa.gov/title-v-operating-permits/who-has-obtain-title-v-permit

USEPA. (2014b). *National Greenhouse Gas Emissions Data*. Retrieved 5 5, 2014, from http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

USEPA. (2014c, October 21). *National Ambient Air Quality Standards (NAAQS)*. Retrieved April 20, 2015, from http://www.epa.gov/air/criteria.html

USEPA. (2015a). *Environmental Justice*. Retrieved July 2015, from https://www.epa.gov/environmentaljustice

USEPA. (2015b, January). *Chesapeake Bay Glossary*. Retrieved July 15, 2015, from http://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&glossaryName=Chesapeake%20Bay%20Glossary

USEPA. (2015c). *Watershed Assessment, Tracking & Environmental Results System*. Retrieved November 23, 2015, from http://iaspub.epa.gov/tmdl_waters10/attains_state.control?p_state=SC

USEPA. (2015d). *USEPA Terms Index*. Retrieved from https://iaspub.epa.gov/sor_internet/registry/termreg/

USEPA. (2015e, July). *U.S. Greenhouse Gas Inventory Report 1990-2013*. Retrieved 07 28, 2015, from Greenhouse Gas Emissions: http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html#data

USEPA. (2015f). *EJSCREEN: Environmental Justice Screening and Mapping Tool*. Retrieved July 2015, from http://www2.epa.gov/ejscreen

USEPA. (2015g, July 14). *Air Permit Programs*. Retrieved April 20, 2015, from Air Quality Planning and Standards: http://www3.epa.gov/airquality/permjmp.html

USEPA. (2015h, April 21). *The Green Book Nonattainment Areas for Criteria Pollutants*. Retrieved April 21, 2015, from http://www.epa.gov/airquality/greenbook/

USEPA. (2015i). *Cleanups in my Community.* Retrieved November 13, 2015, from http://www2.epa.gov/cleanups/cleanups-my-community

USEPA. (2015j). *Cleanups in My Community List Results*. Retrieved November 13, 2015, from http://ofmpub.epa.gov/apex/cimc/f?p=102:35:4273763798579:::35:P35_State_code,P35_ADV_QUERY:SC,((SF_EI_GM_CODE=%27N%27))

USEPA. (2015k, March). *2013 TRI Analysis: State - South Carolina*. Retrieved November 13, 2015, from http://iaspub.epa.gov/triexplorer/tri_factsheet.factsheet_forstate?&pstate=SC&pyear=2013

USEPA. (2015l, November 12). *Envirofacts - PCS-ICIS*. Retrieved November 13, 2015, from http://www3.epa.gov/enviro/facts/pcs-icis/search.html

USEPA. (2015m, October 21). *Envirofacts Search Results*. Retrieved November 13, 2015, from http://www3.epa.gov/enviro/facts/multisystem.html

USEPA. (2015n, June). *U.S. Greenhouse Gas Emissions*. Retrieved September 22, 2015, from http://www3.epa.gov/climatechange/science/indicators/ghg/us-ghg-emissions.html

USEPA. (2015o, October 8). *Emissions & Generation Resource Integrated Database (eGRID) Summary Table 1*. Retrieved March 10, 2016, from http://www.epa.gov/energy/egrid-2012-summary-tables

USEPA. (2015p, July 17). *Technology Transfer Network - Basic Information*. Retrieved July 17, 2015, from http://cfpub.epa.gov/oarweb/mkb/basic_information.cfm

USEPA. (2015q, January 30). *Designations*. Retrieved April 20, 2015, from http://www.epa.gov/airquality/greenbook/define.html

USEPA. (2015r, November 10). *EPA Superfund Program: SAVANNAH RIVER SITE (USDOE), AIKEN, SC*. Retrieved November 16, 2015, from Superfund Program: http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0403485

USEPA. (2016a, February 21). *Ecoregions of North America*. Retrieved from Western Ecology Division: https://archive.epa.gov/wed/ecoregions/web/html/na_eco.html

USEPA. (2016b, March). *Grants and Programs*. Retrieved July 2015, from http://www3.epa.gov/environmentaljustice/grants/index.html

USEPA. (2016c, May 18). *Hazardous Air Pollutants*. Retrieved May 25, 2016, from https://www.epa.gov/haps

USEPA. (2016d, May 29). *Glossary of Climate Change Terms*. Retrieved from https://www3.epa.gov/climatechange/glossary.html

USEPA. (2016e). *Environmental Justice*. Retrieved March 2016, from http://www3.epa.gov/environmentaljustice/

USEPA. (2016f, May 28). *Waste and Cleanup Risk Assessment Glossary*. Retrieved from Vocabulary Catalog: https://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&glossaryName=Waste%20and%20Cleanup%20Risk%20Assess

USEPA. (2016g, May 19). *De Minimis Levels*. Retrieved from https://www3.epa.gov/airquality/genconform/deminimis.html

USFS. (2009a, Sept 30). *Chapter 90 Communications Site Management.* Retrieved Nov 16, 2015, from Forest Service Handbook 2709.11 - Special Uses Handbook: http://www.fs.fed.us/specialuses/documents/Comm_Use_Policy_2709.11_90.doc

USFS. (2009b). *Soil-Disturbance Field Guide*. Retrieved September 2015, from http://www.fs.fed.us/t-d/pubs/pdf/08191815.pdf

USFS. (2014, April 29). *Research and Development*. Retrieved August 5, 2016, from European Starling: http://www.fs.fed.us/research/invasive-species/terrestrial-animals/european-starling.php

USFS. (2015a). *Chattooga Wild and Scenic River*. Retrieved November 2015, from http://www.fs.usda.gov/recarea/scnfs/recreation/wateractivities/recarea/?recid=47159&actid=79

USFS. (2015b). *Francis Marion and Sumter National Forests*. Retrieved November 2015, from http://www.fs.usda.gov/main/scnfs/home

USFS. (2015c). *Francis Marion and Sumter National Forests: About the Forest*. Retrieved November 25, 2015, from http://www.fs.usda.gov/main/scnfs/about-forest

USFS. (2015d). *Savannah River*. Retrieved November 25, 2015, from http://www.fs.usda.gov/main/savannahriver/home

USFS. (2015e, Nov 9). *Invasive Species*. Retrieved Dec 4, 2015, from http://www.nrs.fs.fed.us/disturbance/invasive_species/

USFS. (2015f). *Ecoregions of the United States*. Retrieved from http://www.fs.fed.us/rm/ecoregions/products/map-ecoregions-united-states/

USFS. (2016). *Lichens Glossary*. Retrieved from Lichens: http://www.fs.fed.us/wildflowers/beauty/lichens/glossary.shtml

USFWS. (1984). *Recovery plan for persistent trillium.* Retrieved from http://ecos.fws.gov/docs/recovery_plan/840327.pdf

USFWS. (1985). *Recovery plan Kirtland's warbler.* Retrieved from http://ecos.fws.gov/docs/recovery_plan/850930.pdf

USFWS. (1991a). *Recovery plan for relict trillium.* Retrieved from http://ecos.fws.gov/docs/recovery_plan/910131b.pdf

USFWS. (1991b, September 26). *Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Plant Sisyrinchium dochotomum (White irisette).* Retrieved May 2016, from https://ecos.fws.gov/docs/federal_register/fr1928.pdf

USFWS. (1992). *Small whorled pogonia recovery plan.* Retrieved from http://ecos.fws.gov/docs/recovery_plan/921113b.pdf

USFWS. (1993a). *Recovery plan for three granite outcrop species (black spored quillwort, mat-forming quillwort, and ampianthus).* Retrieved from http://ecos.fws.gov/docs/recovery_plan/930707.pdf

USFWS. (1993b). *Recovery plan for pondberry.* Retrieved from http://ecos.fws.gov/docs/recovery_plan/930923a.pdf

USFWS. (1993c, July 7). *Recovery Plan, Three Granite Outcrop Plants.* Retrieved from U.S. Fish and Wildlife Service: https://www.fws.gov/ecos/ajax/docs/recovery_plan/930707.pdf

USFWS. (1995). *Recovery Plan for White Irisette (Sisyrinchium dichotomum) Bicknell.* Retrieved May 2016, from White Irisette (Sisyrinchium dichotomum): http://ecos.fws.gov/docs/recovery_plan/950410.pdf

USFWS. (1996). *Piping plover Atlantic Coast population recovery plan.* Retrieved from http://ecos.fws.gov/docs/recovery_plan/960502.pdf

USFWS. (1997). *Recovery plan for wood stork.* Retrieved from http://www.fws.gov/northflorida/WoodStorks/Documents/19970127_rpp_Wood-stork-recovery-plan-1997.pdf

USFWS. (1999, September 2). *The Flatwoods Salamander: General Background.* Retrieved from U.S. Fish and Wildlife Service: https://www.fws.gov/panamacity/resources/sallie%20guidelines.pdf

USFWS. (2001a). *Recovery plan for Florida manatee*. Retrieved from http://www.fws.gov/northflorida/Manatee/Recovery%20Plan/manatee-recovery-plan.htm

USFWS. (2001b). *Piping plover fact sheet*. Retrieved from http://www.fws.gov/midwest/endangered/pipingplover/pipingpl.html

USFWS. (2002). *Critical Habitat for the Carolina entire heelsplitter.* Retrieved from http://ecos.fws.gov/docs/federal_register/fr4080.pdf

USFWS. (2003). *Recovery plan for the red-cockaded woodpecker (Picoides borealis).* Retrieved from http://ecos.fws.gov/docs/recovery_plan/030320_2.pdf

USFWS. (2005). *Red knot fact sheet.* Retrieved from http://www.fws.gov/northeast/redknot/pdf/Redknot_BWfactsheet092013.pdf

USFWS. (2008a). *Loggerhead sea turtle recovery plan for northwest Atlantic Ocean population.* Retrieved from http://ecos.fws.gov/docs/recovery_plan/090116.pdf

USFWS. (2008b). *Small Whorled Pogonia-(Isotria medeoloides).* Retrieved from Small Whorled Pogonia-(Isotria medeoloides): http://www.fws.gov/midwest/endangered/plants/pdf/smallwhorledpogoniafctsht.pdf

USFWS. (2009). *Final rule on flatwoods salamanders*. Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1

USFWS. (2011a). *Canby's dropwort (Oxypolis canbyi) summary*. Retrieved from http://www.fws.gov/raleigh/species/es_canbys_dropwort.html

USFWS. (2011b). *Dwarf-flowered heartleaf species profile*. Retrieved from http://www.fws.gov/raleigh/species/es_dwarf-flowered_heartleaf.html

USFWS. (2011c). *Rock gnome lichen summary*. Retrieved from http://www.fws.gov/raleigh/species/es_rock_gnome_lichen.html

USFWS. (2011d). *Rough-leaved loosestrife summary*. Retrieved from http://www.fws.gov/raleigh/species/es_rough-leaf_loosestrife.html

USFWS. (2011e). *Schweinitz's sunflower species summary*. Retrieved from http://www.fws.gov/raleigh/species/es_schweinitz_sunflower.html

USFWS. (2011f). *Species summary for seabeach amaranth*. Retrieved from http://www.fws.gov/raleigh/species/es_seabeach_amaranth.html

USFWS. (2011g, December). *Bunched Arrowhead fact sheet*. Retrieved from https://www.fws.gov/asheville/pdfs/BunchedArrowhead_factsheet.pdf

USFWS. (2011h, November). *White irisette (Sisyrinchium dichotomum) fact sheet.* Retrieved from https://www.fws.gov/asheville/htmls/listed_species/White_irisette.html

USFWS. (2012). *Rayed bean freshwater mussel (Villosa fabalis).* Retrieved from http://www.fws.gov/midwest/endangered/clams/rayedbean/pdf/RayedBeanFactSheet.pdf

USFWS. (2013). *Birds protected by the Migratory Bird Treaty Act*. Retrieved from http://www.fws.gov/migratorybirds/regulationspolicies/mbta/mbtintro.html

USFWS. (2014a). *National Wetlands Inventory website*. Retrieved May 15, 2015, from http://www.fws.gov/wetlands/

USFWS. (2014b). *Rufa red knot background information and threats assessment.* Retrieved from http://www.fws.gov/northeast/redknot/pdf/20141125_REKN_FL_supplemental_doc_FINAL.pdf

USFWS. (2014c). *American chaffseed (Schwalbea americana).* Retrieved from http://www.fws.gov/northeast/njfieldoffice/Endangered/chaffseed.html

USFWS. (2015a, January 26). *Wetlands Mapper Legend Categories*. Retrieved April 20, 2015, from National Wetland Inventory: http://www.fws.gov/wetlands/Data/Mapper-Wetlands-Legend.html

USFWS. (2015aa). *Species profile for frosted flatwoods salamander (Ambystoma cingulatum).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=D013

USFWS. (2015ab). *Species profile for American chaffseed*. Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q2I4

USFWS. (2015ac). *Species profile for bunched arrowhead (Sagittaria fasciculata).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q219

USFWS. (2015ad). *Species profile for black spored quillwort (Isoetes melanospora).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=S015

USFWS. (2015ae). *Species profile for Canby's dropwort (Oxypolis canbyi).* Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=Q2EL

USFWS. (2015af). *Harperella (Ptilimnium nodosum).* Retrieved from http://www.fws.gov/raleigh/species/es_harperella.html

USFWS. (2015ag). *Species profile for harperella (Ptilimnium nodosum).* Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2H9

USFWS. (2015ah). *Species profile for little amphianthus (Amphianthus pusillus).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q1ST

USFWS. (2015ai). *Michaux's sumac (Rhus michauxii).* Retrieved from http://www.fws.gov/raleigh/species/es_michauxs_sumac.html

USFWS. (2015aj). *Species profile for persistent trillium (Trillium persistens).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q23D

USFWS. (2015ak). *Species Profile for pondberry (Lindera melissifolia).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q2CO

USFWS. (2015al). *Species profile for relict trillium (Trillium reliquum).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q2RG

USFWS. (2015am). *Species profile for rock gnome lichen (Gymnoderma lineare).* Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=U001

USFWS. (2015an, November 13). *More About Cape Romain*. Retrieved November 25, 2015, from http://www.fws.gov/refuge/Cape_Romain/about/more_about_cape_romain_NWR.html

USFWS. (2015ao). *Species Profile for Schweinitz's sunflower*. Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q2B7

USFWS. (2015ap). *Species profile for seabeach amaranth (Amaranthus pumilus).* Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2MZ

USFWS. (2015aq). *Species profile for small whorled pogonia (Isotria medeoloides).* Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q1XL

USFWS. (2015ar). *Smooth coneflower (Echinacea laevigata).* Retrieved from http://www.fws.gov/raleigh/species/es_smooth_coneflower.html

USFWS. (2015as, August 6). *Pondberry (Lindera melissifolia)*. Retrieved from Raleigh Ecological Services Field Office: https://www.fws.gov/raleigh/species/es_pondberry.html

USFWS. (2015at). *Swamp Pink fact sheet.* Retrieved from Swamp Pink fact sheet: http://www.fws.gov/northeast/pdf/swamppin.pdf

USFWS. (2015au, November 15). *Cape Romain National Wildlife Refuge*. Retrieved November 25, 2015, from http://www.fws.gov/refuge/cape_romain/

USFWS. (2015av). *White Irisetts (Sisyrinchium dichotomum)*. Retrieved May 2016, from Asheville Ecological Services Field Office: http://www.fws.gov/asheville/htmls/listed_species/White_irisette.html

USFWS. (2015aw). *South Carolina Lowcountry Refuges Complex*. Retrieved November 2015, from http://www.fws.gov/nwrs/threecolumn.aspx?id=2147527947#

USFWS. (2015ax, April). *National Wildlife Refuge System*. Retrieved April 17, 2015, from http://www.fws.gov/refuges/

USFWS. (2015ay). *Refuge List by State: South Carolina*. Retrieved November 25, 2015, from http://www.fws.gov/refuges/profiles/ByState.cfm?state=SC

USFWS. (2015b, January 26). *Data Limitations, Exclusions and Precautions*. Retrieved May 11, 2015, from http://www.fws.gov/wetlands/Data/Limitations.html

USFWS. (2015c). *Listed species believed to or known to occur in South Carolina*. Retrieved from http://ecos.fws.gov/tess_public/reports/species-listed-by-state-report?state=SC&status=listed

USFWS. (2015d). *Northern long-eared bat fact sheet*. Retrieved from http://www.fws.gov/midwest/endangered/mammals/nleb/nlebFactSheet.html

USFWS. (2015e). *Species profile for northern long-eared bat*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A0JE

USFWS. (2015f). *The Red Wolves at Sewee*. Retrieved May 2016, from Sewee Center: http://www.fws.gov/refuge/sewee_center/wildlife_and_habitat/red_wolves/

USFWS. (2015g). *Species profile for West Indian manatee (Trichechus manatus)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=A007

USFWS. (2015h, July 20). *Red-Cockaded Woodpeckers Thrive on Carolina Sandhills Refuge*. Retrieved from National Wildlife Refuge System: https://www.fws.gov/refuges/news/RedCockadedWoodpeckersThrive.html

USFWS. (2015i). *Hawksbill sea turtle fact sheet*. Retrieved from http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/hawksbill-sea-turtle.htm

USFWS. (2015j). *Species profile for hawksbill sea turtle (Eretmochelys imbricata)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C00E

USFWS. (2015k). *Kemp's ridley sea turtle fact sheet*. Retrieved from http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/kemps-ridley-sea-turtle.htm

USFWS. (2015l). *Species profile for Kemp's ridley sea turtle (Lepidochelys kempii)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C00O

USFWS. (2015m). *Leatherback sea turtle fact sheet.* Retrieved from http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/PDF/Leatherback-Sea-Turtle.pdf

USFWS. (2015n). *Species profile for leatherback sea turtle (Dermochelys coriacea)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C00F

USFWS. (2015o). *Loggerhead sea turtle fact sheet.* Retrieved from http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/PDF/Loggerhead-Sea-Turtle.pdf

USFWS. (2015p). *Species profile for loggerhead sea turtle (Caretta caretta)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C00U

USFWS. (2015q). *Species profile for Bachman's warbler (Vermivora bachmanii)*. Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=B03G

USFWS. (2015r). *5-year review for Bachman's warbler.* Retrieved from http://ecos.fws.gov/docs/five_year_review/doc4548.pdf

USFWS. (2015s). *Species profile for Kirtland's warbler (Setophaga kirtlandii)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=B03I

USFWS. (2015t). *U.S. FWS Georgia - Critical Habitat Portal.* Retrieved from https://ecos-beta.fws.gov/ecp0/profile/speciesProfile?spcode=B079#crithab

USFWS. (2015u). *Piping plover (Charadrius melodus).* Retrieved from http://www.fws.gov/charleston/pdf/PIPL_page.pdf

USFWS. (2015v). *Red-cockaded woodpecker recovery*. Retrieved from http://www.fws.gov/rcwrecovery/rcw.html

USFWS. (2015w). *Species profile for red-cockaded woodpecker (Picoides borealis)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B04F

USFWS. (2015x). *Species profile for red knot (Calidris canutus rufa)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0DM

USFWS. (2015y). *Species profile for wood stork (Mycteria americana)*. Retrieved from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=B06O

USFWS. (2015z). *Species profile for shortnose sturgeon (Acipenser brevirostrum)*. Retrieved from http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E00B

USFWS. (2016a). *Listed species believed or known to occur in South Carolina*. Retrieved from http://ecos.fws.gov/tess_public/reports/species-listed-by-state-totals-report?state=SC&status=listed

USFWS. (2016b). *Red Wolf Recovery Program*. Retrieved May 2016, from http://www.fws.gov/redwolf/

USFWS. (2016c). *Red Wolf Fact Sheet.* Retrieved May 2016, from Red Wolf Recovery Program: http://www.fws.gov/redwolf/Images/RedWolfFacts_final.pdf

USFWS. (2016d). *Species profile for Smooth coneflower*. Retrieved from ECOS: http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q293

USFWS. (2016e). *Red Wolf (Canis rufus)*. Retrieved May 2016, from http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=A00F

USFWS. (2016f). *Green Sea Turtle Fact Sheet*. Retrieved from North Florida Ecological Services Office: https://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/green-sea-turtle.htm

USFWS. (2016g). *Species profile for Michaux's sumac*. Retrieved from ECOS: http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q2HH

USFWS. (2016h). *Species profile for Rough-leaved loosestrife*. Retrieved from ECOS: http://ecos.fws.gov/tess_public/profile/speciesProfile?spcode=Q2DF

USGCRP. (2009). *Global Climate Change Impacts in the United States.* New York: Cambridge University Press. Retrieved 8 10, 2015, from downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf

USGCRP. (2014a). *National Climate Assessment: Southeast and Caribbean*. Retrieved from U.S. Global Change Research Program: http://nca2014.globalchange.gov/report/regions/southeast

USGCRP. (2014b). *U.S. Global Change Research Program: Precipitation Change*. Retrieved from National Climate Assessment: http://nca2014.globalchange.gov/report/our-changing-climate/precipitation-change

USGCRP. (2014c). *National Climate Assessment: Coastal Zone Development and Ecosystems*. Retrieved from U.S. Global Change Research Program: http://nca2014.globalchange.gov/report/regions/coasts#narrative-page-16832

USGCRP. (2014d). *National Climate Assessment: Changes in Storms*. Retrieved July September, 2015, from U.S. Global Change Research Program: http://nca2014.globalchange.gov/report/our-changing-climate/changes-storms

USGCRP. (2014e). *National Climate Assessment - Southeast Region*. Retrieved January 4, 2016, from http://nca2014.globalchange.gov/report/regions/southeast

USGCRP. (2014f). *National Climate Assessment - Coastal Zone Development and Ecosystems*. Retrieved December 31, 2015, from http://nca2014.globalchange.gov/report/regions/coasts#intro-section-2

USGCRP. (2014g). *National Climate Assessment - Extreme Weather*. Retrieved October 6, 2015, from http://nca2014.globalchange.gov/report/our-changing-climate/extreme-weather#intro-section-2

USGS. (1990a). *Groundwater Atlas of the United States -- Alabama, Florida, Georgia, South Carolina*. Retrieved November 2015, from http://pubs.usgs.gov/ha/ha730/ch_g/G-text1.html

USGS. (1990b). *Ground Water Atlas of the United States, HA 730-G*. Retrieved November 23, 2015, from http://pubs.usgs.gov/ha/ha730/ch_g/index.html

USGS. (1999). *How Ground Water Occurs*. Retrieved February 12, 2013, from U.S. Geological Survey General Interest Publication: http://pubs.usgs.gov/gip/gw/how_a.html

USGS. (2000). *Land Subsidence in the United States (Fact Sheet 165-00)*. Retrieved September 2013, from http://water.usgs.gov/ogw/pubs/fs00165/SubsidenceFS.v7.PDF

USGS. (2001). *Elevations and Distances in the United States*. Retrieved November 2015, from http://pubs.usgs.gov/gip/Elevations-Distances/elvadist.html

USGS. (2003a). *A Tapestry of Time and Terrain: The Union of Two Maps, Geology and Topography*. Retrieved September 2013, from http://tapestry.usgs.gov/two/two.html

USGS. (2003b). *National Landslide Hazards Mitigation Strategy – A Framework for Loss Reduction*. Retrieved September 2013, from http://pubs.usgs.gov/circ/c1244/c1244.pdf

USGS. (2008). *Debris-Flow Hazards within the Appalachian Mountains of the Eastern United States*. Retrieved November 2015, from http://pubs.usgs.gov/fs/2008/3070/fs2008-3070.pdf

USGS. (2010). *What is "Peak Acceleration" or "Peak Ground Acceleration" (PGA)?* Retrieved April 2015, from http://geohazards.usgs.gov/deaggint/2002/documentation/parm.php

USGS. (2012a). *Earthquake Glossary - Earthquake*. Retrieved July 2015, from http://earthquake.usgs.gov/learn/glossary/?term=earthquake

USGS. (2012b, November 17). *South Carolina Land Cover*. Retrieved November 18, 2015, from http://landcover.usgs.gov/southcarolina.php

USGS. (2012c). *Earthquake Glossary -- liquefaction*. Retrieved November 2015, from http://earthquake.usgs.gov/learn/glossary/?term=liquefaction

USGS. (2012d, December). *The USGS Land Cover Institute*. Retrieved August 2015, from http://landcover.usgs.gov/classes.php/

USGS. (2013a). *Glossary of Glacier Terminology.* Retrieved August 2015, from http://pubs.usgs.gov/of/2004/1216/text.html#tz

USGS. (2013b). *Land Subsidence from Ground-water Pumping*. Retrieved September 2013, from http://geochange.er.usgs.gov/sw/changes/anthropogenic/subside/

USGS. (2014a). *South Carolina Seismicity Map - 1973 to March 2012.* Retrieved November 2015, from http://earthquake.usgs.gov/earthquakes/states/south_carolina/seismicity.php

USGS. (2014b, November). *Water Resources of the United States*. Retrieved July 2015, from http://www.usgs.gov/water/

USGS. (2014c). *Sedimentary Rocks.* Retrieved July 2015, from http://geomaps.wr.usgs.gov/parks/rxmin/rock2.html

USGS. (2014d). *Rocks.* Retrieved July 2015, from http://geomaps.wr.usgs.gov/parks/rxmin/rock.html

USGS. (2014e). *Measuring the Size of an Earthquake.* Retrieved July 2015, from http://earthquake.usgs.gov/learn/topics/measure.php

USGS. (2014f). *Landslide Overview Map of the Conterminous United States.* Retrieved June 2015, from http://landslides.usgs.gov/hazards/nationalmap/

USGS. (2014g). *Historic Earthquakes -- Charleston, South Carolina*. Retrieved November 2015, from http://earthquake.usgs.gov/earthquakes/states/events/1886_09_01.php

USGS. (2014h). *Historic Earthquakes -- Charleston, South Carolina (Damage Photos).* Retrieved November 2015, from http://earthquake.usgs.gov/earthquakes/states/events/1886_09_01_pics.php

USGS. (2014i, October 15). *National Atlas of the United States*. Retrieved October 15, 2015, from http://nationalmap.gov/small_scale/printable/fedlands.html

USGS. (2015a, September 8). *Geographic Names Information System (GNIS).* Retrieved September 8, 2015, from http://geonames.usgs.gov/apex/f?p=136:1:2933318154716

USGS. (2015b). *Structural Geology.* Retrieved July 2015, from http://www2.usgs.gov/science/science.php?thcode=2&code=1117

USGS. (2015c). *2010-2011 Minerals Yearbook.* Retrieved November 2015, from http://minerals.usgs.gov/minerals/pubs/state/2010_11/myb2-2010_11-sc.pdf

USGS. (2015d). *About U.S. Volcanoes.* Retrieved August 2015, from http://volcanoes.usgs.gov/about/volcanoes/

USGS. (2015e). *Water Science Glossary of Terms.* Retrieved June 2015, from http://water.usgs.gov/edu/dictionary.html#B

USGS. (2015f). *Geologic Glossary*. Retrieved November 2015, from http://geomaps.wr.usgs.gov/parks/misc/glossarya.html

USGS. (2015g). *Geologic Processes*. Retrieved Nov 16, 2015, from http://www.usgs.gov/science/science.php?term=1145

USGS. (2015h). *Paleontology.* Retrieved July 2015, from http://www.usgs.gov/science/science.php?term=861

USGS. (2016a). *Mineral Commodity Summaries.* Reston: USGS. Retrieved from http://minerals.usgs.gov/minerals/pubs/mcs/

USGS. (2016b, February 10). *Explanations for the National Water Conditions*. Retrieved from Water Resources of the United States: http://water.usgs.gov/nwc/explain_data.html

USGS. (2016c). *Tectonic Processes*. Retrieved from http://www.usgs.gov/science/science.php?code=1145&thcode=2

Vereecken, W., Heddeghem, W. V., Deruyck, M., Puype, B., Lannoo, B., & Joseph, W. (2011, July). Power Consumption in Telecommunications Networks: Overview and Reduction Strategies. *IEEE Communications Magazine*, pp. 62-69. Retrieved September 22, 2015, from http://www.researchgate.net/publication/228774201

Vinelli, R. (2000). *Charadrius melodus, piping plover*. Retrieved from Animal Diversity Web: http://animaldiversity.org/accounts/Charadrius_melodus/

Waters, K. (2003). *Ground-water Levels in South Carolina -- A Compilation of Historical Water-Level Data.* Retrieved November 2015, from http://www.dnr.sc.gov/water/admin/pubs/pdfs/IntroReport26.pdf

White-Perry, G. (2010). In Freedom's Shadow: The Reconstruction Legacy of Renty Franklin Greaves of Beaufort County, South Carolina. *Prologue Magazine, 42*(3). Retrieved January 27, 2016, from http://www.archives.gov/publications/prologue/2010/fall/greaves.html

Wilderness.net. (2015a). *Wilderness Data Search Results*. Retrieved September 27, 2015, from http://www.wilderness.net/NWPS/stateView?state=WI

Wilderness.net. (2015b). *The Wilderness Act of 1964*. Retrieved September 17, 2015, from http://www.wilderness.net/nwps/legisact

Wilderness.net. (2015c). *List Wilderness Areas by Location: South Carolina*. Retrieved November 25, 2015, from http://www.wilderness.net/NWPS/stateView?state=SC

World Wildlife Fund. (2015). *What is an ecoregion*. Retrieved from http://wwf.panda.org/about_our_earth/ecoregions/about/what_is_an_ecoregion/

Yarrow, G. (2009). *Wetland Ecology: Value and Conservation*. Retrieved November 2015, from http://www.clemson.edu/extension/natural_resources/wildlife/publications/fs32_wetland_ecology.html

GIS REFERENCES

BIA. (2003, December). Cultural Resources: Approximate Historic Boundaries of Tribes. (GIS Metadata) Retrieved August 2015, from http://sagemap.wr.usgs.gov/ftp/regional/ind3.html and http://www.arcgis.com/home/item.html?id=2e915ef3df48422283e5b2c7d89dfcba

BLS. (2015). Socioeconomics: Unemployment. (GIS Metadata) Retrieved August 2015, from Local Area Unemployment Statistics, Employment status of the civilian noninstitutional population, 1976 to 2014 annual averages. State Data, Annual Average Series, Employment status of the civilian noninstitutional population, annual averages.: http://www.bls.gov/lau/rdscnp16.htm

Digital Aeronautical Flight Information File. (2015, June). Land Use, Recreation, and Airspace: MTR Airspace. (GIS Metadata) Retrieved June 2015, from National Geospatial-Intelligence Agency: https://pki.geo.nga.mil/servlet/ShowHomepage?menu=Products and Services

Digital Aeronautical Flight Information File. (2015, June). Land Use, Recreation, and Airspace: SUA Airspace. (GIS Metadata) Retrieved June 2015, from National Geospatial-Intelligence Agency: https://pki.geo.nga.mil/servlet/ShowHomepage?menu=Products and Services

Environmental Systems Research Institute (ESRI). (2016). All Maps. (GIS Metadata) Retrieved August 2015, from http://www.arcgis.com/home/group.html?owner=esri&title=ESRI%20Data%20%26%20Maps&content=all&_ga=1.174384612.712313298.1421186728&q=rivers&t=group&start=1

FAA. (2015, June). Infrastructure: Transportation. (GIS Metadata) Retrieved June 2015, from Airport hubs data. Data is updated every 8 weeks. Data downloaded by state: http://www.faa.gov/airports/airport_safety/airportdata_5010/

FAA. (2015, June). Land Use, Recreation, and Airspace: Composite Airspace. (GIS Metadata) Retrieved June 2015, from Data is updated every 8 weeks: http://www.faa.gov/airports/airport_safety/airportdata_5010/

FAA. (2015, June). Land Use, Recreation, and Airspace: Private Airspace. (GIS Metadata) Retrieved June 2015, from Data is updated every 8 weeks. : http://www.faa.gov/airports/airport_safety/airportdata_5010/

FAA. (2015, June). Land Use, Recreation, and Airspace: Public Airspace. (GIS Metadata) Retrieved June 2015, from Data is updated every 8 weeks.: http://www.faa.gov/airports/airport_safety/airportdata_5010/

FCC. (2014, June). Infrastructure: FCC Towers. (GIS Metadata) Retrieved August 2015, from Data was obtained through a more advanced search by BAH being in direct touch with Cavell, Mertz & Associates to obtain ALL the relevant data across the country.: http://wireless2.fcc.gov/UlsApp/AsrSearch/asrAdvancedSearch.jsp

FCC. (2014, June). Infrastructure: FCC Wireless. (GIS Metadata) Retrieved August 2015, from David F. LaBranche, P.E. Geospatial Information Officer (GIO) OASD (EI&E) 571-372-6768 at Defense Installations Spatial Data Infrastructure (DISDI).: http://www.broadbandmap.gov/data-download

FCC. (2015). Infrastructure: FCC Fiber. (GIS Metadata) Retrieved August 2015, from http://www.broadbandmap.gov/data-download

FHWA. (2015, September 14). Infrastructure: Transportation. (GIS Metadata) Retrieved September 14, 2015, from Byways and National Scenic Trails; Gary A. Jensen; Research Implementation Team Leader; FHWA; 1200 New Jersey Ave, SE Room E76-304: http://www.fhwa.dot.gov/byways/ https://www.nps.gov/ncrc/programs/nts/nts_trails.html

FHWA. (2015, August). Visual Resources: Natural Areas. (GIS Metadata) Retrieved August 2015, from National Scenic Byways Program. Data obtained by Gary A. Jensen, Research Implementation Team Leader, Office of Human Environment HEPH-30, Federal Highway Administration, 1200 New Jersey Avenue, SE Room E76-304, Washington, DC 20590, 202-366-2048, gary.je: http://www.fhwa.dot.gov/byways/

National Atlas and Interagency Wild and Scenic Rivers Coordinating Council. (2009). Visual Resources: Natural Areas. (GIS Metadata) Retrieved September 2015, from NPS: https://www.rivers.gov/mapping-gis.php

National Atlas and Interagency Wild and Scenic Rivers Coordinating Council. (2009). Water Resources: Surface Water / Watershed. (GIS Metadata) Retrieved September 2015, from National Wild and Scenic Rivers Program, NPS, Department of Interior: https://www.rivers.gov/mapping-gis.php

National Audubon Society. (2015). Biological Resources: Important Bird Areas. (GIS Metadata) Retrieved September 2015, from Web service, data is not saved locally:

http://gis.audubon.org/arcgisweb/rest/services/NAS/ImportantBirdAreas_Poly/MapServer

National Heritage Areas Program Office. (2011, April). Cultural Resources: National Heritage. (GIS Metadata) Retrieved September 2015, from Department of Interior, NPS, National Heritage Areas Program Office: https://www.nps.gov/heritageareas/

National Heritage Areas Program Office. (2011). Visual Resources: Representative Sample of Some Historic and Cultural Resources that May be Visually Sensitive. (GIS Metadata) Retrieved August 2015, from Department of Interior, National Parks Service, National Heritage Areas Program Office: https://www.nps.gov/heritageareas/

Native Languages of the Americas. (2015). Cultural Resources: Approximate Historic Boundaries of Tribes. (GIS Metadata) Retrieved August 2015, from http://www.native-languages.org/states.htm

NERR. (2012). Water Resources: Estuaries and Critical Resource Waters. (GIS Metadata) Retrieved August 2015, from NOAA, Office of Coastal Management, National Estuarine Research Reserve System (NERRS): http://cdmo.baruch.sc.edu/get/gis.cfm

NPS. (2011). Air Quality: Class 1 Areas. (GIS Metadata) Retrieved August 2015, from http://science.nature.nps.gov/im/gis/index.cfm

NPS. (2015). Land Use, Recreation, and Airspace: Recreation. (GIS Metadata) Retrieved September 2015, from United States Park, NPS, Department of Interior: http://www.arcgis.com/home/item.html?id=578968f975774d3fab79fe56c8c90941

NPS. (2015, August). Visual Resources: Cultural Heritage. (GIS Metadata) Retrieved September 2015, from United States Park, NPS, Department of Interior [US Parks]: http://www.arcgis.com/home/item.html?id=578968f975774d3fab79fe56c8c90941

NPS. (2015, August). Visual Resources: Cultural Heritage. (GIS Metadata) Retrieved September 2015, from United States Park, NPS, Department of Interior [National Monuments and Icons]: http://mapservices.nps.gov/arcgis/rest/services/cultural_resources/nhl_public/MapServer

NPS. (2015, August). Visual Resources: Natural Areas. (GIS Metadata) Retrieved September 2015, from United States Park, National Parks Service, Department of Interior [National Scenic and Historic trails]: https://www.nps.gov/ncrc/programs/nts/nts_trails.html

NPS. (2015, August). Visual Resources: Natural Areas. (GIS Metadata) Retrieved September 2015, from United States Park, NPS, Department of Interior [US Parks]: http://www.arcgis.com/home/item.html?id=578968f975774d3fab79fe56c8c90941

NRCS. (2006). Soils: Soil Suborders. (GIS Metadata) Retrieved April 2015, from Downloaded by state-level: https://gdg.sc.egov.usda.gov/

NRHP. (2015). Cultural Resources: National Heritage. (GIS Metadata) Retrieved August 2015, from Stutts M. 2014. NRHP. National Register properties are located throughout the U.S. and their associated territories around the globe.: https://irma.nps.gov/DataStore/Reference/Profile/2210280

U.S. Census Bureau. (2015c). Environmental Justice. (GIS Metadata) Retrieved July 2915, from U.S. Environmental Protection Agency. "EJSCREEN Environmental Justice Mapping and Screening Tool: EJSCREEN Technical Documentation.": http://www2.epa.gov/ejscreen/technical-documentation-ejscreen

U.S. Census Bureau. (2015f, April). Socioeconomics: Population Distribution. (GIS Metadata) Retrieved August 2015, from American Community Survey and Puerto Rico Community Survey 2013 Subject Definitions. 2013_ACSSubjectDefinitions:

http://www2.census.gov/programs-surveys/acs/tech_docs/subject_definitions/2013_ACSSubjectDefinitions.pdf

U.S. Census Bureau. (2015j). Socioeconomics: Median Household Income. (GIS Metadata) Retrieved August 2015, from American Community Survey, 2009-2013 5-Year Summary File, Table B02001, Race. Obtained via Census Bureau online DataFerrett tool.: http://www.census.gov/geo/maps-data/data/tiger-data.html

U.S. Census Bureau. (Undated(a)). Environmental Justice. (GIS Metadata) Retrieved August 2015, from "2010 Census Urban and Rural Classification and Urban Area Criteria." Lists of 2010 Census Urban Areas: A national, state-sorted list of all 2010 urbanized areas and urban clusters for the U.S., Puerto Rico, and Island Areas: http://www.census.gov/geo/maps-data/data/tiger-data.html

U.S. Census Bureau. (Undated(a)). Socioeconomics: Median Household Income. (GIS Metadata) Retrieved August 2015, from "2010 Census Urban and Rural Classification and Urban Area Criteria." Lists of 2010 Census Urban Areas: A national, state-sorted list of all 2010 urbanized areas and urban clusters for the U.S., Puerto Rico, and Island Areas: http://www.census.gov/geo/maps-data/data/tiger-data.html

U.S. Census Bureau. (Undated(a)). Socioeconomics: Population Distribution. (GIS Metadata) Retrieved August 2015, from "2010 Census Urban and Rural Classification and Urban Area Criteria." Lists of 2010 Census Urban Areas: A national, state-sorted list of all 2010 urbanized areas and urban clusters for the U.S. first sorted by state FIPS code, then USACE code.: http://www.census.gov/geo/maps-data/data/tiger-data.html

U.S. Census Bureau. (Undated(a)). Socioeconomics: Unemployment. (GIS Metadata) Retrieved August 2015, from "2010 Census Urban and Rural Classification and Urban Area Criteria." Lists of 2010 Census Urban Areas: A national, state-sorted list of all 2010 urbanized areas and urban clusters for the U.S. first sorted by state FIPS code then by USACE code.: http://www.census.gov/geo/maps-data/data/tiger-data.html

U.S. DOT Bureau of Transportation Statistics National Transportation Atlas Database. (2015). Infrastructure: Transportation. (GIS Metadata) Retrieved August 2015, from Railroads, Major Highways data: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_atlas_database/2015/polyline

United States National Atlas. (2014). Land Use, Recreation, and Airspace: Recreation. (GIS Metadata) Retrieved September 2015, from http://nationalmap.gov/small_scale/

United States National Atlas. (2014). Visual Resources: Natural Areas. (GIS Metadata) Retrieved September 2015, from http://nationalmap.gov/small_scale/

USACE. (2015, March 17). Infrastructure: Transportation. (GIS Metadata) Retrieved August 2015, from Port Data. Has since been updated: http://www.navigationdatacenter.us/gis/gis1.htm

USEPA. (2013). Biological Resources: Ecoregions. (GIS Metadata) Retrieved August 2015, from Level III and IV ecoregions of the continental United States. National Health and Environmental Effects Research Laboratory, Corvallis, Oregon, Map scale 1:3,000,000: http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm

USEPA. (2014). Water Resources: Impaired Water. (GIS Metadata) Retrieved August 2015, from https://www.epa.gov/waterdata/waters-geospatial-data-downloads

USEPA. (2015). Human Health and Safety: TRI. (GIS Metadata) Retrieved September 2015, from Web service, data is not saved locally: https://map11.epa.gov/arcgis/rest/services/NEPAssist/NEPAVELayersPublic

USEPA. (2015b, April 21). Air Quality: Nonattainment Areas. (GIS Metadata) Retrieved August 2015, from The Green Book Nonattainment Areas for Criteria Pollutants: https://www3.epa.gov/airquality/greenbook/gis_download.html

USFWS. (2014). Wetlands. (GIS Metadata) Retrieved August 2015, from State level data layer: https://www.fws.gov/wetlands/Data/Data-Download.html

USFWS. (2015). Biological Resources: Critical Habitat. (GIS Metadata) Retrieved September 2015, from https://www.fws.gov/gis/data/national/

USFWS. (2015, December 4). Land Use, Recreation, and Airspace: Recreation. (GIS Metadata) Retrieved September 2015, from National Wildlife Refuge Boundaries: http://www.arcgis.com/home/item.html?id=7b90f9c5e8044d189a5764758ce3775e

USFWS. (2015, December 14). Visual Resources: Natural Areas. (GIS Metadata) Retrieved September 2015, from USFWS National Wildlife Refuge System, Realty Division: http://www.arcgis.com/home/item.html?id=7b90f9c5e8044d189a5764758ce3775e

USGS. (1999 to 2001). Visual Resources: Land Cover. (GIS Metadata) Retrieved August 2015, from USGS GAP Analysis Land Cover, National Land Cover Dataset; Landsat 7 ETM+; Imagery provided for Spring, Summer and Fall dates between 1999 and 2001: http://gapanalysis.usgs.gov/gaplandcover/data/download/

USGS. (2003, October). Water Resources: Groundwater. (GIS Metadata) Retrieved August 2015, from http://water.usgs.gov/ogw/aquifer/map.html

USGS. (2012). Cultural Resources: Physiographic Provinces. (GIS Metadata) Retrieved April 2015, from Physiographic provinces and regions are made from the same dataset; downloaded by state-level: http://services.arcgis.com/ZzrwjTRez6FJiOq4/arcgis/rest/services/US_PhysiographicProvinces/FeatureServer

USGS. (2012). Geology: Landslide Incidence. (GIS Metadata) Retrieved May 2015, from Web service, data is not saved locally: https://www.arcgis.com/home/item.html?id=b3fa4e3c494040b491485dbb7d038c8a

USGS. (2013). Geology: Karst Subsidence. (GIS Metadata) Retrieved May 2015, from Two data layers within the same source show different varieties of Karst, and were published on different dates: http://services.arcgis.com/hoKRg7d6zCP8hwp2/arcgis/rest/services/Appalachian_Karst_Features/FeatureServer

USGS. (2014). Geology: Seismic Hazard. (GIS Metadata) Retrieved April 2015, from http://services.arcgis.com/VTyQ9soqVukalItT/arcgis/rest/services/USPGA_Seismic_Hazard/FeatureServer

USGS, Protected Areas of the United States. (2012, 11 30). Land Use, Recreation, and Airspace: Land Ownership. (GIS Metadata) Retrieved August 2015, from Data was updated in 5/5/2016. Maps were completed in December 2015 prior to this update: http://gapanalysis.usgs.gov/padus/data/download/

USGS, Protected Areas of the United States. (2012, November 30). Land Use, Recreation, and Airspace: Recreation. (GIS Metadata) Retrieved September 2015, from Data was updated in 5/5/2016. Maps were completed in December 2015 prior to this update.: http://gapanalysis.usgs.gov/padus/data/download/

USGS, Protected Areas of the United States. (2012, November 30). Visual Resources: Cultural Heritage. (GIS Metadata) Retrieved September 2015, from Data was updated in 5/5/2016. Maps were completed in December 2015 prior to this update.: http://gapanalysis.usgs.gov/padus/data/download/

USGS, Protected Areas of the United States. (2012, November 30). Visual Resources: Natural Areas. (GIS Metadata) Retrieved September 2015, from Data was updated in 5/5/2016. Maps were completed in December 2015 prior to this update. : http://gapanalysis.usgs.gov/padus/data/download/

USGS-NRCS STATSGO2. (2006). Geology: Surface Geology. Retrieved June 2015, from STATSGO2 Database: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

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